From VM Fri Jun 14 12:52:14 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["144" "Fri" "14" "June" "1996" "16:50:27" "+0100" "Robert Laing" "rl@ast.cam.ac.uk" nil "5" "3C 31 proposal"
"^From:" nil nil "6" nil nil nil nil]
nil)
Content-Length: 144
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA26543; Fri, 14 Jun 1996 11:54:22 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.7.5/8.7.1/CV-2.1) with SMTP
id LAA21053 for <abridle@polaris.cv.nrao.edu>; Fri, 14 Jun 1996 11:54:19 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id QAA16054; Fri, 14 Jun 1996 16:50:29 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id QAA13844; Fri, 14 Jun 1996 16:50:28 +0100
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.93.960614164909.13841A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
X-UIDL: 834770586.004
Status: RO
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: 3C 31 proposal
Date: Fri, 14 Jun 1996 16:50:27 +0100 (BST)

Thanks - looks good to me. I came back to a relatively small heap of
post, so I shall start on the optimization code today.

Cheers, Robert

From VM Wed Jun 19 15:55:16 1996
X-VM-v5-Data: ([nil nil nil t t nil nil nil nil]
["1079" "Mon" "17" "June" "1996" "19:57:52" "+0100" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.93.960617194056.18007A-100000@rgosf>" "30" "Optimization strategy" "^From:" nil nil "6" nil nil nil nil]
nil)
Content-Length: 1079
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA20026; Mon, 17 Jun 1996 15:01:46 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.7.5/8.7.1/CV-2.1) with SMTP
id PAA08047 for <abridle@polaris.cv.nrao.edu>; Mon, 17 Jun 1996 15:01:45 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id TAA09320; Mon, 17 Jun 1996 19:57:55 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id TAA18024; Mon, 17 Jun 1996 19:57:54 +0100
X-Sender: rl@rgosf
Reply-To: Robert Laing <rl@ast.cam.ac.uk>
Message-Id: <Pine.GSO.3.93.960617194056.18007A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: Optimization strategy
Date: Mon, 17 Ju9 1996 19:57:52 +0100 (BST)

Dear Alan

I have now restructured the code so that the model-making part is a
separate subroutine, which makes it much easier to use it in the 3 main
programs we need:
- map2d (makes images of a given model)
- angle (makes images of a model for various angles to the l of s)
- optimize (compares models with real data)

I am now doing the optimization bit. What do you think is the best way to
specify the ranges of parameter space to be searched? My initial thought
was to have a file with one line per parameter, e.g.:

60.0 62.5 65.0 67.5 ! Theta
0.55 ! Alpha

and so on. This is then used to build a table of configurations which are
executed in sequence (slightly messy, but general). Lines could be
commented, as above (I probably have some routines to sort out each line
of the file). Alternatively, the configurations could be tabulated
in full (one per line), although there are too many parameters to do this
neatly unless quite a lot are fixed. I don't think that a set of 24+
nested DO-loops is a good idea!

Any thoughts appreciated.

Regards, Robert

From VM Wed Jun 19 15:55:24 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["885" "Tue" "18" "June" "1996" "14:12:42" "+0100" "Robert Laing" "rl@ast.cam.ac.uk" nil "27" "Change to map2d"
"^From:" nil nil "6" nil nil nil nil]
nil)
Content-Length: 885
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA45894; Tue, 18 Jun 1996 09:16:32 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.7.5/8.7.1/CV-2.1) with SMTP
id JAA18849 for <abridle@polaris.cv.nrao.edu>; Tue, 18 Jun 1996 09:16:31 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id OAA18149; Tue, 18 Jun 1996 14:12:46 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id OAA18929; Tue, 18 Jun 1996 14:12:43 +0100
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.93.960618140401.18914A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
X-UIDL: 835113484.001
Status: RO
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: Change to map2d
Date: Tue, 18 Jun 1996 14:12:42 +0100 (BST)

Dear Alan

I am not sure which version of map2d you have at the moment, but you should be warned that I introduced a change to the definitions of the input of the variables RHO1, RHO0 and RHOF at some stage. In the spirit of using only observed values, I changed the program so that they are input as distances projected on the sky. I forgot this yesterday, and spent some time wondering why I couldn't repeat 2D TRIPLE 58 with the restructured code. In case of doubt, the new version has the lines

```
RHO0 = RHO0/ST
RHO1 = RHO1/ST
RHOF = RHOF/ST
```

added. The values input to make model 58 then become

RHO0 = 0.2944
RHO1 = 0.1083
RHOF = 0.8660

Obviously, the other program (angle) has to have values fixed in the jet frame. Sorry about the confusion - I'll tidy up the notation soon to make a clearer distinction between projected and intrinsic values.

Robert

From VM Wed Jun 19 15:55:44 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["1820" "Tue" "18" "June" "1996" "16:06:33" "-0400" "Alan Bridle" "abridle" nil "48" "Re: Optimization strategy"
"^From:" nil nil "6" nil nil nil nil]
nil)
Content-Length: 1820
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA26440; Tue, 18 Jun 1996 16:06:33 -0400
Message-Id: <9606182006.AA26440@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.93.960617194056.18007A-100000@rgosf>
References: <Pine.GSO.3.93.960617194056.18007A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Optimization strategy
Date: Tue, 18 Jun 1996 16:06:33 -0400

Robert Laing writes:

> I have now restructured the code so that the model-making part is a
> separate subroutine, which makes it much easier to use it in the 3 main
> programs we need:
> - map2d (makes images of a given model)
> - angle (makes images of a model for various angles to the l of s)
> - optimize (compares models with real data)
>
> I am now doing the optimization bit. What do you think is the best way to
> specify the ranges of parameter space to be searched? My initial thought
> was to have a file with one line per parameter, e.g.:
>
> 60.0 62.5 65.0 67.5 ! Theta
> 0.55 ! Alpha
>
>
> and so on. This is then used to build a table of configurations which ire
> executed in sequence (slightly messy, but general). Lines could be
> commented, as above (I probably have some routines to sort out each line
> of the file). Alternatively, the configurations could be tabulated
> in full (one per line), although there are too many parameters to do this
> neatly unless quite a lot are fixed. I don't think that a set of 24+
> nested DO-loops is a good idea!
>

Hi Robert, sorry not to get back sooner but Users' Committee were here
since Monday a.m.

How about something like

65.0 2.5 !Theta to generate 62.5 65 67.5 ?
0.55 0 !Alpha to fix 0.55 for nll?

Can only specify uniform triplets this way but that's enough to
see if a minumum is possible in specified range.

I agree we should try to minimize number of characters required to specify
a run.

May also be a good investment to have the run write a table that records parameters

of each model, and link filenames to the model numbers used to index such a table. This would eliminate possibly flawed and certainly cumbersome parameter-bookkeeping handwork, even when models are run singly.

A.

From VM Wed Jun 19 15:56:09 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["2700" "Tue" "18" "June" "1996" "21:26:39" "+0100" "Robert Laing" "rl@ast.cam.ac.uk" nil "70" "Re: Optimization strategy" "^From:" nil nil "6" nil nil nil nil]
nil)
Content-Length: 2700
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA17529; Tue, 18 Jun 1996 16:26:44 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.7.5/8.7.1/CV-2.1) with SMTP id QAA26800 for <abridle@nrao.edu>; Tue, 18 Jun 1996 16:26:43 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id VAA04925; Tue, 18 Jun 1996 21:26:41 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id VAA19397; Tue, 18 Jun 1996 21:26:39 +0100
X-Sender: rl@rgosf
In-Reply-To: <9606182006.AA26440@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.93.960618210909.19390A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@nrao.edu>
Subject: Re: Optimization strategy
Date: Tue, 18 Jun 1996 21:26:39 +0100 (BST)

>
> Hi Robert, sorry not to get back sooner but Users' Committee were here
> since Monday a.m.
>

I sympathise - we had the Chief Exec of PPARC on Friday.

> How about something like
>
> 65.0 2.5 !Theta to generate 62.5 65 67.5 ?
> 0.55 0 !Alpha to fix 0.55 for all?
>
> Can only specify uniform triplets this way but that's enough to
> see if a minumum is possible in specified range.

What I have done so far is to have an input file that looks like this:

```
* PARAMETERS.DAT - input file for jet model optimization
THETA 55.0 57.5 60.0 62.5 65.0
RHOF  0.8 0.9 1.0
```

with the remaining parameters at their (hard-coded) default settings.
The variable name must start at the beginning of a line, but variables
can be specified in arbitrary order. Comment lines and in-line comments
are allowed, and up to 10 values can be given per variable.

>
> I agree we should try to minimize number of characters required to specify
> a run.
>
> May also be a good investment to have the run write a table that records
> parameters
> of each model, and link filenames to the model numbers used to index

> such a table. This would eliminate possibly flawed and certainly
> cumbersome parameter-bookkeeping handwork, even when models are run singly.
>

Absolutely. The current vers
on of the log file looks like:

```
Configuration   1
 55.000  0.550 16.750  8.000  8.375  3.000  0.294  0.108  0.950  0.950
  0.750  0.200  0.800  0.000  4.750  1.000  0.000  3.750  1.650  0.000
  0.800  0.700  0.000  0.800
Configuration   2
 55.000  0.550 16.750  8.000  8.375  3.000  0.294  0.108  0.950  0.950
  0.750  0.200  0.900  0.000  4.750  1.000  0.000  3.750  1.650  0.000
  0.800  0.700  0.000  0.800
```

etc.

(no answers yet - I spent all of today on the book-keeping). The idea is
to put the results after the parameters, but also to write a separate file
with just the configuration number and the chi-squareds, which would be
easier to search/plot. I was not intending to write an output image for
every run, but it would be fairly easy to provide this as an option, and
to give the files the same index number as the configuration. The output
table will have a proper header, by the way.

The program is now almost ready to roll - it reads in the VLA maps,
rotates Q and U to the right reference direction and sets up all of the
parameter combinations in sequence (no way out of the nested DO-loops, I'm
afraid). It then calls the same code as map2d to make the models, so this
should work. I'll do the chi-squared stuff tomorrow.

Ideas on the output format would be gratefully received - I'd like to
stick with the input code for now, since it was quite tedious to write.

Cheers, Robert

From VM Wed Jun 19 15:56:46 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["644" "Wed" "19" "June" "1996" "18:43:07" "+0100" "Robert Laing" "rl@ast.cam.ac.uk" nil "16" "New code"
"^From:" nil nil "6" nil nil nil nil]
nil)
Content-Length: 644
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA45769; Wed, 19 Jun 1996 13:48:29 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.7.5/8.7.1/CV-2.1) with SMTP
id NAA09298 for <abridle@polaris.cv.nrao.edu>; Wed, 19 Jun 1996 13:48:27 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id SAA16641; Wed, 19 Jun 1996 18:43:09 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id SAA21213; Wed, 19 Jun 1996 18:43:08 +0100
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.93.960619183734.21199A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
X-UIDL: 835212485.001
Status: RO
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: New code
Date: Wed, 19 Jun 1996 18:43:07 +0100 (BST)

Dear Alan

I've put a copy of the current code (source, shell files and an example parameters file) in our anonymous ftp area. To get at it, ftp to ftp.ast.cam.ac.uk, cd pub/rl and get jets.tar.gz. This is a gnu-zipped tar file.

I have (I think) a working optimization routine now. I'll send you the instructions later today. I'd value your opinion on how to proceed from here. In particular, the program currently just lists chi-squared for the source as a whole and the jet and counter-jet separately. This may be quite good, since the base contributes more, but has fewer points, but I'm not very sure about this.

Regards, Robert

From VM Wed Jun 19 15:56:53 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["4797" "Wed" "19" "June" "1996" "19:06:10" "+0100" "Robert Laing" "rl@ast.cam.ac.uk" nil "119" "Driving
instructions" "^From:" nil nil "6" nil nil nil nil]
nil)
Content-Length: 4797
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA34562; Wed, 19 Jun 1996 14:09:55 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.7.5/8.7.1/CV-2.1) with SMTP
id OAA09748 for <abridle@polaris.cv.nrao.edu>; Wed, 19 Jun 1996 14:09:54 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id TAA16810; Wed, 19 Jun 1996 19:06:12 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id TAA21241; Wed, 19 Jun 1996 19:06:11 +0100
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.93.960619190511.21239A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
X-UIDL: 835212485.003
Status: RO
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: Driving instructions
Date: Wed, 19 Jun 1996 19:06:10 +0100 (BST)

Jet model optimization program

The program is called optimize, and the main program is in optimize.f.
The two shell files optcomp and optlink compile and link the program
(and therefore contain a list of all of the modules). Note that the main
program contains a heavily nested DO-loop and has to be compiled (under
Solaris) with the -Nc30 switch. I do not know what might happen with other
implementations of f77.

Input files

1. The program expects the VLA data to be in three files called 3C31.I,
3C31.Q and 3C31.U in the same directory as the executable. These files
are the output from IMTXT with an E10.3 format descriptor.

2. The set of parameters to be used is defined in a file called
PARAMETERS.DAT, which should also be in the same directory as optimize.
Default values are defined in the code, and will be used in the absence of
an entry in PARAMETERS.DAT. The names of the parameters and their default
values are as follows:

```
60.0,    ! THETA
0.55,    ! ALPHA
16.75,   ! XI0
8.0,     ! XI1
8.375,   ! ZETA0
3.0,     ! ZETA1
0.2944,  ! RHO0
0.1083,  ! RHO1
0.95,    ! BETAI
0.95,    ! BETA1
0.75,    ! BETA0
0.2,     ! BETAF
```

```
0.8660,  ! RHOF
0.0,     ! ESP_IN
4.75,    ! ESP_MID
1.0,     ! ESP_OUT
0.0,     ! ESL_IN
3.75,    ! ESL_MID
1.65,    ! ESL_OUT
0.0,     ! RHOTRUNC
0.8,     ! SPINE_SL
0.7,     ! SLMIN
0.0,     ! VMIN0
0.8,     ! VMIN1
```

These are as used in 2D TRIPLE 58, with a change of convention for RHO0, RHO1 and RHOF. These ar now defined in the plane of the sky, rather than in the frame of the jet (and their values have therefore been multiplied by sin 60 = 0.866).

The format of PARAMETERS.DAT is as follows:

A set of parameters is specified by giving the name of the variable (in full, and in upper case, starting in column 1) followed by up to 10 values, separated by spaces. For example:

THETA 55.0 57.5 60.0 62.5 65.0

Anything after a ! or * is treated as a comment. Lines starting with ! or *, or entirely blank lines, are ignored.

To run the program, type

optimize

You will be asked whether you want the model and chi-squared maps to be written (answer y or n).

The program:
- reads in the VLA images
- rotates Q and U (incidentally, the headers still have CROTA2 = -70.3 deg, so PCNTR will malfunction on the rotated images)
- reads the PARAMETERS.DAT file and tells you what default values are being used
- opens any output files and writes their headers
- sets up the configurations to be modelled
- makes the models, writing out maps and chi-squared images
- writes a log file.

The format of the log file is:

```
Configuration   1
 50.000  0.550 16.750  8.000  8.375  3.000  0.294  0.108  0.950  0.950
  0.750  0.200  0.866  0.000  4.750  1.000  0.000  3.750  1.650  0.000
  0.800  0.700  0.000  0.800
 0.195E+07 0.187E+07 0.861E+05 0.243E+07 0.227E+07 0.160E+06
 0.632E+06 0.518E+06 0.115E+06   57544
Configuration   2
 60.000  0.550 16.750  8.000  8.375  3.000  0.294  0.108  0.950  0.950
  0.750  0.200  0.866  0.000  4.750  1.000  0.000  3.750  1.650  0.000
```

0.800 0.700 0.000 0.800
0.587E+06 0.482E+06 0.105E+06 0.173E+07 0.153E+07 0.207E+06
0.610E+06 0.481E+06 0.129E+06 57544

and so on. The configuration number is included in the output filenames, for example configuration 1 corresponds to

IMAP01.TXT, QMAP01.TXT, UMAP01.TXT, ICHISQ01.TXT, QCHISQ01.TXT and UCHISQ01.TXT.

The first 3 lines are the input parameters, as entered, in the order given above. The remaining 2 lines have chi-squared values in the order I (whole source, jet, counter-jet), Q (ditto), U (ditto), number of points. Chi-squared is evaluated over a pair of quadrilaterals chosen just to include the jet and counter-jet, but not the core. The vertices are at

(6,6), (274, 102), (274, -102), (-6, -6) if the core is at (0,0) - add (275, 103) to get AIPS coordinates. I have assumed that the off-source noise levels are appropriate for evaluating chi-squared, but this just scales everyting, of course).

The models are as we had previously and the chi-squared images can be duplicated to within digitization accuracy, using COMB. I'm therefore fairly sure that there are no major bugs. I am going to let the program roam through parameter space tonight and see what happens - more intelligence can be introduced tomorrow.

Regards, Robert

From VM Thu Jun 20 10:48:23 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["12270" "Thu" "20" "June" "1996" "12:38:39" "+0100" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.93.960620123028.21848A-100000@rgosf>" "406" "Oops" "^From:" nil nil "6" nil nil (number " " mark " R
Robert Laing Jun 20 406/12270 " thread-indent "\"Oops\"\n") nil]
nil)
Content-Length: 12270
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA17540; Thu, 20 Jun 1996 07:42:42 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.7.5/8.7.1/CVt2.1) with SMTP
id HAA21205 for <abridle@polaris.cv.nrao.edu>; Thu, 20 Jun 1996 07:42:38 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id MAA25965; Thu, 20 Jun 1996 12:38:44 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id MAA21851; Thu, 20 Jun 1996 12:38:41 +0100
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.93.960620123028.21848A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
X-UIDL: 835278382.001
Status: RO
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: Oops
Date: Thu, 20 Jun 1996 12:38:39 +0100 (BST)

I think you might find the attached version of optimize.f works rather
better. The previous version was fine under some circumstances, but did
have the annoying habit of dividing the angle by 180/PI on successive
executions if anything other than THETA was varied. (A clot error, as
Martin Ryle would have said).

What do you think is the effective number of degrees of freedom, given
that points on the map are not independent?

R.

```
      PROGRAM OPTIMIZE

* Evaluate range of jet models and compare with observations.
* Tabulate chi-squared for all of the parameter combinations.

*+

      IMPLICIT NONE

      INCLUDE 'model.inc'

      PARAMETER SOBS = 0.396        ! Total extended flux (Jy)
                                    ! for normalization
      PARAMETER SCORE = 0.091       ! Core flux
      PARAMETER XMIN = 6            ! Half-width of region to exclude around
                                    ! the core (pixels)
      PARAMETER YMIN = 6            ! Minimum value of Y to define region
                                    ! to calculate chi-squared
      PARAMETER SIGMA_I = 7.3E-6    ! rms Stokes I
      PARAMETER SIGMA_P = 3.4E-6    ! rms Stokes QU
```

```
      REAL IARR(-XMAX:XMAX,-YMAX:YMAX) ! Stokes I (model)
      REAL QARR(-XMAX:XMAX,-YMAX:YMAX) ! Stokes Q (model)
      REAL UARR(-XMAX:XMAX,-YMAX:YMAX) ! Stokes U (model)

      REAL IMAP(-XMAX:XMAX,-YMAX:YMAX) ! Stokes I (observed)
      REAL QMAP(-XMAX:XMAX,-YMAX:YMAX) ! Stokes Q (observed)
      REAL UMAP(-XMAX:XMAX,-YMAX:YMAX) ! Stokes U (observed)

      INTEGER NCONFIG, TOTCONFIG
      INTEGER I1,I2,I3,I4,I5,I6,I7,I8,I9,I10
      INTEGER I11,I12,I13,I14,I15,I16,I17,I18,I19,I20
      INTEGER I21,I22,I23,I24
      REAL FWHM

      INTEGER NPOINTS          ! No of points used
      REAL SCALE, ST, RADEG, DECDEG
      INTEGER STOKESCODE(3)
      REAL ICHISQ(-XMAX:XMAX,-YMAX:YMAX) ! Stokes I chi-squared map
      REAL QCHISQ(-XMAX:XMAX,-YMAX:YMAX) ! Stokes Q chi-squared map
      REAL UCHISQ(-XMAX:XMAX,-YMAX:YMAX) ! Stokes U chi-squared map
      LOGICAL PLOTMAP   ! Output model maps
      LOGICAL PLOTCHISQ ! Output chi-squared maps

      REAL ICHISQ_J, QCHISQ_J, UCHISQ_J
      REAL ICHISQ_CJ, QCHISQ_CJ, UCHISQ_CJ

      INTEGER I, J, LU

      DATA STOKESCODE /1,2,3/


* Output filenames

      CHARACTER*10 IMAPFILE
      CHARACTER*10 QMAPFILE
      CHARACTER*10 UMAPFILE
      CHARACTER*12 ICHISQFILE
      CHARACTER*12 QCHISQFILE
      CHARACTER*12 UCHISQFILE

      CHARACTER*1 DUMMY

      REAL A,B

*+

* Convolving beam

*     PRINT *, 'Convolving beam FWHM (pixels)'
*     READ (5, *) FWHM
      FWHM = 3.0

* Output model option

100   CONTINUE
      PRINT *,'Output model maps (y/n)?'
      READ (5,*) DUMMY
      IF (DUMMY .EQ. 'Y' .OR. DUMMY .EQ. 'y') THEN
```

```
      PLOTMAP = .TRUE.
     ELSE IF (DUMMY .EQ. 'N' .OR. DUMMY .EQ. 'n') THEN
      PLOTMAP = .FALSE.
     ELSE
      GO TO 100
     END IF

* Output chi-squared option

200   CONTINUE
     PRINT *,'Output chi-squared maps (y/n)?'
     READ (5,*) DUMMY
     IF (DUMMY .EQ. 'Y' .OR. DUMMY .EQ. 'y') THEN
      PLOTCHISQ = .TRUE.
     ELSE IF (DUMMY .EQ. 'N' .OR. DUMMY .EQ. 'n') THEN
      PLOTCHISQ = .FALSE.
     ELSE
      GO TO 200
     END IF

* Open log file

     OPEN (UNIT=20, FILE='LOG.DAT', STATUS='UNKNOWN')

* Parameters needed to define area over which chi-squared is calculated

     A = REAL(YMAX-YMIN)/REAL(XMAX-XMIN)
     B = REAL(YMIN) - A*REAL(XMIN)

* Values for map headers

     RADEG =   15.0*(1.0 + 7.0/60.0 + 24.955/3600.0) ! Phase centre RA
     DECDEG =   32.0 + 24.0/60.0 + 45.05/3600.0      ! Phase centre Dec

* Read in maps and rotate Q and U to correct reference frame.

     CALL READMAPS (IMAP, QMAP, UMAP)

* Read parameter file

     CALL READCONFIG

     NCONFIG = 0
     TOTCONFIG = 1
     DO I = 1,NVAR
      TOTCONFIG = TOTCONFIG*NVALUE(I)
     END DO

* Loop over variables

     DO I1 = 1, NVALUE(1)
     DO I2 = 1, NVALUE(2)
     DO I3 = 1, NVALUE(3)
     DO I4 = 1, NVALUE(4)
     DO I5 = 1, NVALUE(5)
     DO I6 = 1, NVALUE(6)
     DO I7 = 1, NVALUE(7)
     DO I8 = 1, NVALUE(8)
```

```
      DO I9 = 1, NVALUE(9)
      DO I10 = 1, NVALUE(10)
      DO I11 = 1, NVALUE(11)
      DO I12 = 1, NVALUE(12)
      DO I13 = 1, NVALUE(13)
      DO I14 = 1, NVALUE(14)
      DO I15 = 1, NVALUE(15)
      DO I16 = 1, NVALUE(16)
      DO I17 = 1, NVALUE(17)
      DO I18 = 1, NVALUE(18)
      DO I19 = 1, NVALUE(19)
      DO I20 = 1, NVALUE(20)
      DO I21 = 1, NVALUE(21)
      DO I22 = 1, NVALUE(22)
      DO I23 = 1, NVALUE(23)
      DO I24 = 1, NVALUE(24)
        THETA    = VALUE(1, I1)
        ALPHA    = VALUE(2,I2)
        XI0      = VALUE(3,I3)
        XI1      = VALUE(4,I4)
        ZETA0    = VALUE(5,I5)
        ZETA1    = VALUE(6,I6)
        RHO0     = VALUE(7,I7)
        RHO1     = VALUE(8,I8)
        BETAI    = VALUE(9,I9)
        BETA1    = VALUE(10,I10)
        BETA0    = VALUE(11,I11)
        BETAF    = VALUE(12,I12)
        RHOF     = VALUE(13,I13)
        ESP_IN   = VALUE(14,I14)
        ESP_MID  = VALUE(15,I15)
        ESP_OUT  = VALUE(16,I16)
        ESL_IN   = VALUE(17,I17)
        ESL_MID  = VALUE(18,I18)
        ESL_OUT  = VALUE(19,I19)
        RHOTRUNC = VALUE(20,I20)
        SPINE_SL = VALUE(21,I21)
        SLMIN    = VALUE(22,I22)
        VMIN0    = VALUE(23,I23)
        VMIN1    = VALUE(24,I24)

* End of parameter setting: real work starts here.

      NCONFIG = NCONFIG + 1
      IF (NCONFIG .GE. 100) THEN
        TYPE *, '>99 configurations: turning off map output option'
        PLOTMAP = .FALSE.
        PLOTCHISQ = .FALSE.
      END IF

* If options to write out model maps and/or chi-squared maps are enabled,
* construct filenames and open files.

      IF (PLOTMAP) THEN
        IF (NCONFIG .LT. 10) THEN
          WRITE (IMAPFILE, '(A5,I1,A4)') 'IMAP0',NCONFIG,'.TXT'
          WRITE (QMAPFILE, '(A5,I1,A4)') 'QMAP0',NCONFIG,'.TXT'
          WRITE (UMAPFILE, '(A5,I1,A4)') 'UMAP0',NCONFIG,'.TXT'
```

```
   ELSE
     WRITE (IMAPFILE, '(A4,I2,A4)') 'IMAP',NCONFIG,'.TXT'
     WRITE (QMAPFILE, '(A4,I2,A4)') 'QMAP',NCONFIG,'.TXT'
     WRITE (UMAPFILE, '(A4,I2,A4)') 'UMAP',NCONFIG,'.TXT'
   END IF
   OPEN(UNIT=30,FILE=IMAPFILE,STATUS='UNKNOWN')
   OPEN(UNIT=31,FILE=QMAPFILE,STATUS='UNKNOWN')
   OPEN(UNIT=32,FILE=UMAPFILE,STATUS='UNKNOWN')
   DO LU = 30, 32   ! Write headers
     WRITE (LU,'(A)') 'NAXIS = 4'
     WRIT, (LU,'(A)') 'DIM  = 549, 205, 1, 1'
     WRITE (LU,'(A)') 'FORMAT = "549E10.3"'
     WRITE (LU,'(A)') 'OBJECT = "Model"'
     WRITE (LU,'(A)') 'CRTYPE="RA---SIN","DEC--SIN",
&              "FREQ","STOKES"'
     WRITE (LU,'(A)') 'CRINC =-0.000027777778,0.000027777778,
&    1.0E8,1.0'
     WRITE (LU,'(A,F12.8,A,F12.8,A,I2)') 'CRVAL = ',RADEG,',',
&   DECDEG,',8.4399E9,',STOKESCODE(LU)
     WRITE (LU,'(A)') 'CRREF = 275.0,103.0,1.0,1.0'
     WRITE (LU,'(A)') 'CRROT = 0.0, 0.0,0.0,0.0'
     WRITE (LU,'(A)') 'UNITS = "JY/BEAM"'
     WRITE (LU,'(A)') 'EPOCH = 2000.0'
     WRITE (LU,'(A)') '/'
   END DO
 END IF

 IF (PLOTCHISQ) THEN
   IF (NCONFIG .LT. 10) THEN
     WRITE (ICHISQFILE, '(A7,I1,A4)') 'ICHISQ0',NCONFIG,'.TXT'
     WRITE (QCHISQFILE, '(A7,I1,A4)') 'QCHISQ0',NCONFIG,'.TXT'
     WRITE (UCHISQFILE, '(A7,I1,A4)') 'UCHISQ0',NCONFIG,'.TXT'
   ELSE
     WRITE (ICHISQFILE, '(A6,I2,A4)') 'ICHISQ',NCONFIG,'.TXT'
     WRITE (QCHISQFILE, '(A6,I2,A4)') 'QCHISQ',NCONFIG,'.TXT'
     WRITE (UCHISQFILE, '(A6,I2,A4)') 'UCHISQ',NCONFIG,'.TXT'
   END IF
   OPEN(UNIT=40,FILE=ICHISQFILE,STATUS='UNKNOWN')
   OPEN(UNIT=41,FILE=QCHISQFILE,STATUS='UNKNOWN')
   OPEN(UNIT=42,FILE=UCHISQFILE,STATUS='UNKNOWN')
   DO LU = 40, 42   ! Write headers
     WRITE (LU,'(A)') 'NAXIS = 4'
     WRITE (LU,'(A)') 'DIM  = 549, 205, 1, 1'
     WRITE (LU,'(A)') 'FORMAT = "549E10.3"'
     WRITE (LU,'(A)') 'OBJECT = "Error"'
     WRITE (LU,'(A)') 'CRTYPE="RA---SIN","DEC--SIN",
&              "FREQ","STOKES"'
     WRITE (LU,'(A)') 'CRINC =-0.000027777778,0.000027777778,
&    1.0E8,1.0'
     WRITE (LU,'(A,F12.8,A,F12.8,A,I2)') 'CRVAL = ',RADEG,',',
&   DECDEG,',8.4399E9,',STOKESCODE(LU)
     WRITE (LU,'(A)') 'CRREF = 275.0,103.0,1.0,1.0'
     WRITE (LU,'(A)') 'CRROT = 0.0, 0.0,0.0,0.0'
     WRITE (LU,'(A)') 'UNITS = "CHI-SQ"'
     WRITE (LU,'(A)') 'EPOCH = 2000.0'
     WRITE (LU,'(A)') '/'
   END DO
 END IF
```

```
* Convert to radians and project to frame of jet

      THETA = THETA*DEGRAD
      ST = SIN(THETA)

      RHO0 = RHO0/ST
      RHO1 = RHO1/ST
      RHOF = RHOF/ST

      XI0 = XI0*DEGRAD
      ZETA0 = ZETA0*DEGRAD
      XI0 = ASIN(SIN(XI0)*ST)
      ZETA0 = ASIN(SIN(ZETA0)*ST)
      XI1 = XI1*DEGRAD
      ZETA1 = ZETA1*DEGRAD
      XI1 = ASIN(SIN(XI1)*ST)
      ZETA1 = ASIN(SIN(ZETA1)*ST)

* Calculate model

      CALL MAKEMODEL (SOBS, SCORE, FWHM, IARR, QARR, UARR, SCALE)

* Evaluate chi-squared over defined areas

      ICHISQ_J = 0.0
      QCHISQ_J = 0.0
      UCHISQ_J = 0.0
      ICHISQ_CJ = 0.0
      QCHISQ_CJ = 0.0
      UCHISQ_CJ = 0.0
      NPOINTS = 0
      DO I = -XMAX, XMAX
        DO J = -YMAX, YMAX
          IF (ABS(I) .GT. XMIN .AND.
     &        ABS(J) .LT. NINT(A*REAL(ABS(I))+B)) THEN
            ICHISQ(I,J) = ((IMAP(I,J)-IARR(I,J))/SIGMA_I)**2
            QCHISQ(I,J) = ((QMAP(I,J)-QARR(I,J))/SIGMA_P)**2
            UCHISQ(I,J) = ((UMAP(I,J)-UARR(I,J))/SIGMA_P)**2
            NPOINTS = NPOINTS + 1
          ELSE
            ICHISQ(I,J) = 0.0
            QCHISQ(I,J) = 0.0
            UCHISQ(I,J) = 0.0
          END IF
          IF (I .GT. 0) THEN   ! Jet side
            ICHISQ_J = ICHISQ_J + ICHISQ(I,J)
            QCHISQ_J = QCHISQ_J + QCHISQ(I,J)
            UCHISQ_J = UCHISQ_J + UCHISQ(I,J)
          ELSE
            ICHISQ_CJ = ICHISQ_CJ + ICHISQ(I,J)
            QCHISQ_CJ = QCHISQ_CJ + QCHISQ(I,J)
            UCHISQ_CJ = UCHISQ_CJ + UCHISQ(I,J)
          END IF
        END DO
      END DO

* Write out model maps
```

```
      IF (PLOTMAP) THEN
        DO J = -YMAX,YMAX
          WRITE (30,'(549E10.3)') (IARR(I,J),I=-XMAX,XMAX)
          WRITE (31,'(549E10.3)') (QARR(I,J),I=-XMAX,XMAX)
          WRITE (32,'(549E10.3)') (UARR(I,J),I=-XMAX,XMAX)
        END DO
      END IF

* Write out chi-squared maps

      IF (PLOTCHISQ) THEN
        DO J = -YMAX,YMAX
          WRITE (40,'(549E10.3)') (ICHISQ(I,J),I=-XMAX,XMAX)
          WRITE (41,'(549E10.3)') (QCHISQ(I,J),I=-XMAX,XMAX)
          WRITE (42,'(549E10.3)') (UCHISQ(I,J),I=-XMAX,XMAX)
        END DO
      END IF

* Write log file entry

      WRITE (20,'(A, I3)') 'Configuration ',NCONFIG
      WRITE (20, '(10F7.3)')
     & VALUE(1,I1), VALUE(2,I2), VALUE(3,I3), VALUE(4,I4), VALUE(5,I5),
     & VALUE(6,I6), VALUE(7,I7), VALUE(8,I8), VALUE(9,I9),
     & VALUE(10,I10)
      WRITE (20, '(10F7.3)')
     & VALUE(11,I11),VALUE(12,I12),VALUE(13,I13),VALUE(14,I14),
     & VALUE(15,I15),VALUE(16,I16),VALUE(17,I17),VALUE(18,I18),
     & VALUE(19,I19),VALUE(20,I20)
      WRITE (20, '(4F7.3)')
     & VALUE(21,I21),VALUE(22,I22),VALUE(23,I23),VALUE(24,I24)
      WRITE (20, '(6E10.3)')
     &  ICHISQ_J+ICHISQ_CJ, ICHISQ_J,ICHISQ_CJ,
     &  QCHISQ_J+QCHISQ_CJ, QCHISQ_J,QCHISQ_CJ
      WRITE (20, '(3E10.3,I8)')
     &  UCHISQ_J+UCHISQ_CJ, UCHISQ_J,UCHISQ_CJ,
     &  NPOINTS

* Close any open output files

      IF (PLOTMAP) THEN
        CLOSE(30)
        CLOSE(31)
        CLOSE(32)
      END IF

      IF (PLOTCHISQ) THEN
        CLOSE(40)
        CLOSE(41)
        CLOSE(42)
      END IF

      TYPE *,'Done ',NCONFIG,' out of ',TOTCONFIG,' combinations'


      END DO
      END DO
```

```
END DO
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END DO
END DO

END
```

From VM Tue Jun 25 11:42:03 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["366" "Thu" "20" "June" "1996" "10:56:07" "-0400" "Alan Bridle" "abridle" nil "11" "Re: Oops" "^From:" nil nil "6"
nil nil nil nil]
nil)
Content-Length: 366
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA26071; Thu, 20 Jun 1996 10:56:07 -0400
Message-Id: <9606201456.AA26071@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.93.960620123028.21848A-100000@rgosf>
References: <Pine.GSO.3.93.960620123028.21848A-100000@rgosf>
X-UIDL: 835283144.000
Status: RO
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Oops
Date: Thu, 20 Jun 1996 10:56:07 -0400

Hi Robert,

Got the new version o.k. Will try it asap, but probably early next
week rather than this, looking at the pile of stuff I have to do
by yesterday (also M. going to Seattle on Saturday so I will be
kinda busy round the house over the weekend).

I would think our number of independent points is about 3*no. of
restoring beam areas with signal in them?

A.

From VM Tue Jun 25 11:42:08 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["1826" "Thu" "20" "June" "1996" "16:33:32" "+0100" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.93.960620145227.22017A-100000@rgosf>" "44" "Additional thoughts" "^From:" nil nil "6" nil nil (number
" " mark " R Robert Laing   Jun 20   44/1826 " thread-indent "\"Additional thoughts\"\n") nil]
nil)
Content-Length: 1826
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA20996; Thu, 20 Jun 1996 11:36:52 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.7.5/8.7.1/CV-2.1) with SMTP
id LAA24211 for <abridle@polaris.cv.nrao.edu>; Thu, 20 Jun 1996 11:36:44 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/BMI-SVR4)
id QAA00935; Thu, 20 Jun 1996 16:33:36 +0100
Received: from localhost by rgosf.ast.cam.ac-uk (SMI-8.6/SMI-SVR4)
id QAA22152; Thu, 20 Jun 1996 16:33:34 +0100
X-Sender: rl@rgosf
Reply-To: Robert Laing <rl@ast.cam.ac.uk>
Message-Id: <Pine.GSO.3.93.960620145227.22017A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: Additional thoughts
Date: Thu, 20 Jun 1996 16:33:32 +0100 (BST)

No rush - I'll probably leave a long sequence running over the weekend.
The program has managed 110 models without falling over so far, so I think
it is probably OK. There is a spurious message about turning off plot
options which is emitted on models 100+ even when it isn't plotting, and
which I will remove.

In the process of doing the optimization code, I have become a little
concerned by the extent to which numbers specific to 3c31 are creeping in.
If this is allowed to continue, it will become very difficult to change
things if we try to model something else (usual problem of writing
software before designing it!)

I think I will do something about this soon, whilst I still remember what
the code does. In particular, I think that the following need to be
generalised:

- Map dimensions (we should probably leave a maximum array size set, and
  specify the actual size of the map elsewhere)
- Other header parameters (RA, Dec, cell-size, ...)
- Rotation
- Extended and core flux
- Convolving beam
- Default values
- Input filenames
- Size of array for convolution (nearest powers of 2 above maximum array
  size set earlier)

Can you think of anything else?

I think I will set up a defaults file to be read on startup. What do you
think is the maximum likely size of map? I was thinking of using 1024 x
512 for the convolution and setting the array size to some suitable pair
of odd numbers just less than this (a small guard zone is needed).

Do you think that there is a role for map2d, or would you rather run optimize with a single configuration instead? Likewise, should we incorporate angle in the same shell, and just put in an option to turn the flux scaling on and off? I'm tempted to put everything in one program to avoid having to change code in more than one place.

Regards, Robert

From VM Tue Jun 25 11:43:50 1996
X-VM-v5-Data: ([nil nil nil t nil nil nil nil nil]
["14771" "Mon" "24" "June" "1996" "15:50:57" "+0100" "Robert Laing" "rl@ast.cam.ac.uk" nil "469"
"Optimizations" "^From:" nil nil "6" nil nil (number " " mark " F Robert Laing Jun 24 469/14771 " thread-indent
"\"Optimizations\"\n") nil]
nil)
Content-Length: 14771
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA42863; Mon, 24 Jun 1996 10:55:56 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.7.5/8.7.1/CV-2.1) with SMTP
id KAA20937 for <abridle@polaris.cv.nrao.edu>; Mon, 24 Jun 1996 10:55:54 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id PAA06846; Mon, 24 Jun 1996 15:51:00 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id PAA08000; Mon, 24 Jun 1996 15:50:58 +0100
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.93.960624153458.7986A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: Optimizations
Date: Mon, 24 Jun 1996 15:50:57 +0100 (BST)

Dear Alan

I let optimize wander through parameter space this weekend, not really to
much good effect. We made a remarkably good attempt at fitting the model
by eye! I modified the program a bit - latest version attached. I now
only bother to print out the total chi-squared values (in the order I, Q+U
and I+Q+U) since further subdivision didn't seem to help much - it is
usually easy to repeat a suspect run with the map output option turned on.
One change I have just made, but have not yet tried out, is to restrict
the area over which the chi-squared is summed to exclude the arc in the
main jet and the equivalent region in the counterjet. As expected,
polarization and total intensity want different things (to a first
approximation, the polarization wants less spine) and the ratio between
assumed I and Q/U noise levels is therefore important in assessing the
quality of the fit. It's not obvious to me that the off-source noise
level is actually the right thing to use, but the absolute values only
matter if we are really trying for a good fit.

I think that the way to get a true chi-squared value is indeed to use one
point per beam, in which case the number of degrees of freedom must be 3 x
the number of points with signal - number of model parameters - 1 (for the
flux constraint).

I'd value your thoughts on how to steer the optimization process, since I
think I'm running out of ideas.

Regards, Robert

Latest version of optimize.f:

```
      PROGRAM OPTIMIZE

* Evaluate range of jet models and compare with observations.
```

```
* Tabulate chi-squared for all of the parameter combinations.

*+

      IMPLICIT NONE

      INCLUDE 'model.inc'

      PARAMETER SOBS = 0.396        ! Total extended flux (Jy)
                                    ! for normalization
      PARAMETER SCORE = 0.091       ! Core flux
      PARAMETER XMIN = 6            ! Half-width of region to exclude around
                                    ! the core (pixels)
      PARAMETER YMIN = 6            ! Minimum value of Y to define region
                                    ! to calculate chi-squared
      PARAMETER XCMAX = 210
      PARAMETER SIGMA_I = 7.3E-6    ! rms Stokes I
      PARAMETER SIGMA_P = 3.4E-6    ! rms Stokes QU

      REAL IARR(-XMAX:XMAX,-YMAX:YMAX) ! Stokes I (model)
      REAL QARR(-XMAX:XMAX,-YMAX:YMAX) ! Stokes Q (model)
      REAL UARR(-XMAX:XMAX,-YMAX:YMAX) ! Stokes U (model)

      REAL IMAP(-XMAX:XMAX,-YMAX:YMAX) ! Stokes I (observed)
      REAL QMAP(-XMAX:XMAX,-YMAX:YMAX) ! Stokes Q (observed)
      REAL UMAP(-XMAX:XMAX,-YMAX:YMAX) ! Stokes U (observed)

      INTEGER NCONFIG, TOTCONFIG
      INTEGER I1,I2,I3,I4,I5,I6,I7,I8,I9,I10
      INTEGER I11,I12,I13,I14,I15,I16,I17,I18,I19,I20
      INTEGER I21,I22,I23,I24
      REAL FWHM

      INTEGER NPOINTS          ! No of points used
      REAL SCALE, ST, RADEG, DECDEG
      INTEGER STOKESCODE(3)
      REAL ICHISQ(-XMAX:XMAX,-YMAX:YMAX) ! Stokes I chi-squared map
      REAL QCHISQ(-XMAX:XMAX,-YMAX:YMAX) ! Stokes Q chi-squared map
      REAL UCHISQ(-XMAX:XMAX,-YMAX:YMAX) ! Stokes U chi-squared map
      LOGICAL PLOTMAP   ! Output model maps
      LOGICAL PLOTCHISQ ! Output chi-squared maps

      REAL ICHISQ_J, QCHISQ_J, UCHISQ_J
      REAL ICHISQ_CJ, QCHISQ_CJ, UCHISQ_CJ

      INTEGER IBEST    ! NCONFIG for lowest I chi-squared
      INTEGER PBEST    ! NCONFIG for lowest Q+U chi-squared
      INTEGER IQUBEST  ! NCONFIG for lowest I+Q+U chi-squared

      REAL ICHISQ_MIN
      REAL PCHISQ_MIN
      REAL IQUCHISQ_MIN

      INTEGER I, J, LU

      DATA STOKESCODE /1,2,3/
```

```
* Output filenames

      CHARACTER*10 IMAPFILE
      CHARACTER*10 QMAPFILE
      CHARACTER*10 UMAPFILE
      CHARACTER*12 ICHISQFILE
      CHARACTER*12 QCHISQFILE
      CHARACTER*12 UCHISQFILE

      CHARACTER*1 DUMMY

      REAL A,B

*+

* Convolving beam

*     PRINT *, 'Convolving beam FWHM (pixels)'
*     READ (5, *) FWHM
      FWHM = 3.0

* Output model option

100   CONTINUE
      PRINT *,'Output model maps (y/n)?'
      READ (5,*) DUMMY
      IF (DUMMY .EQ. 'Y' .OR. DUMMY .EQ. 'y') THEN
        PLOTMAP = .TRUE.
      ELSE IF (DUMMY .EQ. 'N' .OR. DUMMY .EQ. 'n') THEN
        PLOTMAP = .FALSE.
      ELSE
        GO TO 100
      END IF

* Output chi-squared option

200   CONTINUE
      PRINT *,'Output chi-squared maps (y/n)?'
      READ (5,*) DUMMY
      IF (DUMMY .EQ. 'Y' .OR. DUMMY .EQ. 'y') THEN
        PLOTCHISQ = .TRUE.
      ELSE IF (DUMMY .EQ. 'N' .OR. DUMMY .EQ. 'n') THEN
        PLOTCHISQ = .FALSE.
      ELSE
        GO TO 200
      END IF

* Open log file

      OPEN (UNIT=20, FILE='LOG.DAT', STATUS='UNKNOWN')

* Parameteis needed to define area over which chi-squared is calculated

      A = REAL(YMAX-YMIN)/REAL(XMAX-XMIN)
      B = REAL(YMIN) - A*REAL(XMIN)

* Values for map headers
```

```
      RADEG =   15.0*(1.0 + 7.0/60.0 + 24.955/3600.0) ! Phase centre RA
      DECDEG =   32.0 + 24.0/60.0 + 45.05/3600.0      ! Phase centre Dec

* Read in maps and rotate Q and U to correct reference frame.

      CALL READMAPS (IMAP, QMAP, UMAP)

* Read parameter file

      CALL READCONFIG

      NCONFIG = 0
      TOTCONFIG = 1
      DO I = 1,NVAR
        TOTCONFIG = TOTCONFIG*NVALUE(I)
      END DO

*eLoop over variables

      DO I1 = 1, NVALUE(1)
      DO I2 = 1, NVALUE(2)
      DO I3 = 1, NVALUE(3)
      DO I4 = 1, NVALUE(4)
      DO I5 = 1, NVALUE(5)
      DO I6 = 1, NVALUE(6)
      DO I7 = 1, NVALUE(7)
      DO I8 = 1, NVALUE(8)
      DO I9 = 1, NVALUE(9)
      DO I10 = 1, NVALUE(10)
      DO I11 = 1, NVALUE(11)
      DO I12 = 1, NVALUE(12)
      DO I13 = 1, NVALUE(13)
      DO I14 = 1, NVALUE(14)
      DO I15 = 1, NVALUE(15)
      DO I16 = 1, NVALUE(16)
      DO I17 = 1, NVALUE(17)
      DO I18 = 1, NVALUE(18)
      DO I19 = 1, NVALUE(19)
      DO I20 = 1, NVALUE(20)
      DO I21 = 1, NVALUE(21)
      DO I22 = 1, NVALUE(22)
      DO I23 = 1, NVALUE(23)
      DO I24 = 1, NVALUE(24)
        THETA    = VALUE(1, I1)
        ALPHA    = VALUE(2,I2)
        XI0      = VALUE(3,I3)
        XI1      = VALUE(4,I4)
        ZETA0    = VALUE(5,I5)
        ZETA1    = VALUE(6,I6)
        RHO0     = VALUE(7,I7)
        RHO1     = VALUE(8,I8)
        BETAI    = VALUE(9,I9)
        BETA1    = VALUE(10,I10)
        BETA0    = VALUE(11,I11)
        BETAF    = VALUE(12,I12)
        RHOF     = VALUE(13,I13)
        ESP_IN   = VALUE(14,I14)
        ESP_MID  = VALUE(15,I15)
```

```
      ESP_OUT  = VALUE(16,I16)
      ESL_IN   = VALUE(17,I17)
      ESL_MID  = VALUE(18,I18)
      ESL_OUT  = VALUE(19,I19)
      RHOTRUNC = VALUE(20,I20)
      SPINE_SL = VALUE(21,I21)
      SLMIN    = VALUE(22,I22)
      VMIN0    = VALUE(23,I23)
      VMIN1    = VALUE(24,I24)

* End of parameter setting: real work starts here.

    NCONFIG = NCONFIG + 1
    IF (NCONFIG .GE. 100 .AND. (PLOTMAP .OR. PLOTCHISQ)) THEN
      TYPE *, '>99 configurations: turning off map output option'
      PLOTMAP = .FALSE.
      PLOTCHISQ = .FALSE.
    END IF

* If options to write out model maps and/or chi-squared maps are enabled,
* construct filenames and open files.

    IF (PLOTMAP) THEN
      IF (NCONFIG .LT. 10) THEN
        WRITE (IMAPFILE, '(A5,I1,A4)') 'IMAP0',NCONFIG,'.TXT'
        WRITE (QMAPFILE, '(A5,I1,A4)') 'QMAP0',NCONFIG,'.TXT'
        WRITE (UMAPFILE, '(A5,I1,A4)') 'UMAP0',NCONFIG,'.TXT'
      ELSE
        WRITE (IMAPFILE, '(A4,I2,A4)') 'IMAP',NCONFIG,'.TXT'
        WRITE (QMAPFILE, '(A4,I2,A4)') 'QMAP',NCONFIG,'.TXT'
        WRITE (UMAPFILE, '(A4,I2,A4)') 'UMAP',NCONFIG,'.TXT'
      END IF
      OPEN(UNIT=30,FILE=IMAPFILE,STATUS='UNKNOWN')
      OPEN(UNIT=31,FILE=QMAPFILE,STATUS='UNKNOWN')
      OPEN(UNIT=32,FILE=UMAPFILE,STATUS='UNKNOWN')
      DO LU = 30, 32   ! Write headers
        WRITE (LU,'(A)') 'NAXIS = 4'
        WRITE (LU,'(A)') 'DIM  = 549, 205, 1, 1'
        WRITE (LU,'(A)') 'FORMAT = "549E10.3"'
        WRITE (LU,'(A)') 'OBJECT = "Model"'
        WRITE (LU,'(A)') 'CRTYPE="RA---SIN","DEC--SIN",
     &              "FREQ","STOKES"'
        WRITE (LU,'(A)') 'CRINC =-0.000027777778,0.000027777778,
     &    1.0E8,1.0'
        WRITE (LU,'(A,F12.8,A,F12.8,A,I2)') 'CRVAL = ',RADEG,',',
     &   DECDEG,',8.4399E9,',STOKESCODE(LU)
        WRITE (LU,'(A)') 'CRREF = 275.0,103.0,1.0,1.0'
        WRITE (LU,'(A)') 'CRROT = 0.0, 0.0,0.0,0.0'
        WRITE (LU,'(A)') 'UNITS = "JY/BEAM"'
        WRITE (LU,'(A)') 'EPOCH = 2000.0'
        WRITE (LU,'(A)') '/'
      END DO
    END IF

    IF (PLOTCHISQ) THEN
      IF (NCONFIG .LT. 10) THEN
        WRITE (ICHISQFILE, '(A7,I1,A4)') 'ICHISQ0',NCONFIG,'.TXT'
        WRITE (QCHISQFILE, '(A7,I1,A4)') 'QCHISQ0',NCONFIG,'.TXT'
```

```
        WRITE (UCHISQFILE, '(A7,I1,A )') 'UCHISQ0',NCONFIG,'.TXT'
       ELSE
        WRITE (ICHISQFILE, '(A6,I2,A4)') 'ICHISQ',NCONFIG,'.TXT'
        WRITE (QCHISQFILE, '(A6,I2,A4)') 'QCHISQ',NCONFIG,'.TXT'
        WRITE (UCHISQFILE, '(A6,I2,A4)') 'UCHISQ',NCONFIG,'.TXT'
       END IF
       OPEN(UNIT=40,FILE=ICHISQFILE,STATUS='UNKNOWN')
       OPEN(UNIT=41,FILE=QCHISQFILE,STATUS='UNKNOWN')
       OPEN(UNIT=42,FILE=UCHISQFILE,STATUS='UNKNOWN')
       DO LU = 40, 42   ! Write headers
        WRITE (LU,'(A)') 'NAXIS = 4'
        WRITE (LU,'(A)') 'DIM  = 549, 205, 1, 1'
        WRITE (LU,'(A)') 'FORMAT = "549E10.3"'
        WRITE (LU,'(A)') 'OBJECT = "Error"'
        WRITE (LU,'(A)') 'CRTYPE="RA---SIN","DEC--SIN",
     &              "FREQ","STOKES"'
        WRITE (LU,'(A)') 'CRINC =-0.000027777778,0.000027777778,
     &    1.0E8,1.0'
        WRITE (LU,'(A,F12.8,A,F12.8,A,I2)') 'CRVAL = ',RADEG,',',
     &   DECDEG,',8.4399E9,',STOKESCODE(LU)
        WRITE (LU,'(A)') 'CRREF = 275.0,103.0,1.0,1.0'
        WRITE (LU,'(A)') 'CRROT = 0.0, 0.0,0.0,0.0'
        WRITE (LU,'(A)') 'UNITS = "CHI-SQ"'
        WRITE (LU,'(A)') 'EPOCH = 2000.0'
        WRITE (LU,'(A)') '/'
       END DO
      END IF

* Convert to radians and project to frame of jet

      THETA = THETA*DEGRAD
      ST = SIN(THETA)

      RHO0 = RHO0/ST
      RHO1 = RHO1/ST
      RHOF = RHOF/ST

      XI0 = XI0*DEGRAD
      ZETA0 = ZETA0*DEGRAD
      XI0 = ASIN(SIN(XI0)*ST)
      ZETA0 = ASIN(SIN(ZETA0)*ST)
      XI1 = XI1*DEGRAD
      ZETA1 = ZETA1*DEGRAD
      XI1 = ASIN(SIN(XI1)*ST)
      ZETA1 = ASIN(SIN(ZETA1)*ST)

* Calculate model

      CALL MAKEMODEL (SOBS, SCORE, FWHM, IARR, QARR, UARR, SCALE)

* Evaluate chi-squared over defined areas

      ICHISQ_J = 0.0
      QCHISQ_J = 0.0
      UCHISQ_J = 0.0
      ICHISQ_CJ = 0.0
      QCHISQ_CJ = 0.0
      UCHISQ_CJ = 0.0
```

```
      NPOINTS = 0
      DO I = -XCMAX, XCMAX
        DO J = -YMAX, YMAX
          IF (ABS(I) .GT. XMIN .AND.
     &        ABS(J) .LT. NINT(A*REAL(ABS(I))+B)) THEN
            ICHISQ(I,J) = ((IMAP(I,J)-IARR(I,J))/SIGMA_I)**2
            QCHISQ(I,J) = ((QMAP(I,J)-QARR(I,J))/SIGMA_P)**2
            UCHISQ(I,J) = ((UMAP(I,J)-UARR(I,J))/SIGMA_P)**2
            NPOINTS = NPOINTS + 1
          ELSE
            ICHISQ(I,J) = 0.0
            QCHISQ(I,J) = 0.0
            UCHISQ(I,J) = 0.0
          END IF
          IF (I .GT. 0) THEN   ! Jet side
            ICHISQ_J = ICHISQ_J + ICHISQ(I,J)
            QCHISQ_J = QCHISQ_J + QCHISQ(I,J)
            UCHISQ_J = UCHISQ_J + UCHISQ(I,J)
          ELSE
            ICHISQ_CJ = ICHISQ_CJ + ICHISQ(I,J)
            QCHISQ_CJ = QCHISQ_CJ + QCHISQ(I,J)
            UCHISQ_CJ = UCHISQ_CJ + UCHISQ(I,J)
          END IF
        END DO
      END DO

* Write out model maps

      IF (PLOTMAP) THEN
        DO J = -YMAX,YMAX
          WRITE (30,'(549E10.3)') (IARR(I,J),I=-XMAX,XMAX)
          WRITE (31,'(549E10.3)') (QARR(I,J),I=-XMAX,XMAX)
          WRITE (32,'(549E10.3)') (UARR(I,J),I=-XMAX,XMAX)
        END DO
      END IF

* Write out chi-squared maps

      IF (PLOTCHISQ) THEN
        DO J = -YMAX,YMAX
          WRITE (40,'(549E10.3)') (ICHISQ(I,J),I=-XMAX,XMAX)
          WRITE (41,'(549E10.3)') (QCHISQ(I,J),I=-XMAX,XMAX)
          WRITE (42,'(549E10.3)') (UCHISQ(I,J),I=-XMAX,XMAX)
        END DO
      END IF

* Write log file entry

      WRITE (20,'(A, I3)') 'Configuration ',NCONFIG
      WRITE (20, '(10F7.3)')
     & VALUE(1,I1), VALUE(2,I2), VALUE(3,I3), VALUE(4,I4), VALUE(5,I5),
     & VALUE(6,I6), VALUE(7,I7), VALUE(8,I8), VALUE(9,I9),
     & VALUE(10,I10)
      WRITE (20, '(10F7.3)')
     & VALUE(11,I11),VALUE(12,I12),VALUE(13,I13),VALUE(14,I14),
     & VALUE(15,I15),VALUE(16,I16),VALUE(17,I17),VALUE(18,I18),
     & VALUE(19,I19),VALUE(20,I20)
      WRITE (20, '(4F7.3)')
```

```
     & VALUE(21,I21),VALUE(22,I22),VALUE(23,I23),VALUE(24,I24)
      WRITE (20, '(3E10.3,I8)')
     &  ICHISQ_J+ICHISQ_CJ, S     &  QCHISQ_J+QCHISQ_CJ+UCHISQ_J+UCHISQ_CJ,
     &  ICHISQ_J+ICHISQ_CJ + QCHISQ_J+QCHISQ_CJ+UCHISQ_J+UCHISQ_CJ,
     &  NPOINTS

* Keep track of various chi-squared minima

      IF (NCONFIG .EQ. 1) THEN ! First configuration
        ICHISQ_MIN = ICHISQ_J + ICHISQ_CJ
        PCHISQ_MIN = QCHISQ_J + QCHISQ_CJ + UCHISQ_J + UCHISQ_CJ
        IQUCHISQ_MIN = ICHISQ_MIN + PCHISQ_MIN
        IBEST = 1
        PBEST = 1
        IQUBEST = 1
      ELSE
        IF (ICHISQ_J + ICHISQ_CJ .LT. ICHISQ_MIN) THEN
          IBEST = NCONFIG
          ICHISQ_MIN = ICHISQ_J + ICHISQ_CJ
        END IF
        IF (QCHISQ_J + QCHISQ_CJ + UCHISQ_J + UCHISQ_CJ
     &       .LT. PCHISQ_MIN) THEN
          PBEST = NCONFIG
          PCHISQ_MIN = QCHISQ_J + QCHISQ_CJ + UCHISQ_J + UCHISQ_CJ
        END IF
        IF (ICHISQ_J + ICHISQ_CJ +
     &       QCHISQ_J + QCHISQ_CJ + UCHISQ_J + UCHISQ_CJ
     &       .LT. IQUCHISQ_MIN) THEN
          IQUBEST = NCONFIG
          IQUCHISQ_MIN = ICHISQ_J + ICHISQ_CJ +
     &              QCHISQ_J + QCHISQ_CJ + UCHISQ_J + UCHISQ_CJ
        END IF
      END IF


* Close any open output files

      IF (PLOTMAP) THEN
        CLOSE(30)
        CLOSE(31)
        CLOSE(32)
      END IF

      IF (PLOTCHISQ) THEN
        CLOSE(40)
        CLOSE(41)
        CLOSE(42)
      END IF

      TYPE *,'Done ',NCONFIG,' out of ',TOTCONFIG,' combinations'


      END DO
      END DO
      END DO
      END DO
      END DO
      END DO
```

```
 END DO
 END DO
 END DO
 END DO
 END DO
 END DO
 END DO
 END DO
 END DO
 END DO
 END DO
 END DO
 END DO
 END DO
 END DO
 END DO
 END DO

 TYPE *,'Best I model ',IBEST,' chi-squared = ',ICHISQ_MIN
 TYPE *,'Best QU model ',PBEST,' chi-squared = ',PCHISQ_MIN
 TYPE *,'Best IQU model ',IQUBEST,' chi-squared = ',
&        IQUCHISQ_MIN

 END
```

From VM Tue Jun 25 16:06:11 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["1915" "Tue" "25" "June" "1996" "14:22:54" "-0400" "Alan Bridle" "abridle" nil "50" "Re: Additional thoughts"
"^From:" nil nil "6" nil nil nil nil]
nil)
Content-Length: 1915
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA35059; Tue, 25 Jun 1996 14:22:54 -0400
Message-Id: <9606251822.AA35059@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.93.960620145227.22017A-100000@rgosf>
References: <Pine.GSO.3.93.960620145227.22017A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Additional thoughts
Date: Tue, 25 Jun 1996 14:22:54 -0400

Robert Laing writes:

>
> In the process of doing the optimization code, I have become a little
> concerned by the extent to which numbers specific to 3c31 are creeping in.
> If this is allowed to continue, it will become very difficult to change
> things if we try to model something else (usual problem of writing
> software before designing it!)
>
> I think I will do something about this soon, whilst I still remember what
> the code does. In particular, I think that the following need to be
> generalised:
>
> - Map dimensions (we should probably leave a maximum array size set, and
> specify the actual size of the map elsewhere)
> - Other header parameters (RA, Dec, cell-size, ...)
> - Rotation
> - Extended and core flux
> - Convolving beam
> - Default values
> - Input filenames
> - Size of array for convolution (nearest powers of 2 above maximum array
> size set earlier)
>
> Can you think of anything else?
>

This hits everything that I could think of.

> I think I will set up a defaults file to be read on startup. What do you
> think is the maximum likely size of map? I was thinking of using 1024 x
> 512 for the convolution and setting the array size to some suitable pair
> of odd numbers just less than this (a small guard zone is needed).

This also seems pretty reasonable.

>
> Do you think that there is a role for map2d, or would you rather run
> optimize with a single configuration instead? Likewise, should we
> incorporate angle in the same shell, and just put in an option to turn the
> flux scaling on and off? I'm tempted to put everything in one program to
> avoid having to change code in more than one place.

>

I think it's best to have it all in one place and run single configs
as a particular case of the optimizer; minimum maintenance, plus the
chi-squareds will be useful even when modeling "by hand" (or eye).

A.

From VM Tue Jun 25 16:06:13 1996
X-VM-v5-Data: ([nil nil nil nil lil nil nil nil nil]
["467" "Tue" "25" "June" "1996" "19:36:47" "+0100" "Robert Laing" "rl@ast.cam.ac.uk" nil "12" "More intelligent optimization" "^From:" nil nil "6" nil nil nil nil]
nil)
Content-Length: 467
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA21783; Tue, 25 Jun 1996 14:40:32 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.7.5/8.7.1/CV-2.1) with SMTP id OAA17669 for <abridle@polaris.cv.nrao.edu>; Tue, 25 Jun 1996 14:40:31 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id TAA21794; Tue, 25 Jun 1996 19:36:49 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id TAA09354; Tue, 25 Jun 1996 19:36:48 +0100
X-Sender: rl@rgosf
Reply-To: Robert Laing <rl@ast.cam.ac.uk>
Message-Id: <Pine.GSO.3.93.960625192209.9342A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
X-UIDL: 835732655.000
Status: RO
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: More intelligent optimization
Date: Tue, 25 Jun 1996 19:36:47 +0100 (BST)

I have been thinking a bit about the optimization process. One possibility
is to do the minimization using some standard method. I am tempted to try
downhill simplex (as in the Numerical Recipes routine amoeba). Jasper has
had some experience with this and thinks that it will do a reasonable job
if we can get the number of floating parameters <10 or so. Any thoughts?

I'll set up a generalized version of optimize as agreed within the next
few days.

Robert

From VM Wed Sep 11 13:40:36 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["1461" "Mon" "2" "September" "1996" "19:59:07" "+0100" "Robert Laing" "rl@ast.cam.ac.uk" "<Pine.GSO.3.94.960902190410.16221A-100000@rgosf>" "31" "3C 31" "^From:" nil nil "9" nil nil nil nil]
nil)
Content-Length: 1461
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA25214; Mon, 2 Sep 1996 15:02:53 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.7.5/8.7.1/CV-2.1) with SMTP id PAA07241 for <abridle@polaris.cv.nrao.edu>; Mon, 2 Sep 1996 15:02:52 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id TAA20665; Mon, 2 Sep 1996 19:59:11 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id TAA16268; Mon, 2 Sep 1996 19:59:09 +0100
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.960902190410.16221A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>

To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: 3C 31
Date: Mon, 2 Sep 1996 19:59:07 +0100 (BST)

Dear Alan

I have now run various optimizations with the 0.7-arcsec data, using an error estimate which is the rms of a percentage of the flux and a constant. If the "calibration error" is set to 5%, the program tends to emphasize the fit to the outer structure, as expected, and goes for a somewhat higher angle to the line of sight. With no calibration error term, it does better on the inner jet. I have also tried varying the area over which chi-squared is calculated.

None of this makes much of a difference to the polarization fit. As ever, this is qualitatively reasonable, but underestimates the Bperp polarization in the counter-jet by a factor of 2 and (less seriously) overestimates it in the main jet. I think that it will be impossible to fix this with any simple field configuration. Is the most likely solution that the counter-jet is bending towards the line of sight (20 - 30 degrees should do) in the outer regions of the fit? It would have to have done most of its bending by 10 arcsec from the nucleus in order to get the polarization right. There is certainly no obvious bending in this region in the plane of the sky, so the solution isn't all that plausible, but such bends are not unheard of in other sources (e.g. 3C66B).

I could, without very serious difficulty, model the case where the main and counter-jets are not aligned: do you think that is worth doing? Any subtler would be hard.

Advice appreciated.

Robert

From VM Wed Sep 11 13:44:08 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["1741" "Tue" "3" "September" "1996" "17:05:41" "+0100" "Robert Laing" "rl@ast.cam.ac.uk" nil "36" "Bending jets" "^From:" nil nil "9" nil nil nil nil]
nil)
Content-Length: 1741
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA31883; Tue, 3 Sep 1996 13:24:12 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.7.5/8.7.1/CV-2.1) with SMTP id NAA20284 for <abridle@polaris.cv.nrao.edu>; Tue, 3 Sep 1996 13:24:11 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA00732; Tue, 3 Sep 1996 17:05:44 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA17136; Tue, 3 Sep 1996 17:05:42 +0100
X-Sender: rl@rgosf
Reply-To: Robert Laing <rl@ast.cam.ac.uk>
Message-Id: <Pine.GSO.3.94.960903144444.17005A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: Bending jets
Date: Tue, 3 Sep 1996 17:05:41 +0100 (BST)

Second thoughts: bending the counter-jet won't be enough. In order to get the very high central polarization, we would have to decrease the shear layer fraction, in which case the transverse brightness profile would go wrong.

That leaves us with different ratios of longitudinal and toroidal field in the 2 jets, on average, although I hate the idea of breaking the symmetry to such an extent. If the longitudinal field component were to be larger in the main jet, then the field transition would move further from the nucleus, and overall Bperp polarizations would drop. Likewise, if the toroidal component were larger in the counter-jet, then all of the Bperp polarizations would go up. Using a 1D field in the shear layer moves the field transition to 11 arcsec from the core at 0.3 arcsec resolution, which is further out than observed, so a 2:1 ratio might be about right. The counter-jet would need a fair amount of toroidal field, since the central polarization reaches 40% even at 0.7 arcsec resolution.

Why would the two jets have different field configurations in their shear layers? The only thing that occurs to me is motion through the IGM: if a jet is moving against the flow, is it likely that its shear layer properties are affected?

The reason I'm harping on about this is that I would like to work out how much our conclusions on velocities are likely to be affected by changes in the field model. I can't help feeling I'm missing something here. My intuition says that there ought to be a natural way of generating the polarization differences between jet and counter-jet: they look too regular to be some random environmental effect. And are the "arcs" trying to tell us something?

Any ideas?

Robert

From VM Wed Sep 11 13:44:22 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["2782" "Tue" "3" "September" "1996" "15:53:18" "-0400" "Alan Bridle" "abridle" nil "56" "Re: 3C 31" "^From:" nil nil "9" nil nil nil nil]
nil)
Content-Length: 2782
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA30488; Tue, 3 Sep 1996 15:53:18 -0400
Message-Id: <9609031953.AA30488@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.960902190410.16221A-100000@rgosf>
References: <Pine.GSO.3.94.960902190410.16221A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: 3C 31
Date: Tue, 3 Sep 1996 15:53:18 -0400

Robert Laing writes:
> Dear Alan
>
> I have now run various optimizations with the 0.7-arcsec data, using an
> error estimate which is the rms of a percentage of the flux and a
> constant. If the "calibration error" is set to 5%, the program tends to
> emphasize the fit to the outer structure, as expected, and goes for a
> somewhat higher angle to the line of sight. With no calibration error
> term, it does better on the inner jet. I have also tried varying the
> area over which chi-squared is calculated.

I have been presuming that chi-sq is already intrinsically intensity-weighted,
do we need to do any more than that to give equal weight to areas of equal
integrated flux density?

>
> None of this makes much of a difference to the polarization fit. As ever,
> this is qualitatively reasonable, but underestimates the Bperp
> polarization in the counter-jet by a factor of 2 and (less seriously)
> overestimates it in the main jet. I think that it will be impossible to
> fix this with any simple field configuration. Is the most likely solution
> that the counter-jet is bending towards the line of sight (20 - 30 degrees
> should do) in the outer regions of the fit? It would have to have done
> most of its bending by 10 arcsec from the nucleus in order to get the
> polarization right. There is certainly no obvious bending in this region
> in the plane of the sky, so the solution isn't all that plausible, but
> such bends are not unheard of in other sources (e.g. 3C66B).
>

I'm reluctant to go off in that direction. There's a bottomless pit
once one lets the two jets have intrinsically different properties.
It's probably unsafe to dive into that without an explicit physical
picture of what the difference should be. My real concern is
(shudder) that it's the 2-d field approximation that limits us, in
other words the ratios of the organized (axial, toroidal) and
randomized (third dimension) field components. I would hope that to
first order any environmental effects on the field configurations are
symmetric; the source itself is not grotesquely asymmetric, and we are
modeling only a restricted region.

The arcs say there's clearly something going on that we are missing,

such a deviation from azimuthal symmetry in the shear layer. But the only way to tackle that would also imply a 3-d model.

I think I'd be worried if we have to go far beyond varying the ratios of azimuthal to axial fields in the shear layer away from unity, but keeping the same in both jets. Anything else might be helpful in telling what sorts of further complications may be needed in the real world, but uniqueness of the model would probably be reduced, not improved.

How much worse is the best 1-d fit than the best 2-d fit?

A.

From VM Wed Sep 11 13:44:24 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["3585" "Tue" "3" "September" "1996" "21:38:12" "+0100" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.960903205539.17334A-100000@rgosf>" "87" "Re: 3C 31" "^From:" nil nil "9" nil nil nil nil]
nil)
Content-Length: 3585
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA46322; Tue, 3 Sep 1996 16:38:21 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.7.5/8.7.1/CV-2.1) with SMTP
id QAA25737 for <abridle@nrao.edu>; Tue, 3 Sep 1996 16:38:19 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id VAA03371; Tue, 3 Sep 1996 21:38:14 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id VAA17347; Tue, 3 Sep 1996 21:38:12 +0100
X-Sender: rl@rgosf
Reply-To: Robert Laing <rl@ast.cam.ac.uk>
In-Reply-To: <9609031953.AA30488@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.960903205539.17334A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@nrao.edu>
Subject: Re: 3C 31
Date: Tue, 3 Sep 1996 21:38:12 +0100 (BST)

On Tue, 3 Sep 1996r Alan Bridle wrote:

>
> I have been presuming that chi-sq is already intrinsically intensity-weighted,
> do we need to do any more than that to give equal weight to areas of equal
> integrated flux density?
>

You are quite correct, it is intensity-weighted. I think that this
probably works quite well. The idea of the calibration error was to make
some allowance for (e.g.) deconvolution errors which affect the
high-brightness structure disproportionately. The differences are not
extreme, and I think a calibration error of 5% is too generous.

... bent jets, intrinsic differences,....

>
> I'm reluctant to go off in that direction. There's a bottomless pit
> once one lets the two jets have intrinsically different properties.

Yes, it is horrible. And the jets look straight. That's why the problem
is irritating me so much.

> It's probably unsafe to dive into that without an explicit physical
> picture of what the difference should be. My real concern is
> (shudder) that it's the 2-d field approximation that limits us, in
> other words the ratios of the organized (axial, toroidal) and
> randomized (third dimension) field components.

I'd better find some large sheets of paper ...

> I would hope that to
> first order any environmental effects on the field configurations are
> symmetric; the source itself is not grotesquely asymmetric, and we are
> modeling only a restricted region.
>
> The arcs say there's clearly something going on that we are missing,
> such a deviation from azimuthal symmetry in the shear layer. But
> the only way to tackle that would also imply a 3-d model.

I don't even know how to specify this. In any case, the arcs might even be axisymmetric (if they are shells, for instance) and their effect on the degree of polarization is not as obvious as that on total intensity, so the present difficulties might remain.

>
> I think I'd be worried if we have to go far beyond varying the ratios
> of azimuthal to axial fields in the shear layer away from unity,
> but keeping the same in both jets. Anything else might be helpful
> in telling what sorts of further complications may be needed in the
> real world, but uniqueness of the model would probably be reduced,
> not improved.

I'm not sure that even this will work: to a first approximation (no beaming), what you gain in the jet, you lose in the counter jet, and vice versa. The only thing that I can think of in the second approximation is to start with something like B_long = 2 or 3B_tor at the base of the jet, evolving to B_log = 0.5B_tor at the end of the straight region. Then the aberration in the shear layer at least goes in the right sense. We would have to use the mechanism that creates the high Bperp polarization at the base of the counter-jet - i.e. the rotation of shear layer field so that we see it edge-on in the rest frame - but over a longer distance. Might just work, if optimized carefully.

>
> How much worse is the best 1-d fit than the best 2-d fit?
>

In the jet, the fit isn't bad. In the counter-jet it is dreadful (parallel field everywhere).

I think what I will do is the following:
- finish the set of instructions and send you the current program by close of play on Friday - have a play and see what you think;
- consider the problem of unequal field components next week (I'm planning a few day's walking);
- if I succeed, plug that into the code and let the ratio change with distance from the nucleus.

At least if there is an answer, it ought to be unique!?

Regards, Robert

From VM Wed Sep 11 13:44:26 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["3419" "Tue" "3" "September" "1996" "17:06:29" "-0400" "Alan Bridle" "abridle" nil "86" "Re: 3C 31" "^From:" nil nil "9" nil nil nil nil]
nil)
Content-Length: 3419
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA30341; Tue, 3 Sep 1996 17:06:29 -0400
Message-Id: <9609032106.AA30341@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.960903205539.17334A-100000@rgosf>
References: <9609031953.AA30488@polaris.cv.nrao.edu>
<Pine.GSO.3.94.960903205539.17334A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laiog <rl@ast.cam.ac.uk>
Subject: Re: 3C 31
Date: Tue, 3 Sep 1996 17:06:29 -0400

Robert Laing writes:

> ... bent jets, intrinsic differences,....
>
> > I'm reluctant to go off in that direction. There's a bottomless pit
> > once one lets the two jets have intrinsically different properties.
>
> Yes, it is horrible. And the jets look straight. That's why the problem
> is irritating me so much.

OK, let's agree to swear off on intrinsic differences for the forseable future, then.

> > picture of what the difference should be. My real concern is
> > (shudder) that it's the 2-d field approximation that limits us, in
> > other words the ratios of the organized (axial, toroidal) and
> > randomized (third dimension) field components.
>
> I'd better find some large sheets of paper ...

or Mathematica?

> > The arcs say there's clearly something going on that we are missing,
> > such a deviation from azimuthal symmetry in rhe shear layer. But
> > the only way to tackle that would also imply a 3-d model.
>
> I don't even know how to specify this. In any case, the arcs might even
> be axisymmetric (if they are shells, for instance) and their effect on the
> degree of polarization is not as obvious as that on total intensity, so
> the present difficulties might remain.

True 'nuff.

> > I think I'd be worried if we have to go far beyond varying the ratios
> > of azimuthal to axial fields in the shear layer away from unity,

> > but keeping the same in both jets. Anything else might be helpful
> > in telling what sorts of further complications may be needed in the
> > real world, but uniqueness of the model would probably be reduced,
> > not improved.
>
> I'm not sure that even this will work: to a first approximation (no
> beaming), what you gain in the jet, you lose in the counter jet, and vice
> versa. The only thing that I can think of in the second approximation is
> to start with something like B_long = 2 or 3B_tor at the base of the jet,
> evolving to B_log = 0.5B_tor at the end of the straight region. Then the
> aberration in the shear layer at least goes in the right sense. We would
> have to use the mechanism that creates the high Bperp polarization at the
> base of the counter-jet - i.e. the rotation of shear layer field so that
> we see it edge-on in the rest frame - but over a longer distance. Might
> just work, if optimized carefully.

>
> >
> > How much worse is the best 1-d fit than the best 2-d fit?
> >
>
> In the jet, the fit isn't bad. In the counter-jet it is dreadful
> (parallel field everywhere).

Does this comparison give any clues to the robustness of the inferred velocity regime, however?

>
> I think what I will do is the following:
> - finish the set of instructions and send you the current program by
> close of play on Friday - have a play and see what you think;
> - consider the problem of unequal field components next week (I'm
> planning a few day's walking);
> - if I succeed, plug that into the code and let the ratio change with
> distance from the nucleus.
>
> At least if there is an answer, it ought to be unique!?
>

I agree. And I will kick it around as you suggest with latest version.
I have been having a bad interrupt cycle the last week (usual stuff plus Labor Day weekend plus some fortunately minor medical problems, been a but more distracted than usual). Things should improve now.

A.

From VM Wed Sep 11 13:44:47 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["474" "Thu" "5" "September" "1996" "16:32:07" "+0100" "Robert Laing" "rl@ast.cam.ac.uk" nil "14" "New program" "^From:" nil nil "9" nil nil nil nil]
nil)
Content-Length: 474
Received: from tarsier.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA45022; Thu, 5 Sep 1996 11:45:44 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by tarsier.cv.nrao.edu (8.6.13/$Revision: 2.10 $) with ESMTP id LAA28676; Thu, 5 Sep 1996 11:43:59 -0400
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id QAA26196; Thu, 5 Sep 1996 16:32:09 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id QAA19655; Thu, 5 Sep 1996 16:32:08 +0100
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.960905162722.19589A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: New program
Date: Thu, 5 Sep 1996 16:32:07 +0100 (BST)

Dear Alan,

I have finished a set of fairly comprehensive instructions for the new program, and put it, all of the code and associated files in a tar file for you.

All of the files needed to build and run model are included in the gnu-zipped tar file model.tar.gz in the anonymous ftp area on ast.cam.ac.uk. To get the file, ftp ftp.ast.cam.ac.uk, login as anonymous, and cd to pub/rl.

The instructions are in instructions.txt. Good luck!

Regards, Robert

From VM Mon Oct 7 13:17:33 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["743" "Wed" "25" "September" "1996" "13:52:31" "+0100" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.960925134450.16184A-100000@rgosf>" "16" "B fields" "^From:" nil nil "9" nil nil nil nil]
nil)
Content-Length: 743
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA28963; Wed, 25 Sep 1996 08:56:30 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.7.5/8.7.1/CV-2.1) with SMTP
id IAA29830 for <abridle@polaris.cv.nrao.edu>; Wed, 25 Sep 1996 08:56:27 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id NAA25311; Wed, 25 Sep 1996 13:52:34 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id NAA16187; Wed, 25 Sep 1996 13:52:32 +0100
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.960925134450.16184A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: B fields
Date: Wed, 25 Sep 1996 13:52:31 +0100 (BST)

Dear Alan

I now have a solution for the variable toroidal/axial field case. There is some difficulty because of the need to do the integrations for I, Q and U for different values of the anisotropy parameter, and for 2 angular degrees of freedom rather than 1 (+ a more complicated expression for the polarization PA). My previous approach of making a grid of integrations and interpolating to the correct angle would lead to a very large array. I think, therefore, that I will use the analytical solutions for alpha = 1, and merely scale the polarization to the correct spectral index. The percentage error will be quite small - less than other approximations in the model, I think. Does that sound reasonable to you?

Regards, Robert

From VM Mon Oct 7 13:17:41 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["268" "Wed" "25" "September" "1996" "14:09:24" "+0100" "Robert Laing" "rl@ast.cam.ac.uk" nil "7" "Form of anisotropy variation" "^From:" nil nil "9" nil nil nil nil]
nil)
Content-Length: 268
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA29318; Wed, 25 Sep 1996 09:15:38 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.7.5/8.7.1/CV-2.1) with SMTP id JAA00283 for <abridle@polaris.cv.nrao.edu>; Wed, 25 Sep 1996 09:15:37 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id OAA25683; Wed, 25 Sep 1996 14:09:27 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id OAA16267; Wed, 25 Sep 1996 14:09:25 +0100
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.960925140703.16257A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: Form of anisotropy variation
Date: Wed, 25 Sep 1996 14:09:24 +0100 (BST)

What do you think should be the form of variation of the
toroidal/longitudinal field ratio? First guess would be to use the same
idea as for the velocity, with fiducial values at the beginning of the
jet, rho1, rho0 and rhof + linear variation between them.

Robert

From VM Mon Oct 7 13:17:43 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["140" "Wed" "25" "September" "1996" "14:29:16" "+0100" "Robert Laing" "rl@ast.cam.ac.uk" nil "5" "P.S."
"^From:" nil nil "9" nil nil nil nil]
nil)
Content-Length: 140
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA22254; Wed, 25 Sep 1996 09:33:02 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.7.5/8.7.1/CV-2.1) with SMTP
id JAA00453 for <abridle@polaris.cv.nrao.edu>; Wed, 25 Sep 1996 09:33:01 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id OAA26052; Wed, 25 Sep 1996 14:29:18 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id OAA16284; Wed, 25 Sep 1996 14:29:17 +0100
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.960925142731.16282A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: P.S.
Date: Wed, 25 Sep 1996 14:29:16 +0100 (BST)

I wonder whether it would be better to use log(field ratio)? Otherwise,
we are effectively treating the 2 components differently.

Robert

From VM Mon Oct 7 13:17:49 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["2562" "Wed" "25" "September" "1996" "11:40:53" "-0400" "Alan Bridle" "abridle" nil "51" "Re: B fields" "^From:"
nil nil "9" nil nil nil nil]
nil)
Content-Length: 2562
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA25220; Wed, 25 Sep 1996 11:40:53 -0400
Message-Id: <9609251540.AA25220@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.960925134450.16184A-100000@rgosf>
References: <Pine.GSO.3.94.960925134450.16184A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: B fields
Date: Wed, 25 Sep 1996 11:40:53 -0400

Robert Laing writes:

> I now have a solution for the variable toroidal/axial field case. There
> is some difficulty because of the need to do the integrations for I, Q and
> U for different values of the anisotropy parameter, and for 2 angular
> degrees of freedom rather than 1 (+ a more complicated expression for the
> polarization PA). My previous approach of making a grid of integrations
> and interpolating to the correct angle would lead to a very large array.
> I think, therefore, that I will use the analytical solutions for alpha =
> 1, and merely scale the polarization to the correct spectral index. The
> percentage error will be quite small - less than other approximations in
> the model, I think. Does that sound reasonable to you?
>

That sounds perfectly reasonable to me. At least at the moment, we know we are limited in interpreting the observations by what seem to be "local" features. And we need to explore how much the overall polarization patterns can still be conditioned by our field assumptions. We are not expecting to extract precise numbers in any case at present, rather to see if there is a general regime that fits the overall polarization pattern a little better than at present. I doubt that the spectral index dependence is anywhere near as large as other effects in that context.

Might it be worth us running some spectral differences with the present "best fit" model just to verify that? Maybe you've done that already? I wonder what we would get if we looked for a chisq minimum just in spectral index, with other parameters in their 0.7-arc sec optimized state, for example?

As to the form of the ratio variation, I would think varying the log of the field ratio in some proportion (linearly?) to the velocity gradient might be appropriate. Basically we expect the velocity gradient to encourage the axial component but to leave the toroidal one alone. Without some real physics telling us how the componenIs are likely to be maintained, I think just having something convenient to calculate that generates a correlation of that sign is all we can aspire to! So how about making log(B_z/B_phi) = a (grad v) + b in the layer? Then we could vary a for the strength of the effect and b for the bias value, and see if the velocity field does anything

interesting with the rest!

This is all _terribly_ hueristic, I wonder if there will ever be any relativistic boundary-layer magnetohydrodynamicists to guide us in this? Possibly we can hope to motivate them, and no more than that?

A.

From VM Mon Oct 7 13:17:51 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["1568" "Wed" "25" "September" "1996" "17:35:24" "+0100" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.960925172834.16438A-100000@rgosf>" "39" "Re: B fields" "^From:" nil nil "9" nil nil nil nil]nil)
Content-Length: 1568
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id AA46344; Wed, 25 Sep 1996 12:35:29 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.7.5/8.7.1/CV-2.1) with SMTP
id MAA03809 for <abridle@nrao.edu>; Wed, 25 Sep 1996 12:35:28 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA01461; Wed, 25 Sep 1996 17:35:25 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA16441; Wed, 25 Sep 1996 17:35:24 +0100
X-Sender: rl@rgosf
In-Reply-To: <9609251540.AA25220@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.960925172834.16438A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@nrao.edu>
Subject: Re: B fields
Date: Wed, 25 Sep 1996 17:35:24 +0100 (BST)

> Might it be worth us running some spectral differences with the
> present "best fit" model just to verify that? Maybe you've done that
> already? I wonder what we would get if we looked for a chisq minimum
> just in spectral index, with other parameters in their 0.7-arc sec
> optimized state, for example?
>

I haven't tried this. The differences must be very subtle. Worth a look,
though.

> As to the form of the ratio variation, I would think varying the log
> of the field ratio in some proportion (linearly?) to the velocity
> gradient might be appropriate. Basically we expect the velocity gradient
> to encourage the axial component but to leave the toroidal one
> alone. Without some real physics telling us how the components are
> likely to be maintained, I think just having something convenient to
> calculate that generates a correlation of that sign is all we can
> aspire to! So how about making log(B_z/B_phi) = a (grad v) + b
> in the layer? Then we could vary a for the strength of the effect
> and b for the bias value, and see if the velocity field does anything
> interesting with the rest!

That's an interesting thought, although the expansion/deceleration rate is
also relevant.

> This is all _terribly_ hueristic, I wonder if there will ever
> be any relativistic boundary-layer magnetohydrodynamicists to
> guide us in this? Possibly we can hope to motivate them, and no
> more than that?
>

Bad enough getting a consistent story out of the theorists in the
supersonic, non-magnetised non-relativistic case!

Robert

From VM Mon Oct 7 13:17:54 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["1294" "Wed" "25" "September" "1996" "13:25:35" "-0400" "Alan Bridle" "abridle" nil "31" "Re: B fields" "^From:" nil nil "9" nil nil nil nil]
nil)
Content-Length: 1294
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA35224; Wed, 25 Sep 1996 13:25:35 -0400
Message-Id: <9609251725.AA35224@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.960925172834.16438A-100000@rgosf>
References: <9609251540.AA25220@polaris.cv.nrao.edu>
<Pine.GSO.3.94.960925172834.16438A-100000@rgosf>
From:tabridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: B fields
Date: Wed, 25 Sep 1996 13:25:35 -0400

Robert Laing writes:
>
> > As to the form of the ratio variation, I would think varying the log
> > of the field ratio in some proportion (linearly?) to the velocity
> > gradient might be appropriate. Basically we expect the velocity gradient
> > to encourage the axial component but to leave the toroidal one
> > alone. Without some real physics telling us how the components are
> > likely to be maintained, I think just having something convenient to
> > calculate that generates a correlation of that sign is all we can
> > aspire to! So how about making log(B_z/B_phi) = a (grad v) + b
> > in the layer? Then we could vary a for the strength of the effect
> > and b for the bias value, and see if the velocity field does anything
> > interesting with the rest!
> >
>
> That's an interesting thought, although the expansion/deceleration rate is
> also relevant.
>

Right, I overlooked that. dv_z/dz affects B_phi, probably more predictably than dv_r/dr affects B_z, as it is likely an adiabat. For that case it would probably be sensible to take the adiabat as the "baseline" behavior? God knows why B_phi is there unless it came off the accretion disk that way, but once we have it in the mix there is probably no harm in dealing with it adiabatically.

A.

From VM Mon Oct 7 13:18:33 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["428" "Thu" "26" "September" "1996" "20:36:07" "+0100" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.960926203112.19552A-100000@rgosf>" "12" "Progress" "^From:" nil nil "9" nil nil nil nil]
nil)
Content-Length: 428
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA24181; Thu, 26 Sep 1996 15:39:55 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.7.5/8.7.1/CV-2.1) with SMTP
id PAA25351 for <abridle@polaris.cv.nrao.edu>; Thu, 26 Sep 1996 15:39:54 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id UAA03496; Thu, 26 Sep 1996 20:36:11 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id UAA19554; Thu, 26 Sep 1996 20:36:09 +0100
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.960926203112.19552A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: Progress
Date: Thu, 26 Sep 1996 20:36:07 +0100 (BST)

Dear Alan

I now have the variable Bz/Bphi code working (at least it duplicates the
previous version when there is no difference in field strengths, and gives
sensible-looking results). I will run some optimizations to see whether
it can be used to make major improvements to the fit.

We have open days tomorrow and Saturday, so I am planning to work at home
- I'll probably have something useful on Monday.

Cheers, Robert

From VM Mon Oct 7 13:18:42 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["842" "Thu" "26" "September" "1996" "18:09:34" "-0400" "Alan Bridle" "abridle" nil "27" "Re: Progress" "^From:"
nil nil "9" nil nil nil nil]
nil)
Content-Length: 842
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA47601; Thu, 26 Sep 1996 18:09:34 -0400
Message-Id: <9609262209.AA47601@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.960926203112.19552A-100000@rgosf>
References: <Pine.GSO.3.94.960926203112.19552A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Progress
Date: Thu, 26 Sep 1996 18:09:34 -0400

Robert Laing writes:

> I now have the variable Bz/Bphi code working (at least it duplicates the
> previous version when there is no difference in field strengths, and gives
> sensible-looking results). I will run some optimizations to see whether
> it can be used to make major improvements to the fit.
>

Tremendous!

> We have open days tomorrow and Saturday, so I am planning to work at home
> - I'll probably have something useful on Monday.

Sounds good; I should warn that I will quasi-disappear for a hile
as we have a visit from Mary's brother in Australiia next week, then I have
been talked into being on an NSF review panel which involves reading
30 grant proposals in the next couple of week before a two-day meeting
in DC to priorize them. It's going to be hard to come up for air in
the middle of that lot ...

A.

From VM Mon Oct 7 13:19:41 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["714" "Mon" "30" "September" "1996" "14:56:18" "+0100" "Robert Laing" "rl@ast.cam.ac.uk" nil "14" "P.S."
"^From:" nil nil "9" nil nil nil nil]
nil)
Content-L.ngth: 714
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA36888; Mon, 30 Sep 1996 10:00:14 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.7.5/8.7.1/CV-2.1) with SMTP
id KAA23935 for <abridle@polaris.cv.nrao.edu>; Mon, 30 Sep 1996 10:00:12 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id OAA10141; Mon, 30 Sep 1996 14:56:21 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id OAA23356; Mon, 30 Sep 1996 14:56:19 +0100
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.960930144648.23318C-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: P.S.
Date: Mon, 30 Sep 1996 14:56:18 +0100 (BST)

A couple of random thoughts before I forget. Firstly, the highest value
of jet/counterjet (at 5 arcsec from the nucleus) corresponds to a minimum
in the counter-jet. Although we model the knot at the beginning of the
counter-jet quite well, it is (inevitably, I suppose) more extended than
in real life. The jet fit is very good at that distance. Secondly, it
might be that the fit in the rapid expansion region is now limited by the
assumption that the flow is purely radial. If you look at the field
vectors, you see that they first diverge rapidly, and then recollimate
(as, presumably, does the flow). I will have a quick look to see whether
there is some straightforward way of including this.

Robert

From VM Mon Oct 7 13:19:47 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["460" "Thu" "3" "October" "1996" "11:34:00" "-0400" "Alan Bridle" "abridle" nil "14" "Re: Progress" "^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 460
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA38454; Thu, 3 Oct 1996 11:34:00 -0400
Message-Id: <9610031534.AA38454@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.960930141333.23318A-100000@rgosf>
References: <Pine.GSO.3.94.960930141333.23318A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Progress
Date: Thu, 3 Oct 1996 11:34:00 -0400

Hi Robert,

I think a previous message of mine might have got lost, so if
this turns out to be a repeat please forgive the confusion.

Great news that the extra degree of freedom gets the polarization
looking much better. Especially so soon after you got the more
complicated code going -- any chance you could put the code or
the present images somewhere I can ftp them some time soon? I'm
very curious to see the goodies myself, of course!

Cheers, A.

From VM Mon Oct 7 13:19:49 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["3310" "Fri" "4" "October" "1996" "15:35:48" "+0100" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.961004150540.28080A-100000@rgosf>" "74" "Re: Progress" "^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 3310
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA17302; Fri, 4 Oct 1996 10:36:22 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.7.6/8.7.1/CV-2.1) with SMTP
id KAA11015 for <abridle@nrao.edu>; Fri, 4 Oct 1996 10:36:18 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id PAA20504; Fri, 4 Oct 1996 15:35:52 +0100
Received: from localhost by rgosf.ast.cam.Ic.uk (SMI-8.6/SMI-SVR4)
id PAA28691; Fri, 4 Oct 1996 15:35:50 +0100
X-Sender: rl@rgosf
In-Reply-To: <9610031534.AA38454@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.961004150540.28080A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@nrao.edu>
Subject: Re: Progress
Date: Fri, 4 Oct 1996 15:35:48 +0100 (BST)

On Thu, 3 Oct 1996, Alan Bridle wrote:

> Hs Robert,
>
> I think a previous message of mine might have got lost, so if
> this turns out to be a repeat please forgive the confusion.
>

I think I replied to your message and then got side-tracked and forgot to
put the new code where you could find it.

>
> Great news that the extra degree of freedom gets the polarization
> looking much better. Especially so soon after you got the more
> complicated code going -- any chance you could put the code or
> the present images somewhere I can ftp them some time soon? I'm
> _very_ curious to see the goodies myself, of course!
>
> Cheers, A.

New version of the program is now in the anon ftp area here. As before,
cd pub/rl and get model.tar.gz. The current data files CONSTL.DAT and
VARLOW.DAT are set up to do the optimized model with unequal field
components and chi-squared evaluated over the central region. modell.csh
has the right steering parameters.

I have also put some images and colour postscript files in the same area.
ANIS1.I,Q,U are the convolved models with chis-squared evaluated over the
whole (jet+CJ) region. ANIS2.I,Q,U are the output of the model using the
variables in VARLOW.DAT and a restricted area for chi-squared. These are
all disk FITS files. ANIS*.PS are files generated by TVCPS for ANIS1.
They are I, P, %P, data/model and jet/cj in fairly obvious notation.

ANIS2*.PS are the corresponding files for the other model (the data files are much smaller!).

My current scheme is to improve the verisimilitude of the transition region. At present, flow lines start from nowhere, which is unphysical. Also, the observed field lines suggest that the flow expands and recollimates. As I think I said in a previous message, my original idea was to interpolate using a cubic function which matched values and directions of flow lines at the transition radii. It turned out to be straightforward, but messy, to write down the expression for the flow lines, but hideous to convert from position in the jet to flow-line parameters. I then decided on a simpler approach, which is to abandon matching of derivatives, and just have flow along straight lines in the transition region, enforcing continuity at each end. Solving for the velocity in the shear layer still wasn't trivial (and isn't exact - I used a small-angle approximation), but I think I now have the maths done. I'll code it and see what happens.

It also occurred to me that doing the field sheet with unequal components using numerical integration might not be as hard as I thought, for 2 reasons:

- we probably don't need such a large range of anisotropy parameter and
- the way I set the problem up at the moment may have an unnecessary degree of freedom (I calculate I, Q and U directly, rather than calculating I and P as integrals and evaluating the PA separately). I'm not sure whether this can be done for the new field configuration, but if it can, only a 2D array is needed for the values of I and P.

I'll see whether the numerical approach is sensible.

I tried to put some of the maths into Latex the other day .... nearly drove myself insane and started to suspect that the worst difficulty in proving Fermat's last theorem was typesetting the paper.

Have fun.

Robert

From VM Mon Oct 7 13:20:10 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["446" "Fri" "4" "October" "1996" "11:48:17" "-0400" "Alan Bridle" "abridle" nil "11" "Re: Progress" "^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 446
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
: id AA57118; Fri, 4 Oct 1996 11:48:17 -0400
Message-Id: <9610041548.AA57118@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961004150540.28080A-100000@rgosf>
References: <9610031534.AA38454@polaris.cv.nrao.edu>
<Pine.GSO.3.94.961004150540.28080A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Progress
Date: Fri, 4 Oct 1996 11:48:17 -0400

Hi Robert,

I think there may have been a message or two in both directions
that got lost, but I now have the new code and the I,Q,U files
here. I guess having I Q and U is a sanity check and at least
in the models I did here years ago it helped when adding the
Faraday rotation to the sums (not that I think we will try to
do that here!). But it may be worth leaving this program
extensible in such directions so far as possible?

Cheers, A.

From VM Thu Oct 10 16:11:23 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["2648" "Thu" "10" "October" "1996" "15:59:33" "-0400" "Alan Bridle" "abridle" nil "53" "Re: Progress" "^From:" nil
nil "10" nil nil (number " " mark " Alan Bridle Oct 10 53/2648 " thread-indent "\"Re: Progress\"\n") nil]
nil)
Content-Length: 2648
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA26138; Thu, 10 Oct 1996 15:59:33 -0400
Message-Id: <9610101959.AA26138@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961004150540.28080A-100000@rgosf>
References: <9610031534.AA38454@polaris.cv.nrao.edu>
<Pine.GSO.3.94.961004150540.28080A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Progress
Date: Thu, 10 Oct 1996 15:59:33 -0400

Robert Laing writes:
>
>
> New version of the program is now in the anon ftp area here. As before,
> cd pub/rl and get model.tar.gz. The current data files CONSTL.DAT and
> VARLOW.DAT are set up to do the optimized model with unequal field
> components and chi-squared evaluated over the central region. modell.csh
> has the right steering parameters.
>
> I have also put some images and colour postscript files in the same area.
> ANIS1.I,Q,U are the convolved models with chis-squared evaluated over the
> whole (jet+CJ) region. ANIS2.I,Q,U are the output of the model using the
> variables in VARLOW.DAT and a restricted area for chi-squared. These are
> all disk FITS files. ANIS*.PS are files generated by TVCPS for ANIS1.
> They are I, P, %P, data/model and jet/cj in fairly obvious notation.
> ANIS2*.PS are the corresponding files for the other model (the data files
> are much smaller!).
>

I didn't try to grab the .PS files as they were so big, but I remade
the model and some others here - I take it that the VARLOW.DAT in the
ftp area did in fact correspond to ANIS2.

Do you happen to have a note of the VARLOW.DAT that produced your
ANIS1, by any chance? It does do noticeably better on the large-scale
sidedness, but I agree they the models are pretty good across the
board now that the extra field freedom is there, so we can probably
declare victory by the usual standards quite soon.

I notice that even in the center-weighted optimization the sidedness
peak in the model is fighting hard to be closer to the base of the
jet, and the modeled polarized intensity is much more obviously
bifurcated as we start to resolving the shear layer than is the
observed polarized intensity. Looks like the field in the actual
shear layer is a little less axial in the transition regime than we
are making it at present. Both of these seem to point to things still
not being quite right in the first transition zone, and presumably
this connects to your misgivings about the nonphysical velocity field
there.

Even so, my feeling from the responses I get showing any of this to

people here is that the general populace is quite ready to agree that we are headed in the right direction. The local VLBI'ers (Tony Z., Ken K.) are in fact quite astounded by the idea that so much image detail can be represented with just a few analytic forms!

There's an internal symposium going on here at the end of the month (immediately after I get back from DC for the NSF reviews, so I'll have to prepare everything for it this week). Will it be o.k. by you if I show the current state of these models there?

Cheers, A.

From VM Fri Oct 11 09:00:30 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["2784" "Fri" "11" "October" "1996" "11:46:12" "+0100" "Robert Laing" "rl@ast.cam.ac.uk" nil "85" "Re: Progress"
"^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 2784
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA58010; Fri, 11 Oct 1996 06:46:20 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.1) with SMTP
id GAA03238 for <abridle@nrao.edu>; Fri, 11 Oct 1996 06:46:18 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id LAA25432; Fri, 11 Oct 1996 11:46:15 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id LAA08637; Fri, 11 Oct 1996 11:46:14 +0100
X-Sender: rl@rgosf
In-Reply-To: <9610101959.AA26138@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.961011113529.8622A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@nrao.edu>
Subject: Re: Progress
Date: Fri, 11 Oct 1996 11:46:12 +0100 (BST)

On Thu, 10 Oct 1996, Alan Bridle wrote:

>
> I didn't try to grab the .PS files as they were so big, but I remade
> the model and some others here - I take it that the VARLOW.DAT in the
> ftp area did in fact correspond to ANIS2.
>

That's right. I've had to clear the disk space now, so I;m relieved you
got the important bits.

> Do you happen to have a note of the VARLOW.DAT that produced your
> ANIS1, by any chance? It does do noticeably better on the large-scale
> sidedness, but I agree they the models are pretty good across the
> board now that the extra field freedom is there, so we can probably
> declare victory by the usual standards quite soon.
>

Yes, here it is:

THETA 56.990
SPANG0 5.621
BETA1 0.945
BETA0 0.859
BETAF 0.352
ESP_MID 4.405
ESP_OUT 1.699
ESL_IN -1.906
ESL_MID 3.851
ESL_OUT 1.309
SPINE_SL 0.682
SLMIN 0.237

VMIN0 0.153
VMIN1 0.623
LG_ANISI -0.409
LG_ANIS1 -0.003
LG_ANIS0 -0.110
LG_ANISF -0.171

Rest as in ANIS2.

> I notice that even in the center-weighted optimization the sidedness
> peak in the model is fighting hard to be closer to the base of the
> jet, and the modeled polarized intensity is much more obviously
> bifurcated as we start to resolving the shear layer than is the
> observed polarized intensity. Looks like the field in the actual
> shear layer is a little less axial in the transition regime than we
> are making it at present. Both of these seem to point to things still
> not being quite right in the first transition zone, and presumably
> this connects to your misgivings about the nonphysical velocity field
> there.
>

I agree. I have made a fair amount of progress with the alternative velocity configuration, although I seem to have made more than the usual ration of what Martin Ryle would have described as "clot errors" in the first attempt. The spine is right, as is the 1D shear layer: the rest is still a bit broken. I should finish this over the weekend, with luck, and rerun the optimization.

> Even so, my feeling from the responses I get showing any of this to
> people here is that the general populace is quite ready to agree that
> we are headed in the right direction. The local VLBI'ers (Tony Z.,
> Ken K.) are in fact quite astounded by the idea that so much image
> detail can be represented with just a few analytic forms!
>

Perhaps it will encourage them to dig out some VLBI counter-jets for us to practice on!

> There's an internal symposium going on here at the end of the month
> (immediately after I get back from DC for the NSF reviews, so I'll
> have to prepare everything for it this week). Will it be o.k. by
> you if I show the current state of these models there?
>

Of course. Let me know if you need more on any of the details.

> Cheers, A.
>

Regards, Robert

From VM Thu Oct 17 09:46:58 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["1039" "Thu" "17" "October" "1996" "14:06:02" "+0100" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.961017133634.19352A-100000@rgosf>" "23" "Progress" "^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 1039
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA28300; Thu, 17 Oct 1996 09:09:53 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.1) with SMTP
id JAA10248 for <abridle@polaris.cv.nrao.edu>; Thu, 17 Oct 1996 09:09:50 -04t0 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id OAA27778; Thu, 17 Oct 1996 14:06:05 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id OAA19456; Thu, 17 Oct 1996 14:06:04 +0100
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.961017133634.19352A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrSo.edu>
Subject: Progress
Date: Thu, 17 Oct 1996 14:06:02 +0100 (BST)

Just to let you know that I have the revised geometry working, after a lot
of wall-climbing and hair-tearing (some real numerical problems, but most
due to a single line deleted by acciedent ... why is this never obvious)?

Anyway, I have run one optimization so far. This was not an improvement
over the old geometry, but I may not have given it a fair chance. It
wanted some unphysical things at the jet bases, and went for a nearly
longitudinal field for RHO < RHO0, thus screwing up the polarization and
intensity at the base of the counter-jet. It may be that my approach of
fixing the spine power law index in the innermost region (where it was
poorly contrained) is at the root of the problem. I think I may also have
failed to set the jet boundary parameters correctly. On the other hand,
it does make the qualitative shape of the boundary look better.

I'll play around with the parameters over the next day or two before
deciding whether this modification is worth the effort.

Hope DC wasn't too awful.

Regards, Robert

From VM Thu Oct 17 10:30:50 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["1670" "Thu" "17" "October" "1996" "09:46:54" "-0400" "Alan Bridle" "abridle" nil "39" "Re: Progress" "^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 1670
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA27172; Thu, 17 Oct 1996 09:46:54 -0400
Message-Id: <9610171346.AA27172@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961017133634.19352A-100000@rgosf>
References: <Pine.GSO.3.94.961017133634.19352A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Progress
Date: Thu, 17 Oct 1996 09:46:54 -0400

Robert Laing writes:

> Anyway, I have run one optimization so far. This was not an improvement
> over the old geometry, but I may not have given it a fair chance. It
> wanted some unphysical things at the jet bases, and went for a nearly
> longitudinal field for RHO < RHO0, thus screwing up the polarization and
> intensity at the base of the counter-jet. It may be that my approach of
> fixing the spine power law index in the innermost region (where it was
> poorly contrained) is at the root of the problem. I think I may also have
> failed to set the jet boundary parameters correctly. On the other hand,
> it does make the qualitative shape of the boundary look better.

I suppose the only clear-cut alternative to capping the emissivity in the
inner region would be to keep it the same as the second
power law and thus to make deceleration do _all_ the work. But
I have a feeling that we tried that once and always got too much
"VLBI jet" sticking out of the core close in?

Perhaps one problem is that there aren't as many relativistic
electrons in the shear layer early on as later, so the spine:shear
layer emissivity ratio needs to vary in there more than we are
pTrmitting it to at the moment? That would help to inhibit both
the emission and the parallel polarization?

> I'll play around with the parameters over the next day or two before
> deciding whether this modification is worth the effort.
>
> Hope DC wasn't too awful.
>

I'm still plowing through all the proposals, I go up on Wed
for meetings on Thu and Fri next week. Some interesting reading
of course but 28 of them in 2 weeks is a bit much.

Cheers, A.

From VM Thu Oct 31 10:42:09 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["58" "Mon" "23" "September" "1996" "17:11:29" "-0600" "Barry Clark" "bclark@aoc.nrao.edu"
"<199609232311.RAA01299@bclark.aoc.nrao.edu>" "1" "AL 405 = 3C 31" "^From:" nil nil "9" nil nil nil nil]
nil)
Content-Length: 58
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA47212; Mon, 23 Sep 1996 19:13:03 -0400
Received: from arana (arana.aoc.nrao.edu [146.88.1.7]) by cv3.cv.nrao.edu (8.7.5/8.7.1/CV-2.1) with SMTP id TAA06531 for <abridle@polaris.cv.nrao.edu>; Mon, 23 Sep 1996 19:12:57 -0400 (EDT)
Received: from bclark.aoc.nrao.edu (bclark.aoc.nrao.edu [146.88.6.9]) by arana (8.6.12/8.6.10) with ESMTP id RAA29230; Mon, 23 Sep 1996 17:11:31 -0600
Received: (from bclark@localhost) by bclark.aoc.nrao.edu (8.7.3/8.6.10) id RAA01299; Mon, 23 Sep 1996 17:11:29 -0600 (MDT)
Message-Id: <199609232311.RAA01299@bclark.aoc.nrao.edu>
X-Sun-Charset: US-ASCII
From: Barry Clark <bclark@aoc.nrao.edu>
To: abridle@aoc.nrao.edu
Cc: bclark@aoc.nrao.edu
Subject: AL 405 = 3C 31
Date: Mon, 23 Sep 1996 17:11:29 -0600 (MDT)

I propose to schedule this on November 12, 1900-0700 LST.

From VM Thu Oct 31 10:42:38 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["3099" "Fri" "18" "October" "1996" "17:43:56" "+0100" "Robert Laing" "rl@ast.cam.ac.uk" nil "89" "Models"
"^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 3099
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA30038; Fri, 18 Oct 1996 12:49:29 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.1) with SMTP
id MAA02306 for <abridle@polaris.cv.nrao.edu>; Fri, 18 Oct 1996 12:47:59 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA16193; Fri, 18 Oct 1996 17:43:59 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA21921; Fri, 18 Oct 1996 17:43:58 +0100
X-Sender: rl@rgosf
Reply-To: Robert Laing <rl@ast.cam.ac.uk>
Message-Id: <Pine.GSO.3.94.961018151557.21687A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: Models
Date: Fri, 18 Oct 1996 17:43:56 +0100 (BST)

After adjusting the geometry parameters, I can now get very similar
results to ANIS1 and 2, but with the new geometry. Probably not worth all
of the effort, except in so far as it makes it somewhat easier to
translate the fitting results into physics (all streamlines are
now continuous). The current state of play is:

MAPX 140
MAPY 75
RA 16.853979167
DEC 32.412513889
ROTN 70.3
PIXEL 0.2
FREQ 8439.9
BW 100.0
EPOCH 2000.0
FWHM 0.7
XCMIN 6
YCMIN 10
XCMAX 135
YCMAX 40
SIGMA_I 8.4E-6
SIGMA_P 8.4E-6
CALERR 0.0
SOBS 0.244
SCORE 0.0885
FTOL 0.01
ALPHAC 0.0

Old geometry	New geometry
THETA 56.990	THETA 56.060
ALPHA 0.55	ALPHA 0.55
JETANG0 16.75	JETANG0 16.75

JETANG1 8.0	JETANG1 8.0
SPANG0 5.621	SPANG0 4.311
SPANG1 3.0	SPANG1 2.0
X0 0.2944	X0 0.2944
X1 0.108	X1 0.108
XF 0.800	XF 0.8
BETAI 0.99	BETAI 0.990
BETA1 0.945	BETA1 0.978
BETA0 0.859	BETA0 0.834
BETAF 0.352	BETAF 0.391
ESP_IN 0.000	ESP_IN -0.183
ESP_MID 4.405	ESP_MID 3.109
ESP_OUT 1.699	ESP_OUT 2.307
ESL_IN -1.906	ESL_IN -1.032
ESL_MID 3.851	ESL_MID 3.364
ESL_OUT 1.309	ESL_OUT 1.159
RHOTRUNC 0.0	RHOTRUNC 0.0
SPINE_SL 0.682	SPINE_SL 0.963
SLMIN 0.237	SLMIN 0.196
VMIN0 0.153	VMIN0 0.095
VMIN1 0.623	VMIN1 0.491
LG_ANISI -0.409	LG_ANISI 0.022
LG_ANIS1 -0.003	LG_ANIS1 -0.014
LG_ANIS0 -0.110	LG_ANIS0 -0.092
LG_ANISF -0.171	LG_ANISF -0.183

Npoints 12702	12702
I chisq 0.469E+02	0.670E+02
QU chisq 0.323E+02	0.318E+02
IQU chisq 0.372E+02	0.435E+02

so the old geometry is still a bit better. I suspect that the values of RHO1 and RHO0 are not quite right for the new one. As you can see, most of the parameters come out reassuringly similar: in fact, optimizing over a different area probably introduces bigger changes than changing the geometry. The major difference is in the values of ESL_MID and ESP_MID, as expected (path lengths have changed), and in SPINE_SL (which I don't really understand).

Anyway, I agree with you that further tweaking is now almost certainly a waste of effort. I would have liked to do the case of alpha not equal to 1 more rigorously, but apart from that I think things have converged. I'd like to settle on a standard model soon, and make a resolution not to change it!

I am not sure how to quote the allowed range of parameters, given that the model doesn't "fit" the data in a true sense (there is a very broad minimum in chi-squared, which is always much greater than 1). Obviously, we cannot fit small-scale variations and non-axisymmetric structure. We need some sort of recipe for this.

Cheers, Robert

From VM Thu Oct 31 10:43:03 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["653" "Mon" "21" "October" "1996" "19:42:21" "+0100" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.961021193318.26611A-100000@rgosf>" "15" "Geometry etc." "^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 653
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA24708; Mon, 21 Oct 1996 14:46:17 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.1) with SMTP
id OAA20654 for <abridle@polaris.cv.nrao.edu>; Mon, 21 Oct 1996 14:46:10 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id TAA29302; Mon, 21 Oct 1996 19:42:23 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id TAA26625; Mon, 21 Oct 1996 19:42:22 +0100
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.961021193318.26611A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: Geometry etc.
Date: Mon, 21 Oct 1996 19:42:21 +0100 (BST)

Dear Alan

I ran various optimizations over the weekend. It turns out that the fit is always slightly better for the old geometry, although there is very little in it and the derived quantities are fairly similar. The physical difference, I suppose, is that the old geometry is a smooth change from a conical flow with a small opening angle to one with a larger angle, whereas the new one is an expansion followed by a recollimation. How does this fit in with what we know about jet base collimation in other sources?

I was wrong to say that streamlines start from nowhere in the old geometry, so perhaps we should stick with that?

Cheers, Robert

From VM Thu Oct 31 10:43:06 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["3425" "Mon" "21" "October" "1996" "15:21:05" "-0400" "Alan Bridle" "abridle" nil "71" "Re: Geometry etc."
"^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 3425
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA31576; Mon, 21 Oct 1996 15:21:05 -0400
Message-Id: <9610211921.AA31576@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961021193318.26611A-100000@rgosf>
References: <Pine.GSO.3.94.961021193318.26611A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Geometry etc.
Date: Mon, 21 Oct 1996 15:21:05 -0400

Robert Laing writes:
> Dear Alan
>
> I ran various optimizations over the weekend. It turns out that the fit
> is always slightly better for the old geometry, although there is very
> little in it and the derived quantities are fairly similar. The physical
> difference, I suppose, is that the old geometry is a smooth change from a
> conical flow with a small opening angle to one with a larger angle,
> whereas the new one is an expansion followed by a recollimation. How does
> this fit in with what we know about jet base collimation in other sources?
>
> I was wrong to say that streamlines start from nowhere in the old
> geometry, so perhaps we should stick with that?
>

Would it be possible that the streamlines acquire kinks in the new
geometry, whereas the old one lets them change more slowly and
thus perhaps more realistically?

I have been wondering if a useful display from the modeling would be
to write out the magnitudes (and also direction?) of the velocity
field for the mid-plane of the jet as a table that could also be
passed across to AIPS. A false-color image of the velocity field
(and/or the Lorentz factor) might be quite handy to compare with the
images?

I'm not sure how much to can believe about quantitative recollimation
statements in the literature on FRI sources. These were mostly based
on fitting single Gaussian models to the transverse profiles (we also
did "equivalent width" measures for NGC6251). When I went back into
my 6 cm construction+A configuration dataset on 3C31 as we were
gearing up for this new attack, I re-fitted its profiles using the
more sophisticated fitting in drawspec (the old stuff had been done
with (shudder) AIPS. I found by looking at the residuals there that a
two-component fit was much better than the old one-component fits had
been. Also that we could directly see the evidence for intensity
ratios changing faster in the inner (spine) component than in the
broader (layer) component. I.e. better data and more careful fitting
showed up the differential profile changing that we are now using as
the bread-and-butter data for the model-fitting. Collimation
estimates that were published from just the single-Gaussian fits are
probably o.k. only for very gross details (like the FRI's expanding

more rapidly than the FRII's!). We are now being an order of magnitude more subtle about transverse profile shapes and how they vary down the jet. So it will be interesting to revisit the old "recollimation" regimes in NGC315 and NGC6251 for example to see how much we now think was genuinely recollimation, and how much was the result of varying the mix of spine and sheath, each having longitudinally-varying transverse profiles because of the velocity field, within a less "active" geometry.

The "rapid expansion" bit of 3C31 is much smaller than the regimes we were looking at with these other sources, in any case; it's a qualitatively new region that was simply smoothed out in the older images (and would also be smoothed out similarly in NGC315 and NGC6251 because the data were at lower resolution).

Basically, with what we think we know today, I wouldn't try to sell the old collimation plots to a deaf blind man in the street, let alone to one of our discriminating colleagues!

It will be interesting to see which statements about collimation survive once the dust clears from our present exercise!

A.

From VM Thu Oct 31 10:43:06 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["1954" "Tue" "22" "October" "1996" "11:47:50" "+0100" "Robert Laing" "rl@ast.cam.ac.uk"
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id AA35101; Tue, 22 Oct 1996 0.:48:05 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.a1.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.1) with SMTP
id GAA01249 for <abridle@nrao.edu>; Tue, 22 Oct 1996 06:48:03 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id LAA07002; Tue, 22 Oct 1996 11:47:53 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id LAA27152; Tue, 22 Oct 1996 11:47:52 +0100
X-Sender: rl@rgosf
In-Reply-To: <9610211921.AA31576@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.961022113715.27059B-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@nrao.edu>
Subject: Re: Geometry etc.
Date: Tue, 22 Oct 1996 11:47:50 +0100 (BST)

On Mon, 21 Oct 1996, Alan Bridle wrote:

>
> Would it be possible that the streamlines acquire kinks in the new
> geometry, whereas the old one lets them change more slowly and
> thus perhaps more realistically?
>

Yes, that's quite possible.

> I have been wondering if a useful display from the modeling would be
> to write out the magnitudes (and also direction?) of the velocity
> field for the mid-plane of the jet as a table that could also be
> passed across to AIPS. A false-color image of the velocity field
> (and/or the Lorentz factor) might be quite handy to compare with the
> images?
>

Do you mean "table" in the strict FITS/AIPS sense? A vector image of the velocity could be generated by making pseudo-U and Q maps. I would be tempted to make images of the x and y velocity components and export them in the same way as the intensity image.

> I'm not sure how much to can believe about quantitative recollimation
> statements in the literature on FRI sources. These were mostly based
> on fitting single Gaussian models to the transverse profiles (we also
> did "equivalent width" measures for NGC6251). When I went back into
> my 6 cm construction+A configuration dataset on 3C31 as we were
> gearing up for this new attack, I re-fitted its profiles using the
> more sophisticated fitting in drawspec (the old stuff had been done
> with (shudder) AIPS.

We haven't got drawspec here. Any chance I could get hold of a copy?

>
> Basically, with what we think we know today, I wouldn't try to
> sell the old collimation plots to a deaf blind man in the street,
> let alone to one of our discriminating colleagues!
>

Point taken! I have, for purposes of comparison with the B2 data, derived the variation of FWHM with distance from the nucleus, as derived from a single Gaussian fit, and this worked out quite well, but for well-resolved data it makes sense to go straight for the more sophisticated model.

Robert

From VM Thu Oct 31 10:43:08 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["1243" "Tue" "22" "October" "1996" "12:27:56" "+0100" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.961022121358.27227A-100000@rgosf>" "26" "Oops" "^From:" nil nil "10" nil nil nil nil]
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id AA42182; Tue, 22 Oct 1996 07:31:42 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.1) with SMTP
id HAA01662 for <abridle@polaris.cv.nrao.edu>; Tue, 22 Oct 1996 07:31:41 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)

id MAA07639; Tue, 22 Oct 1996 12:27:58 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id MAA27241; Tue, 22 Oct 1996 12:27:57 +0100
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.961022121358.27227A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: Oops
Date: Tue, 22 Oct 1996 12:27:56 +0100 (BST)

I was right the first time about streamlines starting from nowhere in the old model. My brain must have blown a fuse.

So, we have 2 models, one of which has continuous streamlines with discontinuous derivatives; the other with continuous derivatives and discontinuous streamlines, which fits a bit better. This goes back to my original abortive attempt to conseruct a flow pattern which matched smoothly between the inner and outer regions. I suspect that this is what the data really want. In the end, I had to use a numerical method to invert the relation between the grid coordinates (known) and the position in the shear layer (unknown). I gave up on the more complicated flow pattern because I was unable to solve it analytically, but perhaps it would be worth just throwing Newton-Raphson at it.

The idea would be to use the simplest polynomial relation between RHO and ZETA which matches the values and derivatives at RHO0 and RHO1 (4 constraints => cubic). Shouldn't be too hard to do numerically.

What do you think?

The reason I'm worrying about this is primarily to do with understanding the answer and comparing it with "adiabatic" models. I can't really see how to do this if the flow has sources and sinks.

Robert

From VM Thu Oct 31 10:43:09 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["2688" "Tue" "22" "October" "1996" "10:37:45" "-0400" "Alan Bridle" "abridle" nil "60" "Re: Geometry etc."
"^From:" nil nil "10" nil nil nil nil]
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Content-Length: 2688
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA23544; Tue, 22 Oct 1996 10:37:45 -0400
Message-Id: <9610221437.AA23544@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961022113715.27059B-100000@rgosf>
References: <9610211921.AA31576@polaris.cv.nrao.edu>
<Pine.GSO.3.94.961022113715.27059B-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Geometry etc.
Date: Tue, 22 Oct 1996 10:37:45 -0400

Robert Laing writes:

>
> > I have been wondering if a useful display from the modeling would be
> > to write out the magnitudes (and also direction?) of the velocity
> > field for the mid-plane of the jet as a table that could also be
> > passed across to AIPS. A false-color image of the velocity field
> > (and/or the Lorentz factor) might be quite handy to compare with the
> > images?
> >
>
> Do you mean "table" in the strict FITS/AIPS sense? A vector image of the
> velocity could be generated by making pseudo-U and Q maps. I would be
> tempted to make images of the x and y velocity components and export them
> in the same way as the intensity image.

No I wasn't using "table" as FITS-speak here, but indeed of passing the
velocity info to AIPS from a text file using FETCH. I had been thinking
mainly of the magnitude information but it might be useful to have
the components also, especially now we are worrying about
discontinuities. (Maybe we can add Lorentz transformation of
velocities to COMB one day, but for simple visualization I was
thinking about images of beta and gamma only!)

> We haven't got drawspec here. Any chance I could get hold of a copy?

Sure, it's at ftp://ftp.cv.nrao.edu/NRAO-staff/hliszt/drawspec/

or you can get there by anon-ftp; readme.now is the file with
all the instructions.

>
> >
> > Basically, with what we think we know today, I wouldn't try to
> > sell the old collimation plots to a deaf blind man in the street,
> > let alone to one of our discriminating colleagues!
> >
>
> Point taken! I have, for purposes of comparison with the B2 data, derived
> the variation of FWHM with distance from the nucleus, as derived from a
> single Gaussian fit, and this worked out quite well, but for well-resolved
> data it makes sense to go straight for the more sophisticated model.

It's probably fair enough to do this at moderate resolution for the
purpose of overall comparisons between sources. But at some point the
non-Gaussian nature of the profiles and the departures from profile
self-similarity (along the jet) must mean that the Gaussian-fitted
FWHMs are only a first approximation to what the streamlines are
doing. (One of the things we also used in NGC6251 was an isophotal
width, which has its own problems of course).

It may be worth asding noise to some of our models and fitting them
the old eay to see what sort of "collimation plots" they generate
relative to the angular information that we actually put in. That
might be an interesting comment on what the old plots actually
measure, and perhaps could give some pointers about how to interpret
them a little less naively.

From VM Thu Oct 31 10:43:09 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["2349" "Tue" "22" "October" "1996" "11:01:40" "-0400" "Alan Bridle" "abridle" nil "49" "Re: Oops" "^From:" nil nil
"10" nil nil nil nil]
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id AA16339; Tue, 22 Oct 1996 11:01:40 -0400
Message-Id: <9610221501.AA16339@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961022121358.27227A-100000@rgosf>
References: <Pine.GSO.3.94.961022121358.27227A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Oops
Date: Tue, 22 Oct 1996 11:01:40 -0400

Robert Laing writes:
> I was right the first time about streamlines starting from nowhere in the
> old model. My brain must have blown a fuse.

Yes, it seems to me that we have new streamlines starting at the jet boundary all the way from the first transition distance to the second. So we are positing a net influx of particles and field into the jet across the surface of the shear layer everywhere in the transition zone, whereas what we wanted to do was to redistribute the already-existing particles and fields across the new geometry. This means that the power law indices in the transition region don't mean quite the same thing as the power law indices in the initial and final regions, they are partly compensating for "extra" fields and particles that we are effectively "injecting" at the outside of the jet.

I presume we also have some streamlines that started out in the shear layer suddenly being relabeled as streamlines that are part of the spine, as we cross the transition region. That may also be a rather sharper boundary effect than we really intended!.

> So, we have 2 models, one of which has continuous streamlines with
> discontinuous derivatives; the other with continuous derivatives and
> discontinuous streamlines, which fits a bit better. This goes back to my
> original abortive attempt to construct a flow pattern which matched
> smoothly between the inner and outer regions. I suspect that this is what
> the data really want.

I agree. This may be why we see the "edges" of the outer transition in projection so clearly in the models.

> In the end, I had to use a numerical method to
> invert the relation between the grid coordinates (known) and the position
> in the shear layer (unknown). I gave up on the more complicated flow
> pattern because I was unable to solve it analytically, but perhaps it
> would be worth just throwing Newton-Raphson at it.

>
> The idea would be to use the simplest polynomial relation between RHO and
> ZETA which matches the values and derivatives at RHO0 and RHO1 (4

> constraints => cubic). Shouldn't be too hard to do numerically.
>
> What do you think?

I think this is worth a try, because it will otherwise be quite tricky
to discount these effects when comparing with the "adiabats". And I
agree that is an obvious step for "later".

From VM Thu Oct 31 10:43:29 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
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Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP id RAA29317 for <abridle@polaris.cv.nrao.edu>; Wed, 23 Oct 1996 17:20:17 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id WAA00962; Wed, 23 Oct 1996 22:16:36 +0100
Received: fcom localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id WAA00096; Wed, 23 Oct 1996 22:16:35 +010e
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Message-Id: <Pine.GSO.3.94.96102322i406.90A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: Yet another geometry
Date: Wed, 23 Oct 1996 22:16:33 +0100 (BST)

Dear Alan

Just to let you know that I have the latest geometry working (I think).
It's a bit tricky to cross-check with the older versions, since the
special case to which they all reduce (an entirely conical flow)
bypasses some of the code in the new geometry in order to avoid a
zero-divide. The results look reasonable so far, and I am optimizing to
get the power-laws right.

The new streamlines are aesthetically much more pleasing and, with a bit
of luck, will fit the data as well as the old ones. I'd welcome a break
from the program - both it and my file of algebra are getting a bit too
large for comfort.

Regards, Robert

From VM Thu Oct 31 10:43:40 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
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id AA35009; Thu, 24 Oct 1996 12:32:16 -0400
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP

id MAA12112 for <abridle@polaris.cv.nrao.edu>; Thu, 24 Oct 1996 12:32:15 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA11791; Thu, 24 Oct 1996 17:28:34 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA01665; Thu, 24 Oct 1996 17:28:32 +0100
X-Sender: rl@rgosf
Reply-To: Robert Laing <rl@ast.cam.ac.uk>
Message-Id: <Pine.GSO.3.94.961024164046.1613A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: New geometry
Date: Thu, 24 Oct 1996 17:28:32 +0100 (BST)

I have put the results from the optimized model with the new geometry in my anonymous ftp directory as V3.I, .Q and .U. The chi-squared is slightly worse than with the oldest (discontinuous streamline) flow, but slightly better than with the second attempt (continuous streamlines with kinks).

I think I would recommend sticking with the latest version, since it avoids obviously non-physical flows. The models look pretty good to me. The main deficiencies for those of a critical turn of mind are:

- doesn't match the peak sidedness (but this may just be because of small-scale bumps);
- doesn't quite get the main jet polarization minimum right (crossover at 5 arcsec rather than 8 arcsec) - no model has ever succeeded here;
- produces a minimum in the counter-jet emission at 10 arcsec or so, rather than a flat intensity profile;
- if you go out further (as I did when making a sequence of models at different angles to the l of s), the spine emissivity becomes so low compared with the shear layer than the jet apparently bifurcates (but we aren't really trying to model that far out).

The ridge-line polarization is pretty good now, as is the jet-side profile. Most of the other discrepancies are clearly due to non-axisymmetric structures.

Regards, Robert

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"<Pine.GSO.3.94.961024174539.1684A-100000@rgosf>" "8" "Correction" "^From:" nil nil "10" nil nil nil nil]
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id MAA12365 for <abridle@polaris.cv.nrao.edu>; Thu, 24 Oct 1996 12:51:24 -0400 (EDT)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA12008; Thu, 24 Oct 1996 17:47:43 +0100
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA01687; Thu, 24 Oct 1996 17:47:42 +0100
X-Sender: rl@rgosf

Message-Id: <Pine.GSO.3.94.961024174539.1684A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: Correction
Date: Thu, 24 Oct 1996 17:47:41 +0100 (BST)

Turns out the situation is better than I suggested - I made an error transcribing the parameters for the optimized model, and this in fact has a chi-squared which is LESS than that of either previous geometry. So I think that we can standardize on the latest geometry with clear consciences.

Robert

From VM Thu Oct 31 10:43:45 1996
X-VM-v5-Data: ([nil nil nil t nil nil t nil nil]
["12380" "Fri" "25" "October" "1996" "09:41:33" "EDT" "Bill Cotton" "bcotton@nrao.edu" nil "339" "FYI: forwarded message from Serguei Komissarov" "^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 12380
Received: from gorilla.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA30241; Fri, 25 Oct 1996 09:41:34 -0400
Received: by gorilla.cv.nrao.edu (4.1/DDN-CV/1.10)
id AA19041; Fri, 25 Oct 96 09:41:33 EDT
Message-Id: <9610251341.AA19041@gorilla.cv.nrao.edu>
From: bcotton@NRAO.EDU (Bill Cotton)
To: abridle
Subject: FYI: forwarded message from Serguei Komissarov
Date: Fri, 25 Oct 96 09:41:33 EDT

------- start of forwarded message (RFC 934 encapsulation) -------
Return-Path: <serguei@amsta.leeds.ac.uk>
Received: from cv3.cv.nrao.edu by gorilla.cv.nrao.edu (4.1/DDN-CV/1.10)
id AA18945; Fri, 25 Oct 96 09:18:06 EDT
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Received: by gladys.leeds.amsta (5.x/SMI-SVR4)
id AA24999; Fri, 25 Oct 1996 14:15:13 +0100
Message-Id: <9610251315.AA24999@gladys.leeds.amsta>
Content-Type: X-sun-attachment
From: serguei@amsta.leeds.ac.uk (Serguei Komissarov)
To: apj@noao.edu
Cc: sbaum@stsci.edu, odea@stsci.edu, ggiovannini@astbo1.bo.cnr.it,
biretta@stsci.edu, bcotton@nrao.edu, dekoff@stsci.edu,
lferetti@astbo1.bo.cnr.it, golombek@stsci.edu, lucas@astbo1.bo.cnr.it,
macchetto@stsci.edu, miley@strw.leidenuniv.nl, sparks@stsci.edu,
tventuri@astbo1.bo.cnr.it
Subject: Paper review for ApJ
Date: Fri, 25 Oct 1996 14:15:13 +0100

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X-Sun-Data-Type: default
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X-Sun-Data-Name: review.tex
X-Sun-Charset: us-ascii
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%%%%%%%%%
%  Review of the paper "HST and MERLIN observations of 3C264 ..." by
%  S.A.Baum et al.
%  This is a LaTex file
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%

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\oddsidemargin=-0in
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\begin{document}
\large
Dear Editor and the Authors,

\vskip 0.5in

The paper "HST and MERLIN observations of 3C264 - A Laboratory for Jet Physics and
Unified Schemes" I am honoured to review for ApJ is very interesting indeed. It is
devoted to the relatively young problem of relativistic astrophysics - physics of
extragalactic jets - which has been shown to be very important to understand
the nature of Active Galaxies altogether. It contains new fine results of the
combined optical and radio study of the jets in 3C264 which could make quite an
impact in this field. As far as these observational results are concerned the paper
satisfies the highest standards of ApJ.

However, the interpretation of these data is not adequately good. In fact, the adiabatic jet
model described in Sec.4.6 is based  on equations (1)--(2) which are incorrect
both  for relativistic and for classical jets. The correct equations for classical jets can be
found in Perley et al. (1984) and can also easily be derived from the equations given in
Bicknell (1984).  They look similar but have different powers of $I_\nu$ and $r_b$.


To my best knowledge the similar model for relativistic jets has not been developed yet.
However, since the dynamics of relativistic jets is rather different it would be very
surprising if they exhibited the same dependence of the proper jet emissivity on its velocity
and radius as their classical counterparts. Because I am sort of interested in the
results of the analysis proposed in the reviewed paper, I decided to derive the required
equations myself ( the results are enclosed). As I expected they differ from the ones found
in the classical limit. Moreover, the difference is such that these new equations seem to
be capable of providing better fits of the data on the jet/counter-jet brightness ratio in 3C264, but
this needs further investigation.


Summarising

\begin{itemize}
\item The article does contain new results significant enough to warrant its publication;
\item It is more appropriate for The Astrophysical Journal then for The Supplementary
Series;
\item Modelling of the jets in 3C264 should be corrected along the lines suggested above.
```

This might lead to qualitatively different conclusions on their physics.
\end{itemize}

\vskip 0.5in
\begin{center}
Yours sincerely \\
Serguei Komissarov
\end{center}

\end{document}

- ----------
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%%%%%%%%%%
% This is a LaTex file
%%
\documentstyle{article}
\begin{document}
\large
\begin{center}
{\Large \bf Brightness Variations Along Steady Relativistic Jet }
\end{center}

\section{Proper and observed emissivity}

If the electron distribution in the reference frame of the jet plasma
is

\begin{equation}
\tilde N(E) = \tilde N_0 \tilde E^{-\gamma} \quad
(\tilde E_1 < \tilde E < \tilde E_2)
\end{equation}
when the proper emissivity is given by

\begin{equation}
\tilde \epsilon_{\nu} \propto
\tilde N_0 {\tilde B}^{\frac{\gamma+1}{2}}
{\tilde \nu }^{-\alpha} \quad (\tilde\nu_1 < \tilde\nu < \tilde\nu_2)
\end{equation}
where $\alpha = (\gamma-1)/2$ and $\tilde B$ is the magnetic field
measured in the plasma frame (I use tilde to indicate quantities measured
in this frame). The observed emissivity is then found
using Lorentz transformations:

\begin{equation}
\epsilon_\nu \propto \tilde N_0 \tilde B^{\frac{\gamma+1}{1}}
D^{2+\alpha}\nu^{-\alpha},
\end{equation}
where

\[

$$ D = \left(\Gamma(1-{v \over c}\cos\xi)\right)^{-1}, $$
v and Γ are the velocity and the Lorentz factor of the emitting plasma
and ξ is the angle between
this velocity and the line of sight in the frame of the observer.

Variation of $\tilde N_0$ along the jet

Let us use the same approach as in Perley et al.(1984). The proper number density of relativistic electrons in the jet frame is given by

$$ \tilde n = \tilde N_0 \int_{\tilde E_1}^{\tilde E_2} \tilde E^{-\gamma}d\tilde E \simeq \tilde N_0 \frac{\tilde E_1^{1-\gamma}}{1-\gamma} $$
If only adiabatic losses/gains are taken into account then

$$ \tilde E_1 \propto \tilde n^{1/3} $$
and thus

$$ \tilde N_0 \propto \tilde n^{\frac{\gamma+2}{3}} . $$
To find the variation of $\tilde n$ along the jet we use the relativistic conservation law for the number of particles which reads

$$ \frac{\partial \tilde n \Gamma}{\partial t} + \frac{\partial}{\partial x_i} \left(\tilde n \Gamma v^i \right) $$
For a steady-state flow $\partial/\partial t = 0$ and using Gauss theorem we obtain

$$ \int_S \tilde n \Gamma \mbox{\boldmath $v dS$} = 0 $$
Applying this equation to the jet segment between any two its cross sections and assuming that in the cross sections the jet is uniform we obtain

$$ \tilde n \Gamma_j v_j r_j^2 = \mbox{const} $$
Finally, from equations (6) and (9) we have

$$ \tilde N_0 \propto (\vamma_j v_j r_j^2)^{-\frac{\gamma+2}{3}} $$

Variation of $\tilde B$ along the jet

Parallel field

Let {\boldmath$\triangle \tilde S_{||}$} be the surface element
that travels with the jet plasma and has its normal directed along
the jet axis. Then, let {\boldmath$\tilde B$} be the
magnetic field threading this element. Then from the magnetic flux conservation
it follows that

\begin{equation}
   \tilde B_{||} \triangle \tilde S_{||} = \mbox{const}
\end{equation}
Lorentz transformations do not change the surface area of such element
($\triangle S_{||} = \triangle \tilde S_{||}$). If we now assume
that $\triangle S_{||}$ varies in the same fashion as the jet cross section
then we obtain

\begin{equation}
   \tilde B_{||} \propto r_j^{-2}
\end{equation}
This is the same behaviour as the one found in the classical case.

\subsection{ Transversal field}

First let us consider the toroidal component of magnetic field,
$\tilde B_{\phi}$. Now we
introduce the surface element {\boldmath $\triangle\tilde S_\phi$}
that also travels with the jet plasma but has its normal directed along
ϕ-coordinate line.
If $\triangle \tilde z$ and $\triangle \tilde r$ are the sizes of this
element along the jet axis and radius respectively then the
conservation of magnetic flux for this surface reads as

\begin{equation}
   \tilde B_{\phi} \triangle\tilde z \triangle\tilde r =
    \mbox{const}.
\end{equation}
Via Lorentz transformation we have

\begin{equation}
   \triangle r = \triangle\tilde r \qquad
   \triangle z = \triangle\tilde z/\Gamma_j \qquad ,
\end{equation}
It can be easily shown that for infinitesimal $\triangle z $ we have

\begin{equation}
   \triangle z \propto v_j ,
\end{equation}
Then combining equations (13)--(15) and assuming that
$\triangle r \propto r_j$ we finally obtain

\begin{equation}
   \tilde B_{\phi} \propto (r_j v_j \Gamma_j)^{-1}
\end{equation}
Similar analysis allows us to conclude that $\tilde B_r$ and therefore
$\tilde B_{\perp}$ obey the same law. Thus,

\begin{equation}
   \tilde B_{\perp} \propto (r_j v_j \Gamma_j)^{-1}
\end{equation}

\section{Brightness variations}

Combining the results of previous sections we obtain the following
equations for the proper emissivity and the observed brightness
variations along
steady relativistic jet:

\begin{itemize}
 \item Predominantly parallel field (case of 3C264):

\begin{equation}
   \tilde\epsilon_\nu \propto
   (\Gamma_j v_j)^{-\frac{\gamma+2}{3}}
   r_j^{-\frac{5\gamma+7}{3}}
\end{equation}

\begin{equation}
   I_\nu \propto
   (\Gamma_j v_j)^{-\frac{\gamma+2}{3}}
   r_j^{-\frac{5\gamma+4}{3}} D^{2+\alpha}
\end{equation}

 \item Predominantly transverse field:

\begin{equation}
   \tilde\epsilon_\nu \propto
   (\Gamma_j v_j)^{-\frac{5\gamma+7}{6}}
   r_j^{-\frac{7\gamma+11}{6}}
\end{equation}

\begin{equation}
   I_\nu \propto
   (\Gamma_j v_j)^{-\frac{5\gamma+7}{6}}
   r_j^{-\frac{7\gamma+5}{6}} D^{2+\alpha}
\end{equation}
\end{itemize}

As one can see the difference between these equations and the
classical ones is not only in the appearance of Doppler factor D.
In addition, the combination $\Gamma_j v_j$ appears instead of
v_j in the classical equations. Therefore, in those places where
the classical equations would require significant decrease of the jet
velocity (v_j) relativistic equations could keep it at much higher
level asking for a significant decrease of the Lorentz factor (Γ_j)
only. This could lead to much higher brightness contrast between the
jet and the counter-jet deduced from the model.

Finally, I would like to mention that this model as well as its classical
counterpart (of Perley et al.1984 and Bicknell 1984) is even more simplified
then you might think. Indeed, it is assumed here that the observed
jet spreading can be described as adiabatic expansion only. This is not
true in the case of turbulent jets. In fact, the spreading of low
Mach number turbulent jets in chambers is entirely diffusive. Moreover,
turbulent resistivity could destroy the flux conservation for the
large scale magnetic field
(see

Komissarov \& Ovchinnikov 1990, Soviet Astron.Lett,16, p.119),
whereas the behaviour of the small scale
turbulent component of magnetic field is much more complicated.
The turbulent
model of extragalactic jets has not yet reached the level that
could allow critical testing against observations.

\vskip 1in
{\bf P.S.}
\vskip 0.2in

Physics of extragalactic jets is one of the main research field of
our astrophysical group at The Department of Applied Math., University
of Leeds. Currently we are pushing forward a program on relativistic
fluid and magneto-fluid dynamics with applications to various
astrophysical flows. We are interested in keeping close contacts with
observers (like you) actively working on the jet physics and would welcome
a cooperation
in the interpretation of their data.

\vskip 0.3in

\begin{center}
Best regards \\
Sergei Komissarov
\end{center}
\end{document}
------- end -------

From VM Thu Oct 31 10:43:47 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
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id AA32821; Sat, 26 Oct 1996 14:06:43 -0400
Message-Id: <9610261806.AA32821@polaris.cv.nrao.edu>
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References: <Pine.GSO.3.94.961024174539.1684A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Correction
Date: Sat, 26 Oct 1996 14:06:43 -0400

Robert Laing writes:
> Turns out the situation is better than I suggested - I made an error
> transcribing the parameters for the optimized model, and this in fact has
> a chi-squared which is LESS than that of either previous geometry. So I
> think that we can standardize on the latest geometry with clear
> consciences.
>

Excellent! I'll pull the code over on Sunday when I get back to C'ville.

I just got the reminder for the high-resolution run at the VLA, and will
set this up also as soon as possible after the internal symposium.

Have just finished with the NSF review panel, which I ended up chairing.
I'm looking forward to getting back to 3C31 in earnest now.

Sounds like this last iteration on the velocity field has been well worth
it -- smile and take a break!

A.

From VM Thu Oct 31 10:43:48 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
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References: <Pine.GSO.3.94.961024164046.1613A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: New geometry
Date: Sun, 27 Oct 1996 16:54:00 -0500

Hi Robert, I pulled the I,Q,U images today. looking nice though still
seem to have some problems with the shear layer polarization close in.
The spine polarization now looks really pretty good, though!

I didn't pull the code or the parameters to go with these as you did
not actually say these were ready. Let me know if so.

Bill & I are putting together the observe file for NGC315; it's
going to be a bumper time for us at the VLA, first NGC315, then all
the small quasars, then 3C31!

Data reduction time looms .....

Cheers, A.

From VM Thu Oct 31 10:43:55 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["3075" "Mon" "28" "October" "1996" "11:40:13" "+0000" "Robert Laing" "rl@ast.cam.ac.uk" nil "63" "Errors on parameters" "^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 3075
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA23663; Mon, 28 Oct 1996 06:44:10 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP id GAA05371 for <abridle@polaris.cv.nrao.edu>; Mon, 28 Oct 1996 06:44:01 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id LAA28182; Mon, 28 Oct 1996 11:40:18 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id LAA06088; Mon, 28 Oct 1996 11:40:16 GMT
X-Sender: rl@rgosf
Reply-To: Robert Laing <rl@ast.cam.ac.uk>
Message-Id: <Pine.GSO.3.94.961025205333.3436A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: Errors on parameters
Date: Mon, 28 Oct 1996 11:40:13 +0000 (GMT)

Dear Alan

Thanks for the messages, and for the Komissarov note, which looks useful. Sam Falle is giving a colloquium across the road either this week or next, and I'll find out what the Leeds people are up to then. I'd be interested in the 3C 264 paper when it's ready for public distribution (STScI preprints appear to come by slow sailing vessel).

I am afraid I misled you slightly about chi-squareds - the new geometry does, in fact, still have slightly worse chi-squared than the original one. I was running a test with CALERR set to 1% and forgot to unset it again. I hadn't put the new code in the ftp area, but will do so today. As you say, the polarization near the field transition in the main jet still isn't quite right. The only obvious thing to do now is to put a small component of B_long in the spine - not technically difficult, but I'm worried by the number of degrees of freedom.

Having settled on a model, I have been trying to decide what to say about the errors on parameters. The trouble is that effects which we believe to be significant can have a smaller influence on chi-squared than the non-axisymmetric features we cannot model. I tried to estimate the magnitude of this effect, by differencing the image and its reflection in the x-axis. This suggested that an error model with sigma set to some fraction of the flux would work better than the current constant, but I have never got very satisfactory results when I tried this - not sure why. In addition, a number of the parameters are closely coupled, so assessing their errors by varying them independently is a bit tiresome. My impression is that we complain about a model fit if its chi-squared is 5-10 larger than the optimum, for the current normalization (how do we justify this in a convincing way?)

This allows us to make statements like:

- the central velocity for rho < rho0 must be >0.8
- there must be some limit on the fraction of low-velocity emission at
  small distances from the nucleus
- theta = 54 +/- 5 degrees (more secure, because it affects the whole fit)
- the ratio of longitudinal to toroidal field component in the outer
  region is 0.6 +/- 0.2

and so on. We are (obviously) much better constrained where we have good transverse resolution, and the conclusions about the inner regions are much less firm. I think we need to be quite cautious here.

I think it would be valuable for both of us to go through the model in a sceptical way, asking which of the conclusions are really solid. A modification to the code which might help is to write out the chi-squareds for the 3 regimes separately, since some parameters only affect individual bits (although even there, the flux normalization causes unintuitive correlations).

I scribbled an outline for a short paper over the weekend - I'll put something on disk and see if it makes sense. May already be too long for Nature, though.

Cheers, Robert

P.S. I'm looking forward to the A-configuration stuff and to M84 (I'll try to use this as an excuse to get a larger disk on my machine).

From VM Thu Oct 31 10:43:58 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["1662" "Mon" "28" "October" "1996" "17:56:08" "+0000" "Robert Laing" "rl@ast.cam.ac.uk" nil "38" "Adiabats"
"^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 1662
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA39807; Mon, 28 Oct 1996 12:59:56 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id MAA11265 for <abridle@polaris.cv.nrao.edu>; Mon, 28 Oct 1996 12:59:54 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA04571; Mon, 28 Oct 1996 17:56:11 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA06757; Mon, 28 Oct 1996 17:56:09 GMT
X-Sender: rl@rgosf
Reply-To: Robert Laing <rl@ast.cam.ac.uk>
Message-Id: <Pine.GSO.3.94.961028172355.6691A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: Adiabats
Date: Mon, 28 Oct 1996 17:56:08 +0000 (GMT)

Komissarov's note indeed agrees with my understanding of the relativistic modifications. In fitting the spine to an adiabatic model, we have 3 problems, I think:

- We would have to assume that the emissivity fall-off for rho < rho1 is quite steep (about r**-3, I think). This may be OK, since we can't see much spine emission in this region anyway. We can't allow much deceleration here.
- The deceleration in the transition region would have to be from about beta = 0.96 to 0.75 in order to flatten the emissivity fall-off. I think this is allowed by the data.
- The killer seems to me to be to get the outer region right. The adiabat actually wants the emissivity to increase with distance from the nucleus, if we keep our current velocity law. However, the velocity law is non-physical, in the sense that beta -> 0, in which case the adiabatic expression (like the jet!) explodes. We could get round this by using a more sensible functional form. It will still be quite hard to keep the emissivity fall-off from becoming too flat, or even rising with distance from the nucleus. I reckon we would need beta proportional to rho**-0.4 or so for rho > rho0 in order to match the current best fit, although I suspect that a somewhat flatter emissivity fall-off would still fit adequately.

I think that the use of the linear velocity law in the outer region is probably a mistake, since we should really avoid anything which is obviously unphysical. A power law would be easier to cope with in the context of adiabatic models, so perhaps we should try that?

Robert

From VM Thu Oct 31 10:43:59 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["709" "Mon" "28" "October" "1996" "19:46:15" "+0000" "Robert Laing" "rl@ast.cam.ac.uk" nil "13" "Code"
"^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 709
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA42255; Mon, 28 Oct 1996 14:50:04 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id OAA13328 for <abridle@polaris.cv.nrao.edu>; Mon, 28 Oct 1996 14:50:03 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id TAA06174; Mon, 28 Oct 1996 19:46:17 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id TAA07360; Mon, 28 Oct 1996 19:46:16 GMT
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.96102:192833.7346A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: Code
Date: Mon, 28 Oct 1996 19:46:15 +0000 (GMT)

I have put the latest version of the code in the usual place. I also
tried a velocity variation proportional to rho**-1 for rho > rho0: this
gives roughly the same velocity at rhof as the previous one, and looks
quite reasonable. I guess that some obvious things to do are:
- try power-law variations of beta at least in the outer region (there
are obvious problems close in) in order to avoid the logical difficulty
of a stopped jet and to make comparison with adiabatic models easier;
- with this, try an adiabatic model for the spine (i.e. specify the
velocity parameters and derive the emissivity - might work).

I'm not sure that any such exercise makes sense for the shear layer.

Robert

From VM Thu Oct 31 10:44:01 1996
X-VM-v5-Data: ([nil nil nil t nil nil nil nil nil]
["1367" "Tue" "29" "October" "1996" "15:21:32" "+0000" "Robert Laing" "rl@ast.cam.ac.uk" nil "74" "Forgot"
"^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 1367
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA20658; Tue, 29 Oct 1996 10:25:19 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id KAA26701 for <abridle@polaris.cv.nrao.edu>; Tue, 29 Oct 1996 10:25:17 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id PAA16207; Tue, 29 Oct 1996 15:21:35 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id PAA08219; Tue, 29 Oct 1996 15:21:33 GMT
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.961029151854.8217A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: Forgot
Date: Tue, 29 Oct 1996 15:21:32 +0000 (GMT)

As a result of putting code and data files in separate directories, I
forgot to send you the parameters for the current model. These are:

MAPX 140
MAPY 75
RA 16.853979167
DEC 32.412513889
ROTN 70.3
PIXEL 0.2
FREQ 8439.9
BW 100.0
EPOCH 2000.0
FWHM 0.7
XCMIN 6
YCMIN 10
XCMAX 135
YCMAX 40
SIGMA_I 8.4E-6
SIGMA_P 8.4E-6
CALERR 0.0

SOBS 0.244
SCORE 0.0885
FTOL 0.01
ALPHAC 0.0

* V3_1.DAT - input file for jet model (v3 code; full area chi-squared,
* 0.7 arcsec comparison)
THETA 53.895
ALPHA 0.55
JETANG0 16.75
JETANG1 8.0
SPANG0 3.491
SPANG1 2.0
X0 0.2944
X1 0.108
XF 0.800
BETAI 0.99
BETA1 0.927
BETA0 0.929
BETAF 0.380
ESP_IN 0.084
ESP_MID 3.165
ESP_OUT 3.079
ESL_IN -2.006
ESL_MID 3.728
ESL_OUT 1.204
RHOTRUNC 0.0
SPINE_SL 0.942
SLMIN 0.271
VMIN0 0.106
VMIN1 0.498
LG_ANISI 0.001
LG_ANIS1 -0.037
LG_ANIS0 -0.118
LG_ANISF -0.198

C-shell file to run jet modelling program
3C31: 0.7 arcsec resolution maps
setenv OPTIMIZE F
setenv COMPARE T
setenv PLOTMAP T
setenv PLOTCHISQ F
setenv FLUXNORM T
setenv DOPOL T
setenv BTYPE SU
setenv IMAPFILE /scratch/rgosc/FITS/3C31LOW.I
setenv QMAPFILE /scratch/rgosc/FITS/3C31LOW.Q
setenv UMAPFILE /scratch/rgosc/FITS/3C31LOW.U
setenv CFILE /scratch/rgosc/rl/doppler/CONST1.DAT
setenv VFILE /scratch/rgosc/rl/doppler/V3_1.DAT
setenv LOGFILE /scratch/rgosc/rl/doppler/NEWBETA.LOG
/scratch/rgosc/rl/doppler/v3/model

From VM Thu Oct 31 10:44:03 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
	["952" "Tue" "29" "October" "1996" "17:26:09" "+0000" "Robert Laing" "rl@ast.cam.ac.uk"

"<Pine.GSO.3.94.961029171603.9006A-100000@rgosf>" "26" "Noise" "^From:" nil nil "10" nil nil nil nil]
nil)
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Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA41323; Tue, 29 Oct 1996 12:29:56 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP id MAA28424 for <abridle@polaris.cv.nrao.edu>; Tue, 29 Oct 1996 12:29:54 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA18451; Tue, 29 Oct 1996 17:26:12 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA09016; Tue, 29 Oct 1996 17:26:11 GMT
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.961029171603.9006A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: Noise
Date: Tue, 29 Oct 1996 17:26:09 +0000 (GMT)

How about the following as a way to specify the "noise" due to deviations from axisymmetry?

- Take IQU maps and flip them about the x axis.
- For each Stokes parameter, subtract the flipped and unflipped images to make a map of deviations from axisymmetry.
- Calculate the rms on the difference map.
- Take rms/sqrt 2 as an estimate of the noise.

It turns out that a constant "noise" level over the jet is a reasonable approximation, but that the values for the counter-jet are smaller in all Stokes parameters. The numbers I got were:

RMS (microJY/beam	I	Q	U
Jet	100	69	60
CJ	34	31	28

(compare 8-9 microJy/beam off-source in I, Q and U).

The main differences in the analysis will be to emphasise the fit to the counter-jet a bit more. I would be surprised if this made much difference to the conclusions, but I am running an optimization in order to check.

Robert

From VM Thu Oct 31 10:44:03 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["1208" "Tue" "29" "October" "1996" "13:05:47" "-0500" "Alan Bridle" "abridle" nil "34" "Re: Noise" "^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 1208
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA41253; Tue, 29 Oct 1996 13:05:47 -0500
Message-Id: <9610291805.AA41253@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961029171603.9006A-100000@rgosf>
References: <Pine.GSO.3.94.961029171603.9006A-100000@rgosf>

From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Noise
Date: Tue, 29 Oct 1996 13:05:47 -0500

Robert Laing writes:
> How about the following as a way to specify the "noise" due to deviations
> from axisymmetry?
>
> - Take IQU maps and flip them about the x axis.
> - For each Stokes parameter, subtract the flipped and unflipped images to
> make a map of deviations from axisymmetry.
> - Calculate the rms on the difference map.
> - Take rms/sqrt 2 as an estimate of the noise.
>
> It turns out that a constant "noise" level over the jet is a reasonable
> approximation, but that the values for the counter-jet are smaller in all
> Stokes parameters. The numbers I got were:
>
> RMS (microJY/beam) I Q U
>
> Jet 100 69 60
> CJ 34 31 28
>
> (compare 8-9 microJy/beam off-source in I, Q and U).
>
> The main differences in the analysis will be to emphasise the fit to the
> counter-jet a bit more. I would be surprised if this made much difference
> to the conclusions, but I am running an optimization in order to check.
>
> Robert
>

I think this is an excellent idea; is the ratio between the jet and
counterjet numbers pretty much the ratio of the integrated intensities
in the jet?

A.

From VM Thu Oct 31 10:44:05 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
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"<Pine.GSO.3.94.961029181347.9154A-100000@rgosf>" "31" "Re: Noise" "^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 1211
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id AA34389; Tue, 29 Oct 1996 13:29:41 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id NAA29602 for <abridle@nrao.edu>; Tue, 29 Oct 1996 13:29:39 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id SAA19726; Tue, 29 Oct 1996 18:29:36 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id SAA09177; Tue, 29 Oct 1996 18:29:34 GMT
X-Sender: rl@rgosf
In-Reply-To: <9610291805sAA41253@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.961029181347.9154A-100000@rgosf>
Mime-Version: 1.0

Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@nrao.edu>
Subject: Re: Noise
Date: Tue, 29 Oct 1996 18:29:32 +0000 (GMT)

> I think this is an excellent idea; is the ratio between the jet and
> counterjet numbers pretty much the ratio of the integrated intensities
> in the jet?
>
> A.
>
Close enough: I make the integrated intensity ratio about 2.8.
The way the optimization is running, it looks as if it will converge on
almost identical parameters, but there is a rational meaning for
chi-squared now.

I will also leave running a modified version that uses a power-law form
for the velocity at rho > rho0. I have the same input parameters as
before (i.e. pegging the velocity at rho0 and rhof), but used them to
define a power law

beta = beta_0 (rho/rho0)^{-f}

with f > 0, rather than a straight line. I think we tried this at one
stage, but can't remember why we abandoned it - can you? Anyway, at least
we don't have infinite deceleration with this one.

Just got my copy of the VLA schedule - I see what you mean!

Robert

P.S. I will probably be on La Palma from Nov 12 - 26, although I won't
make a final decision until Friday (we are waiting for some software from
a commercial company, without which the trip is a waste of time, and will
cancel if we haven't got it, in a working state, by the end of the week).

From VM Thu Oct 31 10:44:07 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["394" "Wed" "30" "October" "1996" "13:49:36" "+0000" "Robert Laing" "rl@ast.cam.ac.uk"
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id AA40457; Wed, 30 Oct 1996 08:53:34 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id IAA11780 for <abridle@polaris.cv.nrao.edu>; Wed, 30 Oct 1996 08:53:31 -0500 (EST)
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id NAA28768; Wed, 30 Oct 1996 13:49:39 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id NAA10032; Wed, 30 Oct 1996 13:49:37 GMT
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.961030134510.10029A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>

Subject: Revised velocity law
Date: Wed, 30 Oct 1996 13:49:36 +0000 (GMT)

The change to using a velocity beta_0 (rho/rho)^{-s} in the outer region
produced a very slightly better fit. I propose to stick with it, on the
grounds of physical realism. s = 0.89 gives the best fit (and gives
almost the same velocity at rhof).

The new noise prescription made almost no difference at all to the
parameters of the fit, just produced more meaningful chi-squareds.

Robert

From VM Thu Oct 31 10:44:08 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["1793" "Wed" "30" "October" "1996" "15:03:35" "+0000" "Robert Laing" "rl@ast.cam.ac.uk"
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id KAA12815 for <abridle@polaris.cv.nrao.edu>; Wed, 30 Oct 1996 10:07:22 -0500 (EST)
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id PAA00051; Wed, 30 Oct 1996 15:03:38 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id PAA10184; Wed, 30 Oct 1996 15:03:36 GMT
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.961030144137.10147A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: Spines
Date: Wed, 30 Oct 1996 15:03:35 +0000 (GMT)

In my attempts to look at the effects of varying model parameters, it
became clear to me that 3C31 is now virtually spineless in its outer
regions. What has happened is that the toroidal field component in the
shear layer has taken over the function of the perpendicular component in
the spine, at least to a large extent. The emissivity of the spine drops
rapidly compared to thit of the shear layer. We still need the
transverse velocity variation, of course, but the spine is now rather
narrow. As I mentioned before, there is a slight embarassment if we run
the model for small angles to the line of sight, because the outer jets
are hollow. I tried making a model with the spine angle set to 0.1
degree. It wasn't at all bad - the main problem was that the transverse
profiles are too centrally peaked in the outer part of the main jet - the
data seem to like a region of constant emissivity in the centre - and the
B-perp regions in both jets are not wide enough. But the effects are
quite subtle.

The route by which we have got to this point is a perfectly logical one:
we cannot get enough perpendicular polarization out of the spine at an
angle to the line of sight small enough to generate the observed
sidedness, so we put a larger toroidal field component into the shear
layer. This then obviates the need for the spine to provide B perp at

large distances.

I still think that the spine is necessary, but the argument is more complicated than I had thought. Is this a general feature? Some sources have a degree of B perp polarization which hardly varies across the jets (e.g. 1333-33, although that example is probably at 90 deg to the line of sight, so special pleading might be required). Certainly, 3C31 has an unusually prominent parallel-field edge.

Robert

From VM Thu Oct 31 10:44:09 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["461" "Wed" "30" "October" "1996" "15:27:40" "+0000" "Robert Laing" "rl@ast.cam.ac.uk" nil "11" "P.S." "^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 461
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA44444; Wed, 30 Oct 1996 10:31:31 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP id KAA13190 for <abridle@polaris.cv.nrao.edu>; Wed, 30 Oct 1996 10:31:27 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id PAA00904; Wed, 30 Oct 1996 15:27:43 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id PAA10222; Wed, 30 Oct 1996 15:27:42 GMT
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.961030152029.10211A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@polaris.cv.nrao.edu>
Subject: P.S.
Date: Wed, 30 Oct 1996 15:27:40 +0000 (GMT)

The reluctance of the optimization to pick on a wider spine is tied in with the problems of fitting the main jet field transition. Cutting out the spine makes this (a little) easier, but messes up the transverse intensity and polarization profiles at large distances, particularly in the counter-jet. On balance, chi-squared stays low except for very wide spines (> 7 degrees).

I can't help feeling that there is something wrong here .... any ideas?

Robert

From VM Thu Oct 31 10:44:14 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["2590" "Wed" "30" "October" "1996" "10:53:22" "-0500" "Alan Bridle" "abridle" nil "55" "Re: Revised velocity law" "^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 2590
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA27713; Wed, 30 Oct 1996 10:53:22 -0500
Message-Id: <9610301553.AA27713@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961030134510.10029A-100000@rgosf>
References: <Pine.GSO.3.94.961030134510.10029A-100000@rgosf>

From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Revised velocity law
Date: Wed, 30 Oct 1996 10:53:22 -0500

Robert Laing writes:

> The change to using a velocity beta_0 (rho/rho)^{-s} in the outer region
> produced a very slightly better fit. I propose to stick with it, on the
> grounds of physical realism. s = 0.89 gives the best fit (and gives
> almost the same velocity at rhof).

Can't argue with better physics giving a better fit.

>
> The new noise prescription made almost no difference at all to the
> parametersmof the fit, just produced more meaningful chi-squareds.
>

It seems reasonable that it should not make much difference to the fit,
or am I missing something? Can we use the new chisquared to express
the "goodness of fit" in a way that statisticians would recognise?

I gave a 15-min talk on this at the Jansky symposium on Monday.
Most people were quite astounded at the ability to fit at this
level of detail at all, especially the VLBI contingent who were
decidedly sheepish about some of their one-Lorentz-factor-fits-all
analyses later. Got into a good discussion with Dave Hogg about
the same boundary polarization problem that we discussed in
Tuscaloosa -- how come we see high polarization near the edge
if there's a turbulent entrainment layer there, or just beyond it?
Is it enough just to hope that the relativistic particle density
is small in the entrainment region, so we don't see it?

In fact one of the differences between the models and the data now is
that the model predicts higher polarization on the edges of the jet
than we see everywhere. The error is quasi-periodic and also
connected to the "arcs", of course. It makes me wonder if the arcs
are indeed something to do with a macroscopic (fluting) pattern in the
entrainment.

I made the case that because we seem to see the deceleration starting
at the edge and working its way in, this looks more like deceleration
by entrainment than slowdown by mass-loading. Got some sage nods from
the audience, but in odd moments of reverie during the rest of the
symposium (I have a ferocious head cold at the moment, so have a
decongestant-induced stupor on top of my usual one) I was
second-guessing this. Stellar mass-loading might provide a more
uniform "drag" on the jet and thus be more likely to keep the field
configuration and velocity the same all across the spine as we have
assumed. And perhaps some magnetic tension affects apply braking to
the shear layer. Perhaps we have to reconnect fields out on the edge
to prevent this and keep the jet flowing in the outer layers? I
wonder if we can really hope to distinguish the two deceleration
mechanisms at this point?

A.

From VM Thu Oct 31 10:44:15 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["2452" "Wed" "30" "October" "1996" "11:00:01" "-0500" "Alan Bridle" "abridle" nil "45" "Re: Spines" "^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 2452
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA40575; Wed, 30 Oct 1996 11:00:01 -0500
Message-Id: <9610301600.AA40575@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961030144137.10147A-100000@rgosf>
References: <Pine.GSO.3.94.961030144137.10147A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Spines
Date: Wed, 30 Oct 1996 11:00:01 -0500

Robert Laing writes:
> In my attempts to look at the effects of varying model parameters, it
> became clear to me that 3C31 is now virtually spineless in its outer
> regions. What has happened is that the toroidal field component in the
> shear layer has taken over the function of the perpendicular component in
> the spine, at least to a large extent. The emissivity of the spine drops
> rapidly compared to that of the shear layer. We still need the
> transverse velocity variation, of course, but the spine is now rather
> narrow. As I mentioned before, there is a slight embarassment if we run
> the model for small angles to the line of sight, because the outer jets
> are hollow. I tried making a model with the spine angle set to 0.1
> degree. It wasn't at all bad - the main problem was that the transverse
> profiles are too centrally peaked in the outer part of the main jet - the
> data seem to like a region of constant emissivity in the centre - and the
> B-perp regions in both jets are not wide enough. But the effects are
> quite subtle.
>
> The route by which we have got to this point is a perfectly logical one:
> we cannot get enough perpendicular polarization out of the spine at an
> angle to the line of sight small enough to generate the observed
> sidedness, so we put a larger toroidal field component into the shear
> layer. This then obviates the need for the spine to provide B perp at
> large distances.
>
> I still think that the spine is necessary, but the argument is more
> complicated than I had thought. Is this a general feature? Some sources
> have a degree of B perp polarization which hardly varies across the jets
> (e.g. 1333-33, although that example is probably at 90 deg to the line of
> sight, so special pleading might be required). Certainly, 3C31 has an
> unusually prominent parallel-field edge.
>

I had not been worrying too much about that, perhaps because it sends
3C31 on its way looking like a decent model for 3C353's jet!

3C31 is of course the classic example of the parallel-perp-parallel
field configuration and I agree that this may make it a bit
anomalous. Looking at what happens a bit further out, where the
whole transverse profile is decidedly flat-topped (again like 3C353)

I'm not terribly surprised by this.

I agree that it may require some caveats about just how
representative of the whole FRI group 3C31 really is, however.

A.

From VM Thu Oct 31 10:44:16 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["4245" "Wed" "30" "October" "1996" "18:20:00" "+0000" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.961030170046.10316A-100000@rgosf>" "97" "Re: Revised velocity law" "^From:" nil nil "10" nil nil nil
nil]
nil)
Content-Length: 4245
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA32088; Wed, 30 Oct 1996 13:20:14 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id NAA16168 for <abridle@nrao.edu>; Wed, 30 Oct 1996 13:20:11 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id SAA03762; Wed, 30 Oct 1996 18:20:04 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id SAA10400; Wed, 30 Oct 1996 18:20:02 GMT
X-Sender: rl@rgosf
In-Reply-To: <9610301553.AA27713@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.961030170046.10316A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@nrao.edu>
Subject: Re: Revised velocity law
Date: Wed, 30 Oct 1996 18:20:00 +0000 (GMT)

On Wed, 30 Oct 1996, Alan Bridle wrote:

>
> It seems reasonable that it should not make much difference to the fit,
> or am I missing something? Can we use the new chisquared to express
> the "goodness of fit" in a way that statisticians would recognise?
>

The only change to the fit would come from the slightly different
weighting of jet and counter-jet. Not a big deal. I have been talking to
statistically-minded colleagues here about the meaning of the fit. It is
a bit tricky to assess this. I think that the key points are:
- our error model is a very crude approximation, so levels of
significance don't mean very much;
- we have no real reason to suppose that the model should fit the data
exactly: we are trying to extract conclusions about generic
models, rather than to test a specific one;
- more practically, the chi-squared values are dominated by the outer
jet, and the sum is insensitive to quite large errors close in (I
think we have to assess the fit in these regions separately).

> I gave a 15-min talk on this at the Jansky symposium on Monday.
> Most people were quite astounded at the ability to fit at this
> level of detail at all, especially the VLBI contingent who were

> decidedly sheepish about some of their one-Lorentz-factor-fits-all
> analyses later. Got into a good discussion with Dave Hogg about
> the same boundary polarization problem that we discussed in
> Tuscaloosa -- how come we see high polarization near the edge
> if there's a turbulent entrainment layer there, or just beyond it?
> Is it enough just to hope that the relativistic particle density
> is small in the entrainment region, so we don't see it?

Another reason might be that the emission we see actually comes from
filamentary structures with some preferential range of orientations
(defined by large-scale eddies, which will certainly not be isotropic?)
rather than from the general turbulent gunk.

>
> In fact one of the differences between the models and the data now is
> that the model predicts higher polarization on the edges of the jet
> than we see everywhere.

The models are a bit misleading, because of blanking of the real image. I
found it useful to blank the model: intensity levels are very low where
the highest polarization occurs.

> The error is quasi-periodic and also connected to the "arcs", of course.

Again, some of that may be due to enhancement of total intensity, rather
than degree of polarization, although there must be something else going
on because the vector directions are affected.

> It makes me wonder if the arcs
> are indeed something to do with a macroscopic (fluting) pattern in the
> entrainment.
>

Interesting. Are structures as large as the jet radius seen in
supersonic, turbulent jets?

> I made the case that because we seem to see the deceleration starting
> at the edge and working its way in, this looks more like deceleration
> by entrainment than slowdown by mass-loading. Got some sage nods from
> the audience, but in odd moments of reverie during the rest of the
> symposium (I have a ferocious head cold at the moment, so have a
> decongestant-induced stupor on top of my usual one)

Just got rid of one of my own. Bad luck.

> I was
> second-guessing this. Stellar mass-loading might provide a more
> uniform "drag" on the jet and thus be more likely to keep the field
> configuration and velocity the same all across the spine as we have
> assumed.

That had certainly been my assumption. Stars ought to be distributed
throughout the jet volume. I had a look at Bowman et al. (1996): they
don't give a transverse velocity gradient, but looking at their emission
models, I can't see much evidence of slower material near the edges.
I'll ask Paddy Leahy.

> And perhaps some magnetic tension affects apply braking to

> the shear layer. Perhaps we have to reconnect fields out on the edge
> to prevent this and keep the jet flowing in the outer layers? I
> wonder if we can really hope to distinguish the two deceleration
> mechanisms at this point?

Not sure I understand your point here. I still think that the transverse
velocity gradient is prima facie evidence for a boundary layer of some
sort.

Robert

From VM Thu Oct 31 10:44:17 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
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"^From:" nil nil "10" nil nil nil nil]
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id AA42888; Wed, 30 Oct 1996 13:25:17 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id NAA16212 for <abridle@nrao.edu>; Wed, 30 Oct 1996 13:25:15 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id SAA03815; Wed, 30 Oct 1996 18:25:13 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id SAA10416; Wed, 30 Oct 1996 18:25:12 GMT
X-Sender: rl@rgosf
In-Reply-To: <9610301600.AA40575@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.961030182105.10316B-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@nrao.edu>
Subject: Re: Spines
Date: Wed, 30 Oct 1996 18:25:10 +0000 (GMT)

On Wed, 30 Oct 1996, Alan Bridle wrote:

> 3C31 is of course the classic example of the parallel-perp-parallel
> field configuration and I agree that this may make it a bit
> anomalous. Looking at what happens a bit further out, where the
> whole transverse profile is decidedly flat-topped (again like 3C353)
> I'm not terribly surprised by this.

That's a good point (although we may be missing some parallel-field edges
in weaker sources). 3C31 and 66B certainly appear to be anomalous in
their edge polarization. Martin Hardcastle showed me some results on
3C296, which appeared to have at most a very weak parallel-field edge, but
clear evidence for transverse velocity gradients.

>
> I agree that it may require some caveats about just how
> representative of the whole FRI group 3C31 really is, however.
>

>

I wonder if there is any difference between FRI's with bridges and those
with tails?

Robert

From VM Thu Oct 31 10:44:19 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["2539" "Wed" "30" "October" "1996" "13:43:50" "-0500" "Alan Bridle" "abridle" nil "67" "Re: Revised velocity law"
"^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 2539
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA21724; Wed, 30 Oct 1996 13:43:50 -0500
Message-Id: <9610301843.AA21724@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961030170046.10316A-100000@rgosf>
References: <9610301553.AA27713@polaris.cv.nrao.edu>
<Pine.GSO.3.94.961030170046.10316A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Revised velocity law
Date: Wed, 30 Oct 1996 13:43:50 -0500

Robert Laing writes:

> The models are a bit misleading, because of blanking of the real image. I
> found it useful to blank the model: intensity levels are very low where
> the highest polarization occurs.
>
> > The error is quasi-periodic and also connected to the "arcs", of course.
>
> Again, some of that may be due to enhancement of total intensity, rather
> than degree of polarization, although there must be something else going
> on because the vector directions are affected.
>

Well, I blanked the models in the same way as I blanked the images (3-sigma)
level. And, as you say, the errors are present in the polarization angles,
and look quite regular (arc-like with the B-field in the data tending to follow
the arcs rather than the model).

> > It makes me wonder if the arcs
> > are indeed something to do with a macroscopic (fluting) pattern in the
> > entrainment.
> >
>
> Interesting. Are structures as large as the jet radius seen in
> supersonic, turbulent jets?

I don't know about the supersonic case, though I remember a
presentation at Tuscaloosa (De Young?) saying that the scale sizes of the
boundary eddies at high Mach number resembled those seen at lower
Mach numbers. In low-speed turbulent jets I think the answer is

"yes", the jet radius is the only thing that bounds the eddy-size
spectrum.

> > And perhaps some magnetic tension affects apply braking to
> > the shear layer. Perhaps we have to reconnect fields out on the edge
> > to prevent this and keep the jet flowing in the outer layers? I
> > wonder if we can really hope to distinguish the two deceleration
> > mechanisms at this point?

I'm wondering if bits of the field get anchored in slower-moving material
when the entrainment process starts, so that the field loops start
to stretch along the jet axis and have to break away via reconnection.

> Not sure I understand your point here. I still think that the transverse
> velocity gradient is prima facie evidence for a boundary layer of some
> sort.

I agree, but I wonder how turbulent that layer really has to be,
i.e. if the deceleration is entirely due to increasing the mass flux
down the jet, rather than having seme magnetic tension effects also
slow the jet down. There may be a difference between deciding that a
boundary layer is present (about thwich we have little doubt at the
moment) and requiring that all of the deceleration come from
mass-loading by material that is entrained across that boundary
layer.

A.

From VM Thu Oct 31 10:44:32 1996
X-VM-v5-Data: ([nil nil nil t t nil nil nil nil]
["3718" "Thu" "31" "October" "1996" "11:19:46" "+0000" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.961031111324.11170A-100000@rgosf>" "127" "Re: Noise" "^From:" nil nil "10" nil nil nil nil]
nil)
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id AA27497; Thu, 31 Oct 1996 06:19:59 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id GAA27681 for <abridle@nrao.edu>; Thu, 31 Oct 1996 06:19:51 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id LAA10203; Thu, 31 Oct 1996 11:19:49 GMT
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id LAA11174; Thu, 31 Oct 1996 11:19:47 GMT
X-Sender: rl@rgosf
In-Reply-To: <9610302226.AA35020@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.961031111324.11170A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@nrao.edu>
Subject: Re: Noise
Date: Thu, 31 Oct 1996 11:19:46 +0000 (GMT)

On Wed, 30 Oct 1996, Alan Bridle wrote:

>
> I just pulled the .tar file again, but I think it may have preceded
> this last mod. I'll check the code to make sure and adjust if needed.
> Or if you want to be supersafe, I'll hang on until you update the
> .tar file again.
>

Um, I think it preceded two mods of interest, namely separating the jet and counter-jet chi-squareds and changing the velocity law. The mods are independent, so I'll append the modified intrinsic.f to this message. The chi-squared stuff affects the COMMON block and the constants file, so I'd better update the tar file later. I have been pondering the right way to assess allowed parameter ranges and I think that we need to treat the jet base and outer regions separately and/or to adjust their relative weight - I'd like to put the machinery for this in place before sending you another full version - is that OK?

Robert

```
      SUBROUTINE INTRINSIC (SPINE, RHO, ZETA, EMIS, BETA)

      IMPLICIT NONE

* GIVEN

      LOGICAL SPINE ! T => in spine; F => in shear layer
      REAL RHO      ! Distance from nucleus
      REAL ZETA     ! Angle from axis of jet (0 - PI)

* RETURNED

      REAL EMIS     ! Normalization constant for emissivity
      REAL BETA     ! Velocity

* COMMON

      INCLUDE 'model.inc'

* LOCAL

      REAL VL, T
      REAL VEXP

*+

      IF (RHO .EQ. 0.0) THEN  ! Trap error
        EMIS = 0.0
        BETA = BETAI
        ANIS = 1.0
      ELSE                    ! Central velocity (used by spine and SL)
        IF (RHO .LT. RHO1) THEN
          BETA = BETAI - (BETAI - BETA1)*RHO/RHO1
        ELSE IF (RHO .LT. RHO0) THEN
```

```
        BETA = BETA1 - (BETA1-BETA0)*(RHO-RHO1)/(RHO0-RHO1)
       ELSE
        VEXP = (LOG(BETA0)-LOG(BETAF))/(LOG(RHOF)-LOG(RHO0))
        BETA = BETA0*(RHO/RHO0)**(-VEXP)
       END IF
       IF (SPINE) THEN    ! Spine
        IF (SPINE_SL .EQ. 0.0) THEN
         EMIS = 0.0
        ELSE IF (RHO .LT. RHO1) THEN
         EMIS = ((RHO/RHO1)**(-ESP_IN))*((RHO0/RHO1)**(+ESP_MID))
        ELSE IF (RHO .LT. RHO0) THEN
         EMIS = (RHO/RHO0)**(-ESP_MID)
        ELSE
         EMIS = (RHO/RHO0)**(-ESP_OUT)
        END IF
        ANIS = 1.0
       ELSE                ! Shear layer

* Angle from jet axis in 0 - 90 deg

        IF (X .GT. 0.0) THEN
         T = ZETA          ! Approaching jet
        ELSE
         T = PI - ZETA     ! Receding jet
        END IF

* Maximum emissivity

        IF (SPINE_SL .GE. 1000.0) THEN
         EMIS = 0.0
        ELSE IF (RHO .LT. RHO1) THEN
         EMIS = ((RHO/RHO1)**(-ESL_IN))*((RHO0/RHO1)**(+ESL_MID))
        ELSE IF (RHO .LT. RHO0) THEN
         EMIS = (RHO/RHO0)**(-ESL_MID)
        ELSE
         EMIS = (RHO/RHO0)**(-ESL_OUT)
        END IF

* Linear ramp in emissivity

        EMIS = EMIS*(SLMIN + (1.0 - SLMIN)*SL) ! Linear ramp to SLMIN
     &         / SPINE_SL

        IF (RHO .GT. RHO0) THEN
         VL = VMIN0
        ELSE IF (RHO .GT. RHO1) THEN
         VL = VMIN0 - (VMIN0-VMIN1)*(RHO0-RHO)/(RHO0-RHO1)
        ELSE
         VL   VMIN1
        END IF
        BETA = BETA*(VL + (1.0-VL)*SL)
       END IF

* Shear layer field anisotropy (used if BTYPE = 4)

       IF (RHO .LT. RHO1) THEN
        ANIS = 10.0**(LG_ANISI - (LG_ANISI-LG_ANIS1)*RHO/RHO1)
       ELSE IF (RHO .LT. RHO0) THEN
```

```
        ANIS = 10.0**(LG_ANIS1 -
     &          (LG_ANIS1-LG_ANIS1)*(RHO-RHO1)/(RHO0-RHO1))
       ELSE
        ANIS = 10.0**(LG_ANIS0 -
     &          (LG_ANIS0-LG_ANISF)*(RHO-RHO0)/(RHOF-RHO0))
       END IF
       ANIS = ANIS**2
      END IF
      RETURN
      END
```

From VM Thu Oct 31 11:30:23 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["849" "Wed" "30" "October" "1996" "17:26:23" "-0500" "Alan Bridle" "abridle" nil "25" "Re: Noise" "^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 849
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA35020; Wed, 30 Oct 1996 17:26:23 -0500
Message-Id: <9610302226.AA35020@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961029181347.9154A-100000@rgosf>
References: <9610291805.AA41253@polaris.cv.nrao.edu>
<Pine.GSO.3.94.961029181347.9154A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Noise
Date: Wed, 30 Oct 1996 17:26:23 -0500

Robert Laing writes:

> almost identical parameters, but there is a rational meaning for
> chi-squared now.
>
> I will also leave running a modified version that uses a power-law form
> for the velocity at rho > rho0. I have the same input parameters as
> before (i.e. pegging the velocity at rho0 and rhof), but used them to
> define a power law
>
> beta = beta_0 (rho/rho0)^{-f}
>
> with f > 0, rather than a straight line. I think we tried this at one
> stage, but can't remember why we abandoned it - can you? Anyway, at least
> we don't have infinite deceleration with this one.
>

I just pulled the .tar file again, but I think it may have preceded
this last mod. I'll check the code to make sure and adjust if needed.
Or if you want to be supersafe, I'll hang on until you update the
.tar file again.

Cheers, A.

From VM Thu Oct 31 11:30:29 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]

["689" "Thu" "31" "October" "1996" "10:34:04" "-0500" "Alan Bridle" "abridle" nil "17" "Re: Noise" "^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 689
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA21913; Thu, 31 Oct 1996 10:34:04 -0500
Message-Id: <9610311534.AA21913@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961031111324.11170A-100000@rgosf>
References: <9610302226.AA35020@polaris.cv.nrao.edu>
<Pine.GSO.3.94.961031111324.11170A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Noise
Date: Thu, 31 Oct 1996 10:34:04 -0500

Robert Laing writes:
>

> Um, I think it preceded two mods of interest, namely separating the jet
> and counter-jet chi-squareds and changing the velocity law. The mods are
> independent, so I'll append the modified intrinsic.f to this message. The
> chi-squared stuff affects the COMMON block and the constants file, so I'd
> better update the tar file later. I have been pondering the right way to
> assess allowed parameter ranges and I think that we need to treat the jet
> base and outer regions separately and/or to adjust their relative weight -
> I'd like to put the machinery for this in place before sending you another
> full version - is that OK?
>

sure, A.

From VM Thu Oct 31 13:03:50 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["1103" "Thu" "31" "October" "1996" "11:40:58" "-0500" "Alan Bridle" "abridle" nil "27" "Re: Noise" "^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 1103
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA36256; Thu, 31 Oct 1996 11:40:58 -0500
Message-Id: <9610311640.AA36256@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961029181347.9154A-100000@rgosf>
References: <9610291805.AA41253@polaris.cv.nrao.edu>
<Pine.GSO.3.94.961029181347.9154A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Noise
Date: Thu, 31 Oct 1996 11:40:58 -0500

Robert Laing writes:

>
> I will also leave running a modified version that uses a power-law form
> for the velocity at rho > rho0. I have the same input parameters as
> before (i.e. pegging the velocity at rho0 and rhof), but used them to
> define a power law

>
> beta = beta_0 (rho/rho0)^{-f}
>
> with f > 0, rather than a straight line. I think we tried this at one
> stage, but can't remember why we abandoned it - can you? Anyway, at least
> we don't have infinite deceleration with this one.
>

I checked my notes on this; we switched to the linear forms for the velocities when we switched to the three-regime jet. We were very concerned with letting the spine velocity "coast" at that point to keep the polarization maximum in the spine out where it needed to be. The power law was in fact our first guess (after a quick run right at the start that involved exponentials and was obviously doing everything far too abruptly). The linear decline seemed to be a step towards that, but I think that in retrospect there was no very good reason for that particular change.

A.

From VM Mon Nov 4 09:34:41 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["1356" "Thu" "31" "October" "1996" "14:44:34" "-0500" "Alan Bridle" "abridle" nil "28" "Latest polarization model"
"^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 1356
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA41755; Thu, 31 Oct 1996 14:44:34 -0500
Message-Id: <9610311944.AA41755@polaris.cv.nrao.edu>
From: abridle (Alan Bridle)
To: rl@ast.cam.ac.uk
Subject: Latest polarization model
Date: Thu, 31 Oct 1996 14:44:34 -0500

Hi Robert,

I now have the program running with the power law outer velocity and the intrinsic.f from your last update; so apart from the chi-sq values we should be looking at exactly the same stuff again.

Just looking at the (4-sigma blanked) %p in the data and the last model run side-by-side, I think one of the most striking differences is that the polarization predicted for the shear layer in and near the transitioni region is significantly higher than we observe, on both the jet and counterjet. On the counterjet side, we seem to see the predicted polarization only in the outer regime, while on the jet side we start out with the observed edge polarization more or less as predicted but then the observations drop below the prediction through the transition regime, and begin to approach the model values at about the same distance as they do on the counterjet side.

Perhaps this really does suggest that the field in the shear layer is more disordered than we think in just the region where the effects of entrainment on the jet's structure are largest. I.e. it may be consistent with more small-scale turbulence in the shear layer in that region? The regions where the predicted degree of polarization is much higher than the observed are quite well transverse- resolved, so

the discrepancy really may be mainly in the shear layer.

A.

From VM Mon Nov 4 09:34:44 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["2758" "Thu" "31" "October" "1996" "20:20:08" "+0000" "Robert Laing" "rl@ast.cam.ac.uk" nil "60" "Re: Latest polarization model" "^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 2758
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA26335; Thu, 31 Oct 1996 15:20:21 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP id PAA05993 for <abridle@nrao.edu>; Thu, 31 Oct 1996 15:20:18 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id UAA17808; Thu, 31 Oct 1996 20:20:10 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id UAA13346; Thu, 31 Oct 1996 20:20:09 GMT
X-Sender: rl@rgosf
In-Reply-To: <9610311944.AA41755@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.961031195427.12859A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@nrao.edu>
Subject: Re: Latest polarization model
Date: Thu, 31 Oct 1996 20:20:08 +0000 (GMT)

On Thu, 31 Oct 1996, Alan Bridle wrote:

>
> Hi Robert,
>
> I now have the program running with the power law outer velocity and
> the intrinsic.f from your last update; so apart from the chi-sq values
> we should be looking at exactly the same stuff again.
>

I have finished the modifications I mentioned and am trying to test them.
Unfortunately, an evil spirit (something to do with Halloween probably)
tempted me into deleting the data instead of some old models, so I'll have
to restore from tape before proceeding much further. The latest attempt
has a new parameter to specify the oversampling (so that the summed
chi-squareds are worked out from every nth pixel) and therefore deals with
the degrees of freedom sensibly. It also gives the chi-squareds for
regions inside and outside X0, rather than for jet and counter-jet, which
is quite instructive. I have also allowed a non-zero longitudinal
component in the spine field, and this looks as if it can help with the
field transition in the middle.

> Just looking at the (4-sigma blanked) %p in the data and the last
> model run side-by-side, I think one of the most striking differences
> is that the polarization predicted for the shear layer in and near the
> transitioni region is significantly higher than we observe, on both
> the jet and counterjet. On the counterjet side, we seem to see the

> predicted polarization only in the outer regime, while on the jet side
> we start out with the observed edge polarization more or less as
> predicted but then the observations drop below the prediction through
> the transition regime, and begin to approach the model values at about
> the same distance as they do on the counterjet side.
>

That's a VERY good point. I had assumed, without proof, that we just
didn't have enough intensity to see the polarization, but this is clearly
wrong.

> Perhaps this really does suggest that the field in the shear layer is
> more disordered than we think in just the region where the effects of
> entrainment on the jet's structure are largest. I.e. it may be
> consistent with more small-scale turbulence in the shear layer in that
> region? The regions where the predicted degree of polarization is
> much higher than the observed are quite well transverse- resolved, so
> the discrepancy really may be mainly in the shear layer.
>

The implication is that the shear layer field has a significant radial
component in the transition region, and therefore a near-isotropic field.
But that makes it difficult to model the high B perp polarization along
the ridge-line of the counter-jet in this region, which depends on the
shear-layer field sheets being observed edge-on in their rest frames.

Definitely needs thought.

Robert

From VM Mon Nov 4 09:34:45 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["1059" "Thu" "31" "October" "1996" "21:06:52" "+0000" "Robert Laing" "rl@ast.cam.ac.uk" nil "23" "Re: Latest
polarization model" "^From:" nil nil "10" nil nil nil nil]
nil)
Content-Length: 1059
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA23837; Thu, 31 Oct 1996 16:06:58 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id QAA06731 for <abri.le@nrao.edu>; Thu, 31 Oct 1996 16:06:56 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id VAA18236; Thu, 31 Oct 1996 21:06:54 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id VAA13514; Thu, 31 Oct 1996 21:06:53 GMT
X-Sender: rl@rgosf
In-Reply-To: <9610311944.AA41755@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.961031204805.13498B-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@nrao.edu>
Subject: Re: Latest polarization model
Date: Thu, 31 Oct 1996 21:06:52 +0000 (GMT)

I now have the spine field with optional longitudinal field going. This
can be used to make a more realistic polarization profile along the jet,

but doesn't help at the edges, of course. However, I think the point you made in your last message is related to this: we probably need almost to destroy the field order in the transition region (probably more so in the shear layer), leaving just enough to provide the polarization on the ridge of the counter-jet. The point you made earlier about the bifurcation in the polarized intensity image close to the nucleus in the main jet must be related.

I guess that the machinery for the alpha = 1 case should be up to allowing 3 unequal field components. In fact, I think I did this some years ago when exploring a dead end. I'll see what can be done.

I'll tidy up the instructions (which have got a bit out of date) and send you the latest code tomorrow. I need to go home and check whether the trick-or-treat kids have done anything horrible to my house (they threw an egg at it last year).

Robert

From VM Mon Nov 4 09:35:38 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["1332" "Fri" "1" "November" "1996" "18:52:56" "+0000" "Robert Laing" "rl@ast.cam.ac.uk" nil "27" "Polarization minimum " "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 1332
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA37169; Fri, 1 Nov 1996 13:53:03 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP id NAA21016 for <abridle@nrao.edu>; Fri, 1 Nov 1996 13:53:01 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id SAA00067; Fri, 1 Nov 1996 18:52:59 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id SAA15035; Fri, 1 Nov 1996 18:52:57 GMT
X-Sender: rl@rgosf
Reply-To: Robert Laing <rl@ast.cam.ac.uk>
Message-Id: <Pine.GSO.3.94.961101143405.14317A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@nrao.edu>
Subject: Polarization minimum
Date: Fri, 1 Nov 1996 18:52:56 +0000 (GMT)

I tried the simple experiment of putting an isotropic field in the shear layer transition region (rho1 < rho < rho0). This didn't really work, because the resulting polarization minimum is too near the nucleus (it should actually extend from 0.2 to 0.4 or so) and the high-polarization ridge in the counter-jet was destroyed.

It turns out to be relatively straightforward to add the third component to the shear layer in the alpha = 1 approximation. I will have a look at this next. I wonder whether the way to look at it is that the inner region has a shear layer with toroidal and longitudinal components in rough balance; then the entrainment becomes violent, creating a significant radial field in the eddies (hence the low edge polarization).

Further out, the flow becomes much smoother (but still with a velocity gradient) and the field adopts the toroidal + longitudinal mix with the former dominating.

I think that the best thing to do is to allow the 2 independent field ratios to vary, using the usual fiducial points. I'm not sure whether log (as at present) or linear variations are appropriate. I may be quite tricky to avoid losing the highish polarization at ths base of the counter-jet.

Turns out I won't be going to La Palma this month, so I'll concentrate on trying to finish up the model.

Robert

From VM Fri Nov 8 09:38:01 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["1447" "Mon" "4" "November" "1996" "20:07:52" "+0000" "Robert Laing" "rl@ast.cam.ac.uk" nil "30" "3D fields" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 1447
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA44350; Mon, 4 Nov 1996 15:08:02 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP id PAA03498 for <abridle@nrao.edu>; Mon, 4 Nov 1996 15:07:59 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id UAA08989; Mon, 4 Nov 1996 20:07:56 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id UAA19697; Mon, 4 Nov 1996 20:07:54 GMT
X-Sender: rl@rgosf
Reply-To: Robert Laing <rl@ast.cam.ac.uk>
Message-Id: <Pine.GSO.3.94.961104194945.19681A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@nrao.edu>
Subject: 3D fields
Date: Mon, 4 Nov 1996 20:07:52 +0000 (GMT)

I have now implemented a full 3D field for the shear layer in the alpha = 1 approximation. This seems to work, at least qualitatively, and I can reduce the polarization in the transition zone quite easily. I can also preserve the transverse polarization on the counter-jet ridge line, but there is still a little too much Bperp on the ridge line in the main jet transition zone. I have not gone for full generality in the spine: I don't think we have enough information to constrain this, but it could easily be added later. I have used the same functional form for the variation of the anisotropy parameter with distance for both radial/toroidal and longitudinal/toroidal - i.e. linear in log(field ratio) between values fixed at rho1, rho0, etc.

In the course of setting this up, I found an error in the code for BTYPE SU: I had not paid enough attention to normalization of the expressions for I, Q and U in ifunc etc. The effect was to normalize with respect to the toroidal field component, not to the total magnitude. Although the physics is debatable, this was not what I meant. In fact, there was also an inconsistency between the code for 1D and 2D fields in the "exact"

solutions, although that will not have bothered us. The effects of this are not enormous, but there will be some changes to best fit parameters.

I'll reoptimize with the corrected code; both with and without the radial field component.

Regards

Robert

From VM Fri Nov 8 09:38:08 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["1178" "Tue" "5" "November" "1996" "11:54:58" "+0000" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.961105114231.20239A-100000@rgosf>" "22" "New field models" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 1178
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA17336; Tue, 5 Nov 1996 06:55:11 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP id GAA13132 for <abridle@nrao.edu>; Tue, 5 Nov 1996 06:55:08 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id LAA16229; Tue, 5 Nov 1996 11:55:01 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id LAA20428; Tue, 5 Nov 1996 11:54:59 GMT
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.961105114231.20239A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@nrao.edu>
Subject: New field models
Date: Tue, 5 Nov 1996 11:54:58 +0000 (GMT)

As light relief from scheduling, you might like to pick up the FITS files V6.I, Q and U from my ftp area. These are the results of the first attempt to optimize the new 3D shear layer field model. As you will see, the degree of polarization has been reduced at the edges of the transition region, but at some cost. I think that the optimization procedure is now being faced with too hard a problem to handle in one go: during the last run it left all of the field anisotropy parameters at their initial values and, I think, found a local minimum (no worse than usual, but not the best possible). I am now trying a run with just the field anisotropy parameters allowed to vary: this looks as if it is heading for a significantly better solution.

The main problems with the new model are that there is insufficient polarization in the very innermost region on both sides (which probably means that there is too much radial component there) and that the high-polarization ridge in the main jet still starts too close to the nucleus. I'm not sure whether I can get all of this right without tampering with the spine field order, but V6 certainly isn't the last word.

Robert

From VM Fri Nov 8 09:38:12 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["878" "Tue" "5" "November" "1996" "08:28:25" "-0500" "Alan Bridle" "abridle" nil "18" "Re: New field models"
"^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 878
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA37856; Tue, 5 Nov 1996 08:28:25 -0500
Message-Id: <9611051328.AA37856@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961105114231.20239A-100000@rgosf>
References: <Pine.GSO.3.94.961105114231.20239A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: New field models
Date: Tue, 5 Nov 1996 08:28:25 -0500

Robert Laing writes:
> As light relief from scheduling, you might like to pick up the FITS files
> V6.I, Q and U from my ftp area. These are the results of the first
> attempt to optimize the new 3D shear layer field model. As you will see,
> the degree of polarization has been reduced at the edges of the transition
> region, but at some cost. I think that the optimization procedure is now
> being faced with too hard a problem to handle in one go: during the last
> run it left all of the field anisotropy parameters at their initial
> values and, I think, found a local minimum (no worse than usual, but not
> the best possible). I am now trying a run with just the field anisotropy
> parameters allowed to vary: this looks as if it is heading for a
> significantly better solution.

I'm pulling V6.* right now.

I'll get AL405 scheduled some time today.

A.

From VM Fri Nov 8 09:38:22 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["1582" "Tue" "5" "November" "1996" "09:50:27" "-0500" "Alan Bridle" "abridle" nil "32" "3C31 A config" "^From:"
nil nil "11" nil nil nil nil]
nil)
Content-Length: 1582
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA36407; Tue, 5 Nov 1996 09:50:27 -0500
Message-Id: <9611051450.AA36407@polaris.cv.nrao.edu>
From: abridle (Alan Bridle)
To: rperley
Subject: 3C31 A config
Date: Tue, 5 Nov 1996 09:50:27 -0500

Hi Rick,

I need to schedule our 3C31 X-band A config run in the next day or
two. Do you have the observe file that you used for the B config
handy somewhere? If so, could you E-mail me a copy -- we should use
the same calibrators and positions, etc. this time as you did before.

As I mentioned at the end of the message to David Clarke, the modeling that Robert and I are doing is still progressing well. We got a good fit to the polarization as soon as we turned on a variable ratio of axial to azimuthal field in the shear layer; then we noticed that the place where the fit was worst was exactly where the entrainment should be greatest (and thus the field should be more disordered than the simple 2-d model). The next move is to add in the aberration of the third (radial) field component in the layer to take account of extra complexity in the layer in the region where the jet decelerates hard.

I gave a talk on this at the Jansky symposium; the VLB-ers are a bit startled by the amount of detail that we are now fitting. I'm tweaking Tony Zensus particularly with the statement that the polarimetry gives better nonstraints on the velicity field than does the sidedness (which was quite true for 3C31!).

Speaking of Tony, he has been granted tenure at the NRAO so now has a real choice to make. Sabine is expecting again but has also found a good part-time job as a CPA and so is really pushing him to stay in C'ville. It will be a tough call for him now re the offer from Bonn! Neither of them is particularly keen to go back to German society, it seems.

A.

From VM Fri Nov 8 09:38:35 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["130" "Tue" "5" "November" "1996" "08:19:20" "-0700" "Rick Perley" "rperley@aoc.nrao.edu"
"<199611051519.IAA14377@sechelt.aoc.nrao.edu>" "7" "Re: 3C31 A config" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 130
Received: from arana.aoc.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA20664; Tue, 5 Nov 1996 10:19:27 -0500
Received: from sechelt.aoc.nrao.edu (sechelt.aoc.nrao.edu [146.88.6.21]) by arana (8.6.12/8.6.10) with ESMTP id IAA22685 for <abridle@nrao.edu>; Tue, 5 Nov 1996 08:19:21 -0700
Received: (from rperley@localhost) by sechelt.aoc.nrao.edu (8.7.3/8.6.10) id IAA14377 for abridle@nrao.edu; Tue, 5 Nov 1996 08:19:20 -0700 (MST)
Message-Id: <199611051519.IAA14377@sechelt.aoc.nrao.edu>
X-Sun-Charset: US-ASCII
From: Rick Perley <rperley@aoc.nrao.edu>
To: abridle@nrao.edu
Subject: Re: 3C31 A config
Date: Tue, 5 Nov 1996 08:19:20 -0700 (MST)

Alan:

I'll check my old observe files, but my recollection is that all the B-config. data were taken by Gabrielle.

Rick

From VM Fri Nov 8 09:38:46 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["219" "Tue" "5" "November" "1996" "10:40:04" "-0500" "Alan Bridle" "abridle" nil "11" "Re: 3C31 A config"
"^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 219

Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA20687; Tue, 5 Nov 1996 10:40:04 -0500
Message-Id: <9611051540.AA20687@polaris.cv.nrao.edu>
In-Reply-To: <199611051519.IAA14377@sechelt.aoc.nrao.edu>
References: <199611051519.IAA14377@sechelt.aoc.nrao.edu>
From: abridle (Alan Bridle)
To: Rick Perley <rperley@aoc.nrao.edu>
Subject: Re: 3C31 A config
Date: Tue, 5 Nov 1996 10:40:04 -0500

Rick Perley writes:

> I'll check my old observe files, but my recollection is that all the
> B-config. data were taken by Gabrielle.
>

That was 6cm; I think we did the 8 GHz ab initio as a VLA project.

A.

From VM Fri Nov 8 09:38:56 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["396" "Tue" "5" "November" "1996" "15:41:34" "+0000" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.961105153842.20938A-100000@rgosf>" "10" "Re: New field models" "^From:" nil nil "11" nil nil nil
nil]
nil)
Content-Length: 396
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA23015; Tue, 5 Nov 1996 10:41:54 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id KAA16069 for <abridle@nrao.edu>; Tue, 5 Nov 1996 10:41:42 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id PAA20049; Tue, 5 Nov 1996 15:41:37 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id PAA20952; Tue, 5 Nov 1996 15:41:36 GMT
X-Sender: rl@rgosf
In-Reply-To: <9611051328.AA37856@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.961105153842.20938A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@nrao.edu>
Subject: Re: New field models
Date: Tue, 5 Nov 1996 15:41:34 +0000 (GMT)

After some fiddling, I think I have the polarization almost right: the
main problem is still the obstinate B perp feature in the centre of the
transition region in the main jet. I can see no way of making this go away
other than by adding a longitudinal component to the spine field. What do
you think about this?

About reductions: I'd like to concentrate on the FRI projects for now.

Robert

From VM Fri Nov 8 09:38:59 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["749" "Tue" "5" "November" "1996" "10:57:05" "-0500" "Alan Bridle" "abridle" nil "23" "Re: New field models"
"^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 749
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA40590; Tue, 5 Nov 1996 10:57:05 -0500
Message-Id: <9611051557.AA40590@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961105153842.20938A-100000@rgosf>
References: <9611051328.AA37856@polaris.cv.nrao.edu>
<Pine.GSO.3.94.961105153842.20938A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: New field models
Date: Tue, 5 Nov 1996 10:57:05 -0500

Robert Laing writes:

> After some fiddling, I think I have the polarization almost right: the
> main problem is still the obstinate B perp feature in the centre of the
> transition region in the main jet. I can see no way of making this go away
> other than by adding a longitudinal component to the spine field. What do
> you think about this?

I think it's pretty plausible if the spine is decelerating by
entrainment. Not having any in there seems to me to be only a first
approximation.

>
> About reductions: I'd like to concentrate on the FRI projects for now.

Oh yes! I was really inviting the rest of the gang to volunteer for
something here! Everyone's getting the same messages in the present
distribution list ....

A.

rom VM Fri Nov 8 09:41:31 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["1100" "Wed" "6" "November" "1996" "19:02:17" "+0000" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.961106185445.23755A-100000@rgosf>" "26" "Progress + bug fix" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 1100
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA45042; Wed, 6 Nov 1996 14:02:27 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id OAA06288 for <abridle@nrao.edu>; Wed, 6 Nov 1996 14:02:23 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id TAA07397; Wed, 6 Nov 1996 19:02:20 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id TAA23780; Wed, 6 Nov 1996 19:02:18 GMT
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.961106185445.23755A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@nrao.edu>
Subject: Progress + bug fix
Date: Wed, 6 Nov 1996 19:02:17 +0000 (GMT)

I have now put in the ability to change field component ratios separately
in the spine and shear layer. I decided in the process to work with the
field ratios rather than their logarithms - it makes very little
difference. I found one bug which has been present since the advent of
the unequal field component c de: the calculation of the anisotropy
parameter was incorrect if rho1 < rho < rho0 - it was always set to what
should have been the value at rho1. In the version you have,

```
      ANIS = 10.0**(LG_ANIS1 -
     &        (LG_ANIS1-LG_ANIS1)*(RHO-RHO1)/(RHO0-RHO1))
```

should (obviously) read

```
      ANIS = 10.0**(LG_ANIS1 -
     &        (LG_ANIS1-LG_ANIS0)*(RHO-RHO1)/(RHO0-RHO1))
```

I spent ages yesterday wondering why I couldn't get higher polarization
close to the nucleus without messing things up in the transition region!

Fixing this will help a little, but I think it will be more productive to
play around with the spine field. One interesting possibility is that the
field is actually what we have assumed for the shear layer all the way
through the jet.

Robert

From VM Fri Nov 8 09:42:07 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["716" "Wed" "6" "November" "1996" "16:07:04" "-0500" "Alan Bridle" "abridle" nil "21" "Re: Progress + bug fix"
"^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 716
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA42493; Wed, 6 Nov 1996 16:07:04 -0500
Message-Id: <9611062107.AA42493@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961106185445.23755A-100000@rgosf>
References: <Pine.GSO.3.94.961106185445.23755A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Progress + bug fix
Date: Wed, 6 Nov 1996 16:07:04 -0500

Robert Laing writes:
>
> I spent ages yesterday wondering why I couldn't get higher polarization
> close to the nucleus without messing things up in the transition region!
>
> Fixing this will help a little, but I think it will be more productive to
> play around with the spine field. One interesting possibility is that the
> field is actually what we have assumed for the shear layer all the way
> through the jet.
>

Yikes! Is this just because we have turned the spine emissivity "down" in this
case? This will make NGC315 _very_ interesting .....

In 3C353 the data were consistent with "no" spine, either. Just a hollow
jet with the shear layer field going in to about half the radius.

A.

From VM Fri Nov 8 09:42:34 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["1610" "Thu" "7" "November" "1996" "14:20:03" "+0000" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.961107140257.24956A-100000@rgosf>" "34" "Spinelessness" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 1610
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA41117; Thu, 7 Nov 1996 09:20:21 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id JAA18384 for <abridle@nrao.edu>; Thu, 7 Nov 1996 09:20:12 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id OAA16688; Thu, 7 Nov 1996 14:20:05 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id OAA25030; Thu, 7 Nov 1996 14:20:04 GMT
X-Sender: rl@rgosf
Mess<ge-Id: <Pine.GSO.3.94.961107140257.24956A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@nrao.edu>
Subject: Spinelessness
Date: Thu, 7 Nov 1996 14:20:03 +0000 (GMT)

I think that 3C31 has to be unusual amongst the twin-jet sources. We appear to be looking primarily at "boundary-layer" emission in the outer regions, at least. This cannot work in the majority of sources, where there is too far much Bperp. The model does want a thin spine, but the path length is not long enough to make much difference to thegemission.

After fixing the bug and re-optimizing, I got a very good fit to the main jet polarization for the first time (transition at 8 arcsec). As I suspected, this stuffed up the counter-jet ridge line polarization, which is now seriously underestimated from 5 to 20 arcsec. Unfortunately, the inner counter-jet is getting very low weight in the optimization, since the emission is weak, and the "noise level" is determined over the whole of the counter-jet. There has always been an annoying minimum in its total intensity at 9 arcsec as well. Fiddling with the parameters by hand is not very productive - the model is too complicated for this.

I think that the best thing to do is to use different noise levels for the inner and outer regions: the chi-squareds are already evaluated separately. The optimization might then decide on a reasonable compromise.

Contrary to what I said yesterday, I do not now think that the spine field configuration will have much influence on the fit: almost all of the high Bperp ridge in the counter-jet comes from shear layer (even more, of course, than in the main jet).

I have put IQU FITS images of the latest optimization run in the usual place as 3DF.I,Q and U.

There HAS to be a good solution!

Robert

From VM Fri Nov 8 09:42:36 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["681" "Thu" "7" "November" "1996" "11:00:39" "-0500" "Alan Bridle" "abridle" nil "19" "Re: Spinelessness"
"^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 681
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA22234; Thu, 7 Nov 1996 11:00:39 -0500
Message-Id: <9611071600.AA22234@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961107140257.24956A-100000@rgosf>
References: <Pine.GSO.3.94.961107140257.24956A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Spinelessness
Date: Thu, 7 Nov 1996 11:00:39 -0500

Robert Laing writes:

> I think that the best thing to do is to use different noise levels for the
> inner and outer regions: the chi-squareds are already evaluated
> separately. The optimization might then decide on a reasonable
> compromise.
>
> Contrary to what I said yesterday, I do not now think that the spine field
> configuration will have much influence on the fit: almost all of the high
> Bperp ridge in the counter-jet comes from shear layer (even more, of
> course, than in the main jet).
>
> I have put IQU FITS images of the latest optimization run in the usual
> place as 3DF.I,Q and U.
>

I'm pulling them over right now; link is slow today.

A.

From VM Fri Nov 8 09:42:45 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["22519" "Thu" "7" "November" "1996" "17:40:44" "+0000" "Robert Laing" "rl@ast.cam.ac.uk" nil "640" "Latest instructions " "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 22519
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA44667; Thu, 7 Nov 1996 12:42:54 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP id MAA21785 for <abridle@nrao.edu>; Thu, 7 Nov 1996 12:41:08 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA19754; Thu, 7 Nov 1996 17:40:47 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA25508; Thu, 7 Nov 1996 17:40:46 GMT
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.961107173910.25505A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@nrao.edu>
Subject: Latest instructions
Date: Thu, 7 Nov 1996 17:40:44 +0000 (GMT)

I'm sending these for information, even though you haven't got the code
yet.

Building and running model

Revised 7-Nov-1996

1. Introduction

The jet-modelling program model now has three main functions:
- optimize the fit of a jet model to observed data;
- make a set of models and compare them with observed data, optionally
  writing out images of models and chi-squared;
- make a set of models in which parameters are varied
  without constraining the total flux (this is primarily intended to
  show the effect of changing the angle to the line of sight).

The program has the following options:
- optimize or make sequence of models;
- compare models and data;
- output model images;
- output chi-squared images;
- process IQU or I only;
- normalize flux.

2. Building model

All of the files needed to build and run model are included in the
gnu-zipped tar file model.tar.gz in the anonymous ftp area on
ast.cam.ac.uk. To get the file, ftp ftp.ast.cam.ac.uk, login as anonymous,
and cd to pub/rl.

The program is built using two shell files: modcomp (called this for
sentimental reasons) and modlink. The first compiles all of the

subroutines and the second links them. To build model from scratch:

source modcomp
source modlink

This produces an executable called model.

Individual routines may be compiled using

f77 -xl -c -u routine.f

except for the main program, which needs

f77 -xl -c -u -Nc48 model.f

because of its enormous DO-loop.

The program and its input and output files may be in different directories: these can be set using shell scripts (see 4.1)

The programs are not in standard Fortran 77, and use (mostly common) extensions, hence the -xl switch. The -u switch is optional. The routine getenv is called to decode environment variables, and this may only work on Sun workstations. It has only been built and tested under Solaris 2.5, but I have no reason to suppose that it will fail on any Sun machine. I do not know whether getenv works under OSF/1, or whether there is an equivalent routine, but it should be straightforward to port model to an Alpha, if not to an IBM running AIX.

Numerical Recipes routines are used; note that qromb has been modified. All of the modules used are included.

3. Basic operation and algorithms

3.1 Outline

The program has the following basic steps:

- decode environment variables
- read the constants file
- read the variables file
- if comparing with observed data, or optimizing, read the images
- then either:
  optimize the fit
  or:
  make a sequence of models

The model sequence loops over all possible configurations (i.e. combinations of parameter values specified in the variables file), then
- makes a model
- if required, normalizes the flux
- makes chi-squared images and sums them
- writes out the maps
- writes a log file

The optimization process does the following:
- use the variables file to determine which parameters are to be changed
- construct a starting simplex and calculate chi-squared at each vertex

- minimize the value of chi-squared

The function which returns chi-squared is effectively the same as the model calculation described earlier and calls the same code.

3.2 Optimization

Optimization is done using the downhill simplex algorithm of Nelder and Mead, as implemented in the Numerical Recipes routine amoeba. This attempts to find the minimum value of chi-squared in an N-dimensional space defined by the N varying parameters. It starts with N+1 points defining an initial simplex (a geometrical figure consisting of these points and all their connecting line segments, polygonal faces, etc.). Suppose that P_0 is a vector of the N variables, containing the initial best guess. Then the other N vertices are:

$P_i = P_0 + l_i e_i$

where the e_i 's are N unit vectors and the l_i's are length scales for each variable.

The downhill simplex method takes a series of steps, most steps moving the point of the simplex with the highest chi-squared through the opposite face to a lower point. When it can do so, the algorithm expands the simplex to tae larger steps. When moving down a valley in chi-squared, the simplex contracts itself in the other dimensions and tries to move down the valley.
The process terminates when the decrease in chi-squared in the next step is less than a fractional tolerance FTOL.

The algorithm is extremely robust, and appears to cope easily with modification of all of the model parameters (except those which specify the geometry, which are always fixed). It typically takes between 50 and 450 iterations to converge (1 - 5 hours on an unloaded Sparc 10). FTOL = 0.01 appears to work well.

3.3 The model

Geometry

The model has two antiparallel, identical jets whose axis makes an angle THETA to the line of sight. We define RHO to be the distance from the nucleus (in units of half of the computing grid) and ETA to be an angle measured from the jet axis. The model jet is divided into three regions:

Inner: RHO < RHO1
Transition: RHO1 < RHO < RHO0
Outer: RHO0 < RHO

RHOF (>RHO0) is a fiducial distance for velocity calculations.

In the inner and outer regions, the emission is bounded by cones of half-angle XI1 and XI0, respectively. The boundary in the transition region is defined in the XJ, ZJ plane, where ZJ is measured along the jet axis and XJ perpendicular to it. The boundary is XJ = p(ZJ), where p is a cubic with coefficients chose so that the function and its first derivative match the relations XJ = ZJ tan XI1 and XJ = ZJ tan XI0 at RHO1 and RHO0, respectively. The jet spine is defined similarly by the angles ETA1 and ETA0.

The input values of distances and angles are projected onto the plane of the

sky, in order to allow direct comparison with observation. They are also in units of half of the computing grid (i.e X = 0 at the core, +1 at the end of the jet and -1 at the end of the counter-jet).

In projected coordinates, and referring to the outer boundary of the jet:

Inner: X < X1
Transition: X1 < X < X0
Outer: X0 < X

Projected fiducial distance = XF.

Similarly, the input angles refer to the outer boundaries of the jet and the spine emission, projected on the plane of the sky. Half-opening angles:

Inner jet: JETANG1 spine: SPANG1
Outer jet: JETANG0 spine: SPANG0

If flux normalization is turned on, then the distances and angles are projected to the jet frame for each configuration. If not, then this is done only for the first configuration, after which the values are held constant in the jet frame. The former approach is appropriate for fitting models to data; the latter for calculating the appearance of a given model at different angles to the line of sight. If the angle to the line of sight is 90 degrees, then the projected and intrinsic values are equal.

Velocity

Jet velocities are in units of c and are radially away from the nucleus. Within the spine:

Inner jet: Linear variation with RHO from BETAI at RHO = 0 to BETA1 at RHO1.
Transition: Linear variation from BETA1 at RHO1 to BETA0 at RHO0.
Outer: Power-law interpolation passing through (RHO0, BETA0) and (RHOF, BETAF). A linear variation is unsatisfactory because it requires infinite deceleration if the velocity -> 0.

The shear layer and spine have the same velocity at their boundary. The shear layer velocity decreases linearly with ETA to a fraction of the spine value (VMIN1 for the inner region, VMIN0 for the outer region and a linear interpolation between the two for intermediate distances).

Emissivity

In the spine, the emissivity constant (proportional to NB^(1+alpha) in the rest frame) varies as a power-law in RHO:

Inner jet: RHO^ESP_IN
Intermediate: RHO^ESP_MID
Outer jet: RHO^ESP_OUT

In the shear layer, the emissivity at the boundary with the spine has the functional form:

Inner jet: RHO^ESL_IN
Intermediate: RHO^ESL_MID
Outer jet: RHO^ESL_OUT

It then ramps down linearly with increasing ETA to a fraction SLMIN of this value at the edge of the jet.

The ratio of the spine to shear layer emissivity constants at RHO = RHO0 is SPINE_SL.

Field configurations

The fields are special cases of 1, 2 and 3-dimensional partly ordered fields (Laing 1980; Hughes et al. 1985). The 1D and 2D cases use the exact formulae for arbitrary spectral index and numerical integration as in Laing (1980), respectively; for 3D fields, the formulae are exact onlp for alpha = 1.

1D/2D

The field configuration in mhe spine has
no longitudinal component, but the radial and azimuthal components are equal on average. There are three possible shear layer configurations:
- one-dimensional, longitudinal
- two-dimensional, transverse (as in the spine)
- two-dimensional, with no radial component, but longitudinal and toroidal components statistically equal.

3D

In this case, the ratios B_long/B_tor and B_rad/B_tor may be varied, where B_long, B_tor and B_rad are the rms magnetic field components in the longitudinal, toroidal and radial directions with respect to the flow at a given point. The values of these components are specified at the fiducial points and the values of the field ratios are interpolated linearly between these values.

If flux normalization is turned on, the the total I flux on the grid will be scaled to be equal to the input value (the core is excluded in both cases). This is always done for an optimization ron, of course. Otherwise, normalization will be done for the first configuration executed (this will always be defined by the first values for each parameter in the variables file).

4. Inputs

4.1 The shell file

A simple C-shell script is used to set up the environment variables which control the program, and to start execution (these commands could just be typed at the keyboard). Environment variables are of 2 sorts: those which control program execution and filenames. The control variables are:

Variable	Values	Meaning
OPTIMIZE	T	Do optimization run
	F	Do model sequence
COMPARE	T	Compare model(s) and data
	F	Just make models

DOPOL T Model/compare I, Q and U
F Model/compare I only

PLOTMAP T Output model maps
F Don't

PLOTCHISQ T Output chi-squared images
F Don't

FLUXNORM T Constrain extended flux to be equal to SOBS
F Constrain extended flux for the first model in
a sequence to be equal to SOBS; thereafter keep
the same scaling.

BTYPE 1D Shear layer field is purely longitudinal
T2 Shear layer field is same as that for spine (no Bz)
S2 Shear layer field has no radial component,
azimuthal and toroidal components equal on average.
SU Spine and shear-layer fields have varying ratios of
longitudinal:radial:toroidal field.

Some combinations are ignored. If OPTIMIZE = T, then COMPARE and FLUXNORM must be true (and need not be specified). The plotting options PLOTMAP and PLOTCHISQ are also disabled.

The variables for filenames are:

CFILE Constants file (see 4.2)
VFILE Variables file (see 4.3)
IMAPFILE File containing observed I map in IMTXT format (see 4.4)
QMAPFILE Q
UMAPFILE U
LOGFILE Text file to contain a log.

The last line of the shell file starts the program.

The example below (included as modell.csh) does a model sequence, comparing I, Q and U models with observed data and outputting the model and chi-squared images. It uses a 2D shear-layer field and normalizes I to give the observed flux.

```
# C-shell file to run jet modelling program
# 3C31: 0.7 arcsec resolution maps
setenv OPTIMIZE F
setenv COMPARE T
setenv PLOTMAP T
setenv PLOTCHISQ T
setenv FLUXNORM T
setenv DOPOL T
setenv BTYPE SU
setenv IMAPFILE /scratch/rgosc/FITS/3C31LOW.I
setenv QMAPFILE /scratch/rgosc/FITS/3C31LOW.Q
setenv UMAPFILE /scratch/rgosc/FITS/3C31LOW.U
setenv CFILE /scratch/rgosc/rl/doppler/CONST.DAT
setenv VFILE /scratch/rgosc/rl/doppler/VARS.DAT
setenv LOGFILE /scratch/rgosc/rl/doppler/3DF.LOG
/scratch/rgosc/rl/doppler/v6/model
```

The second example (optl.csh) does an optimization run.

```
# C-shell file to run jet modelling program
# 3C31 maps: 0.7 arcsec resolutoon
setenv OPTIMIZE T
setenv DOPOL T
setenv BTYPE SU
setenv IMAPFILE /scratch/rgosc/FITS/3C31LOW.I
setenv QMAPFILE /scratch/rgosc/FITS/3C31LOW.Q
setenv UMAPFILE /scratch/rgosc/FITS/3C31LOW.U
setenv CFILE /scratch/rgosc/rl/doppler/CONST.DAT
setenv VFILE /scratch/rgosc/rl/doppler/OPT.DAT
setenv LOGFILE /scratch/rgosc/rl/doppler/OPT3DF.LOG
/scratch/rgosc/rl/doppler/v6/model
```

4.2 The constants file

The constants file (defined by the environment variable CFILE) is a text file containing parameters for the input and output images, constraints on the model and the comparison/optimization process. The file has a simple keyword value syntax, for example:

```
MAPX 140
MAPY 75
RA  16.853979167
DEC 32.412513889
ROTN 70.3
PIXEL 0.2
FREQ 8439.9
BW 100.0
EPOCH 2000.0
FWHM 0.7
XCMIN 6
YCMIN 10
XCMAX 135
YCMAX 40
SIGI1_J 1.84E-4
SIGP1_J  4.67E-5
SIGI1_CJ 3.18E-5
SIGP1_CJ 1.03E-5
SIGI2_J 4.88E-5
SIGP2_J  3.96E-5
SIGI2_CJ 2.12E-5
SIGP2_CJ 1.98E-5
CALERR 0.0
SOBS  0.244
SCORE 0.0885
FTOL 0.01
ALPHAC 0.0
NFREE 40
SAMPLE 3
```

This file is included as CONST.DAT. It is intended to model 0.7-arcsec FWHM maps of 3C31 on a 0.2-arcsec grid, derived from 3C31 3.6BCD1.IVCSUB, QCLSUB and UCLSUB. The maps are 281 x 151 pixels with the core at 141, 76.

Anything following a * or ! is treated as a comment and is ignored, as is a

blank line. The parameters are as follows (note that the image parameters refer to the input data, the output model or both, depending on context).

MAPX, MAPY: the model is computed on a grid of -MAPX -> MAPX in x by -MAPY -> MAPY in y, with the core at (0,0). The comparison map must be 2*MAPX+1 by 2*MAPY+1 with the core/reference pixel at (MAPX+1, MAPY+1).
RA, DEC: The coordinates of the reference pixel, as in the comparison images, in degrees.
ROTN: the rotation of the map used to align the main jet with the +x axis. Equal to -CROTA2 (in the header), in degrees. Used to rotate observed Q and U to the frame of reference of the model.
PIXEL: the pixel size, in arcsec.
FREQ: the frequency, in MHz.
BW: the bandwidth, in MHz.
EPOCH: the epoch of equinox, in years.
FWHM: the FWHM of the convolving beam, in arcsec. 0.0 => don't convolve the model.
XCMIN, XCMAX, YCMIN, YCMAX. Parameters defining the area over which chi-squared is calculated, in pixels. The jet chi-squared is calculated over the quadrilateral (XCMIN,YCMIN), (XCMAX,YCMAX), (XCMAX,-YCMAX), (XCMIN,-YCMIN) and the counterjet chi-squared over its reflection in the y axis. This is done to exclude the core and any outer regions of the jet which are not appropriate to model.
SIGI1_J RMS noise for I, main jet, X < X0
SIGP1_J RMS noise for Q/U, main jet, X < X0
SIGI1_CJ RMS noise for I, counter jet, X < X0
SIGP1_CJ RMS noise for Q/U, counter jet, X < X0
SIGI2_J RMS noise for I, main jet, X > X0
SIGP2_J RMS noise for Q/U, main jet, X > X0
SIGI2_CJ RMS noise for I, counter jet, X > X0
SIGP2_CJ RMS noise for Q/U, counter jet, X > X0
All noise levels are in Jy/beam area.
CALERR: fractional calibration error, used in the evaluation of chi-squared.
SOBS: the flux in the image excluding the core, in Jy. Used as a constraint (unless flux normalization is disabled).
SCORE: the flux density in the core (assumed to be a point source), in Jy. Not included in the model, but added to the map. Varies with angle to the line of sight if flux normalization is disabled.
FTOL: the fractional change in chi-squared which defines the convergence criterion for optimization. 0.01 appears to work.
ALPHAC: the spectral index of the core, used t compute variation of core flux density with angle to the l of s when flux normalization is turned off.
NFREE number of free parameters, used in estimating the number of degrees of freedom. Currently equal to the number of variables in VARS.DAT (see below - 1 (since ALPHA is known a priori) + 1 (since there is a flux constraint).
SAMPLE the oversampling factor used in summing chi-squared. The program sums chi-squared over every SAMPLE'th point in x and y. The idea is to pick SAMPLE so that the points used are close to independent.

4.3 The variables file

The variables file, defined by the environment variable VFILE, contains the parameters which define the model. Like the constants file, it has a keyword-value syntax, but there may be more than one value per line, depending on context.

For an optimization run, there should be either one or two values per line. If there is a single value, the corresponding variable is fixed at this value during the optimization process. If there are two values, the first is the starting position for the optimization and the second is the change in the variable used to define the corresponding vertex of the starting simplex.

For a model sequence, there should be between 1 and 10 values per line. These are just the values of the variables to be used. The variables are:

THETA Angle to the line of sight, in degrees
ALPHA Spectral index of the jet emission

The following angles and distances are values projected on the plane of the sky:

JETANG0 Half-opening angle of the outer jet (degrees)
JETANG1 Half-opening angle of the inner jet (degrees)
SPANG0 Half-opening angle of the outer spine (degrees)
SPANG1 Half-opening angle of the inner spine (degrees)
X0 Outer transition distance (fraction of model jet length)
X1 Inner transition distance (fraction of model jet length)
XF Fiducial position in outer jet (fraction of model jet length)

Velocities

BETAI Initial velocity (units of c)
BETA1 Velocity at RHO1 (units of c)
BETA0 Velocity at RHO0 (units of c)
BETAF Velocity at RHOF (units of c)

Power-law indices for emissivity

ESP_IN Spine (RHO < RHO1)
ESP_MID Spine (RHO1 < RHO < RHO0)
ESP_OUT Spine (RHO0 < RHO)
ESL_IN Shear layer (RHO < RHO1)
ESL_MID Shear layer (RHO1 < RHO < RHO0)
ESL_OUT Shear layer (RHO0 < RHO)

Field configuration (used for BTYPE SU only)

RHO	Spine		Shear Layer	
	B_long/B_tor	B_rad/B_tor	B_long/B_tor	B_rad/B_tor
0	SPLTI	SPRTI	SLLTI	SLRTI
RHO1	SPLT1	SPRT1	SLLT1	SLRT1
RHO0	SPLT0	SPRT0	SLLT0	SLRT0
RHOF	SPLTF	SPRTF	SLLTF	SLRTF

Misc

RHOTRUNC Truncation distance, within which emissivity is set to 0. Units of jet length. Note that this is in the jet frame, not projected on the sky.
SPINE_SL Ratio of spine to shear layer emissivity at RHO = RHO0
SLMIN Fractional emissivity at outer boundary of shear layer
VMIN0 Fractional velocity at edge of shear layer (RHO > RHO0)

VMIN1 Fractional velocity at edge of shear layer (RHO < RHO1)

Example of a variables file to compute a single model:

```
* VARS.DAT - Current best estimate of jet model (v6 code)
THETA 52.767
ALPHA 0.55
JETANG0 16.75
JETANG1 8.0
SPANG0 3.0
SPANG1 2.0
X0 0.2944
X1 0.108
XF 0.8
BETAI 0.989
BETA1 0.85
BETA0 0.828
BETAF 0.366
ESP_IN 0.094
ESP_MID 3.371
ESP_OUT 3.359
ESL_IN  -2.384
ESL_MID 3.714
ESL_OUT 1.468
RHOTRUNC 0.0
SPINE_SL 0.997
SLMIN 0.115
VMIN0 0.204
VMIN1 0.500
SLLTI  1.005
SLLT1  1.069
SLLT0  0.954
SLLTF  0.572
SLRTI  0.100
SLRT1  0.410
SLRT0  0.810
SLRTF  0.100
SPLTI  0.000
SPLT1  0.000
SPLT0  0.000
SPLTF  0.000
SPRTI  1.000
SPRT1  1.000
SPRT0  1.000
SPRTF  1.000
```

Example of a variables file for optimization:

```
* OPT.DAT - input file for jet model optimization
THETA 52.767 5.0
ALPHA 0.55
JETANG0 16.75
JETANG1 8.0
SPANG0 3.0
SPANG1 2.0
X0 0.2944
X1 0.108
XF 0.8
```

BETAI 0.989
BETA1 0.926 -0.1
BETA0 0.828 -0.1SBETAF 0.366 0.1
ESP_IN 0.094
ESP_MID 3.371 0.75
ESP_OUT 3.359 0.75
ESL_IN -2.384 0.75
ESL_MID 3.714 0.75
ESL_OUT 1.468 0.75
RHOTRUNC 0.0
SPINE_SL 0.997 0.2
SLMIN 0.115 0.2
VMIN0 0.204 0.2
VMIN1 0.500 0.2
SLLTI 1.005
SLLT1 1.069 0.1
SLLT0 0.954 0.1
SLLTF 0.572 0.1
SLRTI 0.100
SLRT1 0.410 0.1
SLRT0 0.810 0.1
SLRTF 0.100
SPLTI 0.000
SPLT1 0.000
SPLT0 0.000
SPLTF 0.000
SPRTI 1.000
SPRT1 1.000
SPRT0 1.000
SPRTF 1.000

4.4 Observed data

It is assumed that the images to be compared with the model have dimensions 2*MAPX+1 by 2*MAPY+1, where MAPX and MAPY are integers. The core of the source must be at the centre of the map (MAPX+1,MAPY+1), which is also the reference pixel. The maps should be rotated (using HGEOM) so that the main jet is along the +x axis. The maximum allowed values of MAPX and MAPY are 500 and 250, respectively.

The data should be written out using the AIPS task IMTXT (modified from the standard version to allow output of larger images) and using an E10.3 format descriptor (TRANSCOD 'E10.3'). The filenames for the I, Q and U maps are read from the environment variables IMAPFILE, QMAPFILE and UMAPFILE (see above).

The effective noise level for evaluation of chi-squared is not obvious. The current best guess is to take a map, reflect it in the x axis (using TRANS with TRANSCOD '1-23', subtract the two images and use the result as an estimate of the error caused by deviations from axisymmetry. The errors may be very different in the inner and outer jets, and the ability to specify them separately for X > X0 and X < X0, and for the main and counter-jets, is included.

5. Output

5.1 Log file

The program generates an output log in the file specified by the environment variable LOGFILE and also writes to the screen.

5.2 Model and chi-squared images

Model and chi-squared images are written out if PLOTMAP = T and PLOTCHISQ = T, respectively. They are written to files

IMAPmn.TXT (model I)
QMAPmn.TXT (Q)
UMAPmn.TXT (U)
ICHISQmn.TXT (chi-squared I)
QCHISQmn.TXT (Q)
UCHISQmn.TXT (U)

in the current working directory, where mn is the number of the configuration (01 - 99). If more than 99 configurations are requested, then plotting will be turned off after number 99.

The images are ASCII files in a format suitable for reading by FETCH.

From VM Fri Nov 8 09:42:51 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["1507" "Thu" "7" "November" "1996" "14:29:25" "-0500" "Alan Bridle" "abridle" nil "33" "Re: Spinelessness"
"^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 1507
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA17788; Thu, 7 Nov 1996 14:29:25 -0500
Message-Id: <9611071929.AA17788@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961107140257.24956A-100000@rgosf>
References: <Pine.GSO.3.94.961107140257.24956A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Spinelessness
Date: Thu, 7 Nov 1996 14:29:25 -0500

Robert Laing writes:

> After fixing the bug and re-optimizing, I got a very good fit to the main
> jet polarization for the first time (transition at 8 arcsec). As I
> suspected, this stuffed up the counter-jet ridge line polarization, which
> is now seriously underestimated from 5 to 20 arcsec. Unfortunately, the
> inner counter-jet is getting very low weight in the optimization, since
> the emission is weak, and the "noise level" is determined over the whole
> of the counter-jet. There has always been an annoying minimum in its
> total intensity at 9 arcsec as well. Fiddling with the parameters by hand
> is not very productive - the model is too complicated for this.
>
> I think that the best thing to do is to use different noise levels for the
> inner and outer regions: the chi-squareds are already evaluated
> separately. The optimization might then decide on a reasonable
> compromise.
>

I see what you mean. The new model has too much polarized emission
from the edges of _both_ shear layers around the first transition
region, so the POLC distribution for the base of the counterjet looks
particularly wrong. The second transition region looks better,
however, and the outer regime of both jets is quite well fitted. The
sidedness pattern in the data is also less sharply peaked toward the
center of the jet than it is in the model.

It's as if the edges of the shear layer are relatively too emissive in
the inner region, and a bit too slow to boot?

A.

From VM Fri Nov 8 16:14:42 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["531" "Fri" "8" "November" "1996" "10:51:01" "-0500" "Alan Bridle" "abridle" nil "17" "AL405: 3C31 on Nov.12"
"^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 531
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA22964; Fri, 8 Nov 1996 10:51:01 -0500
Message-Id: <9611081551.AA22964@polaris.cv.nrao.edu>
From: abridle (Alan Bridle)
To: rperley, rl@ast.cam.ac.uk
Subject: AL405: 3C31 on Nov.12
Date: Fri, 8 Nov 1996 10:51:01 -0500

Rick, Robert

I'm presuming it would be better to use the new default X Band frequencies (8435/8485) for the upcoming A configuration run, rather than the 8414/8464 pair that was used previously for the BCD observations. Let me know if there's any subtle reason for not making the shift to the new defaults, I'm proposing to stay with 50MHZ bandwidth as we are really after sensitivity in the inner counterjet polarized emission rather than fidelity further out.

Robert: the new defaults avoid some internal RFI birdies.

A.

From VM Fri Nov 8 16:14:44 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["278" "Fri" "8" "November" "1996" "15:55:04" "+0000" "Robert Laing" "rl@ast.cam.ac.uk" nil "7" "Re: AL405:
3C31 on Nov.12" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 278
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA45442; Fri, 8 Nov 1996 11:04:59 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id LAA07195 for <abridle@nrao.edu>; Fri, 8 Nov 1996 11:04:56 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id PAA01074; Fri, 8 Nov 1996 15:55:08 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id PAA26728; Fri, 8 Nov 1996 15:55:06 GMT
X-Sender: rl@rgosf
In-Reply-To: <9611081551.AA22964@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.961108155252.26718A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@nrao.edu>
Cc: rperley@polaris.cv.nrao.edu
Subject: Re: AL405: 3C31 on Nov.12
Date: Fri, 8 Nov 1996 15:55:04 +0000 (GMT)

I cannot see that such a small frequency shift would cause any problems,
and avoidance of rfi must be more important. Maximum sensitivity is
vital, and we won't be making any use of A-configuration spacings at
large distances from the core, so 50MHz is clearly right too.

R.

From VM Fri Nov 8 16:16:07 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["13097" "Fri" "8" "November" "1996" "13:37:41" "-0500" "Alan Bridle" "abridle" nil "207" "AL405 schedule draft"
"^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 13097
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA28419; Fri, 8 Nov 1996 13:37:41 -0500
Message-Id: <9611081837.AA28419@polaris.cv.nrao.edu>
From: abridle (Alan Bridle)
To: rperley, rl@ast.cam.ac.uk
Subject: AL405 schedule draft
Date: Fri, 8 Nov 1996 13:37:41 -0500

Here's the schedule draft. It's very similar to the schedule that
Rick used for the B configuration except that about every fourth
synthesis cal I'm going to 3C84 instead of 0042+233. 3C84 should
really nail the polarization calibration and also give us a crack at
baseline-based calibration if necessary. We will also know its flux
density and polarization properties from the AB796 8-GHz runs going on
at the moment, so it will be a "reserve" calibrator on those fronts as
well.

Any comments to me asap, please,

A.

==========

/.AL405 00076
//* ***
//* *** NRAO VLA Observe Program, Version U3.2.28, 1996.02.27
//* ***
//* *** Observation day 57,109 at 19 00 00 LST, 1996.11.12 15:41:08 MST.
//* ***
//* *** Observer
//* ***   Phone
//* ***   Office: 804-296-0375
//* ***   During observation: 804-971-7752
//* ***
//* ***
//* ***
//* *** E-Mail address
//* *** abridle@nrao.edu
//* ***
//* *** Observing mode(s): Continuum
//* ***
//* *** Special Instructions
//* ***
//* *** Please extend first observation (0042+233) manually if necessary
//* *** to obtain 2 min of integration with whole array on-source before
//* *** moving to 3C31
//* ***
//* *** Date Prepared: 1996.11.08 11:21:57 MST.
//* ***
0042+233   19 07 00 00 42 04.5428 +23 20 00.922C   XX   C   0000   1.18
//DS   10

```
3C31         19 37 00 01 07 24.9550 +32 24 45.050C    XX       0000
0137+331     19 42 00 01 37 41.3051 +33 09 35.394C    XX   C   0000   3.25
0042+233     19 45 00 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         20 15 00 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233     20 18 00 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         20 48 00 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233     20 51 00 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         21 21 00 01 07 24.9550 +32 24 45.050C    XX       0000
0319+415     21 24 30 03 19 48.1601 +41 30 42.106C    XX   A   0000  24.00
3C31         21 54 30 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233     21 57 30 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         22 27 30 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233     22 30 30 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         23 00 30 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233     23 03 30 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         23 33 30 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233     23 37 00 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         00 07 00 01 07 24.9550 +32 24 45.050C    XX       0000
0319+415     00 10 30 03 19 48.1601 +41 30 42.106C    XX   A   0000  24.00
3C31         00 40 30 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233     00 44 45 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         01 14 45 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233     01 17 45 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         01 47 45 01 07 24.9550 +32 24 45.050C    XX       0000
0319+415     01 53 45 03 19 48.1601 +41 30 42.106C    XX   A   0000  24.00
3C31         02 23 45 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233     02 26 45 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         02 56 45 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233     02 59 45 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         03 29 45 01 07 24.9550 +32 24 45.050C    XX       0000
0319+415     03 33 45 03 19 48.1601 +41 30 42.106C    XX   A   0000  24.00
3C31         04 03 45 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233     04 06 45 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         04 37 45 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233     04 40 45 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         05 11 45 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233     05 14 45 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         05 45 45 01 07 24.9550 +32 24 45.050C    XX       0000
0319+415     05 49 30 03 19 48.1601 +41 30 42.106C    XX   A   0000  24.00
3C31         06 20 30 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233     06 23 30 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         06 54 30 01 07 24.9550 +32 24 45.050C    XX       0000
0521+166     07 00 00 05 21 09.9039 +16 38 22.116C    XX   C   0000   2.52
```

==========

National Radio Astronomy Observatory VLA observing program AL405
for day 57,109 beginning 19 00 00 LST, 1996.11.12 15:41:08 MST, Analysts' report.

```
                                          Begin Obs          End Obs          Freq MHz   Bandwidth MHz
Item Source  Qual Stop LST  RA       Dec       Epoch     Az     El     PA     Az     El     PA     AC     BD     AC     BD
-------------------------------------------------------------------------------------------------------------------------------
 1 0042+233      19 07 00  00 42 04 +23 20 00 J2000   72.58   16.37  -59.38   73.43   17.75  -59.82      0      0 50.000 50.000
 2 3C31          19 37 00  01 07 24 +32 24 45 J2000   62.25   17.43  -60.24   65.45   23.00  -63.16      0      0 50.000 50.000
 3 0137+331      19 42 00  01 37 41 +33 09 35 J2000   61.54   17.75  -60.42   62.08   18.66  -60.93      0      0 50.000 50.000
```

4 0042+233 19 45 00 00 42 04 +23 20 00 J2000 77.63 24.77 -61.76 77.99 25.37 -61.91 0 0 50.000 50.000
5 3C31 20 15 00 01 07 24 +32 24 45 J2000 66.27 24.51 -63.90 69.26 30.26 -66.54 0 0 50.000 50.000
6 0042+233 20 18 00 00 42 04 +23 20 00 J2000 81.60 31.49 -63.16 81.97 32.10 -63.26 0 0 50.000 50.000
7 3C31 20 48 00 01 07 24 +32 24 45 J2000 69.55 30.84 -66.80 72.40 36.72 -69.23 0 0 50.000 50.000
8 0042+233 20 51 00 00 42 04 +23 20 00 J2000 85.70 38.28 -64.08 86.09 38.90 -64.14 0 0 50.000 50.000
9 3C31 21 21 00 01 07 24 +32 24 45 J2000 72.68 37.31 -69.46 75.44 43.28 -71.70 0 0 50.000 50.000
10 0319+415 21 24 30 03 19 48 +41 30 42 J2000 53.89 22.03 -63.32 54.21 22.62 -63.77 0 0 50.000 50.000
11 3C31 21 54 30 01 07 24 +32 24 45 J2000 75.76 43.98 -71.95 78.48 50.04 -73.98 0 0 50.000 50.000
12 0042+233 21 57 30 00 42 04 +23 20 00 J2000 95.17 52.03 -63.93 95.67 52.65 -63.83 0 0 50.000 50.000
13 3C31 22 27 30 01 07 24 +32 24 45 J2000 78.75 50.65 -74.17 81.50 56.77 -75.97 0 0 50.000 50.000
14 0042+233 22 30 30 00 42 04 +23 20 00 J2000 101.21 58.79 -62.22 101.84 59.40 -61.97 0 0 50.000 50.000
15 3C31 23 00 30 01 07 24 +32 24 45 J2000 81.78 57.38 -76.14 84.70 63.55 -77.62 0 0 50.000 50.000
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17 3C31 23 33 30 01 07 24 +32 24 45 J2000 85.01 64.17 -77.74 88.35 70.37 -78.67 0 0 50.000 50.000
18 0042+233 23 37 00 00 42 04 +23 20 00 J2000 121.27 71.58 -50.44 122.93 72.20 -49.20 0 0 50.000 50.000
19 3C31 00 07 00 01 07 24 +32 24 45 J2000 88.79 71.09 -78.73 93.42 77.30 -78.29 0 0 50.000 50.000
20 0319+415 00 10 30 03 19 48 +41 30 42 J2000 64.27 51.74 -85.05 64.36 52.39 -85.56 0 0 50.000 50.000
21 3C31 00 40 30 01 07 24 +32 24 45 J2000 94.13 78.03 -78.07 104.90 84.16 -71.43 0 0 50.000 50.000
22 0042+233 00 44 45 00 42 04 +23 20 00 J2000 178.27 79.23 -1.56 183.49 79.22 3.15 0 0 50.000 50.000
23 3C31 01 14 45 01 07 24 +32 24 45 J2000 108.13 85.01 -68.78 223.53 87.70 42.50 0 0 50.000 50.000
24 0042+233 01 17 45 00 42 04 +23 20 00 J2000 215.86 77.06 31.89 218.40 76.69 34.07 0 0 50.000 50.000
5 3C31 01 47 45 01 07 24 +32 24 45 J2000 233.28 87.23 51.83 261.57 81.37 76.01 0 0 50.000 50.000
26 0319+415 01 53 45 03 19 48 +41 30 42 J2000 420.93 70.47 -104.85 419.99 71.55 -106.74 0 0 50.000 50.000
27 3C31 02 23 45 01 07 24 +32 24 45 J2000 263.41 80.14 77.02 269.33 73.94 78.77 0 0 50.000 50.000
28 0042+233 02 26 45 00 42 04 +23 20 00 J2000 250.89 65.30 58.46 251.74 64.72 58.93 0 0 50.000 50.000
29 3C31 02 56 45 01 07 24 +32 24 45 J2000 269.76 73.32 78.79 273.48 67.11 78.27 0 0 50.000 50.000
30 0042+233 02 59 45 00 42 04 +23 20 00 J2000 258.88 58.71 62.25 259.49 58.10 62.47 0 0 50.000 50.000
31 3C31 03 29 45 01 07 24 +32 24 45 J2000 273.81 66.49 78.17 276.86 60.30 76.88 0 0 50.000 50.000
32 0319+415 03 33 45 03 19 48 +41 30 42 J2000 345.64 82.31 164.08 340.42 82.07 158.25 0 0 50.000 50.000
33 3C31 04 03 45 01 07 24 +32 24 45 J2000 277.25 59.48 76.68 280.05 53.34 74.99 0 0 50.000 50.000
34 0042+233 04 06 45 00 42 04 +23 20 00 J2000 270.02 44.91 64.41 270.44 44.29 64.41 0 0 50.000 50.000
35 3C31 04 37 45 01 07 24 +32 24 45 J2000 280.32 52.73 74.81 283.13 46.45 72.80 0 0 50.000 50.000
36 0042+233 04 40 45 00 42 04 +23 20 00 J2000 274.54 37.88 64.04 274.92 37.26 63.97 0 0 50.000 50.000
37 3C31 05 11 45 01 07 24 +32 24 45 J2000 283.41 45.84 72.59 286.23 39.64 70.36 0 0 50.000 50.000
38 0042+233 05 14 45 00 42 04 +23 20 00 J2000 278.75 30.89 63.05 279.12 30.27 62.94 0 0 50.000 50.000
39 3C31 05 45 45 01 07 24 +32 24 45 J2000 286.51 39.04 70.13 289.42 32.93 67.69 0 0 50.000 50.000
40 0319+415 05 49 30 03 19 48 +41 30 42 J2000 295.39 60.42 92.47 295.34 59.72 91.81 0 0 50.000 50.000
41 3C31 06 20 30 01 07 24 +32 24 45 J2000 289.78 32.20 67.38 292.82 26.22 64.71 0 0 50.000 50.000
42 0042+233 06 23 30 00 42 04 +23 20 00 J2000 287.02 17.02 59.59 287.38 16.43 59.40 0 0 50.000 50.000
43 3C31 06 54 30 01 07 24 +32 24 45 J2000 293.12 25.65 64.44 296.34 19.82 61.53 0 0 50.000 50.000
44 0521+166 07 00 00 05 21 09 +16 38 22 J2000 236.08 62.73 45.84 238.03 61.78 47.17 0 0 50.000 50.000

National Radio Astronomy Observatory VLA observing program AL405
for day 57,109 beginning 19 00 00 LST, 1996.11.12 15:41:08 MST, Time-on-Source Report.

```
                          -1        0        1                                  -1        0        1
Source   Bnd Qual  Time     8765432109876543210123456789012345678 Source   Bnd Qual  Time
8765432109876543210123456789012345678
-------------------------------------------------------------------------------------------------------------------------------

0042+233     X000  0:36:41 HA      ......-2-22-2--2--......
                    PA...........53-...--..-.24...........

3C31 X00000       10:10:07 HA      .....-233322333232......
                    PA..........75----------48..........

0137+331     X000  0:04:24 HA      .....--.................
                    PA...........-.........................

0319+415     X000  0:09:39 HA      ......-.-.-.-.-.........
                    PA.......-.-.-.................-.....--.

0521+166     X000  0:03:01 HA      ............-..........
                    PA.......................-............
```

From VM Fri Nov 8 16:16:24 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["448" "Fri" "8" "November" "1996" "12:21:39" "-0700" "Rick Perley" "rperley@aoc.nrao.edu"
"<199611081921.MAA22844@sechelt.aoc.nrao.edu>" "12" "Re: AL405 schedule draft" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 448
Received: from arana.aoc.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA22402; Fri, 8 Nov 1996 14:21:53 -0500
Received: from sechelt.aoc.nrao.edu (sechelt.aoc.nrao.edu [146.88.6.21]) by arana (8.6.12/8.6.10) with ESMTP id MAA23389 for <abridle@nrao.edu>; Fri, 8 Nov 1996 12:21:46 -0700
Received: (from rperley@localhost) by sechelt.aoc.nrao.edu (8.7.3/8.6.10) id MAA22844 for abridle@nrao.edu; Fri, 8 Nov 1996 12:21:39 -0700 (MST)
Message-Id: <199611081921.MAA22844@sechelt.aoc.nrao.edu>
X-Sun-Charset: US-ASCII
From: Rick Perley <rperley@aoc.nrao.edu>
To: abridle@nrao.edu
Subject: Re: AL405 schedule draft
Date: Fri, 8 Nov 1996 12:21:39 -0700 (MST)

Alan:

We've had a change of thinking that might make a difference.

We now know there is little to fear about going 'over the top' at the lower frequencies (meaning, X-band and down). The pointing remains fine, the cost is a slightly lower efficiency. Seeing as how 3C84 is 'above' the zenith, while the other sources are below, I think it might be worth looking at how much time is saved by permitting over-the-top observations.

Rick

From VM Fri Nov 8 16:16:31 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["4580" "Fri" "8" "November" "1996" "15:48:56" "-0500" "Alan Bridle" "abridle" nil "75" "AL405: Day 57109 @ 1900 LST" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 4580
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA43919; Fri, 8 Nov 1996 15:48:56 -0500
Message-Id: <9611082048.AA43919@polaris.cv.nrao.edu>
From: abridle (Alan Bridle)
To: observe, analysts
Subject: AL405: Day 57109 @ 1900 LST
Date: Fri, 8 Nov 1996 15:48:56 -0500

/.AL405 00076
//* ***
//* *** NRAO VLA Observe Program, Version U3.2.28, 1996.02.27
//* ***
//* *** Observation day 57,109 at 19 00 00 LST, 1996.11.12 15:41:08 MST.
//* ***
//* *** Observer
//* *** Alan H. Bridle Phone
//* *** NRAO Charlottesville Office: 804-296-0375
//* *** During observation: 804-971-7752
//* ***
//* ***
//* ***
//* *** E-Mail address
//* *** abridle@nrao.edu
//* ***
//* *** Observing mode(s): Continuum
//* ***
//* *** Special Instructions
//* ***
//* *** Please extend first observation (0042+233) manually if necessary
//* *** to obtain 2 min of integration with whole array on-source before
//* *** moving to 3C31
//* ***
//* *** Date Prepared: 1996.11.08 11:21:57 MST.
//* ***
0042+233 19 07 00 00 42 04.5428 +23 20 00.922C XX C 0000 1.18
//DS 10
3C31 19 37 00 01 07 24.9550 +32 24 45.050C XX 0000
0137+331 19 42 00 01 37 41.3051 +33 09 35.394C XX C 0000 3.25
0042+233 19 45 00 00 42 04.5428 +23 20 00.922C XX C 0000 1.18
3C31 20 15 00 01 07 24.9550 +32 24 45.050C XX 0000
0042+233 20 18 00 00 42 04.5428 +23 20 00.922C XX C 0000 1.18
3C31 20 48 00 01 07 24.9550 +32 24 45.050C XX 0000
0042+233 20 51 00 00 42 04.5428 +23 20 00.922C XX C 0000 1.18
3C31 21 21 00 01 07 24.9550 +32 24 45.050C XX 0000
0319+415 21 24 30 03 19 48.1601 +41 30 42.106C XX A 0000 24.00
3C31 21 54 30 01 07 24.9550 +32 24 45.050C XX 000
0042+233 21 57 30 00 42 04.5428 +23 20 00.922C XX C 0000 1.18
3C31 22 27 30 01 07 24.9550 +32 24 45.050C XX 0000
0042+233 22 30 30 00 42 04.5428 +23 20 00.922C XX C 0000 1.18
3C31 23 00 30 01 07 24.9550 +32 24 45.050C XX 0000
0042+233 23 03 30 00 42 04.5428 +23 20 00.922C XX C 0000 1.18

```
3C31         23 33 30 01 0  24.9550 +32 24 45.050C    XX       0000
0042+233      23 37 00 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         00 07 00 01 07 24.9550 +32 24 45.050C    XX       0000
0319+415      00 10 30 03 19 48.1601 +41 30 42.106C    XX   A   0000  24.00
3C31         00 40 30 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233      00 44 45 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         01 14 45 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233      01 17 45 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         01 47 45 01 07 24.9550 +32 24 45.050C    XX       0000
0319+415      01 53 45 03 19 48.1601 +41 30 42.106C    XX   A   0000  24.00
3C31         02 23 45 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233      02 26 45 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         02 56 45 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233      02 59 45 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         03 29 45 01 07 24.9550 +32 24 45.050C    XX       0000
0319+415      03 33 45 03 19 48.1601 +41 30 42.106C    XX   A   0000  24.00
3C31         04 03 45 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233      04 06 45 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         04 37 45 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233      04 40 45 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         05 11 45 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233      05 14 45 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         05 45 45 01 07 24.9550 +32 24 45.050C    XX       0000
0319+415      05 49 30 03 19 48.1601 +41 30 42.106C    XX   A   0000  24.00
3C31         06 20 30 01 07 24.9550 +32 24 45.050C    XX       0000
0042+233      06 23 30 00 42 04.5428 +23 20 00.922C    XX   C   0000   1.18
3C31         06 54 30 01 07 24.9550 +32 24 45.050C    XX       0000
0521+166      07 00 00 05 21 09.9039 +16 38 22.116C    XX   C   0000   2.52
```

From VM Fri Nov 8 16:16:41 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["345" "Fri" "8" "November" "1996" "14:08:23" "MST" "Observe Data Base" "observe@banshee.vla.nrao.edu" nil
"10" "Re: AL405: Day 57109 @ 1900 LST" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 345
Received: from arana.aoc.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA33281; Fri, 8 Nov 1996 16:08:42 -0500
Received: from banshee.vla.nrao.edu (banshee.vla.nrao.edu [146.88.201.10]) by arana (8.6.12/8.6.10) with SMTP id
OAA08666; Fri, 8 Nov 1996 14:08:28 -0700
Received: by banshee.vla.nrao.edu (4.1/SMI-DDN)
id AA05576; Fri, 8 Nov 96 14:08:23 MST
Message-Id: <9611082108.AA05576@banshee.vla.nrao.edu>
From: observe@banshee.vla.nrao.edu (Observe Data Base)
To: abridle@aoc.nrao.edu
Cc: analysts@banshee.vla.nrao.edu
Subject: Re: AL405: Day 57109 @ 1900 LST
Date: Fri, 8 Nov 96 14:08:23 MST

To Whom it may concern,

We have received your Observing file(s), we will put them through our file checking process and inform you of any errors. If you have any questions, please contact the Analysts(analysts@aoc.nrao.edu) or the VLA Operations at (vlaops@banshee.nrao.edu). thank-you.

VLA Operations.

From VM Thu Nov 21 12:16:38 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["1544" "Mon" "11" "November" "1996" "16:21:36" "+0000" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.961111154854.631A-100000@rgosf>" "31" "How's this for an idea?" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 1544
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA26472; Mon, 11 Nov 1996 11:21:43 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id LAA08590 fov <abridle@nrao.edu>; Mon, 11 Nov 1996 11:21:42 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id QAA09819; Mon, 11 Nov 1996 16:21:39 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id QAA00676; Mon, 11 Nov 1996 16:21:37 GMT
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.961111154854.631A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@cv3.cv.nrao.edu>
Subject: How's this for an idea?
Date: Mon, 11 Nov 1996 16:21:36 +0000 (GMT)

I have been pondering the way to fit the polarization data, and I think
that the only way to go is to put regions with more isotropic field on the
outside of the jet, at fairly low emissivity, rather than introducing
significant radial (in the sense of perpendicular to the jet surface)
field over the entire shear layer. The trouble is that the model without
any radial field only just fits the ridge-line polarization. If you put a
significant radial component over the whole shear layer in order to cut
the polarization at the edge, there is inevitably a large drop in the
ridge-line polarization too.

We still need the spine with a half-opening angle of around 3 degrees in
the outer jet in order to fit the sidedness image. The outer boundary is
defined, so we have to put in an even more complex geometry.
Qualitatively, we need much of the shear layer to have an isotropic(ish)
field between rho1 and about 2rho0, but only a very thin layer at larger
and smaller distances. It will be quite hard to get the balance right,
especially near the nucleus.

I wonder whether we are seeing the mixing region around rho0? You
remarked some time ago that there ought to be a region with isotropic
field round the outside of the jet - perhaps this is it?

I am getting very concerned about the complexity of the model (although we
may end up not using many of the variables). Nevertheless, the fit to the
polarization is proving to be sufficiently hard that I think we are
finding out something important.

Ideas appreciated.

Robert

From VM Thu Nov 21 12:16:40 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["5020" "Mon" "11" "November" "1996" "14:40:21" "-0500" "Alan Bridle" "abridle" nil "101" "Re: How's this for an idea?" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 5020
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA43795; Mon, 11 Nov 1996 14:40:21 -0500
Message-Id: <9611111940.AA43795@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961111154854.631A-100000@rgosf>
References: <Pine.GSO.3.94.961111154854.631A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: How's this for an idea?
Date: Mon, 11 Nov 1996 14:40:21 -0500

Robert Laing writes:

> I have been pondering the way to fit the polarization data, and I think
> that the only way to go is to put regions with more isotropic field on the
> outside of the jet, at fairly low emissivity, rather than introducing
> significant radial (in the sense of perpendicular to the jet surface)
> field over the entire shear layer. The trouble is that the model without
> any radial field only just fits the ridge-line polarization. If you put a
> significant radial component over the whole shear layer in order to cut
> the polarization at the edge, there is inevitably a large drop in the
> ridge-line polarization too.

I think one of the root problems is that we don't have a very physical
way to tie the magnetic field details to the velocity field. It seems
reasonable to suppress the radial B-component wherever we have a large
radial velocity gradient, but to preserve ith(and the azimuthal
component) wherever there is a significant longitudinal deceleration.

I agree that a region of disordered field is very likely at the edges,
at or immediately upstream of, anywhere we see strong deceleration.

> I wonder whether we are seeing the mixing region around rho0? You
> remarked some time ago that there ought to be a region with isotropic
> field round the outside of the jet - perhaps this is it?
>

Probably so. One question is whether we should try to model this
explicitly, or simply to go as far as we can with a "simple" model and
note that a discrepancy occurs on the edges in the region where we
should expect entrainment to be going on, broadly consistent with
extra field disordering as a result of such entrainment.

> I am getting very concerned about the complexity of the model (although we
> may end up not using many of the variables). Nevertheless, the fit to the
> polarization is proving to be sufficiently hard that I think we are
> finding out something important.
>

At this point I would distinguish between extra ingredients that we
might add to the model in order to explore the discrepancies
semi-quantitatively, from ones that we consider part of a "basic"

model".

At present, I'm inclined to stick with the idea that we would publish the 2-d model, its successes and failures, as the basic story. The 3-d models should basically be in our back pocket just to test what we say about the "failures" in terms of extra complexity that may be present in the boundary layer. From the 2-d (anisotropic) model we have:

1. The overall polarization pattern specifies a gross form of the jet velocity field that implies gradual deceleration of the spine and general dominance of the emission in 3C31 by the shear layer. The magnetic field picture that goes along with this is first-order what you might expect from the flow physics, but is obviously still a simplification.

2. Within the velocity constraints from the polarization, we can also fit the intensity and sidedness profiles reasonably well provided we specify the velocity field in the shear in a certain way (initially high on the edge, transitioning to low in the "flaring" regime).

3. While satisfying both of these constraints, we are required to stay near the orientation angle limit suggested by the VLBI data for a high-gamma flow on parsec scales.

4. The model "succeeds" in several important areas, relating a first-order plausible B-field and emissivity variation to transitions in the jet collimation via a first-rder plausible velocity field. This is more than enough to suggest that the model is "interesting".

5. The model "fails" in two main areas: (a) the arcs in the outer region and (b) the edge polarization in and near the transition region. Both of these suggest that there are important details in the boundary layer that we cannot address via so simple a 2-d model. We can however offer some hints (based on toying with 3-d models) about where they come from, such as turbulence on the edges of the rapid-slowdown region and (perhaps) large-scale departures from axisymmetry in the entrainment. But we do not think it is worthwhile trying to fit 3-d empirical models in detail to these sources before exploring the underlying dynamics.

Our main point is that 3C31 imaging and polarimetry strongly support the idea that the FRI/FRII transition comes from the deceleration of relativistic jets across well-defined, deep boundary layers. And that the "failures" of the simple model are also quite reasonable ones. The failures are also unlikely to be explained in detail until we know how boundary layers and their fields develop in entraining relativistic jets, probably from numerical 3-d relativistic MHD. Both the "successes" and the "failures" of our 2-d model should motivate such work.

So: present in detail the 2-d model, its constraints and conclusions. Use the 3-d model for the moment only to back up fairly broad statements about how to intepret the failures of the 2-d model, not to extract detailed parameters.

Howzat?

A.

From VM Thu Nov 21 12:16:47 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["5545" "Tue" "12" "November" "1996" "18:21:03" "+0000" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.961112160847.3137A-100000@rgosf>" "116" "Re: How's this for an idea?" "^From:" nil nil "11" nil nil
nil nil]
nil)
Content-Length: 5545
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA27128; Tue, 12 Nov 1996 13:21:13 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id NAA25162 for <abridle@nrao.edu>; Tue, 12 Nov 1996 13:21:10 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id SAA27877; Tue, 12 Nov 1996 18:21:06 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id SAA03253; Tue, 12 Nov 1996 18:21:04 GMT
X-Sender: rl@rgosf
In-Reply-To: <9611111940.AA43795@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.961112160847.3137A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@cv3.cv.nrao.edu>
Subject: Re: How's this for an idea?
Date: Tue, 12 Nov 1996 18:21:03 +0000 (GMT)

On Mon, 11 Nov 1996, Alan Bridle wrote:

>
> I think one of the root problems is that we don't have a very physical
> way to tie the magnetic field details to the velocity field. It seems
> reasonable to suppress the radial B-component wherever we have a large
> radial velocity gradient, but to preserve it (and the azimuthal
> component) wherever there is a significant longitudinal deceleration.
>
> I agree that a region of disordered field is very likely at the edges,
> at or immediately upstream of, anywhere we see strong deceleration.
>

Yes, it may well be that random motions are as important as systematic
velocity gradients in some regions.

> > I wonder whether we are seeing the mixing region around rho0? You
> > remarked some time ago that there ought to be a region with isotropic
> > field round the outside of the jet - perhaps this is it?
> >
>
> Probably so. One question is whether we should try to model this
> explicitly, or simply to go as far as we can with a "simple" model and
> note that a discrepancy occurs on the edges in the region where we
> should expect entrainment to be going on, broadly consistent with
> extra field disordering as a result of such entrainment.
>

I am having a go at a model with a weak, isotropic-field region at the
edge of the shear layer, but with most of the rest of the field ordering
parameters held at their standard values. The depth of this region is

allowed to vary with position, and is specified at the usual fiducial points. First results suggest that the overall polarization pattern can be significantly better provided that the outer ~half of the shear layer at rho0 has an isotropic field, although the emissivity has reduced there (perhaps too much to fit the total intensity - I have to re-optimize the other parameters after these changes, but chi-squared doesn't look too bad so far).

>
> At this point I would distinguish between extra ingredients that we
> might add to the model in order to explore the discrepancies
> semi-quantitatively, from ones that we consider part of a "basic"
> model".
>
> At present, I'm inclined to stick with the idea that we would publish
> the 2-d model, its successes and failures, as the basic story. The
> 3-d models should basically be in our back pocket just to test what
> we say about the "failures" in terms of extra complexity that may be
> present in the boundary layer. From the 2-d (anisotropic) model we have:
>

I don't think that the full 3D field has added much, but I think that the idea of an isotropic-field region at the boundary has some merit. It is hard to avoid something like it without crippling the counter-jet polarization.

> 1. The cverall polarization pattern specifies a gross form of the cet velocity
> field that implies gradual deceleration of the spine and general dominance
> of the emission in 3C31 by the shear layer. The magnetic field picture
> that goes along with this is first-order what you might expect from the
> flow physics, but is obviously still a simplification.
>

At a very basic level, we have been forced to the idea that the field is mostly toroidal+azimuthal.

> 2. Within the velocity constraints from the poearization, we can also
> fit the intensity and sidedness profilns reasonably well provided we
> specify the velocity field in the shear in a certain way (initially high
> on the edge, transitioning to low in the "flaring" regime).
>
> 3. While satisfying both of these constraints, we are required to stay near
> the orientation angle limit suggested by the VLBI data for a high-gamma
> flow on parsec scales.
>
> 4. The model "succeeds" in several important areas, relating a first-order
> plausible B-field and emissivity variation to transitions in the jet
> collimati n via a first-rder plausible velocity field. This is more than
> enough to suggest that the model is "interesting".
>
> 5. The model "fails" in two main areas: (a) the arcs in the outer
> region and (b) the edge polarization in and near the transition
> region. Both of these suggest that there are important details in the
> boundary layer that we cannot address via so simple a 2-d model. We
> can however offer some hints (based on toying with 3-d models) about
> where they come from, such as turbulence on the edges of the
> rapid-slowdown region and (perhaps) large-scale departures from
> axisymmetry in the entrainment. But we do not think it is worthwhile

> trying to fit 3-d empirical models in detail to these sources before
> exploring the underlying dynamics.

Cf. above. Do you agree that the arcs have surprisingly little obvious effect on the degree of polarization? They look to me as if they affect mostly the total intensity and the direction of polarization (e.g. where the strong feature crosses the outer CJ).

> Our main point is that 3C31 imaging and polarimetry strongly support
> the idea that the FRI/FRII transition comes from the deceleration of
> relativistic jets across well-defined, deep boundary layers. And that
> the "failures" of the simple model are also quite reasonable ones.
> The failures are also unlikely to be explained in detail until we know
> how boundary layers and their fields develop in entraining
> relativistic jets, probably from numerical 3-d relativistic MHD. Both
> the "successes" and the "failures" of our 2-d model should motivate
> such work.

Not sure whether it will get much beyond motivation! I talked to Komissarov & Falle last week. Neither was offering much hope.

Robert

From VM Thu Nov 21 12:17:17 1996
X-VM-v5-Data: ([nil nil nil t nil nil t nil nil]
["5798" "Wed" "13" "November" "1996" "10:47:34" "+0000" "VLA Operators" "observe@banshee.vla.nrao.edu" nil
"148" "VLA Observing Log for project AL405 on 96Nov12." "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 5798
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA25761; Wed, 13 Nov 1996 05:47:27 -0500
Received: from banshee.vla.nrao.edu (banshee.vla.nrao.edu [146.88.201.10]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with
SMTP id FAA05956 for <abridle@nrao.edu>; Wed, 13 Nov 1996 05:47:07 -0500 (EST)
Received: from [146.88.201.11] (macops-tng.vla.nrao.edu) by banshee.vla.nrao.edu (4.1/SMI-DDN)
id AA14639; Wed, 13 Nov 96 03:47:01 MST
X-Sender: observe@banshee.vla.nrao.edu (Unverified)
Message-Id: <v01530502aeaf579f8b3d@[146.88.201.11]>
Mime-Version: 1.0
Content-Type: multipart/mixed; boundary="============_-1364240473==_============"
From: observe@banshee.VLA.NRAO.EDU (VLA Operators)
To: abridle@cv3.cv.nrao.edu
Subject: VLA Observing Log for project AL405 on 96Nov12.
Date: Wed, 13 Nov 1996 10:47:34 +0000

--============_-1364240473==_============
Content-Type: text/plain; charset="us-ascii"

An ascii text copy of your VLA Observing Log follows:

--============_-1364240473==_============
Content-Type: text/plain; name="AL405_96Nov12_1719.Text"; charset="us-ascii"
Content-Disposition: attachment; filename="AL405_96Nov12_1719.Text"

****

Program: AL405 Subarray(s): #1
Observer(s): A. Bridle Operator(s): W Ketzeback
Date: Tuesday, Nov 12 1996 Configuration: A
User Number: 76 Decommissioned: 28
Source File(s): 109L409 VLBI Ref. Ant:
Observing Mode: Continuum VLB Antenna Pad:

** Weather Information **

Time	Dew Point	Temp.	Wind	Bar. Pressure
96Nov12 22:47:41	7.2C	20C	W @ 2.2 m/s	795.6mbars
96Nov12 22:50:11	7.7C	20C	SE @ 4.2 m/s	795.6mbars
96Nov13 02:30:38	-3.2C	5.6C	W @ 0.3 m/s	797.7mbars
96Nov13 06:48:30	-5.9C	0.3C	Calm	798.6mbars

Remarks: Operator comments for the above weather entries.
The sky is clear.
The sky is clear.
The sky is clear.
The sky is clear.

** Visibility Tape Information **
Tape # File # Time of Final Record:

N7850 1

** Monitor Tape Information **

Tape #	File #	Time of Final Record:
N7860	2	96Nov13 at 0:00:00
N7860	3	

Antenna(s) Used:
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

** Operator Comments **

96Nov12 22:36:14
Starting program: AL405, observe file: 109L409.

96Nov12 22:41:30
On source 0042+233 with all available antennas.
The band(s) used is(are) X band(s).

96Nov12 22:36:14
The on-line baseline parameters for antenna(s) 2 6 11 16 19 23 28 have recently been updated (prior to your observing run) to correct for errors resulting from their recent relocations. In the analysis of your data would you please check for any significant baseline errors especially on these antennas and let the Data Analysts (email - analysts@nrao.edu) know what you find when there are significant baseline errors. Thank you in advance.

96Nov12 22:50:12
**** K.Michael Malolepszy is your operator. ****

96Nov12 22:55:10
The telescope operator made an inspection of the VLA instrumentation.
No problems found.

96Nov12 23:05:24
Ran a backup on the Modcomp partition where observe files are kept.

96Nov12 23:20:00
Form #: Other # of Ants: Downtime:
Antenna(s) 3 22 - OTHER (Miscellaneous) Problem(s); These antennas were not fringing on calibrator 0137+331. This is probably source related as they looked fine on 0042+233.
Observing Data: No Effect

96Nov13 01:09:00 - 96Nov13 01:15:00
Form #: Interference # of Ants: 0.50 Downtime: 3.00
Antenna(s) 21 - INTERFERE (INTERFERENCE, RADIO FREQUENCY (RFI)) Problem(s); CHECKER is complaing about high system temperatures and fluctuations, no obvious RFI is being seen. Data is flagged, downtime is estimated from number of records flagged. Observing Data: Lost

96Nov13 01:35:40 - 96Nov13 01:38:40
Form #: Other # of Ants: 15.00 Downtime: 45.00
Antenna(s) 1 3 4 6 7 10 11 12 13 14 16 20 22 25 27 - OTHER (Miscellaneous) Problem(s); These antennas lost time slewing trying to go from one wrap to another. I talked to Ken Sowinski

and R. Perley and during the next time we look at 0042+233 I will
EXTEND the array to get all antennas on the same wrap.
Observing Data: Lost

96Nov13 02:10:00 - 96Nov13 02:19:50
Form #: Other # of Ants: 15.00 Downtime: 147.50
Antenna(s) 1 3 4 6 7 10 11 12 13 14 16 20 22 25 27 - OTHER
(Miscellaneous) Problem(s); EXTENDed aray on 0042+233 to get
all antennas on same wrap. Observing Data: Lost

96Nov13 04:08:37
The telescope operator made an inspection of the VLA instrumentation.
No problems found.

96Nov13 04:57:00 - 96Nov13 04:58:30
Form #: Other # of Ants: Downtime: 0.00
Antenna(s) 15 - VLA CORREL (VLA Correlator Harware)
Problem(s); Quad/IF 1 integrator card exchanged & unexchanged
during this time, one record of data lost when this occurs.
Observing Data: Lost

96Nov13 06:16:00
Form #: Other # of Ants: Downtime:
Antenna(s) 8 - VLA CORREL (VLA Correlator Harware)
Problem(s); Quad/IF 4 integrator card exchanged & unexchanged
at this time, one record of data lost when this occurs. Observing
Data: Lost

96Nov13 06:48:32
**** T. Perreault is your operator. ****

96Nov13 07:36:44
Ran a backup on the Modcomp partition where observe files are kept.

96Nov13 10:03:20 - 96Nov13 10:40:00
Form #: 18870 # of Ants: 1.00 Downtime: 36.67
Antenna(s) 3 - CRYOGENICS (Cryogenics and Vacuum
Hardware) Problem(s); The VLBA compressor (B) has shut down.
The L, Q and X band DEWARS are starting to warm up. Since
there is no way that any of the Cryo people can come to the site and
restart the compressor before the end of this program, I have
elected not to call up anyone. Observing Data: Corrupted

96Nov13 10:40:00
End of program AL405. Total Downtime = 232.2 minutes (1.2% of total time).

AsciiFileOut Version: 1.11 -- Version Date: June 20, 1996

--==========_-1364240473==_==========--

From VM Thu Nov 21 12:17:22 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["1130" "Wed" "13" "November" "1996" "15:53:53" "+0000" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.961113154454.4683A-100000@rgosf>" "25" "Might have cracked it this time" "^From:" nil nil "11" nil
nil nil nil]
nil)
Content-Length: 1130
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA15532; Wed, 13 Nov 1996 10:54:00 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id KAA08769 for <abridle@nrao.edu>; Wed, 13 Nov 1996 10:53:58 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id PAA09838; Wed, 13 Nov 1996 15:53:55 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id PAA04686; Wed, 13 Nov 1996 15:53:54 GMT
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.961113154454.4683A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@cv3.cv.nrao.edu>
Subject: Might have cracked it this time
Date: Wed, 13 Nov 1996 15:53:53 +0000 (GMT)

I now have what looks like a pretty reasonable polarization compromise,
which also gives a good chi-squared. The trick (I won't bother you with
myriad false starts) turned out to be to allow the amount of radial field
to increase from 0 at the spine/shear layer interface to a maximum at the
jet boundary, roughly as the square root of the fractional distance into
the layer. It's qualitatively the same idea I was talking about
yesterday, but with a simpler (and physically more reasonable)
implementation. I don't mean to imply that the functional form is
important, but rather that the data insist on having little radial field
in the centre but lots at the edge, over the range rho1 < rho < 2rho0 or
so.

A little further tweaking would be possible (I've perturbed the results of
an older optimization), but most of the parameters are now pretty stable.

I've put IQU in the usual place as V7.I, Q and U. See what you think.
If you are happy with the results, I'll send you the revised code too.
I really think that this might be it (just as well, as I'm starting to see
polarization maps in my nightmares).

Robert

From VM Thu Nov 21 12:17:29 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["1933" "Wed" "13" "November" "1996" "12:17:18" "-0500" "Alan Bridle" "abridle" nil "44" "Re: How's this for an idea?" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 1933
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA43835; Wed, 13 Nov 1996 12:17:18 -0500
Message-Id: <9611131717.AA43835@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961112160847.3137A-100000@rgosf>
References: <9611111940.AA43795@polaris.cv.nrao.edu>
<Pine.GSO.3.94.961112160847.3137A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: How's this for an idea?
Date: Wed, 13 Nov 1996 12:17:18 -0500

Robert Laing writes:

> > 5. The model "fails" in two main areas: (a) the arcs in the outer
> > region and (b) the edge polarization in and near the transition
> > region. Both of these suggest that there are important details in the
> > boundary layer that we cannot address via so simple a 2-d model. We
> > can however offer some hints (based on toying with 3-d models) about
> > where they come from, such as turbulence on the edges of the
> > rapid-slowdown region and (perhaps) large-scale departures from
> > axisymmetry in the entrainment. But we do not think it is worthwhile
> > trying to fit 3-d empirical models in detail to these sources before
> > exploring the underlying dynamics.
> >
>
> Cf. above. Do you agree that the arcs have surprisingly little obvious
> effect on the degree of polarization? They look to me as if they affect
> mostly the total intensity and the direction of polarization (e.g. where
> the strong feature crosses the outer CJ).
>

I'm not so sure about that, the arcs are regions of slightly increased
degree of polarization, as well, on the 0.7"FWHM data that we are fitting.

In the main jet the degree of polarization near the boundary is well
below that predicted by the model until just before the first arc,
it only gets up to the model values as the arc develops. And as the
arc crosses over the center of the jet, there is a ridge on which
the degree of polarization exceeds both the model prediction and the
observed values immediately upstream. It is as if the arcs
are features in the boundary layer induced by some combination of the
recollimation and spine deceleration, and that they include some
increased ordering of the magnetic field as well as realignment of
the field.

>
> Not sure whether it will get much beyond motivation! I talked to
> Komissarov & Falle last week. Neither was offering much hope.
>

Hope of what, though?

A.

From VM Thu Nov 21 12:17:41 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["501" "Wed" "13" "November" "1996" "12:31:23" "-0500" "Alan Bridle" "abridle" nil "16" "Re: Might have cracked it this time" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 501
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA35621; Wed, 13 Nov 1996 12:31:23 -0500
Message-Id: <9611131731.AA35621@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961113154454.4683A-100000@rgosf>
References: <Pine.GSO.3.94.961113154454.4683A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Might have cracked it this time
Date: Wed, 13 Nov 1996 12:31:23 -0500

Robert Laing writes:
> A little further tweaking would be possible (I've perturbed the results of
> an older optimization), but most of the parameters are now pretty stable.
>
> I've put IQU in the usual place as V7.I, Q and U. See what you think.
> If you are happy with the results, I'll send you the revised code too.
> I really think that this might be it (just as well, as I'm starting to see
> polarization maps in my nightmares).
>

/pub/rl seems to be empty at the moment

A.

From VM Thu Nov 21 12:18:06 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["1301" "Wed" "13" "November" "1996" "19:02:56" "+0000" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.961113184020.5464A-100000@rgosf>" "27" "v7 code etc." "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 1301
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB .64/4.07)
id AA42353; Wed, 13 Nov 1996 14:03:04 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id OAA11177 for <abridle@nrao.edu>; Wed, 13 Nov 1996 14:03:03 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id TAA12934; Wed, 13 Nov 1996 19:02:59 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id TAA05486; Wed, 13 Nov 1996 19:02:58 GMT
X-Sender: rl@rgosf
Reply-To: Robert Laing <rl@ast.cam.ac.uk>
Message-Id: <Pine.GSO.3.94.961113184020.5464A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@cv3.cv.nrao.edu>
Subject: v7 code etc.
Date: Wed, 13 Nov 1996 19:02:56 +0000 (GMT)

I have put the usual tar file, together with separate copies of shell and DAT files, and the instructions (barely changed) in pub/rl. VARS.DAT has the parameters for the V7 model.

I take your point about the arcs: it may be that they mark discontinuities in the flow, and I certainly wouldn't take too much notice of the polarization fit to the outer reaches of the main jet for that reason. In the counter-jet, though, the ridge line polarization appears to increase quite smoothly even though an arc crosses it (and is obvious in the vector directions). Perhaps the field is already so well ordered that the arc can't add much?

I'm not entirely happy with the fit to the sidedness image, although I think that this can be sorted out by tweaking the parameters by hand. The trouble is that chi-squared isn't very sensitive to the sidedness ratio. I am still having a little trouble getting appreciable sidednesses close to the edge of the jet at rho0 or so without ending up with too much of a spine in the main jet. It may be that the velocity changes rather more abruptly at rho0 than the model permits.

Robert

P.S. We now have a Sparc Ultra 1 set up for AIPS, with quite a lot of disk space and physical memory (albeit only bookable for short periods). Might be useful for A config.

From VM Thu Nov 21 12:18:16 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["2055" "Wed" "13" "November" "1996" "17:50:49" "-0500" "Alan Bridle" "abridle" nil "43" "Re: v7 code etc."
"^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 2055
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA38988; Wed, 13 Nov 1996 17:50:49 -0500
Message-Id: <9611132250.AA38988@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961113184020.5464A-100000@rgosf>
References: <Pine.GSO.3.94.961113184020.5464A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: v7 code etc.
Date: Wed, 13 Nov 1996 17:50:49 -0500

Robert Laing writes:

> I have put the usual tar file, together with separate copies of shell and
> DAT files, and the instructions (barely changed) in pub/rl. VARS.DAT has
> the parameters for the V7 model.

Got 'em all. Thanks.

>
> I take your point about the arcs: it may be that they mark
> discontinuities in the flow, and I certainly wouldn't take too much notice
> of the polarization fit to the outer reaches of the main jet for that
> reason. In the counter-jet, though, the ridge line polarization appears
> to increase quite smoothly even though an arc crosses it (and is obvious
> in the vector directions). Perhaps the field is already so well ordered
> that the arc can't add much?
>
> I'm not entirely happy with the fit to the sidedness image, although I
> think that this can be sorted out by tweaking the parameters by hand. The
> trouble is that chi-squared isn't very sensitive to the sidedness ratio.
> I am still having a little trouble getting appreciable sidednesses close
> to the edge of the jet at rho0 or so without ending up with too much of a
> spine in the main jet. It may be that the velocity changes rather
> more abruptly at rho0 than the model permits.
>

V7 is certainly the best yet so far as the layer polarizations go,
though it is noticeable from the POLC comparison that there is still
quite a lot more polarized flux in the model layer just downstream of
the second transition than is present in the data. Once again, the
counterjet spine seems to be asking for something different than the
jet spine, or either boundary region. I haven't had a chance to check
the sidedness images, will have to do that tomorrow a.m. This does
look a lot healthier at the base of the counterjet than 3DF did,
however, I agree completely that the present approach is better
than the radial component that was used there. (3DF also suffered from
the low-polarization zone not being low enough for long enough, but it
had already wrecked the counterjet polarization at the base).

Cheers,

A.

From VM Thu Nov 21 12:18:18 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["1889" "Thu" "14" "November" "1996" "11:52:37" "+0000" "Robert Laing" "rl@ast.cam.ac.uk" nil "39" "Re: v7 code etc." "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 1889
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA44450; Thu, 14 Nov 1996 06:52:47 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP id GAA21291 for <abridle@nrao.edu>; Thu, 14 Nov 1996 06:52:45 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id LAA20887; Thu, 14 Nov 1996 11:52:38 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id LAA06131; Thu, 14 Nov 1996 11:52:37 GMT
X-Sender: rl@rgosf
In-Reply-To: <9611132250.AA38988@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.961114113449.6108B-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@cv3.cv.nrao.edu>
Subject: Re: v7 code etc.
Date: Thu, 14 Nov 1996 11:52:37 +0000 (GMT)

On Wed, 13 Nov 1996, Alan Bridle wrote:

> V7 is certainly the best yet so far as the layer polarizations go,
> though it is noticeable from the POLC comparison that there is still
> quite a lot more polarized flux in the model layer just downstream of
> the second transition than is present in the data. Once again, the
> counterjet spine seems to be asking for something different than the
> jet spine, or either boundary region. I haven't had a chance to check
> the sidedness images, will have to do that tomorrow a.m. This does
> look a lot healthier at the base of the counterjet than 3DF did,
> however, I agree completely that the present approach is better
> than the radial component that was used there. (3DF also suffered from
> the low-polarization zone not being low enough for long enough, but it
> had already wrecked the counterjet polarization at the base).
>

I think that one aspect of the arc problem which may seriously affect the global fit is the 50%-ish polarization where the brightest arc crosses the main jet. I think I will rerun the optimization without that area and see what happens.

The polarization in the transition region is VERY sensitive to the exact details of the transverse variation of the radial component, which is the main reason I am confident in the basic scheme, but it makes tweaking the model quite hard. The basic difficulty is that any significant emissivity from the radial component which gets into a sightline on the axis of the counterjet will reduce its polarization a lot. It may be that the exact details of the emissivity fall-off across the shear layer are important here, and that having one SLMIN everywhere is messing things things up, but any additional complexity will result in the optimization wandering around in chi-squared hyperspace for ever. The A configuration ought to

help a lot here.

Robert

From VM Thu Nov 21 12:18:19 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
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id AA31661; Thu, 14 Nov 1996 07:29:01 -0 00
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id HAA21613 for <abridle@nrao.edu>; Thu, 14 Nov 1996 07:29:00 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id MAA21413; Thu, 14 Nov 1996 12:28:53 GMT
Received: from localhost by rgosf.ast.cam.ac6uk (SMI-8.6/SMI-SVR4)
id MAA06212; Thu, 14 Nov 1996 12:28:52 GMT
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In-Reply-To: <9611132250.AA38988@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.961114121921.6162A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@cv3.cv.nrao.edu>
Subject: Re: v7 code etc.
Date: Thu, 14 Nov 1996 12:28:51 +0000 (GMT)

A quick note about last night's optimization. Its only change was to
increase te value of SLRT0 to 0.9. This reduces the polarization at rho0
a little, as requested, with a very slight penalty on the counter-jet.
I would suggest that we fix the polarization parameters now, since any
further refinement really needs better transverse resolution.

See what you think about the sidedness images. I think that a little
tweaking of BETA1 and BETA0 and/or VMIN1 and VMIN0 might be in order.

Robert

From VM Thu Nov 21 12:18:28 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["2172" "Thu" "14" "November" "1996" "09:46:32" "-0500" "Alan Bridle" "abridle" nil "44" "Re: v7 code etc."
"^From:" nil nil "11" nil nil nil nil]
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id AA19464; Thu, 14 Nov 1996 09:46:32 -0500
Message-Id: <9611141446.AA19464@polaris.cv.nrao.edu>
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References: <9611132250.AA38988@polaris.cv.nrao.edu>
<Pine.GSO.3.94.961114121921.6162A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: v7 code etc.
Date: Thu, 14 Nov 1996 09:46:32 -0500

Robert Laing writes:

> A quick note about last night's optimization. Its only change was to
> increase te value of SLRT0 to 0.9. This reduces the polarization at rho0
> a little, as requested, with a very slight penalty on the counter-jet.
> I would suggest that we fix the polarization parameters now, since any
> further refinement really needs better transverse resolution.
>
> See what you think about the sidedness images. I think that a little
> tweaking of BETA1 and BETA0 and/or VMIN1 and VMIN0 might be in order.
>

The sidedness pattern has gone very "conical" now. It's harder to evaluate because the north and south sides of the jet behave rather differently, but I think if we discount everything to do with the arc the new fit is a bit better for the outer jet. We still don't get down to as low a sidedness as in the data on the north edge, but it's a fair fit to the south edge, and the outer spine looks quite reasonable until the arc. Beyond the arc, we are still over-predicting the sidedness pretty much everywhere, and have been for some time. The overprediction seems to be concentrated more towards the center of the jet now than it was before, which seems a bit odd if the spine is not contributing much.

The thing we have never been able to fit well is the fact that the actual sidedness peaks in the transition zone, but the model sidedness peaks close to the core. This seems to me to be a rather basic trend in a decelerating jet, as the sidedness of everything along each line of sight has to decrease outwards if all the velocities are decreasing. The only way I can see to counteract this is to adjust the velocities to boost the faster (high-sidedness) emission from the spine relative to the shear layer in the transition region, but not closer in, which will again mess with the polarization (it might help the counterjet, but not the jet). It's hard to see how to do this while holding the peak sidedness up in the low 20's, unless we move the jet a bit closer to the line of sight. (The fitted angle has been trending down for some time in fact, sosmaybe this is trying to nudge us in that direction?)

A.

From VM Thu Nov 21 12:18:35 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["1455" "Thu" "14" "November" "1996" "14:48:15" "+0000" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.961114135511.6296A-100000@rgosf>" "31" "Sidedness" "^From:" nil nil "11" nil nil nil nil]
nil)
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id AA32790; Thu, 14 Nov 1996 09:48:22 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id JAA23044 for <abridle@nrao.edu>; Thu, 14 Nov 1996 09:48:20 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id OAA23881; Thu, 14 Nov 1996 14:48:17 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id OAA06391; Thu, 14 Nov 1996 14:48:15 GMT
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.961114135511.6296A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@cv3.cv.nrao.edu>
Subject: Sidedness
Date: Thu, 14 Nov 1996 14:48:15 +0000 (GMT)

I'm not sure what to make of discrepancies between the model and observed sidedness images. The observations give a patchier distribution (inevitably), but we don't want to model individual lumps and filaments. The maximum model sidedness is 18 (cf. 21 for the data). The mean value for rho < rho0 is identical in model and data (7.3). The fact that the maximum occurs close to the base of the jet is almost inevitable given the form of our model. It would be possible to fiddle the velocity and emissivity distributions to shift the peak, but I see no justification for this at the moment: I think that we would be modelling fine-scale structure.

You will see that I reduced the velocities and increased the values of VMIN1 and 0. This appeared to help in keeping the sidedness up across the whole width of the jet at small radii whilst leaving it centrally peaked further out (we aren't actually very sensitive to differences in velocity above about beta = 0.75 or so. The central sidedness spine looks a bit narrow now, but the optimization has consistently gone for this: I think it would stuff the fit to the polarization and the counterjet transverse profile to change it.

I also had a look at the ratio image, which I'd mostly been ignoring. I think that this mostly shows the arcs and other non-axisymmetric features now.

I'm in favour of standardising on the V7 model with SLRT0 = 0.9 and trying to write down the implications.

Robert

From VM Thu Nov 21 12:18:45 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
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Message-Id: <9611141513.AA29549@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961114135511.6296A-100000@rgosf>
References: <Pine.GSO.3.94.961114135511.6296A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Sidedness
Date: Thu, 14 Nov 1996 10:13:09 -0500

Robert Laing writes:
> I'm not sure what to make of discrepancies between the model and observed
> sidedness images. The observations give a patchier distribution
> (inevitably), but we don't want to model individual lumps and filaments.
> The maximum model sidedness is 18 (cf. 21 for the data). The mean value
> for rho < rho0 is identical in model and data (7.3). The fact that the
> maximum occurs close to the base of the jet is almost inevitable given the
> form of our model. It would be possible to fiddle the velocity and
> emissivity distributions to shift the peak, but I see no justification for
> this at the moment: I think that we would be modeleing fine-scale
> structure.
>

That's certainly one stand we can take! Another point favoring the
"local detail" stand is that the region with the highest sidedness is
also where the field starts to go oblique on-axis.

> You will see that I reduced the velocities and increased the values of
> VMIN1 and 0. This appeared to help in keeping the sidedness up across the
> whole width of the jet at small radii whilst leaving it centrally peaked
> further out (we aren't actually very sensitive to differences in velocity
> above about beta = 0.75 or so. The central sidedness spine looks a bit
i> narrow now, but the optimization has consistently gone for this: I think
> it would stuff the fit to the polarization and the counterjet transverse
> profile to change it.
>

We've both worried a bit about the fact that chi-squared doesn;t pair
the data at all, just looks at the values without any notion of
symmetry. Perhaps a bit further into all of this we might consider
making a test of the fit to the sidedness ratio images, to include
some "pairing" in the analysis? (Not now, see below ....)

> I also had a look at the ratio image, which I'd mostly been ignoring.
> I think that this mostly shows the arcs and other non-axisymmetric
> features now.
>
> I'm in favour of standardising on the V7 model with SLRT0 = 0.9 and trying
> to write down the implications.

>

I think that's reasonable enough. It's worth trying to get this written up before seeing NGC315 and 3C31 at high resolution from the runs last week! I keep forgetting that the fact that we are fitting the _basic_ pattern so well impresses people who have not been staring at these plots on a daily basis.

A.

From VM Thu Nov 21 12:18:55 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
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Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
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id PAA25165; Thu, 14 Nov 1996 15:41:10 GMT
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id PAA06446; Thu, 14 Nov 1996 15:40:56 GMT
X-Sender: rl@rgosf
Reply-To: Robert Laing <rl@ast.cam.ac.uk>
In-Reply-To: <9611141446.AA19464@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.961114145004.6296B-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@cv3.cv.nrao.edu>
Subject: Re: v7 code etc.
Date: Thu, 14 Nov 1996 15:40:55 +0000 (GMT)

Various things crossed in the post - this is intended as a reply to your
last 2 messages.

> The sidedness pattern has gone very "conical" now. It's harder to
> evaluate because the north and south sides of the jet behave rather
> differently, but I think if we discount everything to do with the arc
> the new fit is a bit better for the outer jet. We still don't get
> down to as low a sidedness as in the data on the north edge, but it's
> a fair fit to the south edge, and the outer spine looks quite
> reasonable until the arc. Beyond the arc, we are still
> over-predicting the sidedness pretty much everywhere, and have been
> for some time. The overprediction seems to be concentrated more
> towards the center of the jet now than it was before, which seems a
> bit odd if the spine is not contributing much.

The trouble with the outermost sidedness is that we can't model abrupt
changes. The on-axis sidedness changes by about a factor of 2 going
through the arc. Whether this is a sudden deceleration or (more likely,
in my view) that the arc has spuriously boosted the sidedness at about 25
arcsec from the core, we can't be sure. I'd be happier if the sidedness
was 1 at the end of the jet, though. I made a symmetrized sidedness map
by flipping about the x axis and averaging and this indeed confirms what
you say about the N vs S differences. The average of the two is pretty
close to the model result. For purposes of display, these artificially
symmetrized images are quite useful - the model fit does the averaging for
you, but the eye sometimes has problems.

Although the spine emissivity is quite small, the velocity of material at
the spine/shear layer interface is still appreciable, hence the ceneral
concentration, I think. It's not really that the jet is spineless, more
that it has a spine with a low emissivity.

Switching to a power-law velocity fall-off at large distances may be

responsible for the central sidedness staying a little too high. We could revert to linear, at the cost of having to explain away some unphysical piling up of material where beta = 0.

The other thing that may have changed is the switch to a larger value of VMIN0i This is forced to continue to the end of the jet. If the velocity were a bit higher at RHOF, we might be forced to add a VMINF. As it is, I don't think it will make much difference.

>
> The thing we have never been able to fit well is the fact that the
> actual sidedness peaks in the transition zone, but the model sidedness
> peaks close to the core. This seems to me to be a rather basic trend
> in a decelerating jet, as the sidedness of everything along each line
> of sight has to decrease outwards if all the velocities are
> decreasing. The only way I can see to counteract this is to adjust
> the velocities to boost the faster (high-sidedness) emission from the
> spine relative to the shear layer in the transition region, but not
> closer in, which will again mess with the polarization (it might
> help the counterjet, but not the jet). It's hard to see how to
> do this while holding the peak sidedness up in the low 20's, unless
> we move the jet a bit closer to the line of sight. (The fitted angle
> has been trending down for some time in fact, so maybe this is trying
> to nudge us in that direction?)
>

We've sort of covered this point in the exchange of messages before this one. Various things could be done: another is to have a weak, low-velocity component which dominates close to the nucleus where the high velocity stuff is suppressed, but which is swamped further out. However, I'm not convinced that the observed sidedness peak is anything other than a very bright filament (+ the absence of a corresponding one in the counter-jet?). Your point about the field going oblique fits very well with this, and the observed sidedness profile is very bumpy. We will know much more from the A configuration data. The higher-resolution observations of M87 and 3C66B (both radio and optical) suggest that the emission in the innermost regions could well be dominated by filaments, and that the brightess distributions are far from smooth. I've also wondered whether the balance of toroidal and longitudinal B is really just caused by a load of filaments wraped around the jet at different pitch angles. If a single filament dominates the emission (because it is bright, or at high resolution), then we will see above-average surface brightness and a random field direction.

Fitting sidedness ratio or difference maps, or somehow telling the program to emphasise the differences would be interesting. I'll consult some of my statistically-minded colleagues. I had a wild thought yesterday about using MEM or clean techniques (cf. lens-clean, or whatever they call the program that deconvolves mass distributions from gravitational lens images), but thought better of it.

Anyway, I vote for calling a halt now, if only to avoid the temptation of peeking at the new data. I'll try to get something on paper a..s.a.p.

Robert

From VM Thu Nov 21 12:19:01 1996
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References: <9611141446.AA19464@polaris.cv.nrao.edu>
<Pine.GSO.3.94.961114145004.6296B-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: v7 code etc.
Date: Thu, 14 Nov 1996 10:54:32 -0500

Robert Laing writes:

> Fitting sidedness ratio or difference maps, or somehow telling the
> program to emphasise the differences would be interesting. I'll consult
> some of my statistically-minded colleagues. I had a wild thought
> yesterday about using MEM or clean techniques (cf. lens-clean, or whatever
> they call the program that deconvolves mass distributions from
> gravitational lens images), but thought better of it.

I'm not sure what this last bit _could_ mean, though it sounds intriguing!

>
> Anyway, I vote for calling a halt now, if only to avoid the temptation of
> peeking at the new data. I'll try to get something on paper a..s.a.p.
>

We're on the same wavelength here. I think your point about symmetrized
sidedness images is a good one and I'll look at that at this end. I do
agree that we've gone into this quite far enough for the moment to
write the first paper, knowing it will not be the last .....

A.

From VM Thu Nov 21 12:19:33 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
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"<Pine.GSO.3.94.961114185843.6829A-100000@rgosf>" "12" "pgeom" "^From:" nil nil "11" nil nil nil nil]
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id AA33605; Thu, 14 Nov 1996 14:06:19 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id OAA26477 for <abridle@nrao.edu>; Thu, 14 Nov 1996 14:06:18 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id TAA28630; Thu, 14 Nov 1996 19:06:15 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id TAA06836; Thu, 14 Nov 1996 19:06:12 GMT
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Message-Id: <Pine.GSO.3.94.961114185843.6829A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@cv3.cv.nrao.edu>
Subject: pgeom
Date: Thu, 14 Nov 1996 19:06:11 +0000 (GMT)

Having got my superposed plots by the customary contorted procedure, it unfortunately occurred to me to repeat the exercise of converting the sidedness map to polar coordinates and averaging over distance from the nucleus. When I plotted the results for the model, I found that the curves were not symmetrically blanked, and that the interpolation in pgeom (I tried various orders) had gone a bit wrong. Have you any idea how to fix this: oversampling the image was the only thing that came to mind.

Do I detect a hint of impatience with aips++?

Robert

From VM Thu Nov 21 12:21:24 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["388" "Fri" "15" "November" "1996" "13:29:16" "-0500" "Alan Bridle" "abridle" nil "13" "Puzzled" "^From:" nil nil "11" nil nil nil nil]
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id AA27306; Fri, 15 Nov 1996 13:29:16 -0500
Message-Id: <9611151829.AA27306@polaris.cv.nrao.edu>
From: abridle (Alan Bridle)
To: rl@ast.cam.ac.uk
Subject: Puzzled
Date: Fri, 15 Nov 1996 13:29:16 -0500

Hi Robert,

I'm puzzled by the VARS.DAT file that came with the v7 code.
It appears to have legislated some of the field transition
by tinkering with the longitudinal field in the spine and
turning off the radial component there. I thought
we were still going with SPLT* = 0.0 and SPRT* = 1.0
everywhere (as in iwstructions.txt) -- was this VARS.DAT
from some other incarnation?

A.

From VM Thu Nov 21 12:21:26 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
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Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id SAA08178; Fri, 15 Nov 1996 18:56:21 GMT
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In-Reply-To: <9611151829.AA27306@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.961115183104.8118B-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@cv3.cv.nrao.edu>
Subject: Re: Puzzled
Date: Fri, 15 Nov 1996 18:56:20 +0000 (GMT)

Er ... I knew my book-keeping would let me down in the end. I have been using 2 spine field configurations: one with the components set equal to those of the shear layer but WITHOUT the radial component; the other with spine field as before (no longitudinal component; other 2 equal). I defy anyone to tell the difference between these without a magnifying glass. The fit using the former is ever so slightly better (although re-optimization could well equalize the chi-squareds). I used it for the latest series of models, but forgot to modify the instructions.

We really cannot say anything about the field configuration in the spine, because it is such a narrow feature now. It still has to be there to define the central velocity, and the optimization is quite sure that it wants the opening angle of 3 degrees, but its polarized flux is too low to matter. I must admit I'm not sure why the optimization is so insistent, but I tried it yesterday with the angle set to 6 degrees and the chi-squared was much worse. I think it must be that the transverse velocity fall-off is intimately related to the polarization.

To what extent the term "spine" is still valid may be debatable, but there is still a narrow, high-speed featue in the middle of the jet: it just doesn't produce enough polarized flux to make much difference.

Cheers, Robert

From VM Thu Nov 21 12:21:48 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
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Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA23236; Mon, 18 Nov 1996 11:50:52 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id LAA17978 for <abridle@nrao.edu>; Mon, 18 Nov 1996 11:50:50 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id QAA19559; Mon, 18 Nov 1996 16:50:42 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id QAA14165; Mon, 18 Nov 1996 16:50:40 GMT
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.961118163743.14125A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@cv3.cv.nrao.edu>
Subject: Minor change of mind
Date: Mon, 18 Nov 1996 16:50:39 +0000 (GMT)

I think I would prefer to revert to the linear variation + truncation of
velocity in the outer regions, despite its annoying deceleration
difficulty (there is an infinitesimal effect on the fit). The reason is
that I am trying to calculate the expected sidedness and width ratios to
compare with the B2 sample, and discovered that the model did not become
completely symmetrical even at twice the present grid size - the veloc-ty
fall-off is very slow. I don't believe that we have any evidence for a
power-law velocity extending way outside our grid, and I don't think that
this will fit the B2 data.

It's annoying to explain, but we can say that we cannot model when the
sidedness ratio falls below our detection limit and that extrapolation of
the velocity law is unjustified.

What do you think?

Robert

P.S. We got a bit of the Salinger allegations, but they were lost in the
tide of speculation about the mood of the US electorate (e.g. >50% don't
trust the president but he gets elected anyway?!).

From VM Thu Nov 21 12:22:11 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["2589" "Mon" "18" "November" "1996" "13:02:40" "-0500" "Alan Bridle" "abridle" nil "55" "Re: Minor change of mind" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 2589
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA23118; Mon, 18 Nov 1996 13:02:40 -0500
Message-Id: <9611181802.AA23118@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961118163743.14125A-100000@rgosf>
References: <Pine.GSO.3.94.961118163743.14125A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Minor change of mind
Date: Mon, 18 Nov 1996 13:02:40 -0500

Robert Laing writes:

> I think I would prefer to revert to the linear variation + truncation of
> velocity in the outer regions, despite its annoying deceleration
> difficulty (there is an infinitesimal effect on the fit). The reason is
> that I am trying to calculate the expected sidedness and width ratios to
> compare with the B2 sample, and discovered that the model did not become
> completely symmetrical even at twice the present grid size - the velocity
> fall-off is very slow. I don't believe that we have any evidence for a
> power-law velocity extending way outside our grid, and I don't think that
> this will fit the B2 data.
>
> It's annoying to explain, but we can say that we cannot model when the
> sidedness ratio falls below our detection limit and that extrapolation of
> the velocity law is unjustified.
>
> What do you think?
>

It's a tad messy either way, but I don't see that it can make a lot of
difference provided velocities do not go strictly to zero inside the
grid. Certainly the fit to the sidedness profile in the outer regions
looked a little better using the linear form.

> P.S. We got a bit of the Salinger allegations, but they were lost in the
> tide of speculation about the mood of the US electorate (e.g. >50% don't
> trust the president but he gets elected anyway?!).

He appears to have been elected to moderate the effects of a
Republican-dominated congress. (It was also rumored that some of
those chanting "four more years" were special prosecutors). The Dole
campaign was one of the worst in living memory (even worse than
Bush's), and voter turnout was a new low. A depressing performance
all-round!

Salinger, it turns out, was attributing great import to a document
that had circulated for months on alt.conspiracy, etc. There are,
however a number of eyewitnesses, including a Pakistani airline pilot,
who say they saw a flash of light approach the plane before it
exploded; and some fishermen who say they saw what looked like a

missile launch from the water. It's very odd as these reports surfaced within hours of the event, well before Boeing or TWA had an interest in "encouraging" such witnesses to come forward. The photograph produced by Salinger has also been on the Net and appears to have been taken facing in the wrong direction to have anything to do with the plane crash. If there is a story buried here, it does not seem that Salinger unearthed anything of value to it; bizarre for someone with as much reputation to lose as he has (had).

I just got the AL405 tape in the mail.

A.

From VM Thu Nov 21 12:22:48 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["134" "Tue" "19" "November" "1996" "11:17:07" "+0000" "Robert Laing" "rl@ast.cam.5c.uk"
"<Pine.GSO.3.94.961119111531.15933C-100000@rgosf>" "5" "Re: 3C31" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 134
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA19876; Tue, 19 Nov 1996 06:17:29 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.2) with SMTP
id GAA29656 for <abridle@nrao.edu>; Tue, 19 Nov 1996 06:17:24 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id LAA27861; Tue, 19 Nov 1996 11:17:09 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id LAA15994; Tue, 19 Nov 1996 11:17:08 GMT
X-Sender: rl@rgosf
In-Reply-To: <199611182105.OAA25135@sechelt.aoc.nrao.edu>
Message-Id: <Pine.GSO.3.94.961119111531.15933C-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@cv3.cv.nrao.edu>, Rick Perley <rperley@aoc.nrao.edu>
Subject: Re: 3C31
Date: Tue, 19 Nov 1996 11:17:07 +0000 (GMT)

I guess that you gentlemen both have the data ... how about one of you
calibrating it, and I'll volunteer to do the mapping?

Robert

From VM Thu Nov 21 12:22:54 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["199" "Tue" "19" "November" "1996" "10:10:36" "-0500" "Alan Bridle" "abridle" nil "9" "Re: 3C31" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 199
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA32282; Tue, 19 Nov 1996 10:10:36 -0500
Message-Id: <9611191510.AA32282@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961119111531.15933C-100000@rgosf>
References: <199611182105.OAA25135@sechelt.aoc.nrao.edu>
<Pine.GSO.3.94.961119111531.15933C-100000@rgosf>
From: abridle (Alan Bridle)
To: rl@ast.cam.ac.uk, rperley
Subject: Re: 3C31
Date: Tue, 19 Nov 1996 10:10:36 -0500

Robert Laing writes:
> I guess that you gentlemen both have the data ... how about one of you
> calibrating it, and I'll volunteer to do the mapping?
>

I'm reading it in right now, Robert!

A.

From VM Thu Nov 21 12:23:23 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["703" "Tue" "19" "November" "1996" "17:14:36" "+0000" "Robert Laing" "rl@ast.cam.ac.uk" nil "16" "Code"
"^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 703
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA22722; Tue, 19 Nov 1996 12:14:57 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.3) with SMTP
id MAA03971 for <abridle@nrao.edu>; Tue, 19 Nov 1996 12:14:46 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA03992; Tue, 19 Nov 1996 17:14:38 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA17295; Tue, 19 Nov 1996 17:14:37 GMT
X-Sender: rl@rgosf
Reply-To: Robert Laing <rl@ast.cam.ac.uk>
Message-Id: <Pine.GSO.3.94.961119162811.17197A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@NRAO.EDU>
Subject: Code
Date: Tue, 19 Nov 1996 17:14:36 +0000 (GMT)

I didn't mean to nag about the data!

I've found a slight error in geom.f which caused the program to hang up in the special case that the flow vector was exactly along the jet axis. The expressions used for the direction cosines in the 3D field case had a zero-divide, which the annoying IEEE floating-point implementation disguised. The physical reason is that an azimuthally symmetrical field can only be longitudinal on the axis. Running the current model at 90 degrees to the line of sight hit this case (it won't affect the results at all, since the problem occurs in an infinitesimal volume).

The next 2 messages will have more robust versions of intrinsic.f and geom.f.

Regards, Robert

From VM Thu Nov 21 12:23:25 1996
X-VM-v5-Data: ([nil nil nil t nil nil nil nil nil]
["4332" "Tue" "19" "November" "1996" "17:15:02" "+0000" "Robert Laing" "rl@ast.cam.ac.uk" nil "153" "intrinsic"
"^From:" nil nil "11" nil nil ("umber " " mark " F Robert Laing Nov 19 153/4332 " thread-indent "\"intrinsic\"\n") nil]
nil)
Content-Length: 4332
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA22728; Tue, 19 Nov 1996 12:15:11 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.3) with SMTP
id MAA03995 for <abridle@nrao.edu>; Tue, 19 Nov 1996 12:15:08 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA04003; Tue, 19 Nov 1996 17:15:05 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA17300; Tue, 19 Nov 1996 17:15:04 GMT
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.961119171439.17289A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@NRAO.EDU>
Subject: intrinsic
Date: Tue, 19 Nov 1996 17:15:02 +0000 (GMT)

```
      SUBROUTINE INTRINSIC (SPINE, RHO, ZETA, EMIS, BETA)

      IMPLICIT NONE

* GIVEN

      LOGICAL SPINE ! T => in spine; F => in shear layer
      REAL RHO      ! Distance from nucleus
      REAL ZETA     ! Angle from axis of jet (0 - PI)

* RETURNED

      REAL EMIS     ! Normalization constant for emissivity
      REAL BETA     ! Velocity

* COMMON

      INCLUDE 'model.inc'

* LOCAL

      REAL VL, T

*+

*---------- Error trap at grid origin ----------------------------------------*

      IF (RHO .EQ. 0.0) THEN
        EMIS = 0.0
        BETA = BETAI
        LTSQ = 1.0
        RTSQ = 1.0

*---------- Common code for spine and shear layer ----------------------------*
```

```
      ELSE                ! Central velocity (used by spine and SL)
        IF (RHO .LT. RHO1) THEN
          BETA = BETAI - (BETAI - BETA1)*RHO/RHO1
        ELSE IF (RHO .LT. RHO0) THEN
          BETA = BETA1 - (BETA1-BETA0)*(RHO-RHO1)/(RHO0-RHO1)
        ELSE
          BETA = BETA0 - (BETA0-BETAF)*(RHO-RHO0)/(RHOF-RHO0)
          IF (BETA .LT. 0.0) BETA = 0.0
        END IF

        IF (SPINE) THEN    ! Spine

*---------- Spine ------------------------------------------------------------*

* Emissivity

          IF (SPINE_SL .EQ. 0.0) THEN
            EMIS = 0.0
          ELSE IF (RHO .LT. RHO1) THEN
            EMIS = ((RHO/RHO1)**(-ESP_IN))*((RHO0/RHO1)**(+ESP_MID))
          ELSE IF (RHO .LT. RHO0) THEN
            EMIS = (RHO/RHO0)**(-ESP_MID)
          ELSE
            EMIS = (RHO/RHO0)**(-ESP_OUT)
          END IF

* Spine field anisotropy (used if BTYPE = 4)

          IF (RHO .LT. RHO1) THEN
            LTSQ = SPLTI - (SPLTI-SPLT1)*RHO/RHO1
            RTSQ = SPRTI - (SPRTI-SPRT1)*RHO/RHO1
          ELSE IF (RHO .LT. RHO0) THEN
            LTSQ = SPLT1 -
     &           (SPLT1-SPLT0)*(RHO-RHO1)/(RHO0-RHO1)
            RTSQ = SPRT1 -
     &           (SPRT1-SPRT0)*(RHO-RHO1)/(RHO0-RHO1)
          ELSE
            LTSQ = SPLT0 -
     &           (SPLT0-SPLTF)*(RHO-RHO0)/(RHOF-RHO0)
            RTSQ = SPRT0 -
     &           (SPRT0-SPRTF)*(RHO-RHO0)/(RHOF-RHO0)
          END IF
          IF (LTSQ .LT. 0.0) LTSQ = 0.0
          IF (RTSQ .LT. 0.0) RTSQ = 0.0
        ELSE

*---------- Shear layer ------------------------------------------------------*

* Angle from jet axis in 0 - 90 deg

          IF (X .GT. 0.0) THEN
            T = ZETA          ! Approaching jet
          ELSE
            T = PI - ZETA     ! Receding jet
          END IF

* Maximum emissivity
```

```
        IF (SPINE_SL .GE. 1000.0) THEN
          EMIS = 0.0
        ELSE IF (RHO .LT. RHO1) THEN
          EMIS = ((RHO/RHO1)**(-ESL_IN))*((RHO0/RHO1)**(+ESL_MID))
        ELSE IF (RHO .LT. RHO0) THEN
          EMIS = (RHO/RHO0)**(-ESL_MID)
        ELSE
          EMIS = (RHO/RHO0)**(-ESL_OUT)
        END IF

* Linear ramp in emissivity to SLMIN of central value at edge of jet
* N.B. SL = 1 at spine/shear layer interface and 0 at jet edge

        EMIS = EMIS*(SLMIN + (1.0 - SLMIN)*SL) ! Linear ramp to SLMIN
     &         / SPINE_SL

        IF (RHO .GT. RHO0) THEN
          VL = VMIN0
        ELSE IF (RHO .GT. RHO1) THEN
          VL = VMIN0 - (VMIN0-VMIN1)*(RHO0-RHO)/(RHO0-RHO1)
        ELSE
          VL = VMIN1
        END IF
        BETA = BETA*(VL + (1.0-VL)*SL)
        IF (BETA .LT. 0.0) BETA = 0.0

* Shear layer field anisotropy (used if BTYPE = 4)

        IF (RHO .LT. RHO1) THEN
          LTSQ = SLLTI - (SLLTI-SLLT1)*RHO/RHO1
          RTSQ = SLRTI - (SLRTI-SLRT1)*RHO/RHO1
        ELSE IF (RHO .LT. RHO0) THEN
          LTSQ = SLLT1 -
     &         (SLLT1-SLL-0)*(RHO-RHO1)/(RHO0-RHO1)
          RTSQ = SLRT1 -
     &         (SLRT1-SLRT0)*(RHO-RHO1)/(RHO0-RHO1)
        ELSE
          LTSQ = SLLT0 -
     &         (SLLT0-SLLTF)*(RHO-RHO0)/(RHOF-RHO0)
          RTSQ = SLRT0 -
     &         (SLRT0-SLRTF)*(RHO-RHO0)/(RHOF-RHO0)
        END IF
        IF (LTSQ .LT. 0.0) LTSQ = 0.0
        IF (RTSQ .LT. 0.0) RTSQ = 0.0
        IF (SL .LT. 1.0) THEN
          RTSQ = RTSQ*(1.0-SL)**0.5
        ELSE
          RTSQ = 0.0
        END IF
      END IF

* Common code for spine and shear layer

      LTSQ = LTSQ**2
      RTSQ = RTSQ**2

    END IF
    RETURN
```

END

From VM Thu Nov 21 12:23:26 1996
X-VM-v5-Data: ([nil nil nil t nil nil nil nil nil]
["12460" "Tue" "19" "November" "1996" "17:15:33" "+0000" "Robert Laing" "rl@ast.cam.ac.uk" nil "441" "geom"
"^From:" nil nil "11" nil nil (number " " mark " F Robert Laing Nov 19 441/12460 " thread-indent "\"geom\"\n") nil
nil)
Content-Length: 12460
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA22736; Tue, 19 Nov 1996 12:15:46 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.3) with SMTP
id MAA04010 for <abridle@nrao.edu>; Tue, 19 Nov 1996 12:15:39 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA04012; Tue, 19 Nov 1996 17:15:36 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id RAA17307; Tue, 19 Nov 1996 17:15:34 GMT
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.961119171505.17289B-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@NRAO.EDU>
Subject: geom
Date: Tue, 19 Nov 1996 17:15:33 +0000 (GMT)

```
      SUBROUTINE GEOM (Z)

* Compute Doppler factor, angle to line of sight in rest frame and position
* angle of polarization and put them in common for integration routines.

      IMPLICIT NONE

* GIVEN

      REAL Z   ! Along line of sight

* IN COMMON

      INCLUDE 'model.inc'


* LOCAL

      REAL RHO, ZETA, DELTA        ! Spherical polar coords in jet
      REAL SD, CD                  ! sin and cos of DELTA
      REAL CT, ST                  ! cos and sin of angle to l of s
      REAL EMIS                    ! Rest frame emissivity constant
      REAL BETA                    ! Velocity
      REAL GAMMA                   ! Lorentz factor
      REAL D                       ! Doppler factor
      REAL CETA, SETA              ! cos and sin of angle to line of sight
                                   ! (observed frame)
      REAL CETA0, SETA0            ! cos and sin of angle to line of sight
                                   ! (emitted frame)
      REAL XSL, YSL, ZSL, VNORM    ! Unit vector normal to field sheet
                                   ! in shear layer, + normalization
      REAL CR, SR                  ! cos and sin of rotation due to Doppler
      REAL PA                      ! B-field position angle
      REAL T                       ! Angle between flow and jet axis,
                                   ! ranged in 0 - 90 deg
```

```
      REAL RSQ                  ! x**2+y**2
      REAL R                   ! sqrt(x**2+y**2)
      REAL NUM, TERM

      REAL XF, YF, ZF             ! Flow vector and components
      REAL XBOUND, XSPINE         ! Boundary of jet and spine in plane
                                  ! defined by jet axis and flow vector
      REAL SP                     ! Parameter for spine streamlines
      REAL GRAD                   ! Streamline gradient
      REAL EPS                    ! Angle between flow and jet axis
      REAL SEPS, CEPS             ! sin and cos of EPS

      REAL EDGE, ZBRENT, SPGRAD, SLGRAD
      EXTERNAL EDGE, ZBRENT, SPGRAD, SLGRAD, SPFUNC, SLFUNC

*+

      ST = SIN(THETA)
      CT = COS(THETA)

* Spherical polar coords in jet frame

      RHO = SQRT (X**2 + Y**2 + Z**2)          ! Distance from nucleus
      XJ = Y**2 + (X*CT - Z*ST)**2
      IF (XJ .GT. 0.0) THEN
        XJ = SQRT (XJ)
      ELSE
        XJ = 0.0
      END IF
      ZJ = X*ST + Z*CT
      ZETA = ATAN2 (XJ,ZJ)
      ZJ = ABS(ZJ)
      IF (Y .EQ. 0.0 .AND. (X*CT - Z*ST) .EQ. 0.0) THEN
        DELTA = 0.0
      ELSE
        DELTA = ATAN2 (Y, X*CT - Z*ST)
      END IF
      CD = COS(DELTA)
      SD = SIN(DELTA)

      IF (ZETA .LT. PI/2.0) THEN
        T = ZETA
      ELSE
        T = PI - ZETA
      END IF

* For inner and outer regions, the flow is purely radial, and the
* flow vector components and angle to the line of sight can be set up
* directly, irrespective of location in the jet

      XF = X/RHO
      YF = Y/RHO
      ZF = Z/RHO
      CETA = ZF
      IF (CETA**2 .LT. 1.0) THEN
        SETA = SQRT(1.0 - CETA**2)
      ELSE
        SETA = 0.0
```

```
      END IF

      IF (RHO .GE. RHO1 .AND. RHO .LE. RHO0) THEN
        XBOUND = EDGE(XI1,XI0)
        XSPINE = EDGE(ZETA1,ZETA0)
      END IF

* Three cases: (i) outside jet, (ii) in spine, (iii) in shear layer.

* Outside jet

      IF ((RHO .GT. RHO0 .AND. T .GT. XI0) .OR.
     &    (RHO .LT. RHO0 .AND. RHO .GT. RHO1 .AND.
     &     XJ .GT. XBOUND) .OR.
     &    (RHO .LT. RHO1 .AND. T .GT. XI1) .OR. RHO .EQ. 0.0) THEN
        I0 = 0.0        ! No emission
        BORD = 1        ! To avoid error trap in IFUNC etc.
        CSQ = 0.0

* Spine

      ELSE IF ((RHO .GT. RHO0 .AND. T .LE. ZETA0) .OR.
     &    (RHO .LE. RHO0 .AND. RHO .GT. RHO1 .AND.
     &     XJ .LE. XSPINE) .OR.
     &    (RHO .LE. RHO1 .AND. T .LE. ZETA1)) THEN

* The values of XF, YF, ZF, CETA and SETA are already set up for the
* conical portions of the flow (RHO < RHO1 and RHO > RHO0).  Work out
* the flow vector for the transition region separately.

        IF (RHO .GT. RHO1 .AND. RHO .LT. RHO0) THEN
          IF (ZETA0 .NE. ZETA1) THEN

* Solve for parameter SP, which specifies the streamline (Brent's method;
* root should be in [0,1], but allow a bit extra.

            SP = ZBRENT (SPFUNC,-0.1,1.1,0.001)
            IF (SP .LT. 0.0) SP = 0.0
            IF (SP .GT. 1.0) SP = 1.0

* Evaluate the gradient of the streamline

            GRAD = SPGRAD(SP)

* sin and cos of the angle to the jet axis

            EPS = ATAN(GRAD)
            SEPS = SIN(EPS)
            CEPS = COS(EPS)
            IF (ZETA .GT. PI/2.0) CEPS = -CEPS ! Receding jet


* Flow vector components

            XF = CD*SEPS*CT+CEPS*ST
            YF = SD*SEPS
            ZF = -CD*SEPS*ST + CEPS*CT
            CETA = ZF
```

```
          IF (CETA**2 .LT. 1.0) THEN
            SETA = SQRT(1.0 - CETA**2)
          ELSE
            SETA = 0.0
          END IF

        END IF

      END IF



      CALL INTRINSIC (.TRUE., RHO, ZETA, EMIS, BETA)

      GAMMA = 1.0/SQRT(1-BETA**2)

* Doppler factor

      D = 1.0/(GAMMA*(1 - BETA*CETA))
      I0 = EMIS*D**(2.0+ALPHA)

      IF (BTYPE .EQ. 1 .OR. BTYPE .EQ. 2 .OR. BTYPE .EQ. 3) THEN

* Spine field is 2D transverse; IQU to be evaluated from numerical
* integration tables.  Require BORD, CSQ, C2PA and S2PA set in COMMON.

        BORD = 2                    ! 2D field

* cos^2 (angle to line of sight in rest frame)

        CETA0 = (CETA - BETA)/(1.0 - BETA*CETA)
        CSQ = CETA0**2

* B-field position angle

        IF (RHO .LT. RHO1 .OR. RHO .GT. RHO0 .OR.
     &      ZETA0 .EQ. ZETA1) THEN
          PA = ATAN2 (Y, X)
        ELSE
          PA = ATAN2(SD*SEPS,CD*SEPS*CT+CEPS*ST)
        END IF

        C2PA = COS (2.0*PA)  ! In COMMON
        S2PA = SIN (2.0*PA)  ! In COMMON

      ELSE IF (BTYPE .EQ. 4) THEN

* General field configuration with 3 unequal components; IQU evaluated using
* alpha = 1 analytical approximation.   Requires BORD and direction
* cosines LX, LY, MX, MY, NX, NY set up in COMMON.

        BORD = 3

* cos (angle of flow vector to line of sight in rest frame)

        CETA0 = (CETA - BETA)/(1.0 - BETA*CETA)
        SETA0 = SQRT(1.0 - CETA0**2)
```

```
* cos and sin of rotation due to Doppler boost

        CR = CETA0*CETA + SETA0*SETA
        SR = SETA0*CETA - CETA0*SETA

* Direction cosines

        IF (X .NE. 0.0 .OR. Y .NE. 0.0) THEN
          RSQ = XF**2+YF**2
          R = SQRT(RSQ)
          NUM = (CR + ZF*SR/R)
          LX = XF*NUM
          LY = YF*NUM
          NUM = RSQ*SQRT(YF**2+(XF*CT-ZF*ST)**2)
          IF (NUM .NE. 0.0) THEN
            NUM = 1.0/NUM
            MX = NUM*(XF*YF*ST*(ZF*CR-R*SR)-XF*YF*ZF*ST+YF*RSQ*CT)
            MY = NUM*(YF*YF*ST*(ZF*CR-R*SR)+XF*XF*ZF*ST-XF*RSQ*CT)
            TERM = (XF*ZF*ST-RSQ*CT)*(R*SR-ZF*CR)
            NX = NUM*(XF*TERM-YF**2*ST)
            NY = NUM*(YF*TERM+XF*YF*ST)
          ELSE   ! Special case: flow vector along jet axis, so field
                 ! must be purely longitudinal, by symmetry
            MX = 0.0
            MY = 0.0
            NX = 0.0
            NY = 0.0
          END IF
        ELSE           ! X = Y = 0
          LX = 0.0
          LY = 0.0
          MX = 0.0
          MY = 0.0
          NX = 0.0
          NY = 0.0
        END IF

       ELSE                ! Error
         TYPE *, 'Illegal BTYPE = ',BTYPE
         STOP
       END IF

* Shear layer

      ELSE

* Fractional distance from spine to outer jet boundary
* and angle between flow and line of sight (needed for
* transition region).

       IF (RHO .LT. RHO1) THEN
         SL = (XI1 - T)/(XI1-ZETA1)
       ELSE IF (RHO .LT. RHO0) THEN
         IF (XI0 .EQ. XI1 .AND. ZETA0 .EQ. ZETA1) THEN

* Special case - radial flow

           SL = (XI0 - T)/(XI0 - ZETA0)
```

```
        ELSE

* Solve for parameter SP, which specifies the streamline (Brent's method;
* root should be in [0,1], but allow a bit extra.

          SP = ZBRENT (SLFUNC,-0.1,1.1,0.001)
          IF (SL .LT. 0.0) SL = 0.0
          IF (SL .GT. 1.0) SL = 1.0

* Evaluate the gradient of the streamline

          GRAD = SLGRAD(SP)

* Shear layer parameter

          SL = 1.0 - SP

* sin and cos of the angle to the jet axis

          EPS = ATAN(GRAD)
          SEPS = SIN(EPS)
          CEPS = COS(EPS)
          IF (ZETA .GT. PI/2.0) CEPS = -CEPS ! Receding jet

* Flow vector components

          XF = CD*SEPS*CT+CEPS*ST
          YF = SD*SEPS
          ZF = -CD*SEPS*ST + CEPS*CT
          CETA = ZF
          IF (CETA**2 .LT. 1.0) THEN
            SETA = SQRT(1.0 - CETA**2)
          ELSE
            SETA = 0.0
          END IF
        END IF
      ELSE          ! Outer region
        SL = (XI0 - T)/(XI0 - ZETA0)
      END IF

      CALL INTRINSIC (.FALSE., RHO, ZETA, EMIS, BETA)

      GAMMA = 1.0/SQRT(1-BETA**2)

* Doppler factor

      D = 1.0/(GAMMA*(1 - BETA*CETA))
      I0 = EMIS*D**(2.0+ALPHA)

      IF (BTYPE .EQ. 1) THEN ! 1D longitudinal field

        BORD = 1            ! 1D field order

* cos^2 (angle to line of sight in rest frame)

          CETA0 = (CETA - BETA)/(1.0 - BETA*CETA)
          CSQ = CETA0**2
```

```
* B-field position angle

        PA = ATAN2 (-XF, YF)   ! Longitudinal
        C2PA = COS (2.0*PA)  ! In COMMON
        S2PA = SIN (2.0*PA)  ! In COMMON

      ELSE IF (BTYPE .EQ. 2) THEN

        BORD = 2            ! 2D field order

* cos^2 (angle to line of sight in rest frame)

        CETA0 = (CETA - BETA)/(1.0 - BETA*CETA)
        CSQ = CETA0**2

* B-field position angle

        PA = ATAN2 (YF, XF)
        C2PA = COS (2.0*PA)  ! In COMMON
        S2PA = SIN (2.0*PA)  ! In COMMON

      ELSE IF (BTYPE .EQ. 3) THEN

        BORD = 2            ! 2D field order
* Unit vector normal to field sheet in shear layer

        XSL = XF*ZF*CT - (YF**2+ZF**2)*ST
        YSL = XF*YF*ST +YF*ZF*CT
        ZSL = XF*ZF*ST - (XF**2+YF**2)*CT
        VNORM = SQRT(XSL**2+YSL**2+ZSL**2)
        XSL = XSL/VNORM
        YSL = YSL/VNORM
        ZSL = ZSL/VNORM

* cos (angle of flow vector to line of sight in rest frame)

        CETA0 = (CETA - BETA)/(1.0 - BETA*CETA)
        SETA0 = SQRT(1.0 - CETA0**2)

* cos and sin of rotation due to Doppler boost

        CR = CETA0*CETA + SETA0*SETA
        SR = SETA0*CETA - CETA0*SETA

* cos^2 (angle between field sheet normal and line of sight in rest frame)

        CSQ = (ZSL*(ZF*SR/SQRT(XF**2+YF**2) + CR))**2

* B-field position angle

        PA = ATAN2 (-YF*ZF*ZSL*CR + YF*SQRT(XF**2+YF**2)*ZSL*SR
     &        + YSL*XF**2 -XSL*XF*YF,
     &        -XF*ZF*ZSL*CR + XF*SQRT(XF**2+YF**2)*ZSL*SR
     &        - YSL*XF*YF + XSL*YF**2)
        C2PA = COS (2.0*PA)  ! In COMMON
        S2PA = SIN (2.0*PA)  ! In COMMON

      ELSE IF (BTYPE .EQ. 4) THEN
```

```
        BORD = 3

* cos (angle of flow vector to line of sight in rest frame)

        CETA0 = (CETA - BETA)/(1.0 - BETA*CETA)
        SETA0 = SQRT(1.0 - CETA0**2)

* cos and sin of rotation due to Doppler boost

        CR = CETA0*CETA + SETA0*SETA
        SR = SETA0*CETA - CETA0*SETA

* Direction cosines

        IF (X .NE. 0 .OR. Y .NE. 0) THEN
          RSQ = XF**2+YF**2
          R = SQRT(RSQ)
          NUM = (CR + ZF*SR/R)
          LU = XF*NUM
          LY = YF*NUM
          NUM = RSQ*SQRT(YF**2+(XF*CT-ZF*ST)**2)
          IF (NUM .NE. 0.0) THEN
            NUM = 1.0/NUM
            MX = NUM*(XF*YF*ST*(ZF*CR-R*SR)-XF*YF*ZF*ST+YF*RSQ*CT)
            MY = NUM*(YF*YF*ST*(ZF*CR-R*SR)+XF*XF*ZF*ST-XF*RSQ*CT)
            TERM = (XF*ZF*ST-RSQ*CT)*(R*SR-ZF*CR)
            NX = NUM*(XF*TERM-YF**2*ST)
            NY = NUM*(YF*TERM+XF*YF*ST)
          ELSE  ! Special case (exactly on jet axis: field is precisely
                ! longitudinal, by symmetry)
            MX = 0.0
            MY = 0.0
            NX = 0.0
            NY = 0.0
          END IF
        ELSE            ! X = Y = 0
          LX = 0.0
          LY = 0.0
          MX = 0.0
          MY = 0.0
          NX = 0.0
          NY = 0.0
        END IF

      ELSE
        TYPE *,'Illegal BTYPE = ',BTYPE
        STOP
      END IF

    END IF

    RETURN
    END
```

From VM Thu Nov 21 12:24:06 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["999" "Wed" "20" "November" "1996" "14:26:02" "+0000" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.961120140909.18817A-100000@rgosf>" "20" "Models" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 999
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA20866; Wed, 20 Nov 1996 09:26:11 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.0/8.8.0/CV-2.3) with SMTP
id JAA17402 for <abridle@nrao.edu>; Wed, 20 Nov 1996 09:26:08 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id OAA15276; Wed, 20 Nov 1996 14:26:05 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id OAA18845; Wed, 20 Nov 1996 14:26:03 GMT
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.961120140909.18817A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@NRAO.EDU>
Subject: Models
Date: Wed, 20 Nov 1996 14:26:02 +0000 (GMT)

Another test prompted by my attempts to generate a set of models at various angles for comparison with the B2 sample data was to optimize with the spine and shear layer power laws forced to be the same. This produced an identical chi-squared to the previous model, with minor changes to a few of the other parameters. This highlights the fact that the optimization algorithm appears to leave parameters set at their input values if changing them makes little difference to chi-squared (hence the importance of a sensitivity analysis). The main reason I tried this test was that the models with smallish THETA (<45 degrees or so) were limb-brightened in an odd-looking way, with a narrow channel down the centre of the jet.

I propose to provide the ability to equalise spine and shear layer power laws (maybe also field component ratios) as an option, switched via an environment variable. I think I would be in favour of doing this for the "production" model too: what do you think?

Robert

From VM Thu Nov 21 12:24:14 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["1614" "Wed" "20" "November" "1996" "10:12:48" "-0500" "Alan Bridle" "abridle" nil "42" "Re: Models" "^From:"
nil nil "11" nil nil nil nil]
nil)
Content-Length: 1614
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA40227; Wed, 20 Nov 1996 10:12:48 -0500
Message-Id: <9611201512.AA40227@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961120140909.18817A-100000@rgosf>
References: <Pine.GSO.3.94.961120140909.18817A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Models
Date: Wed, 20 Nov 1996 10:12:48 -0500

Robert Laing writes:

> Another test prompted by my attempts to generate a set of models at
> various angles for comparison with the B2 sample data was to optimize with
> the spine and shear layer power laws forced to be the same. This produced
> an identical chi-squared to the previous model, with minor changes to a
> few of the other parameters. This highlights the fact that the
> optimization algorithm appears to leave parameters set at their input
> values if changing them makes little difference to chi-squared (hence the
> importance of a sensitivity analysis). The main reason I tried this test
> was that the models with smallish THETA (<45 degrees or so) were
> limb-brightened in an odd-looking way, with a narrow channel down the
> centre of the jet.

This seems reasonable as a parameter-minimizing ploy, but there are
some good reasons for expecting that the emissivity laws can be
different in the two layers. It's a reasonable thing to do when
wanting to see the effects of varying other parameters one at a time
however.

>
> I propose to provide the ability to equalise spine and shear layer power
> laws (maybe also field component ratios) as an option, switched via an
> environment variable. I think I would be in favour of doing this for the
> "production" model too: what do you think?
>

I think it's simpler to have all such switches accessible via the .DAT
file, so you get to see their status when you review the inputs. I
find that the status of environment variables can be forgotten,
especially if you aren't logging out between sessions.

A.

From VM Thu Nov 21 12:24:20 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["2177" "Wed" "20" "November" "1996" "15:29:52" "+0000" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.961120151652.18901B-100000@rgosf>" "52" "Re: Models" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 2177
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA18376; Wed, 20 Nov 1996 10:30:26 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.3/8.8.0/CV-2.3) with SMTP
id KAA18428 for <abridle@nrao.edu>; Wed, 20 Nov 1996 10:30:21 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id PAA16432; Wed, 20 Nov 1996 15:29:54 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id PAA18912; Wed, 20 Nov 1996 15:29:52 GMT
X-Sender: rl@rgosf
In-Reply-To: <9611201512.AA40227@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.961120151652.18901B-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@NRAO.EDU>
Subject: Re: Models
Date: Wed, 20 Nov 1996 15:29:52 +0000 (GMT)

On Wed, 20 Nov 1996, Alan Bridle wrote:

>
> > Another test prompted by my attempts to generate a set of models at
> > various angles for comparison with the B2 sample data was to optimize with
> > the spine and shear layer power laws forced to be the same.

> This seems reasonable as a parameter-minimizing ploy, but there are
> some good reasons for expecting that the emissivity laws can be
> different in the two layers. It's a reasonable thing to do when
> wanting to see the effects of varying other parameters one at a time
> however.

I'm certainly not suggesting that we should drop the ability to keep the
parameters separate, and I suspectathat this will be necessary in at
least some other sources. I'm making 2 points:
- with 3C31, we have no evidence that the laws are different, although
they could be;
- for other angles to the line of sight and/or at larger distances from
the nucleus, the model predicts brightness distributions which are
unlike any I have seen.

> > I propose to provide the ability to equalise spine and shear layer power
> > laws (maybe also field component ratios) as an option, switched via an
> > environment variable. I think I would be in favour of doing this for the
> > "production" model too: what do you think?
> >
>
> I think it's simpler to have all such switches accessible via the .DAT
> file, so you get to see their status when you review the inputs. I
> find that the status of environment variables can be forgotten,
> especially if you aren't logging out between sessions.

>

The environment variable would be set via a shell file (I always run the program from one anyway) along with things like DOPOL and BTYPE. Would a sensible compromise be to write the values of all of the switches into the log file? I hadn't thought of this as a problem before, because the shell files actually set all of the relevant variables. The way the code is written at the moment, any switch would have to be coded as a real number, since readvars is set up to decode a string of the form

keyword var1 var2 ....

which seemed to me to be more confusing than something like

VARYSPINE T

Robert

From VM Thu Nov 21 12:24:37 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["2353" "Wed" "20" "November" "1996" "12:00:10" "-0500" "Alan Bridle" "abridle" nil "61" "Re: Models" "^From:"
nil nil "11" nil nil nil nil]
nil)
Content-Length: 2353
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA20607; Wed, 20 Nov 1996 12:00:10 -0500
Message-Id: <9611201700.AA20607@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961120151652.18901B-100000@rgosf>
References: <9611201512.AA40227@polaris.cv.nrao.edu>
<Pine.GSO.3.94.961120151652.18901B-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Models
Date: Wed, 20 Nov 1996 12:00:10 -0500

Robert Laing writes:
>
>
> On Wed, 20 Nov 1996, Alan Bridle wrote:
>

>
> I'm certainly not suggesting that we should drop the ability to keep the
> parameters separate, and I suspect that this will be necessary in at
> least some other sources. I'm making 2 points:
> - with 3C31, we have no evidence that the laws are different, although
> they could be;
> - for other angles to the line of sight and/or at larger distances from
> the nucleus, the model predicts brightness distributions which are
> unlike any I have seen.
>

All fair enough.

>
> The environment variable would be set via a shell file (I always run the
> program from one anyway) along with things like DOPOL and BTYPE. Would a
> sensible compromise be to write the values of all of the switches into the
> log file? I hadn't thought of this as a problem before, because the
> shell files actually set all of the relevant variables. The way the code
> is written at the moment, any switch would have to be coded as a real
> number, since readvars is set up to decode a string of the form
>
> keyword var1 var2 ....
>
> which seemed to me to be more confusing than something like
>
> VARYSPINE T
>

It's fine to do it in the shell file. oI was momentarily getting
muddled between what was in the shell file and was in the .DAT
file, as I sent the message while playing games with the
polarization angle calibration for AL405 in another window ...

AL405 external calibration is now done (I think), I'm just making a test image to be sure before writing you the tape. The atmosphere was kind to us and most of the antennas behaved well, too. Antenna 3 has a cryogenics problem, it was taken out of service at the end of the run and the data are noisy but normal in their mean; I have left them in the dataset for the moment but they are a candidate for expulsion. The polarization angle calibration left a little to be desired, as both calibrators are resolved and the consistency between them was only to +/- 2 degrees; I've seen better but it's always a bit shakier for runs that have to be calibrated on 3C48 and 3C138. The instrumental polarization calibration looks pretty good.

I'll send you the multisource file and the SPLITs in FITS format later today, then will start in on the six quasar runs.

Cheers, A.

From VM Thu Nov 21 12:25:19 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["936" "Wed" "20" "November" "1996" "17:43:40" "-0500" "Alan Bridle" "abridle" nil "24" "3C31 A config X band"
"^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 936
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA28276; Wed, 20 Nov 1996 17:43:40 -0500
Message-Id: <9611202243.AA28276@polaris.cv.nrao.edu>
From: abridle (Alan Bridle)
To: rperley, rl@ast.cam.ac.uk
Subject: 3C31 A config X band
Date: Wed, 20 Nov 1996 17:43:40 -0500

I've done the external calibrations and two rounds of phase-only self-cal (the first on just the core, the second on the core plus inner jet). I'm getting a 0.24 by 0.21 arc sec beam out of IMAGR with the default robustness.

Things are looking pretty good generally; we have _clearly_ separated the flaring region from the well-collimated innermost jet and counterjet, and see some nice detail in the flaring region.

As it stands, the intensity ratio between the jet and counterjet in the initial (transverse-unresolved) segment is going to give our present model some problems - it's not very large. Don't panic until we've done more self-cal and have the compact arrays added in, however. There may be some spurious symmetry from the core-only self-cal still lurking around down there.

I haven't had time to make polarization images yet but will do so overnight. I'm writing the tape to send to Robert at the moment.

A.

From VM Thu Nov 21 12:25:34 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["325" "Thu" "21" "November" "1996" "10:31:37" "-0500" "Alan Bridle" "abridle" nil "14" "3C31 tape" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 325
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA16306; Thu, 21 Nov 1996 10:31:37 -0500
Message-Id: <9611211531.AA16306@polaris.cv.nrao.edu>
From: abridle (Alan Bridle)
To: rl@ast.cam.ac.uk
Subject: 3C31 tape
Date: Thu, 21 Nov 1996 10:31:37 -0500

is on its way to you.

1) I subim from 2nd phase selfcal, + CC
2) uv dataset also from 2nd phase selfcal
3) multi-source uv dataset + cal table (SPLIT input file)
4) operators' logs
5) calibration printouts
6) CNTR, PCNTR and color display of images from 2nd phase selfcal

I have kept copies of all of this here also.

A.

From VM Mon Nov 25 13:08:08 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["308" "Mon" "25" "November" "1996" "16:07:04" "+0000" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.961125130850.1553B-100000@rgosf>" "11" "Tape" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 308
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA24984; Mon, 25 Nov 1996 11:07:14 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.3/8.8.0/CV-2.3) with SMTP
id LAA26694 for <abridle@nrao.edu>; Mon, 25 Nov 1996 11:0r:12 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id QAA01603; Mon, 25 Nov 1996 16:07:07 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id QAA02975; Mon, 25 Nov 1996 16:07:05 GMT
X-Sender: rl@rgosf
Reply-To: Robert Laing <rl@ast.cam.ac.uk>
Message-Id: <Pine.GSO.3.94.961125130850.1553B-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@NRAO.EDU>
Subject: Tape
Date: Mon, 25 Nov 1996 16:07:04 +0000 (GMT)

Just to say that the DAT etc. arrived safely today.

I see what you mean about the jet/counter-jet ratio, although further
self-cal may change things a bit. I'm not sure whether to try adding in
B+C+D all in one go, or to proceed systematically with A, A+B, etc. Any
strong feelings either way?

Robert

From VM Mon Dec 16 11:31:48 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["689" "Mon" "25" "November" "1996" "13:01:01" "-0500" "Alan Bridle" "abridle" nil "21" "Re: Tape" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 689
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA24874; Mon, 25 Nov 1996 13:01:01 -0500
Message-Id: <9611251801.AA24874@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961125130850.1553B-100000@rgosf>
References: <Pine.GSO.3.94.961125130850.1553B-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Tape
Date: Mon, 25 Nov 1996 13:01:01 -0500

Robert Laing writes:
> Just to say that the DAT etc. arrived safely today.
>
> I see what you mean about the jet/counter-jet ratio, although further
> self-cal may change things a bit. I'm not sure whether to try adding in
> B+C+D all in one go, or to proceed systematically with A, A+B, etc. Any
> strong feelings either way?
>

There may not be enough extended flux density in the A configuration model to pull all the other arrays into alignment with it simultaneously. It may therefore be better to take the second approach. Either way, all three arrays have to be recalibrated to A's positional frame, unfortunately.

A.

P.S. The 264 preprint is in the mail to you.

From VM Mon Dec 16 11:32:14 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["371" "Mon" "25" "November" "1996" "18:25:12" "+0000" "Robert Laing" "rl@ast.cam.ac.uk" nil "15" "Re: Tape"
"^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 371
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA29643; Mon, 25 Nov 1996 13:25:18 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.3/8.8.0/CV-2.3) with SMTP
id NAA28722 for <abridle@nrao.edu>; Mon, 25 Nov 1996 13:25:16 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id SAA04361; Mon, 25 Nov 1996 18:25:14 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id SAA04662; Mon, 25 Nov 1996 18:25:12 GMT
X-Sender: rl@rgosf
In-Reply-To: <9611251801.AA24874@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.961125182236.4619D-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@NRAO.EDU>
Subject: Re: Tape
Date: Mon, 25 Nov 1996 18:25:12 +0000 (GMT)

On Mon, 25 Nov 1996, Alan Bridle wrote:

>
> There may not be enough extended flux density in the A configuration
> model to pull all the other arrays into alignment with it
> simultaneously. It may therefore be better to take the second
> approach.

I fear that you are right. I'll also have to be extremely careful about
possible core flux variations.

Robert

From VM Mon Dec 16 11:35:20 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["504" "Thu" "28" "November" "1996" "12:29:15" "+0000" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.961128122310.7044B-100000@rgosf>" "12" "Preprint" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 504
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA40809; Thu, 28 Nov 1996 07:29:38 -0500
Received: from ast.cam.ac.uk.(cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.3/8.8.0/CV-2.3) with SMTP
id HAA11923 for <abridle@nrao.edu>; Thu, 28 Nov 1996 07:29:36 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id MAA12375; Thu, 28 Nov 1996 12:29:18 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id MAA07059; Thu, 28 Nov 1996 12:29:16 GMT
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.961128122310.7044B-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@NRAO.EDU>
Subject: Preprint
Date: Thu, 28 Nov 1996 12:29:15 +0000 (GMT)

Thanks for the 3C 264 preprint. From what we have done, the adiabatic
hypothesis looks rather unlikely, as does the B_parallel assumption.
I suspect that the source is rather closer to line of sight than they say,
and starts slower. But the similarity to the basal region of 3C31 is
quite striking.

Progress on A-configuration may be a bit slower than I had hoped, since
someone stole our Ultra yesterday. I'll have to do it on my machine,
which entails some difficulties with disk space.

Robert

From VM Mon Dec 16 11:35:22 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["744" "Fri" "29" "November" "1996" "19:30:13" "+0000" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.961129192123.9996A-100000@rgosf>" "18" "Progress" "^From:" nil nil "11" nil nil nil nil]
nil)
Content-Length: 744
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA29340; Fri, 29 Nov 1996 14:30:20 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.3/8.8.0/CV-2.3) with SMTP
id OAA25014 for <abridle@nrao.edu>; Fri, 29 Nov 1996 14:30:18 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id TAA00372; Fri, 29 Nov 1996 19:30:16 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id TAA10008; Fri, 29 Nov 1996 19:30:14 GMT
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.961129192123.9996A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@NRAO.EDU>
Subject: Progress
Date: Fri, 29 Nov 1996 19:30:13 +0000 (GMT)

I have now run 1 further phase-only and 2 amplitude self-cals on the A-configuration data. The phase solution did precisely nothing; the amplitude one cleaned up most of the residual rubbish near the core and the off-source rms is below 9 microJy. I am about to start adding in the other configurations. The jet/counter-jet ratio in the innermost region increased slightly after the amplitude solution, but is still well below the peak value further out. This may mean that there is a little low-velocity stuff, but that the majority of the emission is heavily beamed away on both sides.

Any idea how to combine the information from 0.225 and 0.7 arcsec images in the modelling process?

Robert

P.S. Hope you had a good Thanksgiving.

From VM Mon Dec 16 11:35:43 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["1071" "Mon" "2" "December" "1996" "08:29:41" "-0500" "Alan Bridle" "abridle" nil "28" "Re: Preprint" "^From:"
nil nil "12" nil nil nil nil]
nil)
Content-Length: 1071
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA39242; Mon, 2 Dec 1996 08:29:41 -0500
Message-Id: <9612021329.AA39242@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961128122310.7044B-100000@rgosf>
References: <Pine.GSO.3.94.961128122310.7044B-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Preprint
Date: Mon, 2 Dec 1996 08:29:41 -0500

Robert Laing writes:

> Thanks for the 3C 264 preprint. From what we have done, the adiabatic
> hypothesis looks rather unlikely, as does the B_parallel assumption.
> I suspect that the source is rather closer to line of sight than they say,
> and starts slower. But the similarity to the basal region of 3C31 is
> quite striking.
>

I was wondering how much of angle to the disk they can really have, too.
If the disk is circular in projection and the jet appears to change
character near the projected edge, then the jet should not be too far
from the plane of the sky. Stefi says they need a warp in the disk
to make it work in fact, so a critical parameter is rather arbitrary.

> Progress on A-configuration may be a bit slower than I had hoped, since
> someone stole our Ultra yesterday. I'll have to do it on my machine,
> which entails some difficulties with disk space.
>

Gawd, maybe you need to come to a nice safe country like the U.S.A.!

If you're still stuck when I've got the quasars in shape I'll take
a run at it here if you like.

A.

From VM Mon Dec 16 11:35:45 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["1502" "Mon" "2" "December" "1996" "08:35:17" "-0500" "Alan Bridle" "abridle" nil "32" "Re: Progress" "^From:" nil nil "12" nil nil nil nil]
nil)
Content-Length: 1502
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA43356; Mon, 2 Dec 1996 08:35:17 -0500
Message-Id: <9612021335.AA43356@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961129192123.9996A-100000@rgosf>
References: <Pine.GSO.3.94.961129192123.9996A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Progress
Date: Mon, 2 Dec 1996 08:35:17 -0500

Robert Laing writes:
> I have now run 1 further phase-only and 2 amplitude self-cals on the
> A-configuration data. The phase solution did precisely nothing; the
> amplitude one cleaned up most of the residual rubbish near the core and
> the off-source rms is below 9 microJy. I am about to start adding in the
> other configurations. The jet/counter-jet ratio in the innermost region
> increased slightly after the amplitude solution, but is still well below
> the peak value further out. This may mean that there is a little
> low-velocity stuff, but that the majority of the emission is heavily
> beamed away on both sides.

I had the feeling that once the symmetric stuff survived the first
phase selfcal that included significant jet emission, the sidedness
would not change much. So I think our simple picture of a high-velocity
edge becoming a slow-velocity one takes it on the chin from this new
data. I was already worried that we seemed to have sidedness increasing
ouward for a little bit even at 0.7" resolution. This simply shoves it
into the open where we can't ignore it.

>
> Any idea how to combine the information from 0.225 and 0.7 arcsec images
> in the modelling process?
>

I'm inclined to define an inner region where we model only at the 0.225"
HPBW, and an outer one where we model only at the 0.7" resolution,
and minimize the overall chi-squared. We could possibly allow some,
overlap but it might be statistically more sanitary not to do so.

A.

From VM Mon Dec 16 11:36:14 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["1337" "Mon" "2" "December" "1996" "15:40:09" "+0000" "Robert Laing" "rl@ast.cam.ac.uk" nil "33" "Re:
Progress" "^From:" nil nil "12" nil nil nil nil]
nil)
Content-Length: 1337
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA44917; Mon, 2 Dec 1996 10:40:28 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.3/8.8.0/CV-2.3) with SMTP
id KAA25839 for <abridle@nrao.edu>; Mon, 2 Dec 1996 10:40:26 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id PAA06919; Mon, 2 Dec 1996 15:40:11 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id PAA12779; Mon, 2 Dec 1996 15:40:10 GMT
X-Sender: rl@rgosf
In-Reply-To: <9612021335.AA43356@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.961202153531.12760A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@NRAO.EDU>
Subject: Re: Progress
Date: Mon, 2 Dec 1996 15:40:09 +0000 (GMT)

On Mon, 2 Dec 1996, Alan Bridle wrote:

>
> I had the feeling that once the symmetric stuff survived the first
> phase selfcal that included significant jet emission, the sidedness
> would not change much. So I think our simple picture of a high-velocity
> edge becoming a slow-velocity one takes it on the chin from this new
> data. I was already worried that we seemed to have sidedness increasing
> ouward for a little bit even at 0.7" resolution. This simply shoves it
> into the open where we can't ignore it.

Absolutely. I think that the velocity profile may need to be changed a
bit to reflect the fact that there is always a very little low-velocity
emission at the edge.

> I'm inclined to define an inner region where we model only at the 0.225"
> HPBW, and an outer one where we model only at the 0.7" resolution,
> and minimize the overall chi-squared. We could possibly allow some,
> overlap but it might be statistically more sanitary not to do so.
>

The only problem I can see with that is that we may lose a little signal
on the inner counter-jet at 0.2 arcsec. Anyway, I can easily generalise
the code to use 2 sets of maps and leave some hooks to combine them in
different ways.

I'm glad that Mary is up to full speed. I have been having similar
gardening problems (it's the loose leaf season).

Robert

From VM Mon Dec 16 11:37:19 1996
X-VM-v5-Data: ([nil nil nil nil t nil nil nil nil]
["2185" "Fri" "6" "December" "1996" "12:18:01" "+0000" "Robert Laing" "rl@ast.cam.ac.uk"
"<Pine.GSO.3.94.961206115434.21642A-100000@rgosf>" "38" "Progress" "^From:" nil nil "12" nil nil nil nil] nil)
Content-Length: 2185
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA66006; Fri, 6 Dec 1996 07:18:19 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.3/8.8.0/CV-2.3) with SMTP
id HAA26559 for <abridle@nrao.edu>; Fri, 6 Dec 1996 07:18:14 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id MAA27402; Fri, 6 Dec 1996 12:18:05 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id MAA21661; Fri, 6 Dec 1996 12:18:03 GMT
X-Sender: rl@rgosf
Message-Id: <Pine.GSO.3.94.961206115434.21642A-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@NRAO.EDU>
Subject: Progress
Date: Fri, 6 Dec 1996 12:18:01 +0000 (GMT)

I have a fairly presentable A+B map now. I was hampered a bit by the "ears" which appeared on either side of the core in the B-array data. I am sure these are spurious, and suspect that they result from a point-source A+P selfcal which was done on the B-array data before they got to me. They aren't visible in the A-array data at all. I have reduced their amplitude a lot by a first pass amplitude selfcal on the combined dataset, together with some care with clean boxes. I think that I can probably get rid of them completely in further passes. I needed to add 2 mJy to the core in the B-array dataset: I may try the trick of splitting the dataset and reimaging A and B configurations separately to check that the core flux is the same in both after amplitude correction, but the model is dominated by the core, so this may not be nearly as important as for the more compact arrays.

I played with the robustness parameter in IMAGR a bit, but you may be able to advise. What I have done is to tweak it a little from its default value in order to keep the resolution close to that of the original A-configuration dataset with the default. This appears to do a pretty good job (I think I had the B-array data a bit over-weighted at one stage). Do you have any advice on the use of ROBUST as opposed to the REWEIGHT parameter in DBCON?

It looks as if I can handle all of the reduction on my machine; if not, I have access to one with significantly more disk-space (VTESS at full resolution will need 4096 x 8192). Provided nobody steals it, of course.

The RGO "privatization" has now been put on hold for "complex legal and financial reasons", so we are back in a very csnfused situation (not to anyone's surprise: PPARC almost always charges into things without bothering to find out whether they are legal or affordable). Then there will almost certainly be a change of government, to one that does not believe in selling off everything in sight to the highest bidder. This is probably a good thing, although the mess will last longer. I wish that the right wings of the Conservative and Republican parties would find an uninhabited planet and colonise it.

Robert

From VM Mon Dec 16 11:37:25 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["3134" "Fri" "6" "December" "1996" "09:49:24" "-0500" "Alan Bridle" "abridle" nil "66" "Re: Progress" "^From:" nil nil "12" nil nil nil nil]
nil)
Content-Length: 3134
Received: by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA77320; Fri, 6 Dec 1996 09:49:24 -0500
Message-Id: <9612061449.AA77320@polaris.cv.nrao.edu>
In-Reply-To: <Pine.GSO.3.94.961206115434.21642A-100000@rgosf>
References: <Pine.GSO.3.94.961206115434.21642A-100000@rgosf>
From: abridle (Alan Bridle)
To: Robert Laing <rl@ast.cam.ac.uk>
Subject: Re: Progress
Date: Fri, 6 Dec 1996 09:49:24 -0500

Robert Laing writes:

> I played with the robustness parameter in IMAGR a bit, but you may be able
> to advise. What I have done is to tweak it a little from its default
> value in order to keep the resolution close to that of the original
> A-configuration dataset with the default. This appears to do a pretty
> good job (I think I had the B-array data a bit over-weighted at one
> stage). Do you have any advice on the use of ROBUST as opposed to the
> REWEIGHT parameter in DBCON?

The multi-configuration behavior of ROBUST is still pretty much
unknown. With 3C353 we had done a great deal of the imaging using
MX before IMAGR came along so we kept it that way for the 8 GHz
data. We had also more-or-less matched the observing time to the
constant-brightness-sensitivity criterion so there wasn't much
juggling needed in DBCON either.

My own first try at this for multiconfiguration imaging is
to use DBCON REWEIGHT to get roughly equal surface-brightness sensitivity
then start IMAGR with ROBUST = 0. This gives the image some protection
against the "sinusoidal instability" in unofirm weighting. The
optimum is thought to be somewhere around the mid-range in ROBUST,
but the details themselves depend on the coverage. While calibrating,
I don't think it matters too much, but I think it will be worth
experimenting with ROBUST = 0 +/- 1 once you are happy that the
inter-array calibration is o.k.

>
> It looks as if I can handle all of the reduction on my machine; if not, I
> have access to one with significantly more disk-space (VTESS at full
> resolution will need 4096 x 8192). Provided nobody steals it, of course.

What's the story there? Break-and-enter, or a colleague with a big
project at home?

>
> The RGO "privatization" has now been put on hold for "complex legal and
> financial reasons", so we are back in a very confused situation (not to
> anyone's surprise: PPARC almost always charges into things without
> bothering to find out whether they are legal or affordable). Then there

> will almost certainly be a change of government, to one that does not
> believe in selling off everything in sight to the highest bidder. This is
> probably a good thing, although the mess will last longer. I wish that
> the right wings of the Conservative and Republican parties would find an
> uninhabited planet and colonise it.
>

They were trying for Mars, I think, until the canal crowd started pelting
them with microbe-infested rocks.

NGC315 is turning out a lot less simple than it looked at lower
resolution. The diffuse stuff looks very like 3C31 (narrow at
first, then rapid expansion and recollimation. Hence the basic story
in my antique collimation plots. But there's a good fraction of the
flux in a group of high-brightness knots running back and forth
across the jet in the rapid-expansion region. They are really going
to bugger the chi-squared for modeling, much worse than the "arcs"
in 3C31. Looks a bit like the thing entrained a string of pearls
where it started expanding. So our "simple test case" is certainly
not going to co-operate.

A.

From VM Mon Dec 16 11:37:27 1996
X-VM-v5-Data: ([nil nil nil nil nil nil nil nil nil]
["1659" "Fri" "6" "December" "1996" "15:49:55" "+0000" "Robert Laing" "rl@ast.cam.ac.uk" nil "43" "Re: Progress"
"^From:" nil nil "12" nil nil nil nil]
nil)
Content-Length: 1659
Received: from cv3.cv.nrao.edu by polaris.cv.nrao.edu (AIX 3.2/UCB 5.64/4.07)
id AA76043; Fri, 6 Dec 1996 10:50:12 -0500
Received: from ast.cam.ac.uk (cass41.ast.cam.ac.uk [131.111.69.186]) by cv3.cv.nrao.edu (8.8.3/8.8.0/CV-2.3) with SMTP
id KAA28949 for <abridle@nrao.edu>; Fri, 6 Dec 1996 10:50:10 -0500 (EST)
Received: from rgosf.ast.cam.ac.uk by ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id PAA13341; Fri, 6 Dec 1996 15:49:59 GMT
Received: from localhost by rgosf.ast.cam.ac.uk (SMI-8.6/SMI-SVR4)
id PAA21849; Fri, 6 Dec 1996 15:49:56 GMT
X-Sender: rl@rgosf
In-Reply-To: <9612061429.AA77320@polaris.cv.nrao.edu>
Message-Id: <Pine.GSO.3.94.961206154647.21843B-100000@rgosf>
Mime-Version: 1.0
Content-Type: TEXT/PLAIN; charset=US-ASCII
From: Robert Laing <rl@ast.cam.ac.uk>
To: Alan Bridle <abridle@NRAO.EDU>
Subject: Re: Progress
Date: Fri, 6 Dec 1996 15:49:55 +0000 (GMT)

On Fri, 6 Dec 1996, Alan Bridle wrote:

>
> My own first try at this for multiconfiguration imaging is
> to use DBCON REWEIGHT to get roughly equal surface-brightness sensitivity
> then start IMAGR with ROBUST = 0. This gives the image some protection
> against the "sinusoidal instability" in unofirm weighting. The
> optimum is thought to be somewhere around the mid-range in ROBUST,
> but the details themselves depend on the coverage. While calibrating,
> I don't think it matters too much, but I think it will be worth
> experimenting with ROBUST = 0 +/- 1 once you are happy that the
> inter-array calibration is o.k.

I haven't tried ROBUST outside the range +/-1: current best guess is -0.5
for A/B.

>
>
> What's the story there? Break-and-enter, or a colleague with a big
> project at home?

The former. Computer theft is rife around the university at the moment.
We suspect that most machines end up in Eastern Europe. PC chips are
almost as good as cash.

> NGC315 is turning out a lot less simple than it looked at lower
> resolution. The diffuse stuff looks very like 3C31 (narrow at
> first, then rapid expansion and recollimation. Hence the basic story
> in my antique collimation plots. But there's a good fraction of the
> flux in a group of high-brightness knots running back and forth
> across the jet in the rapid-expansion region. They are really going
> to bugger the chi-squared for modeling, much worse than the "arcs"

> in 3C31. Looks a bit like the thing entrained a string of pearls
> where it started expanding. So our "simple test case" is certainly
> not going to co-operate.
>

This I must see.

Robert