Subject: Re: New version
From: Robert Laing <rlaing@eso.org>
Date: Tue, 8 Nov 2005 16:48:49 +0100
To: Bill Cotton <bcotton@nrao.edu>
CC: Alan Bridle <abridle@nrao.edu>, jcanvin@physics.usyd.edu.au

Quoting Bill Cotton <bcotton@nrao.edu>:

> Robert,
>
> It's looking pretty close. The only substantive comment I have is
> that there is an analagy with 3C31 that could be commented on. The
> size scale in NGC315 for all the various jet features is substantially
> larger than in 3C31 for which there is similar linear resolution.
> However, the RMS RM fluctuations are 10x lower in NGC315. If the RMS
> is proportional to the mean plasma density (or even close) then the
> IGM around NGC315 is much more tenuous than 3C31. If the various
> flaring, recollimation etc, are largely determined by the external
> medium, then the apparent difference in external density between 3C31
> and NGC315 could explain the difference in size scale of the jet features.

Dear Bill

Yes, I agree. In fact, the observed X-ray densities are very different too. The
only question is whether to put a short reference here or to reserve it for the
paper on conservation-law analysis (where it will get heavily emphasised).

What do you (and others) think?

> Minor comments:
> - Introduction. Most of the discussion of features is in terms of
> angular distance from the core which helps identify them on figures.
> However, the the list in the introduction (ii) the distances are given
> in kpc. It might be worth giving angular distances parenthetically.

Good idea. This is a perennial source of confusion.

> - Sect 4.3. The opening of this section is partially redundant with
> Section 4.2, 3rd paragraph. A backwards reference to the tomographic

> technique may be sufficient.

Will tweak.

Thanks

Robert

Subject: Revised version of model paper
From: rlaing@eso.org
Date: Mon, 18 Jul 2005 14:01:06 +0200 (CEST)
To: James Canvin <jcanvin@physics.usyd.edu.au>, Bill Cotton <bcotton@nrao.edu>, Alan Bridle <abridle@nrao.edu>

Dear James, Bill and Alan

Here is a revised version of the model paper, incorporating changes prompted by Paddy's comments, essentially as discussed. The new Fig 5 is as produced by Bill a few days ago, changed slightly in style to match the others. The main changes to the text are a new paragraph in Section 3.2 expanding on the issue of bends, and some alterations referring to the new figure. A suggested reply with more detail is attached.

Please let me know if you are happy to resubmit this version. [Alan - you will probably get this on your return; I think that the changes are all more-or-less as agreed, so I trust that you won't mind our going ahead if you don't see this immediately.]

Cheers

Robert

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We thank Paddy Leahy for his helpful report. We have modified the paper to take account of his comments (see below) and hope that the revised version will be acceptable for MNRAS.

Regards

Robert

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REFEREE'S REPORT (our comments indented)

This is an excellent paper, with very careful modelling of excellent observational data. It should be published almost as it stands.

My one whinge is that it is a bit of a cop-out to consider such a small section of such a long jet (especially given the title of the paper: "A model of the flaring region of the radio jets..." would be more accurate).

We define the modelled region in the first sentence of the abstract, so we do not think that any serious confusion will result.

It would be nice if you could be a bit more quantative about the problems of extending the analysis: what is the actual angle of the "small" bend that prevents further analysis? Can you quantify the errors in the modelling that the bend would produce? Can you not take such a minor perturbation into account in any way?

We have thought about this issue and plan to address it in a later study. The reason that we have not attempted it thus far is that there are technical problems in "straightening out" the jets in order to apply our axisymmetric model and some doubts about the validity of the assumption of intrinsic asymmetry after the bends (e.g. do both jets bend by the same amount perpendicular to the plane of the sky?). For NGC315, we can probably solve the problem, since the jets appear to be fast enough at 70 arcsec that we should be able to fit for the angle to the line of sight independently after the bends, which look quite symmetrical (at least in the plane of the sky). We have added the following paragraph to Section 3.2 to explain this, together with a promisory sentence in Section 6.2.

"The assumption of axisymmetry is clearly violated in NGC\,315 at $\approx$70\,arcsec from the nucleus. Both jets bend clockwise by $\approx$5° (in projection) at this distance, but we do not know the magnitude of any associated bends in the orthogonal direction. Our modelling could be extended to larger distances provided that the jets are indeed antiparallel and intrinsically identical after the bends. This seems plausible from their appearance in projection and we could fit independently for the angle to the line of sight after the bend if necessary. The brightness and polarization structures of the jets are qualitatively consistent with an extrapolation of the fitted model described below, so it is likely that this approach would succeed. It adds significant complexity to the modelling procedure, however, and also requires careful justification of the assumption of intrinsic symmetry at large distances. For these reasons, we defer this analysis to a later paper."

Furthermore, it is intriguing that the jet shows a second flare on large scales, as noted in passing in Sec 5.2. It would be very much worthwhile to comment on the implications of such a double scale for the various models of flaring regions in FR I jets. If you do this in one of the associated papers (Laing et al 2005 or Worrall et al in prep), at least an appropriate forward reference would be useful.

We do not think that either this paper or either of the two associated studies adds a great deal to the discussion of this issue in early references (Willis et al. 1981; Bridle 1982).The second expansion is unusual for FRI jets, and it is unclear whether it occurs at all in the counter-jet. It is not accompanied by significant brigtening. We doubt, therefore, that there is much relevance to the very common flaring phenomenon on small scales.

We have, however, added a reference to Bridle (1982), which has further discussion of the outer flare.

Other minor comments:

Sec 2.1 para 2: Be kind to the reader and quote the size of the source and of the modelled region in the same units (i.e. both in kpc or both in arcsec)!

We now give both in consistent units (arcsec and kpc)

Sec 3.3.1 Defining equation for the offset A has the wrong sign, since you want A to be positive.

Indeed. Corrected.

Fig 5 doesn't really do its job as the main jet is so burnt out that you can't see the knot in the main jet that is supposed to sit opposite the minimum in the counter-jet. Could you use a different greyscale for the right-hand half of the picture, or superpose contours to show what happens in the burnt-out regions?

We agree that this figure was not satisfactory. After some experimentation, we decided to show contours for the model and grey-scales with different levels for the main and counter-jets. We think that this makes the point much more effectively. Captions and text have been modified to reflect this change.

Section 3.3.4 vs 5.6: The symbol f is used for two quite different functions, please change one.

We have changed the first instance to h.

Section 5.6/Fig. 13(d): You imply that the adiabatic approximation works OK in the "innermost region", but we can't tell because the adiabatic model lines are off the top of the plot in that region! Given the gross discrepancy between model and inferred emissivity, it might be a better plan to plot the gradient of the emissivity/distance relation, rather than the emissivity itself, to allow a genuine *local* comparison of model & inferred data.

We prefer not to make the comparison for the inner region. The reason is that the model slope is almost unconstrained (the index E_in has no lower limit and an upper limit of 4.0). Although we made this point in the text, we did not do so forcefully enough. It now reads:

"In the innermost region, where the fit to the counter-jet is poor, the slope E_in of the emissivity variation is essentially unconstrained (Section 5.4 and Table 3). Everywhere else there is a clear difference: the emissivity predicted by the adiabatic approximation falls more rapidly than that derived from the free model."

We now show the adiabatic model emissivity curves with two different normalizations to facilitate comparison over the whole range where out models are well constrained.

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Other minor changes, for clarity

Section 1, para. 4   We referred to "turbulent amplification" of the magnetic field. The word "turbulent" is gratuitous and possibly misleading, so we have removed it.

Section 2.1, bullet 4 We now say that "the intensity ratio is significantly larger than unity over a significant area." as jets which decelerate to sub-relativistic speed should have a ratio close to 1 at large distances from the nucleus (e.g. B2 0326+39 as modelled by CL).

Section 3.4. The description of the derivation of the "noise level" was not precisely correct, as we implied that we used a difference image for U as well as I and Q. This has been corrected.