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1 March 1981

Dr. A. Dalgarno,
Letters Editor,
The Astrophysical Journal,
Center for Astrophysics,
60 Garden Street,
Cambridge, MA 02138

Dear Dr. Dalgarno,

We enclose a revised version of the paper VLA OBSERVATION OF RADIO/OPTICAL KNOTS IN 3C277.3 = COMA-A. We are pleased to note the generally favorable report of the referee and have responded to all of his (her) substantive comments except (5), which we prefer to defer until the new observations referred to at the end of the paper are in hand.

We regret that we cannot shorten the paper as requested. The number of manuscript pages devoted to the text of the paper is only seven, and we therefore regard shortening the text by four pages as out of the question. We therefore hope that in view of the favorable referee's report the paper may be accepted for Part 1 of the journal, and have included an extra Figure with this in mind. This Figure was omitted from the earlier version of the paper in the interests of meeting your page limit for the Letters.

We are in fact puzzled by the page length your staff have estimated for the paper, as it is actually shorter than one you accepted for Part 2 earlier this year (Bridle et al., COLLIMATION OF THE RADIO JETS IN 3C31, Ap.J. Letters, 241, L145).

Yours sincerely,

Alan H. Bridle

Edward B. Fomalont

Edward B. Fomalont

THE ASTROPHYSICAL JOURNAL

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February 18, 1981

Dr. Alan H. Bridle
National Radio Astronomy Observatory
VLA Program
P.O. Box O
Socorro, NM 87801

Dear Dr. Bridle:

I am returning your paper, VLA OBSERVATION OF RADIO/ OPTICAL KNOTS IN 3C277.3 = COMA-A, with a copy of the referee's comments. I will be happy to accept a revised abbreviated version for publication in the Astrophysical Journal Letters.

I would like to remind you that the present length of your paper is 5 1/3 journal pages (our limit is 4 journal pages) and will need to be shortened by at least 4 typewritten pages or 25%.

Yours sincerely,

A. Dalgarno/mb

A. Dalgarno
Letters Editor

AD:mb
Enclosures

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for THE AMERICAN ASTRONOMICAL SOCIETY

The results presented in the manuscript "VLA Observations of Radio/ Optical Knots in 3C277.3 = COMA-A" by Bridle et al are both new and important enough to warrant publication in the Astrophysical Journal.

My specific comments on the manuscript are:

(1) Fast publication as a Letter to the Editor is justified. However some of the text (such as in Section IV) tends to more verbose than necessary. It is possible to shorten the text and still retain the salient features of the discussion.

(2) A number of suggested small text and caption changes are indicated on the manuscript.

(3) Although there is a reference on page 4 line 8 comparing source emission to the noise level in the map, I could not find any mention, either in Section II or in the figure captions, of the value of the estimated rms noise level (in mJy per beam area) in the maps.

(4) I presume the fact that the Figure 1 enclosed with the manuscript has no identification of which map is 1(a) and which map is 1(b) will not present any problem. (This can certainly be figured out from the text of the manuscript or from the caption headings.)

(5) Sentance two in paragraph four on page 9 states that "...constraints on the thermal densities within the flow from studies of the optical emission lines and of the polarization properties of the source could distinguish between models of the second and third kind." Is it not possible to place such constraints on these models using both the authors own radio polarization measurements and the studies of OIII emission lines (see paragraph 2 on page 6 and paragraph 2 on page 8)? Could an estimate to the thermal gas density from the assumption of depolarization of the 4885 MHz radiation by Faraday dispersion be used as a meaningful discriminator?

(Please type your report on this sheet. Use other side if necessary.)

3C 277.3

magnitude of opt. knot at K1 } as measured for paper III $m_O = 18.6$

$m_E = 20$

– remeasured Oct 24/80 $m_O = 18.8$
$m_E =$ not there

NOTE
– position given for radio knot on pg. 5 of preprint is off our optical position by $0^s.05$ ~~our combined~~ sum of errors is $0^s.03$. Is position on pg 5 correct?

Interoffice

National Radio Astronomy Observatory

Very Large Array

To: Ed Fomalont, John Palimaka, Tony Willis

From: Alan Bridle

Subject: 30 October 1980 draft of 3C277.3 paper

Enclosed is the draft that Ed and I went through together this week at the VLA. It includes responses to John's and Tony's comments as well as a few other alterations.

Perhaps the main point is that this is already at the maximum length that could be accepted in Ap.J. Letters. Figures la and lb will be combined into one side-by-side diagram before submission. The letter codes A,B,C,D,Kl,K2 also still have to be added to Fig.la.

We have shortened the description of the observations to the barest minimum on p.3 to allow room for the paragraph on polarization-OIII anticorrelation on p.8.

We have recomputed the parameters for the core in Table I based on a more conservative upper limit for the long axis of the core source.

I am trying to get confirmation of the B=19.5 estimate on p.5 from Harvey Butcher. There may need to be some rewording depending on what he comes up with. John is also re-estimating the magnitudes of the knot from the POSS prints.

The comparisons with 3C388 requested by Tony have not all been included, partly because of length and partly because they branch off the main thrust of the paper. We could make a little more of the lobe morphologies, etc. if we had the low-resolution maps in the paper, as we originally had intended when we were going ahead with radio-only publication. If the optical paper grows beyond Ap.J.Letter length we could allow ourselves the luxury of more diagrams and more discussion. But if they keep to Ap.J.Letter length we will have to put up with not saying everything that we know.

In particular, the comparison with 3C388 could be used to show that the lobe morphology does not depend on which side of a source exhibits the jet (the South lobe of 3C277.3 resembles the east lobe of 3C388, while the north lobe of 3C277.3 resembles the west lobe of 3C388). Both Roger Blandford and Martin Rees have suggested that one-sidedness in jets might correlate with lobe morphology if the side-to-side differences were due to differing jet efficiencies. These two sources would not support that. We may do well to discuss this sort of thing in a larger sample anyway, but it might be included if we do enlarge this paper at the next draft.

I think we may now be ahead of the optical group in their preparation, but will rely on Tony to keep the time-scales in lock.

Interoffice

National Radio Astronomy Observatory

Very Large Array

To: Harvey Butcher, Ed Fomalont, George Miley, Tim Heckman, John Palimaka, Wil van Breugel and Tony Willis.

From: Alan Bridle

Subject: Redraft of the 3C277.3 radio paper, 8 November 1980

I enclose a revised draft of the radio paper which incorporates the changes made by the optical flux-density estimates for knots K1 and K2 that were in the revised optical paper. The numbers change a little from our earlier draft, and we can phrase the statements about knot K2 a little differently. Otherwise the thrust of the paper is unchanged.

We are going in circles with notation for the features by changing to each others' notations in successive drafts. The radio group originally called the core "A", but changed it to "C" to match the optical group's first draft. Now the optical group has changed to the original radio notation. I propose that we stick to the notation in the first optical draft, so that the core is "C" and the broad radio feature in the southern lobe is "A". We seem to agree that the knots are K1 and K2 now.

Harvey and Wil told me that the "Coma-A" designation was used by the optical group because they saw it written on Ed Fomalont's copy of the radio map. Ed and I agreed to use it because we thought the optical group wanted it. It now appears that none of us knew why this little-used name got attached to the source, and thought we were placating the other group. In fact it is a bad name for the source because 3C277.3 is a more recognisable name to radio astronomers and because Coma-A suggests that the source might be in, rather than behind, the Coma Cluster. I suggest that we drop the name Coma-A from both papers and adopt 3C277.3=1251+278 as the primary name for the source, to be shortened to 3C277.3 throughout most of the papers.

The radio draft has been trimmed so that it is just within the maximum page length permitted by Ap.J.Letters (Dalgarno is very tight on this these days). In doing so we have omitted low-resolution maps which show the lobe shapes well, and which give more convincing evidence for the weak polarized signal along the southern edge of the northern lobe. The optical draft appears to be a little over the Ap.J.Letter limit. If we are not going to keep both to Ap.J.Letter length, we could usefully expand the radio paper to show the lower-resolution maps and to expand the discussion in places. Could we decide on this publication strategy soon ? I marginally prefer keeping the papers to Ap.J.Letter length.

8 November 1980

George

Some detailed comments on the draft optical paper brought here by Harvey and Wil:-

p.4, l.4. Why p.a. 160°? The initial p.a. (core to K1) is 154°.

l.10. Goodson et al. is 1979, not 1978, and is missing from references.

p.6, l.6. We do point out the anticorrelation between radio polarization and emission lines in our paper (p.8). Surely the issue is not whether the depolarization is all thermal or all field-ordering/beam-smearing, but how much of each. Given the size of the knots and of our beam, I should be surprised if there is no disordering or beam depolarization.

l.21. Our fig. 1 has been labelled in CV to match your original fig. 1, i.e. the core source is C". Don't relabel your figure!

p.7, l.5 p runs from 5 to 35% over this region. This is best represented by our lower-resolution map, excluded from our present draft to keep it within Ap.J. Letter limits. We'll include it if we decide not to go to Ap.J. Letters

l.8 Significant

l.10 2%

l.2 from end NGC 7385.

p.10 l.9 E_{min} for the bright components on the jetted side comes to ~ 10^{57} ergs. I presume you are estimating the diffuse contribution to get 10^{58} ergs. This discrepancy with our Table I should probably be clarified.

p.10 general. $v \sim 300$ km.s^{-1} and equipartition requires an outflow rate of $\gtrsim 160/\varepsilon\ M_\odot\,yr^{-1}$. If this were maintained for the "kinematic age" you would need a total outflow of $\gtrsim 1.3/\varepsilon \times 10^{10}\ M_\odot$. Unless $\varepsilon \sim 1$ this seems excessive, and may cast some doubt on the equipartition assumptions and/or the kinematic age.

In your (4), l.3, should be $\gtrsim 10^8$ yr.

References Fomalont et al. (1980) should be Bridle, A.H., Fomalont, E.B., Palimaka, J.J., and Willis, A.G. (1981).

Best wishes

Alan

Blob K2 [with opr.]

Peak 8.3 mJy at ($+0^s.18$, $-7''.64$) ⇒ $12^h 51^m 46^s.46$, $27° 53' 41''.8$

Sep. from core = $7''.72$ (8.3 kpc) in p.a. 163° (2.56×10^{20} m)

FWHM = $1''.65 \times 0''.94$ ⇒ sizes $1''.1 \times 0''.8$

Int. flux. from ord. summ = 19 mJy [1.56×10^{23} W.Hz^{-1}]

↑ Difficult to detach from bridge emission

Take $\alpha = 0.75$ (Miley et al.)

$\nu_{min} = 10$ MHz, $\nu_{max} = 10^9$ MHz.

$$\Rightarrow \begin{aligned} L &= 6.42 \times 10^{34} \text{ W} \\ E_{min} &= 1.16 \times 10^{48} \text{ J} \\ B_{eq} &= 7.48 \times 10^{-5} \text{ gauss} \\ U_{min} &= 5.23 \times 10^{-11} \text{ J.m}^{-3} \\ nT &= 1.32 \times 10^{12} \text{ K m}^{-3} \equiv 1.32 \times 10^{6} \text{ K cm}^{-3} \end{aligned}$$

$$\begin{aligned} \tau_{4885} &= 7.41 \times 10^{5} \text{ yrs} \\ \tau_{6.7 \times 10^8} &= 2.00 \times 10^{3} \text{ yrs} \end{aligned}$$

$\frac{SEPN}{c} = 2.70 \times 10^{4}$ yrs ⇒ $\tau_{6.7 \times 10^8}$ if $B = 1.3 \times 10^{-5}$ gauss

USING NEW OPT. FLUXES
FOR K1, K2
7 Nov 80

$L = \varepsilon U A v$

Knots $U_{min} = 3.2\times10^{-11}$ J/m³ (K1), 5.2×10^{-11} J/m³ (K2) $\Big\}$ $\bar{U}_{min} = 4.2\times10^{-11}$ J/m³

$B_{eq} = 5.8\times10^{-5}$ gauss (K1), $= 7.5\times10^{-5}$ gauss (K2) $\Big\}$ $\bar{B}_{eq} = 6.7\times10^{-5}$ gauss

$\pi R^2 = A = \pi(0.43\ \mathrm{kpc})^2 = 5.53\times10^{38}\ \mathrm{m^2}$

$L = 4.6\times10^{35}\ \mathrm{W} \Rightarrow v \gtrsim \frac{L}{\epsilon U A} = \frac{4.6\times10^{35}}{4.2\times10^{-11}\times5.53\times10^{38}\varepsilon} = \frac{1.98}{\varepsilon}\times10^{7}\ \mathrm{m/s}$

If $v \sim 300\ \mathrm{km.s^{-1}}$, need $U \gtrsim \left[\frac{4.6\times10^{35}}{4.2\times10^{-11}\times5.53\times10^{38}\times\varepsilon\times3\times10^{5}}\right] U_{min}$

$$\gtrsim \left(\frac{66}{\varepsilon}\right)\times U_{min}$$

$$\gtrsim 2.77\times10^{-9}\ \mathrm{J/m^3}. \quad (E \gtrsim 7.3\times10^{49}\ \mathrm{J})$$

For low-field models, this needs $B_{knot} \lesssim 2.8\times10^{-6}$ gauss

Or $U_{th} = 2.73\times10^{-9}$ J/m³

At $v = 3\times10^{5}$ m/s, $U = 2.73\times10^{-9}$ J/m³ $\Rightarrow \rho = 6.07\times10^{-20}$ kg/m³
$= 6.07\times10^{-26}$ kg/cm³
$\equiv 36.6$/cc!!

$\dot{M} = \rho A v = 6.07\times10^{-20}\times5.53\times10^{38}\times3\times10^{5} = 1.00\times10^{25}$ kg/s
$= 5.06\times10^{-6}\ M_\odot/\mathrm{s}$
$= 160\ M_\odot/\mathrm{yr}$.

Blob K1
[with opt. data]

Peek 5.2 mJy at $(+0^s.21, -5''.62)$ ⇒ $12^h 51^m 46^s.49 \pm 0^s.01$ $27° 53' 43''.8 \pm 0''.1$

Goodson et al. opt. $12\ 51\ 46.54 \pm 0^s.02$ $27° 53' 43''.8 \pm 0''.5$

Sep. from core = $5''.83$ (6.3 kpc) in p.a. 154° [1.94×10^{20} m]

FWHM = $2''.12 \times 0''.927$ ⇒ size $1''.7 \times 0''.8$ (1.83×0.86 kpc)

Int. flux from ord summ. = 14 mJy [1.15×10^{23} W.Hz^{-1}] $p \leq 2\%$.

Take $\alpha = 0.56$ [Miley et al.]

$\nu_{min} = 10$ MHz, $\nu_{max} = 6.7 \times 10^8$ MHz ⇒ 10^9 MHz

⇒ $L = 2.77 \times 10^{35}$ W
$E_{min} = 1.08 \times 10^{48}$ J
$B_{eq} = 5.82 \times 10^{-5}$ gauss
$U_{min} = 3.16 \times 10^{-11}$ J.m^{-3}
$nT = 7.99 \times 10^{11}$ Km^{-3} ≡ 7.99×10^5 K cm^{-3}

$\tau_{4885} = 1.08 \times 10^6$ yrs
$\tau_{6.7 \times 10^8} = 2.91 \times 10^3$ yrs

$\frac{SEPN}{c} = 2.05 \times 10^4$ yrs $= \tau_{6.7\times10^8}$ if $B = 1.6 \times 10^{-5}$

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Westerbork, Oct. 20, 1980.

onze referentie:
uw referentie:

Dear Alan,

I was dismayed to get your telex this morning and learn that my Coma A suggestions had disappeared into the "black hole" of the mail! I am sending you another version of that paper as my final comments will refer to that anyway. Some major points are –

1/. The radio and optical papers should have a common Hubble constant. GKM and I suggest a compromise of 75. In my version I give powers and luminosities for both $H_0 = 75$ & 100.

Get the optical guys to use 100h.

2/. When comparing different sources I think we should only compare 5 GHz radio luminosities. The integrated luminosities of some components that are intercompared are known poorly, if at all!

✓

3/. We should compare 3C 277.3 to 3C388 – the two sources are very similar in many respects.

if keep it brief. M87 better.

4/. If you use the Ekers et al. reference at the end of the paper, consult with Ron for his permission since that work is only in a pre-preprint stage!

Cheers,
Tony

Bijlage(n):