3C205 - A SOURCE WITH EXTRAORDINARY ALIGNMENT AND A VLBI HOTSPOT

C.J. Lonsdale
Nuffield Radio Astronomy Laboratories, Jodrell Bank
P.D. Barthel,
Sterrewacht te Leiden, Leiden

High resolution maps of 3C205 using MERLIN and the European VLBI network (EVN), some of which are shown in Fig.1, reveal unusual characteristics in this high redshift ($z = 1.534$) source. The most striking of these are as follows:

1) The hotspots A and B, and the core C are aligned to within 0''.05 (at the hotspot), as measured on the MERLIN 6 cm map.

2) The compact feature in the southern hotspot (A_1) has projected dimensions of $\sim$0''.03 x $\lesssim$0''.015 (see Fig.1d). The corresponding minimum internal energy density of this feature is $\gtrsim 2.3 \times 10^{-6}$ erg cm^{-3}.

3) There is a continuous zig-zag ridge in the southern component, which starts with a definite spur of emission extending in a south-east direction from the compact feature A_1 (see Fig.1b). The magnetic field in A_1 is in approximately the same position angle as this spur and the VLBI elongation, which both point towards a bright secondary peak in the southern lobe (1a and 1b).

It is possible to put constraints on specific models, using these observations, which are more severe than hitherto. For example, briefly consider the standard beam model, in which the jet thrust must balance the hotspot internal pressure x area (in the hotspot frame of reference). Due to the high power of the hotspot, and the inferred small diameter of the beam, it is necessary that the beam be fast and light, and that the efficiency of energy conversion in the hotspot ε approach unity. Acceptable numbers would be $v_j \doteq 0.8c$, $\varepsilon = 0.7$. If the beam is required to power the entire lobe at its present luminosity, then $\varepsilon \sim 1$ otherwise the hotspot would be bigger.

A second important question concerns the confinement of the compact VLBI scale hotspot A_1. If it is unconfined, then expansion losses are presently running at $\sim 10^{47}$ erg s^{-1} (internal sound speed $c/\sqrt{3}$). Conversely, if dynamical (ram) pressure is confining the hotspot, external medium densities of $n > 10^{-2}$ cm^{-3} are required. The apparent morphological

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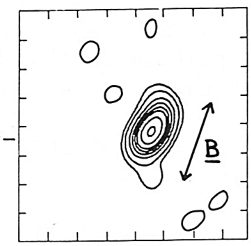
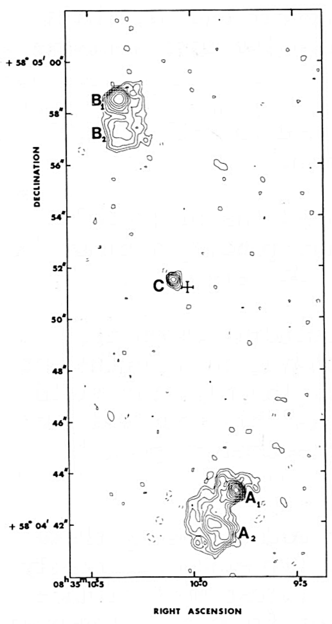
link between A_1 and A_2 (item 3 above) further complicates this issue, since it suggests that A_2 is powered by outflow from A_1. If this is the case, the fact that A_2 contains $\sim 10^{59}$ ergs in visible energy sets a lower limit on the time taken for its formation ($\sim 10^6$ yrs), and an upper limit on the velocity of A_1 ($\sim 0.015c$). At such speeds, ram pressure balance requires an external medium density $n > 1\ cm^{-3}$. The existence of filaments of such dense material >40 kpc from the nucleus is not ruled out by current data as far as we know, and if they are present, one might expect detectable optical emission to occur near A_1.

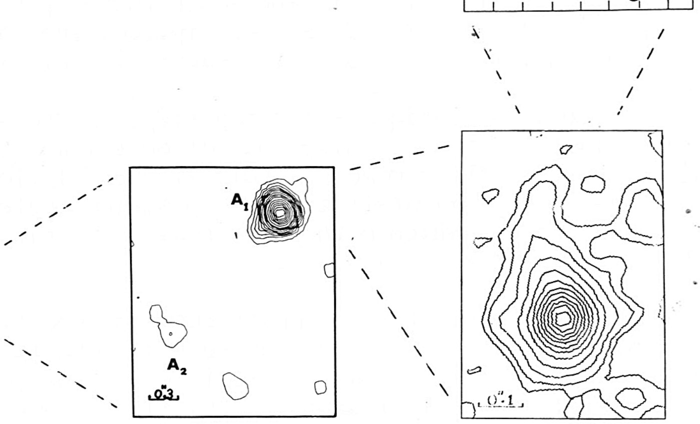
Many further constraints are possible for the beam model and other models, which are meaningful only because the parameters of 3C205 are so extreme.

FIG. 1

1d 3C 205 component A_1 (peak). EVN 1612 MHz 0.025" resolution. The magnetic field direction B is inferred from published data







1a 3C 205 MERLIN 1666 MHz, 0.25" resolution (1" = 5 kpc for H_o = = 75 km s^{-1} Mpc^{-1}, q_o = 0.5)

1b 3C 205 southern lobe, 5 GHz, 0.18" resolution.

1c 3C 205 component A_1; MERLIN 5 GHz, 0.1" resolution.