THE QUASAR JET 4C 32.69 at 1.4 GHz

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One of the most luminous radio jet sources known is 4C 32.69, identified with a z=0.67 QSO. It has previously been mapped at 5 GHz by Potash and Wardle (1980, PW hereafter). Here a 1.4 GHz VLA map of comparable resolution is presented and compared to the earlier map.

Figure 1 shows the source at 1.7" resolution with contours at 1, 2, 4,..., 64, 90% of the peak brightness of 57 mJy/beam. Apart from the prominent jet, the source has a typical high-luminosity-double morphology. Especially interesting is the bridge of emission spanning the outer hotspots and apparently surrounding the jet. Lower resolution maps show no sign of emission extending out beyond the hotspots. Using H=50 and q=0, the scale is 9 kpc/" and the source is 600 kpc across, much larger than average. Note that the central maximum on this map is not the core source but the bright hotspot 3" out along the jet.

For purposes of comparison, maps with identical beams (1.4"x2) were prepared from the 1.4 GHz data and the older 5 GHz data (PW). From these maps the following properties of the jet are evident:

1. The basal hotspot has α=-0.55 while the rest of the jet has α= -0.74 with no significant variations.
2. There appears to be a uniform foreground Faraday rotation of 47° consistent with the RM of -60 rad/m^2 suggested by PW. Any variations in rotation along the jet are $\leq$ 0.1 rad.
3. Most of the jet is not depolarized. At the core end, m(1.4 GHz)> m(5GHz), which is to be expected from the superposition of a flat-spectrum low-polarization core upon a steeper-spectrum, highly-polarized jet. Significant depolarization is seen at the far end of the jet where it begins to fade into the bridge, but the interpretation of this depolarization is unclear since some or all of it could be caused by the combination of polarized flux from the jet and the bridge. Generally, wherever the jet is brightest and the S/N best, the depolarization ratio is 1.0±.1.

The presence of a radio bridge around the jet raises questions about the possibility of jet confinement by external pressure. Recent, high-resolution observations (Wardle, private communication) indicate a minimum energy density of 1.3x10^{-9} at the brightest part of the jet. For confine-

D. S. Heeschen and C. M. Wade (eds.), Extragalactic Radio Sources, 135–136.

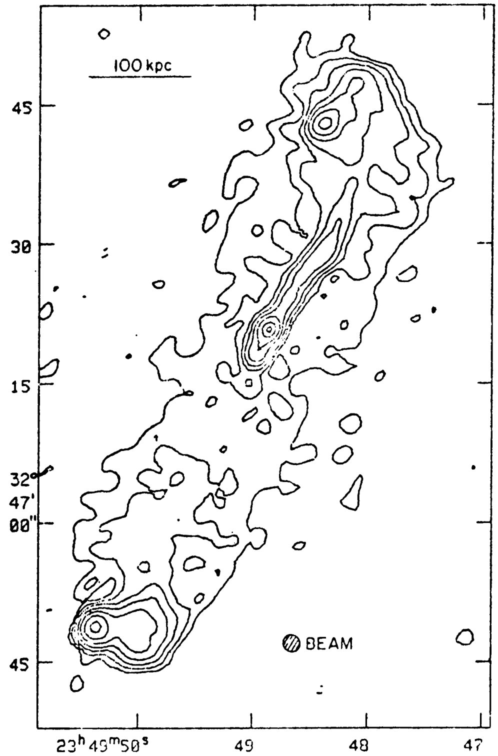

Figure 1

ment by a 10^8K plasma, $n \sim 3\times10^{-2}$ is required. Such a dense plasma in the bridge surrounding the jet should cause non-uniform Faraday rotation of the polarized emission from the jet. How large this rotation will be depends on the field geometry. The high degree of linear polarization normally seen in the bridges of other radio sources is usually taken to indicate that the fields in bridges are highly ordered, with at most a few independent, randomly oriented field regions along each line of sight. In this case, if N is the number of such regions, the bridge will cause fluctuations in RM along the jet of roughly $\sqrt{N}$(RM per cell)$\sim\sqrt{N}(.8\, n_e(B/\sqrt{3})\, l)$ where l is the length through each cell and $l \sim d/N$ if d is the width of the bridge, about 50 kpc. Using the equipartition field in the bridge of 7μG to estimate B, $N \sim 4$, and a limit on the variation in rotation of 0.1 radian, the upper limit on the thermal electron density is 2×10^{-5}, very much less than the density estimated above for pressure confinement.

The density needed for pressure confinement of the jet may be made consistent with the lack of rotation in three ways. Firstly, the confining plasma may be supposed to be extremely hot. For $n_e < 2\times10^{-5}$, a temperature > 10^{11}K would be needed to exert sufficient pressure. Although difficult to rule out observationally, postulating such a relativistically-hot plasma seems implausible without a more compelling argument. Secondly, the bridge could be far out of equipartion. If $n_e \sim 10^{-2}$ then B must be $<10^{-2}$μG. Not only would this lead to an absurdly high total energy for the bridge ($\sim10^{10} M_\odot c^2$), but the consequent inverse-Compton x-ray flux would be >10 times the observed x-ray flux (see Wardle and Potash, in this Symposium). Thirdly, the magnetic field geometry may be such that there are many reversals of $B_\parallel$ along each line of sight with a resulting decrease in the net Faraday rotation. In the extreme, Laing (1981) has recently shown that for some field configurations a high degree of linear polarization may be coupled with no Faraday rotation at all. It is not clear, however, that the special field configurations required for this type of effect are likely to occur in actual radio sources.

Laing, R.A.: 1981, Ap. J., 248, pp 87 - 104.
Potash, R.I., and Wardle, J.F.C.: 1980, Ap. J., 239, pp 41 - 49.