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A one-sided jet in the giant quasar 4C74.26

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SUMMARY

Observations with the VLA of the giant quasar 4C74.26 have revealed a one-sided jet at least 400 kpc long, confirming that such jets occur even in the largest known quasars and indicating that the effects of relativistic beaming are important in quasars whose axes make fairly large angles (~ 45°) to the line-of-sight.

1 INTRODUCTION

The radio source 4C74.26 (Riley *et al.* 1988, hereafter Paper I) is a 10-arcmin double, identified with a quasar with a redshift $z = 0.104$. With a linear size of 1.6 Mpc ($H_0 = 50$ km s^{-1} Mpc^{-1}, $q_0 = 0$) it is one of the largest known sources associated with a quasar. Its radio luminosity at 178 MHz is 4×10^{25} W Hz^{-1} sr^{-1}, placing it on the borderline between the FRI and FRII classes (Fanaroff & Riley 1974) although its structure is typical of an FRII source. In Paper I we discussed the differences between the optical and radio properties of 4C74.26 and 4C34.47, which at the time was the only other giant source associated with a quasar, in terms of the orientations of their radio axes with respect to the line-of-sight and concluded that 4C74.26 is probably closer to the plane of the sky than 4C34.47. We commented that the absence of a jet in our maps of 4C74.26 could be significant in this respect if the Doppler-boosting model of these jets is correct.

In this paper we present more sensitive VLA observations of 4C74.26 at 1.46 GHz which have revealed a one-sided jet at least 400 kpc long and we discuss the implications briefly.

2 OBSERVATIONS AND RESULTS

4C74.26 was observed at 1.46 GHz with the C configuration of the VLA in 1988 May; the bandwidth was 50 MHz. Three ≃ 30-min snapshots were made over a period of 4 hr. The flux-density calibrator was 3C286 for which a flux density of 14.7 Jy (Baars *et al.* 1977) was assumed.

The data were calibrated and reduced at the VLA using standard procedures. After initial mapping and CLEANing, the source was self-calibrated for phase and, on the final iteration, for amplitude as well. The final CLEAN map was restored with a Gaussian beam of half-power width 15 arcsec. The total-intensity map is dynamic-range limited and the noise level is ~ 0.2 mJy.

The CLEAN map is shown in Fig. 1. A single jet emanates from the unresolved central component and extends for about 150 arcsec (400 kpc) in p.a. ~ 160°; it exhibits small oscillations on either side of this line, which is itself about 6°

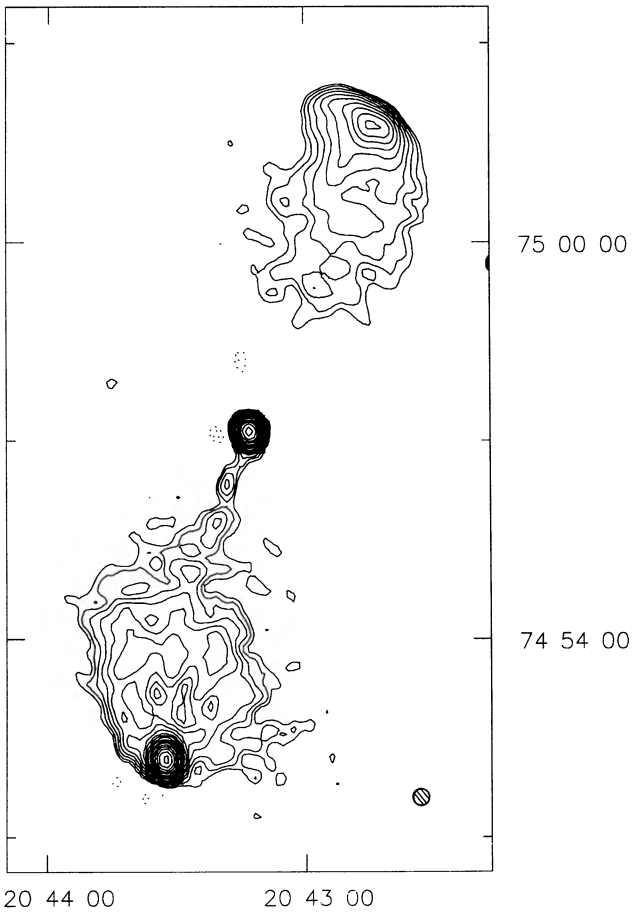

Figure 1. The CLEAN total-intensity map of 4C74.26 made with the VLA in C-array at 1.46 GHz; B1950 coordinates are used. The central component coincides with the position of the 15.5-mag quasar discussed in Paper I. The hatched circle indicates the half-power beamwidth of the Gaussian restoring beam. The contour intervals are logarithmic starting at 1 mJy beam^{-1} with a factor of $\sqrt{2}$ between levels; the peak is 390 mJy beam^{-1}. The dashed contour is at a level of -1 mJy beam^{-1}.

off the line joining the core to the bright southern hotspot. After 150 arcsec the jet is no longer visible against the lobe. The pattern of peaks and troughs in the regions ~1–2 arcmin north of the intense hotspot is very similar to the sidelobes of the dirty beam and is thus unlikely to be real. There is a limit of $\simeq 0.4$ mJy beam^{-1} on the surface brightness of any counter-jet to the north of the central component, so that it is at least a factor of 7 fainter than the observed jet.

3 DISCUSSION

The discovery of a one-sided jet in 4C74.26 confirms that such jets occur even in the largest known quasars, whose radio axes are presumably orientated on average at the largest angles to the line-of-sight (Wardle & Potash 1984; Barthel 1987, 1989). If the jets in quasars are intrinsically one sided this result would be unexceptional. However, it is now widely accepted that, in the majority of cases, the asymmetry is not intrinsic but is the result of Doppler beaming of two-sided relativistic jets (e.g. Garrington *et al.* 1988; Laing 1988) posing the question of where the unbeamed counterparts of the quasars like 4C74.26 and 4C34.47 are. Scheuer (1987) and Barthel (1989) discuss the possibility that these counterparts are narrow-line radio galaxies (NLRG), in which the nuclear and broad-line regions are obscured by a central torus whose axis is aligned with the radio axis; for sources with 178-MHz luminosities $\geqslant 10^{27}$ W Hz^{-1} sr^{-1} from the 3CR sample of Laing, Riley & Longair (1983), Barthel (1989) finds that the relative numbers and linear sizes of the quasars and NLRGs are consistent with the quasars having their radio axes within 45° of the line-of-sight and with the NLRGs lying outside this cone.

It is not clear how this 'unified' scheme extends to sources of lower luminosities such as 4C74.26, but the present observations are consistent with it in so far as the deprojected size of the source, if the axis is at 45° to the line-of-sight, is 2.3 Mpc and is thus not improbably large; furthermore a jet-to-counter-jet flux-density ratio of >7 can be achieved at 45° by Doppler boosting at relatively modest speeds ($\geqslant 0.5$ c). If the jets are highly relativistic, the angle to the line-of-sight could be as much as 70°, although this would be well outside Barthel's 'quasar cone'.

We note that in 4C74.26, in common with many sources possessing one-sided jets (Bridle & Perley 1984), the hotspot on the jet side is much brighter and more compact than that on the opposite side. This has a natural explanation if the jets are intrinsically one sided, as the bright hotspots are those currently being 'fed' by the jet. If the asymmetry in the jets is due to Doppler boosting, however, the difference in brightness implies that some of the radiation from the hotspots must also be beamed.

In conclusion, the discovery of a one-sided jet in the giant quasar 4C74.26 confirms that the effects of relativistic beaming are important even in the largest quasars whose axes are likely to make fairly large angles (~45°) with the line-of-sight. As not only one of the largest, but also probably the nearest, double-lobed quasar with one of the longest continuously connected jets, 4C74.26 is an excellent candidate for further study to test this relativistic beaming model.

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