THE STRUCTURAL VARIATIONS OF 3C454.3 AND 2134+004

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ABSTRACT

3C454.3 has a core-jet structure on the milliarcsec scale. Following a flux density outburst, the core showed a "superluminal brightening". Comparison with older observations suggests superluminal motion in the jet. 2134+004, in contrast, is a double source, with no significant ($v/c < 1$) relative motion of the components.

INTRODUCTION

The quasars 3C454.3 ($z = 0.859$) and 2134+004 ($z = 1.936$) are both strong, variable radio sources. 2134+004 has shown only slow variations, while 3C454.3 has had large changes in flux density at cm wavelengths, as well as significant variations at metre wavelengths. The time scale of the latter has led Jones and Burbidge (1973) to suggest that bulk relativistic motion with $\gamma \sim 50$ should be present. A large outburst in 3C454.3 occurred in mid-1981.

We have observed both sources with an array consisting of the 100 m telescope in Effelsberg and 4 US antennas at wavelengths of 2.8 cm (1981.4) and 6 cm (1981.6), and reobserved 3C454.3 at 2.8 cm with the same array at epoch 1982.1.

3C454.3

The hybrid maps of the source at 6 cm wavelength (Fig. 1) show a bright core and a narrow, elongated "jet" extending to about 10 milliarcsec ($\sim$ 90 pc, for $H_o = 55$ km s^{-1} Mpc^{-1}, $q_o = 0.05$) from the core in P.A. -65°. The peak in the brightness of the jet lies about 6.5 mas (milliarcsec) from the core. The arcsec jet (Browne et al. 1982) is in P.A. -48°, so that the curvature typical of superluminal sources is present. At 2.8 cm, the jet component is weaker, with a peak brightness of $\sim$ 1 percent of that of the core, which, however, shows an extension

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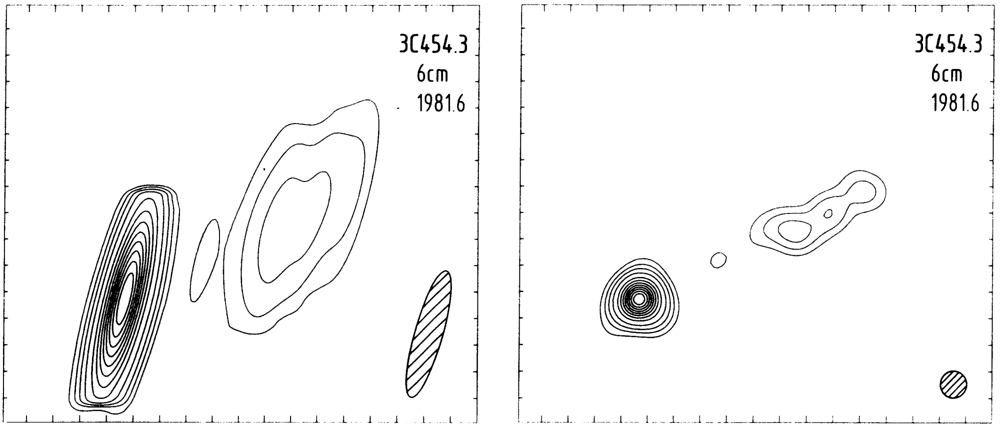

Fig. 1: Hybrid maps of 3C454.3 at 6 cm wavelength. Left: restored with clean beam of 5 x 1 mas; right: restored with a 1 mas circular beam. Contours are 1, 2.5, 5, 10, 20 ... 90 percent of the maximum.

in the same P.A. of -65°.

The core shows no evidence for any double structure on a scale > 0.3 mas. The 2.8 cm data from the long, transatlantic baselines for each of the two epochs are well fitted by an "inner core" ($\lesssim 0.25$ mas) and an "outer core" with a diameter of about 0.5 mas. The flux density of the source increased from 16.3 at epoch 1981.4 to 18.9 Jy at epoch 1982.1. This increase occurred in the outer core, with little change in the flux density of the inner core:

Epoch	Inner core		Outer core		Total core
	Flux(Jy)	Size(mas)	Flux(Jy)	Size(mas)	flux(Jy)
1981.4	9.4	$\lesssim 0.2$	5.4	0.55	14.8
1982.1	8.7	0.25	8.2	0.55	16.9

The core of 3C454.3 has thus shown a "superluminal brightening": the increase in brightness of a region ~ 0.3 mas in radius in 0.7 years requires $v/c \sim 25$.

Earlier 6 cm data, obtained at epoch 1974.1 (Pauliny-Toth et al. 1981) show a similar core-jet structure, but with the peak in the brightness of the jet component about 4 mas from the core, rather than the 6.5 mas seen at epoch 1981.6. The earlier data were sparser, but taken at face value, suggest a motion of 0.33 mas per year, or $v/c \sim 18$, a value similar to that required to account for the superluminal brightening of the core.

The available data on 3C454.3 thus support the predicted relativis-

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tic bulk motion, both in the core and in the jet components.

2134+004

Hybrid maps of the source at 6 and 2.8 cm are shown in Fig. 2. At both wavelengths, the source is double, with a component separation of 1.7 mas (19 pc) in P.A. 62°. The separation is identical with that obtained at epoch 1973.5 (6 cm; Pauliny-Toth et al. 1981). A similar separation, of 1.8 mas, was found by Schilizzi et al. (1975) for epochs between 1972.3 and 1974.1, if we identify two of their three components (only 0.4 mas apart) with one of the components given here.

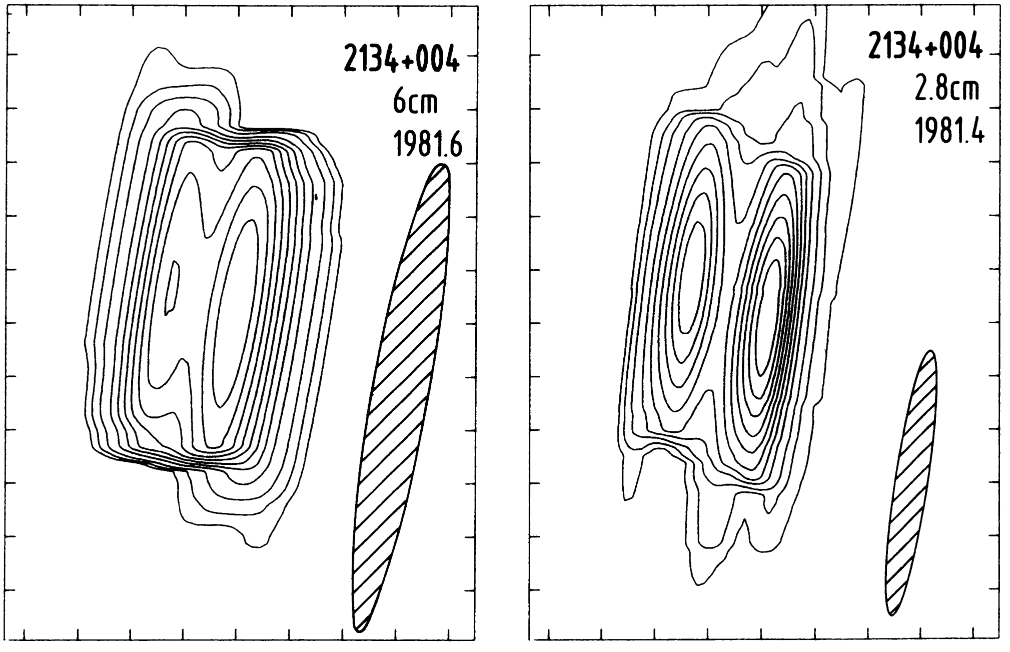

Fig. 2: Hybrid maps of 2134+004 at 6 (left) and 2.8 (right) cm wavelength, restored with the clean beams of 9 x 1 mas and 5 x 0.6 mas respectively. Contours are 2.5, 5, 10, 20 ... 90 percent of the maximum.

We place a limit of 0.1 mas on any change in the component separation over the 9.3 year interval covered by the observations. The limit on the relative rate of separation is 0.01 mas per year, or v/c < 1.

Nevertheless, the source appears more resolved than at earlier epochs: the models of Schilizzi et al. (1975) give half the total flux density in a component < 0.3 mas in size, whereas the present data give equivalent gaussian sizes of ∿ 0.9 mas for both components. The behaviour of the source appears similar to that of 3C84, which shows relative

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component motion of $\sim$ 0.6 c and component expansion velocities of $\sim$ 0.1 c (Preuss et al. 1979, Romney et al. 1982). In the case of 2134+004, however, if the early data are correct, the required velocity of expansion of the component(s) is at least 3 c.

The frequency of the spectral peak in 2134+004 is about 5 GHz, compared with about 8 GHz in 1972-1973, reflecting the component expansion. The spectral indices between 6 and 2.8 cm are α = −0.4 and −0.1 for the W and E components, respectively. ($S \propto \nu^{\alpha}$). Assuming the same turnover frequency of 5 GHz for both components and taking the component sizes of 0.9 mas gives a magnetic field in the emitting regions of $\sim 5 \times 10^{-3}$ gauss and a lifetime for relativistic electrons radiating at 10 GHz of $\sim 10^3$ years.

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