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Search for Short Timescale Structural Variation of 3C 273 at 22 GHz and 43 GHz

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Abstract. The results of VLBI observations of the quasar 3C 273, obtained during a multi-frequency campaign in late 1992 in the radio, millimeter, and X-ray bands are presented. The aim of the campaign was to test the application of the SSC (Synchrotron Self-Compton) model to 3C 273. Independent estimates are obtained through the assumption of the energy equipartition between particles and magnetic field.

1. Observations

The VLBI observations of 3C 273 are part of a multi-frequency campaign carried out from December 12, 1992 to January 24, 1993. Over this period 3C 273 was monitored every 2 days with the PSPC of ROSAT (Leach et al. 1995), at nearly 1 day intervals with the JCMT (Mauna Kea), IRAM and the Kitt Peak telescope (M^{c}Hardy et al. 1994) and with five VLBI observations made at roughly weekly intervals with the VLBA plus Medicina and Effelsberg at 22 GHz and stand-alone VLBA at 43 GHz.

2. Superluminal Motion and Doppler Factors

In the VLBI images we assume the core to be in the easternmost feature and that it is stationary. A comparison between the images at the five epochs is in progress. We do not detect any structural variation when the images of the first two epochs, separated by 9 days, are compared. We compare these images with those at 10.7 GHz from Abraham et al. (1994) and at 22 GHz from Leppänen et al. (1995). If our identifications for the components are correct, the mean proper motion is 0.8 mas/year, corresponding to an apparent speed of $5.4\,h^{-1}\,c$ ($H_0 = 100\,h\,\mathrm{km\,s^{-1}\,Mpc^{-1}}$, $q_0 = 0.5$).

Since we have simultaneous radio and X-ray measurements we can derive lower limits to the Doppler factors for the main components. We have calculated the self-Compton X-ray fluxes for components D_1 and D_3 and have compared them to the X-ray flux detected by ROSAT in simultaneous observations. We consider only the hard component to be due to the SSC process (see Leach et al. 1995: $S_{\rm hard} = 7.7 \times 10^{11}\,\mathrm{erg\,cm^{-2}s^{-1}}$) in order to obtain lower limits to the Doppler factors ($\mathcal{D}_X$ in Tab. 1). The brightness distribution of the components in the 21Dec92 22 GHz image (Fig. 1) has been fitted with elliptical Gaussians and we have calculated $\theta = 1.8\sqrt{\theta_1\theta_2}$. The components D_1 and D_3 show optically-thin spectra. A decomposition of the total spectrum of the compact region of 3C 273 into the spectra of all of the single components gives a range of values

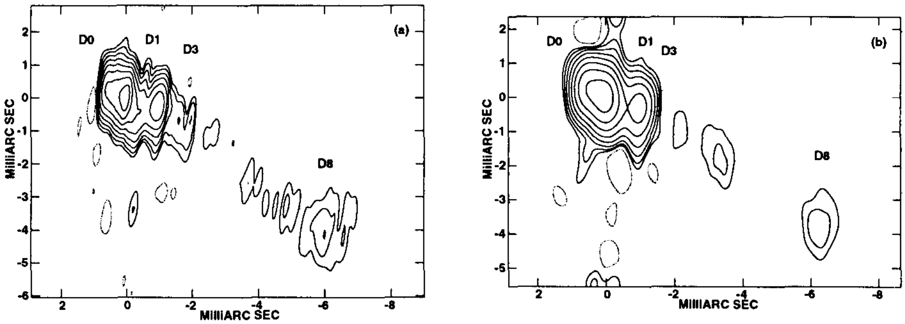

Figure 1. *a)* 3C 273 at 22 GHz and *b)* at 43 GHz.

for ν_m between 15 and 18 GHz for D_1 and D_3. We adopted a value of 200 GHz for ν_2 in both cases. Independent estimates of the Doppler factors ($\mathcal{D}_{eq}$ in Tab. 1) have been obtained assuming energy equipartition between particles and magnetic field in the radio emitting regions and ascribing the apparent departure from equipartition to Doppler boosting (Readhead 1994). With a Doppler factor $2 \leq \mathcal{D} \leq 8$ and an apparent superluminal speed $4 \leq \beta_{app} \leq 6$, we obtain for D_1 a Lorentz factor $\gamma \sim 5$ and an angle of motion with respect to the line of sight $5° \leq \theta \leq 25°$, in agreement with Unwin et al. (1985).

Table 1. Doppler factors.

comp	$\theta_1 \times \theta_2$ [mas]	ν_m [GHz]	S_m [Jy]	$S_{X(0.1-2.4KeV)}$ [erg s^{-1} cm^{-2}]	$\mathcal{D}_X$	u_e/u_m	$\mathcal{D}_{eq}$
D_1	0.42×0.19	15	14	$5.6 \cdot 10^{-9}$	2.2	$1.6 \cdot 10^{6}$	7.7
		18	12	$5.9 \cdot 10^{-10}$	1.45	$2.2 \cdot 10^{4}$	4.2
D_3	0.44×0.33	15	5	$1.2 \cdot 10^{-12}$	0.47	2.6	1.1
		18	4.2	$1.2 \cdot 10^{-13}$	0.3	0.03	0.6

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