1038+528 A, B: PHASE-REFERENCE AND SPECTRAL-INDEX MAPS +

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On 1981 March 17-18 we undertook MkIII VLBI observations of the quasars 1038+528 A, B (Owen et al. 1979; Owen et al. 1980) with an array of 7 telescopes operating simultaneously at λ3.6 and λ13 cm with right circular polarization reception at each wavelength. Because the sources are ∿33" apart they could be observed simultaneously at every telescope. Thus the corrupting contributions of the propagation medium and the instrumentation were approximately the same for each of the quasars, hence allowing us to calibrate the structure phase of B with respect to a reference point chosen in the map of A using the expression

$$\phi_B^S\,(t) \simeq \phi_B\,(t) - [\phi_A\,(t) - \phi_A^S\,(t)] - [\phi_B^G\,(t) - \phi_A^G\,(t)]$$

where ϕ_B and ϕ_A are the observed fringe phases, ϕ_B^G and ϕ_A^G are the geometric contribution with respect to the reference points chosen in each map and ϕ_A^S is the structure phase contribution with respect to the reference point chosen in the A map.

Use of this calibrated phase in the construction of the map of B preserved the information of the position of this map with respect to the reference point chosen in the map of A. Unfortunately the reference points in the λ3.6 and λ13 cm maps of A cannot be related with a similar technique because of the corrupting contribution of the propagation medium, mainly the ionosphere. Hence to register the maps at the two wavelengths we sought plausible simultaneous registrations of the two quasar maps using the positional constraints obtained at each wavelength from phase-reference mapping. We found that to within about 0.1 mas the registration shown in Fig. 1 was the only plausible one. Any shifts larger than 0.1 mas of the λ3.6 cm maps with respect to the λ13 cm maps along directions parallel to the structures of each of the A and B quasars produced 'unreasonable' spectral-index morphologies for one or the other quasar:

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$\alpha >> 2.5$ ($S \propto \nu^{\alpha}$), gradients in the spectral index perpendicular to the axis of the structure, spectral indices larger at the edges of the map than in its center, etc.

A result shown in Fig. 1 which is immediately striking is that the distance between the peak brightness points in the two maps at λ13 cm is about 0.7 mas ($\sim$ 6 pc at the distance of the A quasar for H_o = 60 km s^{-1} Mpc^{-1}, q_o = 0) shorter than the corresponding distance at λ3.6 cm. Using λ18 cm data we ruled out plasma refraction as the cause of this difference. We hypothesize that for the A quasar, which is a 'core-jet' source (Marcaide, 1982), the location of peak brightness may depend on wavelength as $k\lambda^{\beta}$ (k, normalization constant) with respect to the point defined by λ = 0 (apex of the jet - see Blandford and Königl (1979) for a related discussion). Using several other experiments we have determined that, for β, the range is $0.8 < \beta < 2$.

With the registration shown in Fig. 1 we obtain the spectral-index maps shown in Fig. 1. (The four times larger beam of λ13 cm was used to convolve the λ3.6 cm map prior to making the spectral-index map).

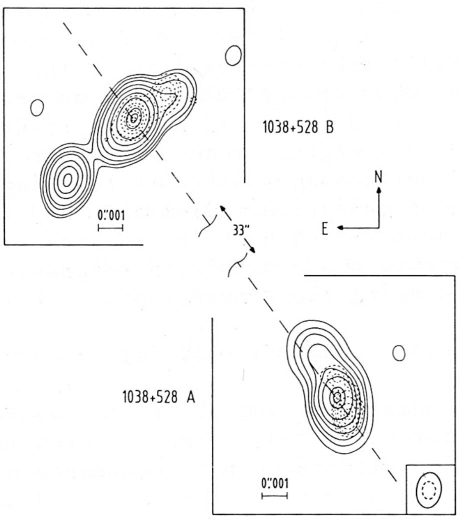

Fig. 1: Brightness distribution of 1038+528 A, B at λ3.6 cm (dashed line) and λ13 cm (continuous line). This particular registration is believed to be correct to within 0.1 mas.

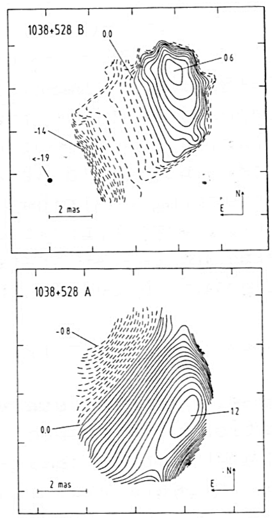

Fig. 2: Spectral-index maps of 1038+528 A, B constructed using the registration of the brightness distributions in Fig. 1.

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