VLA OBSERVATIONS OF RAPID VARIABILITY IN OJ287 *

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ABSTRACT. Using the VLA at 6 cm, we have detected non-periodic variations in the powerful BL Lacertae object OJ287 on timescales between minutes and hours at levels of the order of one percent. Brightness temperatures inferred from causality arguments range from 10^{16} to 10^{20} K. No periodic component was found to a limit of 0.1 %.

We observed OJ287 with the Very Large Array at 5, 15, and 22 GHz several times in early 1983. Here we discuss only the 5 GHz data which were taken coincident with the 22 GHz observations of Valtaoja et al. (1985); a complete discussion is given in Dreher, Roberts, and Lehar (1986). The array was divided into two independent subarrays which observed OJ287 and the calibration source 0839+187 for 6 min 20 s each in two alternating sequences 180 degrees out of step. The visibility data for each subarray and circular polarization were separately corrected for the amplitude and phase gains of each antenna, using 3C286 to set the amplitude scale of the calibrator and phase calibrating each source on itself. Time series of the flux densities of OJ287 and 0839+187 were derived for each antenna from the instantaneous power gains. These were averaged over the antennas and polarizations, filtered of bad data points, and rescaled so that the average was 1000. Errors were assigned to each data point from the internal consistency of the averages. The results are given in Figure 1, and show OJ287 to decrease in flux by about 1.8 % in an irregular way over a 7 hour time span. This corresponds to a formal time scale $\tau = S/|dS/dt| \leq 16$ days, a short but not atypical value for active sources. The more rapid "dip" of ~ 0.5 % which occurs over ~ 15 min near t = 23.89 days has $\tau \leq 2$ days. These variations were seen in both polarizations of all antennas and appear highly significant in terms of the known errors. We feel, therefore, that they are real, but experience using the VLA to measure fluxes to an accuracy of < 1 % is as yet too limited to be absolutely certain.

Simple causality arguments which limit the size R of a source to $R < c\tau/(1+z)$ may be used to infer lower limits to the brightness

* Discussion on p.93

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temperature of OJ287 of 1×10^{16} K for a 1.8% change in 7 hours and 6×10^{17} K for a 0.5 % change in 15 minutes. If the varying component δS is physically distinct from the steady component S, its brightness temperature is increased by a factor $(S/\delta S)$, leading to 6×10^{17} K and 1×10^{20} K. Such extraordinary inferred brightness temperatures would seem to require coherent emission, unprecedented Doppler boosting, or strong centimeter-wavelength scattering. In order to search for periodic variations in OJ287, we formed a discrete Fourier transform of the time series and removed the effects of the data window with a one-dimensional complex CLEAN (Lehár 1985; Roberts, Lehár, and Dreher, in preparation). The resulting distribution of harmonic amplitudes is shown in Figure 2. There is no peak near the previously-reported period of 943 s. Tests with artificial signals enable us to place a conservative upper limit of 0.1 % on any harmonic variation.

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Dreher, J.W., Roberts, D.H., and Lehár, J. 1986, to be published.
Lehar, J. 1985, Bachelor's Thesis, Physics Dept., Brandeis University.
Valtaoja, E. et al. 1985, Nature, 314, 148.

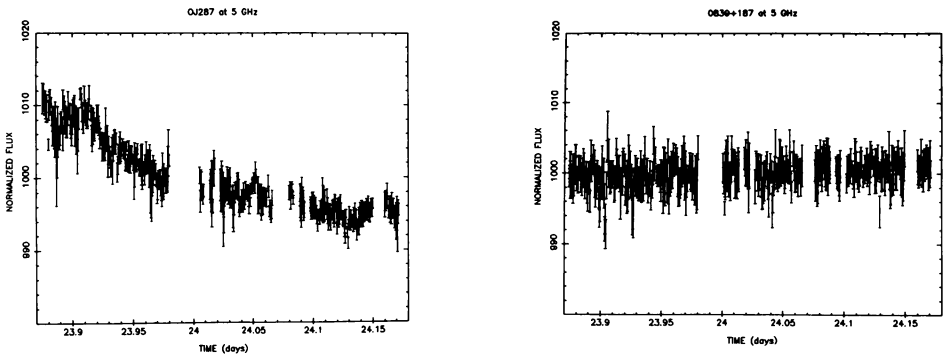

Figure 1. Flux histories of OJ287 and 0839+187 on 1983 May 23-24.

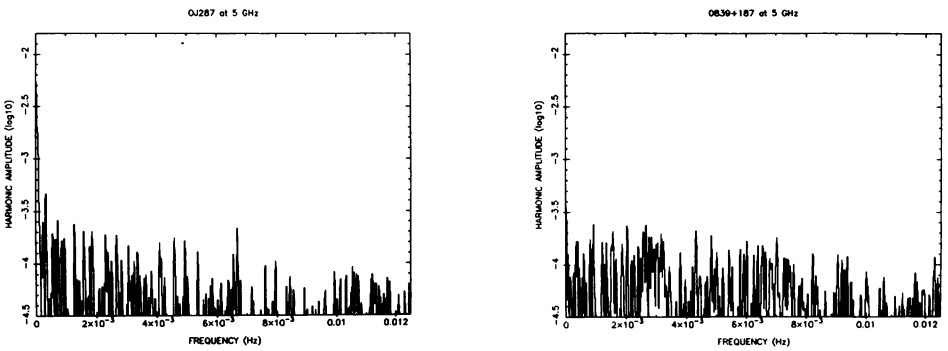

Figure 2. Harmonic amplitudes of the time series in Figure 1, on a logarithmic scale. A conservative upper limit on harmonic variability of OJ287 from these data is 0.1 % of the mean.

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