SUPERLUMINAL MOTION IN BL LACERTAE: 10.65 GHz VLBI OBSERVATIONS FROM 1981.7 to 1982.7 +

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We report here VLBI observations at four epochs of the source BL Lacertae made with the U.S. VLBI Network (plus Bonn) at 10.65 GHz which show clear evidence of uniform superluminal expansion at $v/c = 4.4 \pm 0.2$ ($H_o = 55$ km s^{-1} mpc^{-1}). The maps, which were made every three months from 1981.76 to 1982.75 (Figures 1, 2), were part of an ongoing program of VLBI observations of BL Lacertae at 5 and 10.65 GHz starting in 1980.4, near the beginning of a series of violent flux outbursts (Aller, Hodge, and Aller, 1983; Aller and Aller, 1984). Previous results from earlier epochs have been reported by Mutel, Aller, and Phillips (1981) and Phillips and Mutel (1982).

All four maps are dominated by a nearly unresolved component at the northern end of an extended "jet" of emission along p.a. 10° ± 2°. The northern component ("A") is very likely responsible for the highly polarized flux event reported by Aller, Hodge, and Aller (1983) since the flux of the jet is not large enough to account for the observed increase in total flux. As pointed out by Aller and Aller in these proceedings, the intrinsic polarization angle of the linear polarization is nearly the same as the VLBI jet, so that the magnetic field is nearly perpendicular. This is consistent with a picture of the radio emission arising from a shock which causes axial compression of the magnetic field. The radio emission would arise from electron density enhancement behind the shock which then radiates by ordinary synchrotron radiation.

If this scenario is at least qualitatively correct, it seems unlikely that component "A" is coincident with the "core" source, as is commonly assumed for the brightest end component in the well-known core-jet superluminal sources. Indeed, even though we have detected relative motion between two components, both of them are more likely to be "knots" or other temporary features along a longer-lived channel. The core for this source is not obviously visible, so that the relative velocity of the core and the jet components is unknown.

+ Discussion on page 433

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The uniform motion between components "A" and "B" reported here results in an almost identical value of γ as that derived from the 1980.93 map (Mutel, Aller, and Phillips, 1981). In that case, however, the evidence was less direct since it depended on comparison of the flux and separation of two components made at a single epoch with the time scale of the flux event prior to the observation. The data are consistent with bulk relativistic motion of material with a constant Lorentz factor γ, moving along a long-lived channel in p.a. 10°, at least for the series of flux outbursts between 1980.2 and 1982.7. Inspection of maps for the latest two epochs (1982.44 and 1982.75) shows a tendency for the more diffuse southern end of the jet to bend to the east. This is more pronounced in our 5 GHz maps during the same epochs and can be clearly seen in other 5 GHz maps by Pearson and Readhead (1984) and by Bääth (1983). The total amount of bending appears to be approximately 25°.

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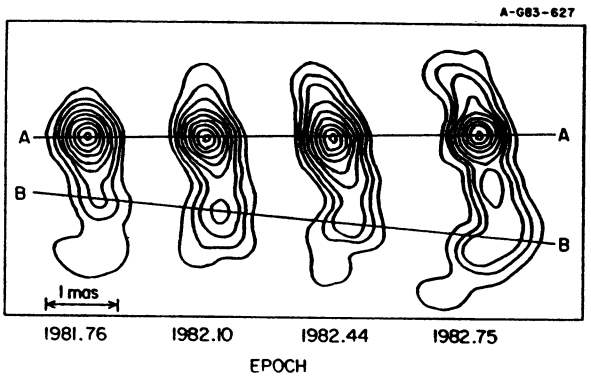

Figure 1. Contour maps (levels: 10, 20, ... , 90% of maximum) of four epochs of BL Lac at 10.65 GHz.

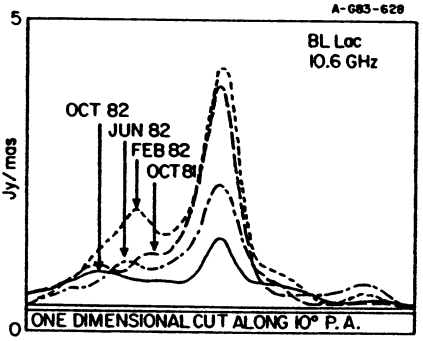

Figure 2. One-dimensional cuts along p.a. 10°.

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