# ROTATING STRUCTURES IN EXTRAGALACTIC VARIABLE RADIO SOURCES

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Abstract: Four sources have now been found by the Michigan variability program which exhibit large amplitude rotations in polarization position angle with time. The most straightforward explanation for the phenomenon is a physical rotation in the radio emitting region.

Since the discovery of an apparently linear rotation with time in the polarization position angle of 0235+164 during the 1975 outburst (Ledden and Aller 1979), our observations at 4.8, 8.0, and 14.5 GHz have found three other sources, 0607-157, 0727-115 and BL Lac, which have exhibited large-amplitude polarization rotations with time (Aller, Aller and Hodge 1981; Aller, Hodge, and Aller 1981); also, a second rotation event appears to have occurred in 0235+164 starting in late 1980. The parameters for these rotations are summarized below. Evidence for rotation in four additional objects has been presented by Altschuler (1980).

TABLE I

| Source | Epoch | Rotation Rate | Observed Range | Comments |
|---|---|---|---|---|
| 0235+164 | 1975 | -3°.3/Day | 180° | Linear rotation at 8.0 and 14.5 GHz |
| | 1980-81 | -2°.1/Day | ≃180° | Rotation at 4.8, 8.0 and 14.5 GHz; gap in data when the source was near the sun makes range uncertain |
| 0607-157 | 1977-78 | -0°.6/Day | ≃180° | Linear rotation; observations only made at 8.0 GHz; range uncertain |
| 0727-115 | 1977-80 | +0°.3/Day | 390° | Rotation at 4.8, 8.0 and 14.5 GHz; initial constant rotation rate followed by jumps of 55°, 70°, 82° and 68°. A modulation of the polarized flux density is apparent |
| BL Lac | 1980 | -12°/Day | 440° | Absence of rotation at 4.8 GHz: evidence for opacity effects |



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In the three sources for which we have multi-frequency data the observations cannot be explained by any frequency dependent mechanism (such as Faraday rotation). The observed rates of rotation have ranged over a factor of 40; and only 0235+164 and 0607-157 have exhibited an apparently constant rate of rotation. In 0727-115 the changes occurred in a series of steps. The large size of the change in position angle (more than 360 degrees in 0727-115 and in BL Lac) appears to rule out the acceleration-aberration process suggested by Blandford and Königl (1979) to explain the apparent rotations; the most straightforward explanation appears to be a true physical rotation in the emitting region such as the accretion-disk scenario discussed by Pineault (1980, 1981) or a helical motion in a jet structure (Hodge, Aller, and Aller 1979).

An important characteristic of the large amplitude rotation event in BL Lacertae is that it was not observed at the lowest frequency, 4.8 GHz. This fact together with the time of appearance of the rotation during the evolution of an outburst have led us to suggest that the rotation arose deep in the emitting region and that self-absorption prevented us from observing the phenomenon at 4.8 GHz (Aller, Hodge, and Aller 1981). Except for the periods when 0235+164 and BL Lac exhibited rotations, their polarization position angles were almost constant over several outbursts in total flux density. During these stable periods the polarization position angle may be determined by a geometrical effect, such as emission from an extended jet structure, while during the rotation phenomenon the emitting region deeper in the core may dominate the polarization of the source.

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