NEW RESULTS FROM VLBI POLARIZATION OBSERVATIONS OF BL LACERTAE OBJECTS

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1. A Systematic Study of the VLBI Polarization Characteristics of BL Lacertae Objects

The major distinguishing features of BL Lacertae Objects are weak or absent line emission and strong and variable optical, infrared, and radio polarization (Angel and Stockman 1980; Kollgaard 1994). The radio emission and much of the optical emission is believed to be synchrotron radiation. In nearly every BL Lacertae object in which polarization structure has been detected, the polarization position angles χ in knots in the jets are nearly parallel to the VLBI structural axis. Assuming the jet components to be optically thin, the inferred magnetic fields **B** are nearly perpendicular to the jet direction θ ; perhaps the most natural interpretation of this is that the knots are associated with shocks that compress an initially tangled **B** field as they propagate down the VLBI jet, enhancing **B** transverse to the compression (Laing 1980; Hughes, Aller, & Aller 1989). The superluminal speeds observed in the jets of BL Lacertae objects are on average lower than those observed in a comparably core-dominated population of quasars (Gabuzda *et al.* 1994). The distribution of core polarization position angles χ_{core} at $\lambda = 6$ cm is bi-modal, suggesting that χ_{core} is roughly perpendicular to θ when the cores are quiescent, and aligns with θ at epochs when polarization from newly emerging shock components is blended with the core polarization (Gabuzda *et al.* 1994).

In order to understand these clear systematic trends, it is useful to examine the polarization properties of a complete sample of BL Lacertae objects. A sample convenient for such studies is that defined by Kühr and Schmidt (1990). $\lambda = 6$ cm VLBI polarization images have already been published for 15 sources in this sample, for 10 sources at more than one epoch (Gabuzda *et al.* 1994 and references therein). $\lambda = 6$ cm observations of 18

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additional BL Lacertae objects are now being reduced and analyzed; these complete first epoch imaging of all sources in the Kühr and Schmidt sample. Second epoch $\lambda = 6$ cm polarization observations for this sample were completed in May of this year. These observations are being complemented by observations of a smaller number of sources at shorter wavelengths (see, e.g., Gabuzda, Pushkarev, & Cawthorne, these proceedings).

2. Recent Results

Recently analyzed $\lambda = 3.6$ cm images, as well as $\lambda = 6$ cm images currently being analyzed, support the trends noted above, but are also providing some surprises. The u-v coverage for comparatively short baselines for these data is somewhat better than at the earlier epochs, and as a result, the extended VLBI structure is better reproduced in the resulting images. These are revealing more sources with complex jet structure, sometimes with evidence that the jet χ vectors maintain their alignment with the local θ when the direction of motion for a given component changes substantially. These new images also support the idea that the $\lambda = 6$ cm distribution of χ_{core} is bimodal, with χ_{core} preferably either aligned with the small scale jet direction or perpendicular to it.

Perhaps most surprising is that these new images are revealing more sources in which the χ vectors in jet components indicate longitudinal **B** fields. In some sources, some jet components have χ aligned with θ (transverse **B**) and some have χ transverse to θ (longitudinal **B**). This indicates that some jet components in BL Lacertae objects are either not shocks, or are rather weak shocks imposed on a comparatively strong underlying longitudinal **B** field. There is some indication that the jet components in which **B** is longitudinal tend to be more extended than those in which **B** is transverse, but this is still uncertain. Completion of the analysis for the first epoch observations for the Kühr and Schmidt BL Lacertae object sample will give more information about how common jet components with longitudinal **B** field are, and how these components differ from those in which **B** is transverse. These studies will as well provide information about the relationship between BL Lacertae objects and quasars, in which longitudinal jet **B** fields are much more common.

References

Angel & Stockman (1980) *Annual Reviews of Astronomy and Astrophysics*. **8**, 321.
Gabuzda *et al.* (1994) *Astrophysical Journal*. **435**, 140.
Hughes, Aller, & Aller (1989) *Astrophysical Journal*. **341**, 68.
Kollgaard (1994) *Vistas in Astronomy*, **38**, 29.
Kühr and Schmidt 1990, *Astronomical Journal*, **99**, 1.
Laing (1980) *Monthly Notices of the Royal Astronimcal Society*, **193**, 439.