

DISTORTION EFFECTS IN BL LAC RADIO JETS

H. SOL¹, S. APPL², L. VICENTE¹

¹ *DARC, UPR176 du CNRS, Observatoire de Paris-Meudon, 92195 Meudon – France*

² *Observatoire Astronomique, 11 rue de l'Université, 67000 Strasbourg – France*

BL Lac objects often show a quite distorted radio morphology. Almost 75% of the BL Lacs for which the information is available show an apparent misalignment angle ΔPA between the VLBI jet and the large scale radio structure larger than 45 degrees. This can be explained by strong enhancement of slight bending due to projection effects, especially if BL Lacs are the most highly beamed sources. However we recently performed a statistical analysis of misalignment angle histograms for 155 extragalactic radio sources of different types and found that the *intrinsic* distortion is significantly more important in BL Lacs than in quasars and even CSS sources. Indeed the best fits of the ΔPA histograms by a simple bend model correspond to $\gamma\psi = 123^\circ$ for BL Lacs, 37° for quasars and 36° for CSS sources, where ψ and γ are the jet typical intrinsic bend and Lorentz factor within a given class of sources (Appl et al, 1995). If, as currently thought, jets in BL Lacs have smaller Lorentz factors than in quasars, high intrinsic bending and misalignment appear to be the rule in BL Lac sources.

Another property of BL Lac objects which might be characteristic of a class of sources is that their magnetic configuration appears perpendicular to their VLBI jet, while it is commonly longitudinal in other radio sources and quasars (Gabuzda et al, 1992). A simple assumption is that VLBI data mainly reveals the magnetic structure of the external medium in which the nuclear beam is injected. Large scale galactic and intergalactic magnetic fields are not rare in the extragalactic space and likely favour formation of accretion discs in a plane perpendicular to them (Asséo, Sol, 1987). Thus one would expect to observe essentially parallel jets and magnetic fields (as for young stellar objects) if jets are launched perpendicular to discs. However this is no more true if the central black hole has formed much

earlier or from a much smaller region, or has undergone some violent interaction with another galactic nucleus. It has in that case an independent rotation axis and drives the inner part of the accretion disc into its equatorial plane through the Bardeen-Petterson mechanism. An inner nuclear beam can then be injected at high angles to the ambient magnetic field. A wide range of parameters allows propagation and radiation of such beams which present the characteristic VLBI magnetic pattern of BL Lac jets (Sol, Vicente, 1994).

Central engines with highly twisted accretion discs therefore provide an interesting frame for a simple explanation of the magnetic peculiarity of BL Lac jets. Clearly they also lead to high distortion in the global radio morphology when jets are emitted perpendicular to the local plane of the disc. Following the view of “double jet” models presented by Dole et al (this symposium), the VLBI elongation is related to the black hole axis while the large scale radio structure is launched from the outer accretion disc in a direction determined by the large scale properties of the AGN surroundings. High apparent misalignment angles ΔPA and intrinsic distortion are thus directly expected. As a “by-product”, this scenario suggests the existence of a population of sources with an intrinsic misalignment close to 90 degrees. Nuclear beams are then injected into the outer part of the discs and perpendicular to the ambient magnetic field, which likely slows them down very efficiently. Such a population provides a straightforward description of the intriguing secondary peak observed at 90 degrees in the histograms of misalignment angles ΔPA (Pearson, Readhead, 1988). Interaction of the nuclear beam with the outer disc and the transverse magnetic field likely favours strong variability, high polarization and enhancement of radiation which can give typical core-dominated properties to such sources (Appl et al, 1995).

Our proposition of highly twisted discs in BL Lac objects has another consequence. Their ionizing cone now intersects an ambient gas distribution with probably different temperature and densities and can induce specific properties of the spectral lines detected in these sources. This illustrates how evolution effects, interaction between galaxies and formation of central engines might be usefully taken into account besides beaming and orientation scheme for unification of active galactic nuclei.

References

- Appl, S., Sol, H., Vicente, L., 1995, *A&A*, in press.
 Asséo, E., Sol, H., 1987, *Physics reports*, 148, 307.
 Gabusda, D.C., Cawthorne, T.V., Roberts, D.H., Wardle, J.F.C., 1992, *ApJ*, **388**, 40.
 Pearson, T.J., Readhead, A.C.S., 1988, *ApJ*, **328**, 114.
 Sol, H., Vicente, L., 1994, *Multi-wavelength continuum emission of AGN*, Courvoisier, T.J.-L., Blecha, A., eds, Kluwer Academic Publishers, p. 473.