

Toroidal magnetic fields and associated currents in AGN jets on kiloparsec scales

Sebastian Knuettel, Denise Gabuzda

Helical fields are generally accepted as the main magnetic field configuration for the launching of astrophysical jets, but it is still unclear how they effect the jet collimation and what role they play on the largest jet scales (if they persist to such distances from the central AGN). The synchrotron emission from these jets can be highly linearly polarised, making the behaviour of the polarised radiation a useful and reliable tool in examining the magnetic field environment of these jets. The observed polarization angle is effected by Faraday rotation, which is depends on the local electron density and line-of-sight magnetic field component. Observations at multiple wavelengths can be used to construct Faraday-rotation images, which provide information about the distribution of both these properties. A significant gradient in the RM transverse to the jet direction may indicate a corresponding gradient in the line-of-sight magnetic field, implying a toroidal or helical magnetic field, which would, in turn, imply the presence of an associated electrical current in the jet. Such an analysis has been done on VLBI scales using observations at centimetre wavelengths, however, relatively few studies have probed the kiloparsec scale jets. The detection of such large scale gradients can reliably demonstrate that helical or toroidal fields can persist to large distances from the central AGN. We present kiloparsec-scale Faraday rotation maps for several AGNs, including NGC 6251, based on archival data from the Very Large Array. NGC 6251 shows statistically significant transverse RM gradients across its kiloparsec scale jet structure that implies an outward current. This adds to previous detections of significant transverse Faraday rotation gradients across large-scale jets, which have all corresponded to outward currents (Christodoulou et al 2016, Knuettel et al 2017). Together with results for AGN jets on parsec scales, which imply inward currents (Gabuzda et al 2018), this suggests that the jets have a current/magnetic field configuration similar to that of a co-axial cable.