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A Polarimetric Survey of CSS Sources at 22 GHz with the VLA

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Abstract. We discuss the preliminary results from radio polarization observations of 22 compact steep spectrum sources made with the VLA at 1.3 cm wavelength. We confirm that 1) the detection of a flat-spectrum synchrotron halo and a radio bridge in two CSSs, suggesting that they may be young sources, 2) CSS galaxies with two lobes of emission asymmetric to the core position show strong polarization asymmetry with the highest polarized emission arising from the component farther away from the core and 3) Source components which are nearest to the cores are generally unpolarized even at such short wavelength, suggesting that the spread in the λ^2 polarization spectra is much narrower than in extended sources.

1. Introduction

Compact steep-spectrum sources (CSS) are radio galaxies and quasars defined to have spectral index α steeper than 0.6 ($S_\nu \propto \nu^{-\alpha}$) and projected angular sizes less than 15 kpc (H=100 km/s Mpc^{-1}, $q_0 = 1/2$) (Fanti et al. 1985). Although CSS sources have galactic dimensions, they are too complex since they present very distorted morphologies and the misalignments are higher in quasars than in radio galaxies. It is unknown whether the CSS sources are a small class of objects confined permanently by the host galaxy (Fanti et al. 1989; Fanti et al. 1990 and references therein) or if they are young sources which are going to evolve to large radio sources (Carvalho 1985). Moreover, an analysis of the depolarization of the synchrotron radiation is a direct tool to estimate the density and magnetic field of the environment in which the CSS sources are embedded. To do so, we observed a sample of CSS sources which consists of the 3C radio sources observed by Lüdke et al. (1997) with the MERLIN network, the Peacock and Wall sample, plus some CSS galaxies from the 4C catalogue for completeness. The VLA in BnC array in standard continuum and polarization mode has been used to produce the polarization images using the NRAO AIPS package.

2. The Results So Far

The fractional polarization is higher at 1.3 cm than at longer wavelengths by about 4%. If the CSS sources are embedded in a very dense medium, even small projection angles would imply in strong polarization asymmetry which could be seen even at short wavelengths and we expect that the components near to the core would be those in which the Faraday depolarization should be stronger (Garrington & Conway 1991), which is an observable characteristics of our images. The alignment between the radio and optical morphologies of extended radio sources has been detected in CSS radio galaxies (de Vries et al., these Proceedings, p. 195). The ionized narrow-optical emitting regions are natural candidates for the dense magneto-ionic medium screening the components which are nearest to the cores and therefore inducing strong depolarization of the synchrotron radio radiation.

Our observations have also been used to quantify the Faraday depolarization in CSS sources by fitting standard Burn's depolarization models (Laing 1985) and the results are discussed in another paper (Lüdke & Bellincanta 1997). It is worth to emphasize that those values have been derived for the jet sides of CSS sources and should be treated as low limits for the depolarization in CSS sources. The counter-jet sides of CSS quasars and galaxies certainly will exhibit much higher depolarization since the polarized emission is absent at wavelengths as short as ~ 1 cm. An exact quantitative analysis could be done if we knew the fractional polarization on the visible components of CSS galaxies but this is a very difficult observational task even with the available technology.

Our 1.3 cm images are more sensitive than previous published images at the same wavelength, which enabled us to detect a high-frequency radio halo in 3C 299 and a bridge of plasma emission in 4C 49.25 which resemble an extended FR II radio galaxy, with a single visible jet and a counter-jet side. High-frequency halos are indicators of young synchrotron ages or very efficient energy replenishment mechanisms (Leahy 1991) but they are rare for CSS galaxies.

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