HIGH-FREQUENCY STUDY OF LOW AND INTERMEDIATE LUMINOSITY RADIO GALAXIES

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1. Introduction

All the information on the morphology, spectral index and polarization properties of low and intermediate luminosity radio galaxies were collected in an intermediate frequency range, and some of the basic questions to be elucidated with such measurements are still unanswered. We therefore decided to extend the study of their characteristics towards higher frequencies. From the B2 and 4C catalogue we selected 26 radio galaxies for which VLA or WSRT data are available. These sources were observed at 10.6 GHz using the Effelsberg 100-m telescope (Gregorini & al. 1992; Mack & al. 1994; Klein & al. 1995).

2. The Spectral Index

The integrated radio spectra between 408MHz and 10.6GHz are found to resemble those of strong 3C sources, the average spectral index being $\alpha = -0.69 \pm 0.02 (S_\nu \propto \nu^\alpha)$. Analysis of the individual spectra shows that most of them are straight up to 10.6 GHz.

The spectral index distribution shows a clear difference between low- and high-luminosity radio galaxies: a strong steepening of the spectrum from the outer hotspots towards the inner cores is present on scales of $\sim$ 200 to 300 kpc for a sample of FRII sources (Jägers 1986), while the B2 and 4C galaxies exhibit a steepening from the cores to the outer lobes.

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3. The Magnetic Field

The degrees of polarization are higher at 10.6 GHz than what is measured at lower frequencies, suggesting a significant Faraday depolarization. The values are generally low ($\sim 5\% - 15\%$) in sources with complex morphologies, while in those with a simple (core/jet/lobe) structure we find high degrees of polarization, with value of up to 50% locally. The magnetic field orientation is related to the morphology of the source: it is perpendicular in the double jets, longitudinal in the one sided jet and tangential to the edges in the lobes. This is interpreted in terms of their presumed helical structure. The observed integrated rotation measures of the sources are rather low, with values hardly exceeding some 20 rad m^{-2} so that at 10.6 GHz we essentially map the intrinsic (projected) magnetic field orientations.

4. Particle Ageing

We interpreted the results of our spectral analysis of B2 and 4C radio galaxies in terms of particle ages and sources lifetime. Using the Kardashev and Pacholczyk model we derived particle ages from $\sim$ 40 to 70 Myrs for most of the sources. The only exception is 1615+35, which is a head-tail source, the spectrum of which suggests an age of $\sim$ 100 Myrs. Comparison with FRII sources shows that the steepening of the spectra in low-luminosity radio galaxies is not as strong as expected on the basis of studies of 3C radio galaxies. Classical FRII radio galaxies appear to have break frequencies between 1 and 5 GHz, while about half of our sample shows break frequencies higher than this. This could indicate that significant re-acceleration take place in low-luminosity radio galaxies.

References

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