RADIO SPECTRA AND PARTICLE AGES OF THE HEAD-TAIL RADIO GALAXY NGC1265

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1. New radio maps

We have performed sensitive observations of three classical head-tail radio galaxies at λ11.1, 6.3, and 2.8 cm using the Effelsberg 100-m telescope (Zech, 1994). Complete maps of the sources 3C129, NGC1265, and 3C465 were obtained, including the distributions of the linearly polarized intensity. Together with the low-frequency interferometric maps these allow a comprehensive study of their radio spectra and, based on models of particle losses, the derivations of particle ages across these sources. The highest frequency involved allows an unambiguous derivation of the projected magnetic field structure, unimpeded by Faraday effects. Here we focus on NGC1265, which is located in the Perseus Cluster.

The head-tail structure is well visible out to a large distance from the source's head. The twin jets in the vicinity of the head are not resolved with our HPBW. As is to be expected, strong linear polarization is found in the tail. The degree of polarization reaches its maximum towards the tail's end, with values exceeding 50%. This means that the fractional polarization is close to its theoretical value.

R. Ekers et al. (eds.), Extragalactic Radio Sources, 347–348.

2. Spectral index and particle ageing

We have computed the distributions of the spectral index across NGC1265, with the aim to investigate the particle ageing across its tail. Tails of radio sources are particularly suited for this purpose due to their extended, relaxed structure. The low-frequency data of NGC1265 were obtained by Sijbring (1993) at $\lambda\lambda 92$ and 49 cm with WSRT. All maps were smoothed to a common resolution, i.e. 147″ when the Effelsberg $\lambda 6.3$ cm map was involved, or 69″, if only the map at $\lambda 2.8$ cm was used for the computation. The spectral index computed between $\lambda\lambda 92$, 49 and 2.8 cm ranges from $\alpha = 0.5$ in the head to $\alpha = 1.6$ at the tail's end ($S_\nu \sim \nu^{-\alpha}$). The spectral index maps computed between $\lambda 11.1$, 6.3, and 2.8 cm exhibit a dramatic steepening to $\alpha \geq 2.0$ towards the tail's end in spite of the low angular resolution of the maps. We have used all maps to calculate break frequencies and corresponding particle ages with a fair angular resolution. We have adopted the method described by Carilli et al. (1991). In the faint tails, inverse Compton losses against the 3K background may also be important so that we use the relation between particle age and break frequency as e.g. given by Alexander and Leahy (1987). The break frequencies have been calculated for the so-called JP (Jaffe and Perola, 1973) model, which accounts for re-isotropization of the pitch angles.

The map of the break frequency exhibits values from 17 GHz in the head of the source to 2.7 GHz at the tails' periphery, corresponding to particle ages of ∼10 Myrs and ∼45 Myrs, respectively. With a Hubble constant of $H_0 = 75$ km s^{-1} Mpc^{-1} the tail's end is at a projected straight distance of 280 kpc from the host galaxy, and probably a lot more, if we account for projection effects and initial bending of the jets. Assuming that the particles were left behind the host galaxy once they emerged from the inner jet regions, they had to travel at a speed of at least ∼6000 km s^{-1} in order to get where they are. This is in flat contradiction with the typical velocities of cluster galaxies, even though the member galaxies of the Perseus Cluster are known to have a relatively high velocity dispersion (1308 km s^{-1}). This discrepancy implies that the particles still have to move at a considerable speed along the tails. It is conceivable that the very uniform magnetic field indicated by our polarization measurements alleviates this rapid propagation.

References

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