Discovery of High Faraday Rotation Measures in Giant Radio Galaxies

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We report Rotation Measure (RM) estimates of five Giant Radio Galaxies (GRGs) observed by Mack et al. (1997, A&A 123, 423). GRGs are radio galaxies with projected linear sizes exceeding 1 Mpc. In four GRGs (NGC 315, DA 240, 3C 236 and NGC 6251), we found $|\mathrm{RM}| > 100\,\mathrm{rad/m^2}$ after the correction for the galactic foreground contribution.

In three well-resolved GRGs (NGC 315, DA 240 and NGC6251), the product $\langle \overline{B_\parallel} \cdot n_e \rangle \approx 10^{-3} \mu\mathrm{G\,cm^{-3}}$. Assuming pressure balance between the magnetic and the gas pressure, $p_m/p_g = 1$, and a single-cell Faraday medium model, we derive magnetic field strengths of a few μG and a thermal electron density of a few $10^{-4}\,\mathrm{cm^{-3}}$. These densities are one or two orders of magnitude higher than the extrapolation from the X-ray halo of NGC 315 (Worrall & Birkinshaw 2000, ApJ 530, 719).

The relatively high particle density in the extended lobes along with the weak X-ray emission make the gravitational binding of the Faraday medium around GRGs and the gravitation-related amplification (merger, cooling flow) of the magnetic field unlikely.

An alternative could be the inter-cluster 'weather' (Burns 1998, Sci 280, 400). In the case of NGC 315, we can compare the magnetic energy and the energy from the large-scale flow (Enßlin et al. 2001, ApJL 549, 39). The total magnetic energy contained in the RM structure of NGC 315 can be explained if such a flow has a time scale of 10^8 yr.