WHAT MECHANISM DEPOLARIZES THE EMISSION FROM THE SW ARM OF M31?

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ABSTRACT. Gradients in rotation measure and dispersion in rotation measure, both *across* the telescope beam, depolarize the radio emission from the SW arm of M31. Faraday effects along the line of sight appear to be negligible.

A highly polarized region in the SW arm of M31 near the minor axis was recently observed with the VLA D-array at λ20.1 cm (Loiseau et al., 1987). In order to study the distribution of rotation measures (RM), the detailed structure of the magnetic field in the arm (Beck and Berkhuijsen, this volume; Beck et al., 1989), and depolarization mechanisms a comparison was made of the polarization properties at λ20.1 cm and λ6.3 cm (Berkhuijsen et al., 1987) at a resolution of 3'.

A first analysis of the depolarization factor $DP_n(20,6)$ (= ratio of nonthermal polarization percentages at λ20.1 cm and λ6.3 cm) of 7 points along the arm yielded the following results:

1. DP_n is not correlated with $|RM_i|$ (= RM internal to M31) as would be expected in the case of internal differential Faraday rotation along the line of sight caused by a uniform magnetic field (see Fig. 1a). Possible explanations are: *a.* there are magnetic field reversals in the line of sight; *b.* the rotating medium is inhomogeneous and has a small filling factor in the line of sight. The latter case would also be in agreement with the observed thermal emission as derived from radio data.

2. Fig. 1b shows that DP_n is anticorrelated with the maximum *gradient* of RM_i across the 3' beam, i.e. perpendicular to the line of sight. This could happen either in M31 or in our Galaxy on scales of $\gtrsim 600$ pc or $\gtrsim 1$ pc, respectively. Note that in the absence of a gradient $DP_n \simeq 0.35$, hence another depolarizing mechanism causing a decrease of DP_n by a factor of $\simeq 3$ must play a role.

3. Internal Faraday dispersion along the line of sight would give a general depolarization if the properties of the dispersing cells do not vary greatly along the arm. However, dispersing cells with $d_\parallel \gtrsim 30$ pc would be needed making their number along the line of sight too small for this mechanism to be important.

R. Beck et al. (eds.), Galactic and Intergalactic Magnetic Fields, 201–202.

4. Faraday dispersion *across* the 3' beam occurring either in M31 or in our Galaxy may be a likely mechanism. With 50 cells in the beam a dispersion in RM $\sigma_{RM} \lesssim 3$ rad m^{-2} would be required caused by cells with either $d_\perp < 200$ pc in M31 or $d_\perp < 0.4$ pc in our Galaxy, assuming a one-dimensional filling factor $f_\perp = 1$. For $f_\perp < 1$ also $d_\perp$ would be smaller for a given σ_{RM}. Interestingly Cordes et al. (this volume), using a completely different method, derived cell sizes in our Galaxy between 0.01 and 1 pc in agreement with our values.

References

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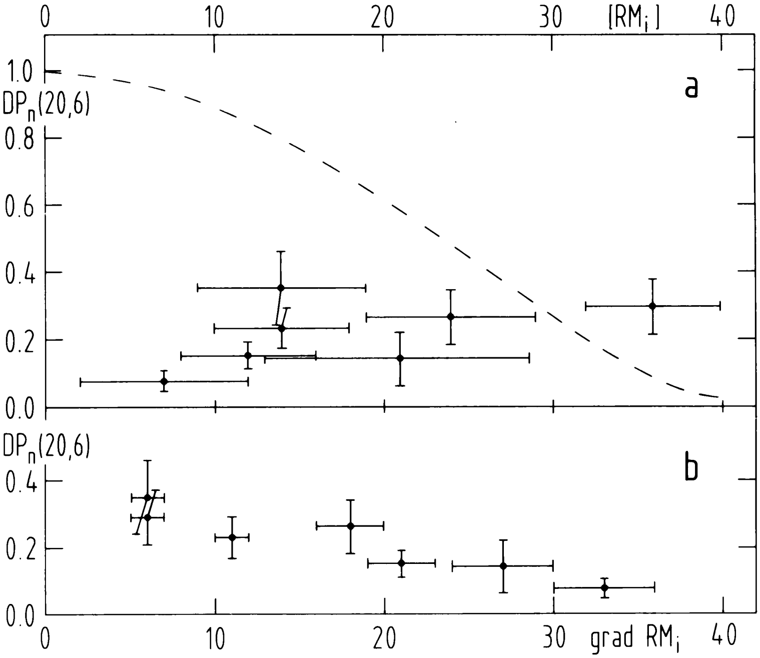

Figure 1. (a) DP_n as a function of $|RM_i|$. The dashed curve shows the dependence expected for differential Faraday rotation along the line of sight caused by one uniform magnetic field component. (b) DP_n as a function of the maximum gradient in RM_i across the 3' beam.