POLARIZED RADIO EMISSION FROM M 51

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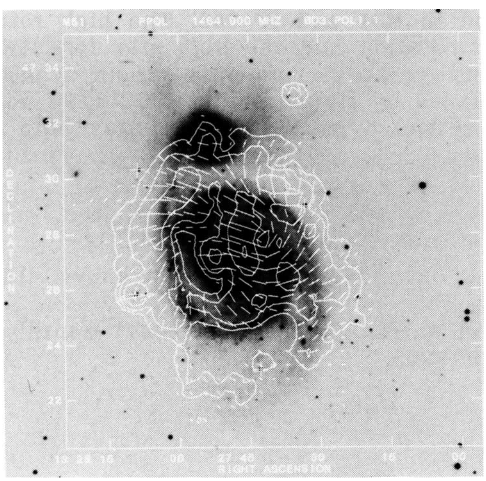
ABSTRACT. The polarized radio continuum emission of M51 is found to be strongest outside the optical spiral arms. The rotation measure varies double-sinusoidally with azimuthal angle which for the first time clearly shows a dominating *bisymmetric spiral* (BSS) structure of the large-scale magnetic field in M51. The pitch angle of the magnetic spiral is similar to that of the optical spiral arms. The lowest (axisymmetric) dynamo mode is possibly suppressed by interaction with the companion galaxy.

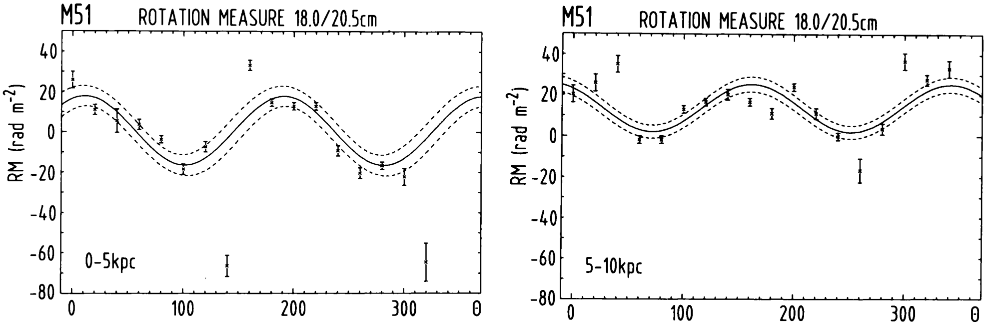
Observations and Results

We observed the spiral galaxy M51 for 12 hours at λ18.0 cm (1.66 GHz) and λ20.5 cm (1.46 GHz) simultaneously (bandwidth 50 MHz each), using the VLA in its D-configuration. The half-power width of the synthesized beam is 43", corresponding to 2.0 x 2.3 kpc in the galaxy's plane at a distance of 9.7 Mpc. The sensitivity is 30 μJy per beam area.



The maxima of the polarized emission at λ20.5 (Fig. 1) and λ18.0 cm are **not** located on the optical spiral arms (except for some weak emission from the outer southern spiral arm). The maxima lie *outside* the main spiral arm in the NE and the NW quadrants, and in the *interarm* regions in the SW and the SE quadrants. Hence the strong density waves which are supposed to be present in M51 are unable to align the interstellar magnetic field. The enhanced star formation in the spiral arms could induce enhanced turbulence to the magnetic field.

R. Beck et al. (eds.), Galactic and Intergalactic Magnetic Fields, 211–212.



The variation of rotation measures (RM) with azimuthal angle θ in the plane of the galaxy (inclination 31°, PA = −10°) is an indicator of the large-scale magnetic field structure. In M51 RM clearly varies double-sinusoidally in the galactocentric intervals 0–5 kpc and 5–10 kpc (Fig.2). The small values of RM confirm that Faraday rotation is low at λ6.3 cm, as had been assumed by Beck et al. (1987) to establish the spiral structure of the large-scale magnetic field. The discrepancy between the radio and the optical polarization data by Scarrott et al. (1987) in the southwest quadrant is also confirmed by the new radio maps.

The RM amplitude slightly decreases from 17 rad/m^2 in the inner ring to 12 rad/m^2 in the outer ring, while the amplitudes in other galaxies like IC 342 and NGC 6946 increase with radius. Beyond 10 kpc no systematic variation is detectable. The amplitudes of the RM curves of around 15 rad/m^2 are similar to those found in other spiral galaxies such as IC 342 and M81 (see M.Krause, this volume). The phases of the RM curves are consistent with the assumption that the pitch angle of the magnetic field lines follows that of the optical spiral arms.

M51 is (beside M81) the second case of a clear *bisymmetric spiral* (BSS) field structure, both galaxies having a companion galaxy. Axisymmetric structures have been detected in M31 and IC 342. The high rotation velocity, the strong differential rotation and the high star formation rate of M51 are favourable conditions for the action of a strong dynamo. The asymmetric gravitational disturbance by its companion NGC 5195 possibly suppresses the lowest (axisymmetric) dynamo mode and may help to excite the higher (bisymmetric) mode.

References

Beck, R., Klein, U. and Wielebinski, R. (1987) Astron. Astrophys. **186**, 95–98.

Scarrott, S.M., Ward-Thompson, D. and Warren-Smith, R.F. (1987) Monthly Notices Roy. Astron. Soc. **224**, 299–305.