MAGNETIC FIELDS IN MOLECULAR CLOUDS AT HIGH GALACTIC LATITUDES

MUNEZO SEKI
College of General Education
Tohoku University
Kawauchi, Sendai 980
Japan

ABSTRACT. We have detected interstellar polarization amounting to 2.6 % in the Ursa Major molecular clouds at a distance of 110 pc. Assuming that paramagnetic grains in those clouds are aligned with the magnetic fields and combining our results with the measurement of Zeeman splitting at 21 cm (Heiles 1989), we argue the strength and direction of magnetic fields.

1. EXTINCTION AND DISTANCE OF MOLECULAR CLOUDS IN URSA MAJOR

Among the molecular clouds detected at high galactic latitudes,a complex of clouds in Ursa Major is notable because of its close association with infrared cirrus features[1]. Since the distance and the magnetic field are critical in the argument on the stability of the cloud, we have made both photometric and polarimetric observations of stars in and around the Ursa Major clouds, using the 36-inch telescopes of the National Astronomical Observatory of Japan. Observed stars are indicated in Fig.1 with small circles. Photometric data in the uvby system are calibrated following Crawford[4] and the distance moduli and color excesses are derived for B, A, and F stars. The distance to the cloud is estimated to be 110 pc.

2. INTERSTELLAR POLARIZATION IN SAO 14889

Polarization degrees less than 0.2 % are obtained for the programmed stars except #12,#13 and #20. Polarization degree is exceptionally large in star #12 (= SAO14489). The wavelength dependence is well represented by Serkowski's law with P_{max} = 2.63 % and λ_{max} = 0.43 μm. Spectral type, V magnitude, color excess, and distance of this star are A5 III, V=9.17 mag, E(b-y)= 0.233 mag, and r = 433 pc, respectively. The polarization efficiency defined by P/Av is 2.6 %/mag. It is interesting to compare our results with the distribution of CO molecules and of infrared flux at 100 um. There exists strong correlation between them: polarization is detected toward stars behind the cloud and near the local maxima of CO emission or 100 um flux. The line of sight to star #12 passes through denser part of the cloud than that to star#13.

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3. STRENGTH AND DIRECTION OF MAGNETIC FIELDS IN CLOUDS

Following the improved theory on alignment of paramagnetic grains[3],the observed polarization efficiency is approximately written as

$$(P/A_V)_{obs} = (P/A_V)_{max} \sin^2\psi$$

where the suffix 'max' refers to the perfect spinning alignment and ψ is the angle between the line of sight and the magnetic field. Setting $(P/A_V)_{max}$ = 3.0 %/mag and substituting the value of 2.63 %/mag into $(P/A_V)_{obs}$, we obtain $\psi = 69^\circ$ or 111°. From the measurement of the Zeeman effect for the 21-cm line, Heiles[4] obtained $B_{/\!/}$ = +9 μG at a position between two local maxima of CO/100 um emissions. If the same B is assumed at the position of #12, then we obtain $\psi = 111^\circ$ and B = 25 μG. The fairly strong field results from the assumption that magnetic fields are uniform in the cloud. It may occur that the direction of the field changes from place to place. It should be noted, however, that the position angle of the polarization is not so changed over the cloud complex and is parallel to the HI loop which is prominent around the North Celestial Pole[4].

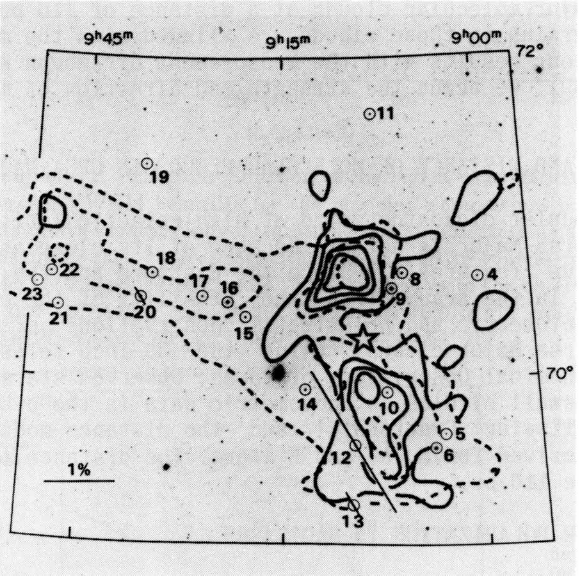

Fig.1. Observed stars are shown with small circles. The contours of CO emission are mapped with solid lines and those of infrared flux at 100 um are with dotted lines. Both are reproduced from [1]. The asterisk indicate the position where the Zeeman effect is observed.

REFERENCES

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