MAGNETIC FIELD STRUCTURE IN DARK CLOUDS

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The magnetic field geometry in the central regions of two dark clouds has been mapped by measuring the polarization at 2.2 μm of background stars and of stars embedded in the clouds. The observations were done with the Kyoto polarimeter on the Agematsu 1m IR telescope in December 1984 for Heiles Cloud 2 in the Taurus dark cloud complex, and on the UKIRT 3.8m in May and July 1985 for the ρ Ophiuchus dark cloud core. The main results are:

i) Most of the stars in both regions show polarization and their maxima are 2.7% in Heiles Cloud 2 and 7.6% in ρ Oph, respectively. There are similar positive relations between polarization degree and extinction A_V's.

ii) The distribution of position angles for Heiles Cloud 2 shows a single mode at about 50° and that for ρ Oph shows a bimode, at about 50° and 150°.

iii) The magnetic fields, as delineated by the infrared polarization, appear perpendicular to the flattened elongations of the molecular clouds.

Although the efficiency of the alignment P_k/A_V in dense regions is lower than that in the vicinity of the clouds, it is still significant and would require a large magnetic field strength, if normal paramagnetic effects are required. The stratified structure of the clouds could be the result of a fragmentation process under the effect of the magnetic field.

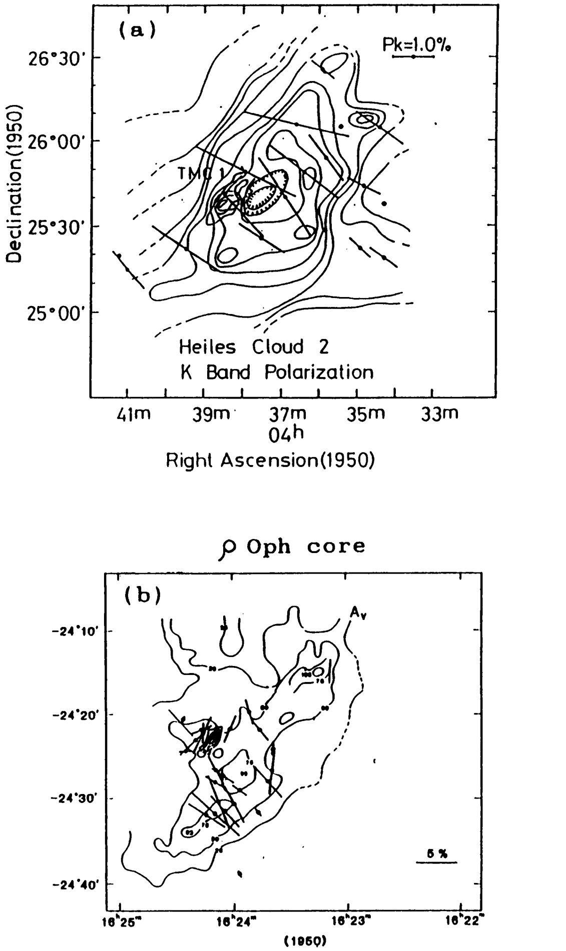

Figure 1

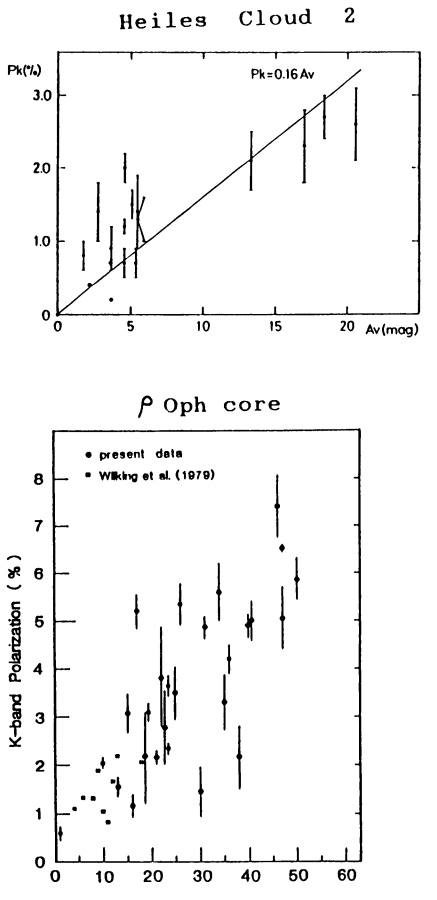

Figure 2

Fig. 1 (a) K-band polarization map towards Heiles Cloud 2 superposed on the A_V contour map (Sherwood and Wilson 1981). The CS emission contour map of TMCI (Snell, Langer, and Frerking 1982) is also shown. (b) K-band polarizations of the central core of the ρ Oph dark cloud are superposed on the map of the visual extinction (Wilking and Lada 1983).

Fig. 2 Degree of polarization in the K-band versus total visual extinction A_V.

REFERENCES

Sherwood, W.A., and Wilson, T.L.: 1981, Astron. Astrophys. 101, 72.
Snell, R.L., Langer, W.D., Frerking, M.A.: 1982, Astrophys. J. 255, 149.
Wilking, B.A.,and Lada, C.J.: 1983, Astrophys. J. 274, 698.

MOUSCHOVIAS: What are the number densities in these clouds?

TAMURA: $\sim 10^3$ cm^{-3} in Heiles Cloud 2 and $\sim 10^4$ cm^{-3} in the ρ Oph core.

MOUSCHOVIAS: At such low densities ($\lesssim$ a few $\times$ 10 cm^{-3}), ambipolar diffusion cannot account for your derived, relatively small k(= 1/4) in the relation $(B/B_0) = (n/n_0)^k$. The uncertainties in deriving the field *strength*, as opposed to just its *direction*, from polatization observations must have something to do with it; aslo the values of B_0 and n_0 you use (*e.g.* see 1985, Astron. & Astrophys. 142, 41); they should be those values at which self gravity becomes important (and contraction perpendicular to field lines begins) and k becomes 1/2 (see 1976, Ap. J. 207, 141). The quantity B_0 can typically be 3 microgauss but n_0 is given by

$$n_0 = 137 \frac{B_0^{3/2}}{M^{1/2}} \text{ cm}^{-3} ,$$

where B_0 is the field measured in microgauss and M the mass measured in solar masses (see above reference, equation 5b).

PUDRITZ: Your observation of the alignment of the magnetic field of subcondensations with one another is extremely interesting. It suggests that the first structures to have formed in molecular clouds are large scale sheets, out of which subcondensations have fragmented. If subcondensations form first, one would see a more random orientation of their associated magnetic field orientations. Could you comment on this?

TAMURA: As I have shown in the talk, the polarization vectors are aligned fairly regularly; most of them are nearly perpendicular to the elongation of the clouds. One exception I think of is the "streamer" region to the east of the ρ Oph core. The polarizations there are parallel to the streams, but they are quite regular again.

FAZIO: Have you got any evidence of rotation or measurements of Doppler shifts across the structure for the same clouds where you observe magnetic fields polarized perpendicular to the elongation of the clouds?

TAMURA: No, I have no knowledge of rotation measurements for these complexes.

FAZIO: If not, it would be worthwhile to do those measurements, in order to investigate the role of magnetic field and rotation on the instability of these clouds (compare, i.e., with the Chandrasekhar and the Fermi Jeans mass).