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The Magnetic Field in Star-Forming Regions of the Perseus Molecular Cloud

To understand the influence of magnetic fields on star formation processes, we estimated the magnetic field strength in IC348, L1448, L1455, NGC1333, and B1 of the Perseus molecular cloud using the Davis-Chandrasekhar-Fermi (DCF) method and its modified approaches. The angular dispersion was derived from 850~μm polarization data observed by the JCMT, while velocity dispersion was measured from N_2H^+ (1-0) and NH_3 (1,1) spectral lines observed with the NRO and the GBT, respectively. The average plane-of-sky magnetic field strength calculated by the DCF method is around a few hundred μG, consistently higher than those obtained using the modified methods. Nevertheless, the observed mass-to-flux ratio with all the methods show a transition from subcritical in filaments to supercritical in the cores, suggesting that cores initially form in subcritical environments before evolving into supercritical ones. In addition, all regions exhibit sub-Alfvénic or trans-Alfvénic conditions, indicating that magnetic fields dominate over turbulence. Although these results may reflect our selection criteria in angular dispersion measurements, which exclude regions with large perturbations in polarization angles, the excluded area is only 17.5 % of the core regions with column density larger than $\sim 4\times10^{22}$ cm^{-2}. To assess the relative importance of magnetic fields, gravity, and turbulence, we also calculated these energies for prestellar and protostellar cores. Our results show that the proportion of gravitational energy is higher in the denser regions traced by NH_3. These findings align with the ambipolar diffusion model, indicating a weakening magnetic field and increasing gravitational dominance toward core centers.

Section

Star Formation

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