What are we learning from the relative orientation between the magnetic field and the density structures in molecular clouds?

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We present the study of the relative orientation between the gas column density structures and the magnetic field projected on the plane of the sky, as inferred from observations of dust polarized thermal emission, in two density regimes. First, toward the Orion-Eridanus superbubble, a nearby structure that spans more than 1600 square degrees in the sky, where we use the observations from the all-sky HI survey based on the EBHIS and GASS surveys (HI4PI) and Planck 353-GHz polarization. There we find that the large-scale magnetic field was primarily shaped by the expanding superbubble, playing only a secondary effect in structuring the HI shell. Second, toward the Vela C molecular complex, a high-mass star-forming region located at 700 pc from the Sun, where we use the column density estimates obtained with Herschel and the 250, 350, and 500 μm polarization observations by the Balloon-borne Large-Aperture Submillimetre Telescope for Polarimetry (BLASTPol). We find that the relative orientation between the gas column density structures and the magnetic field and the shape of the column density probability distribution functions are correlated in different subregions of Vela C. This correlation suggests that the magnetic field is dynamically important for the formation of density structures in the molecular cloud. We interpret both of these results by revisiting the transport equations of ideal magnetohydrodynamic (MHD) turbulence and constructing an expression for the time evolution of the angle between the density gradient and the magnetic field.

Molecular Clouds