Exploring Magnetic Field Structure in Star-Forming Cores with Polarization of Thermal Dust Emission

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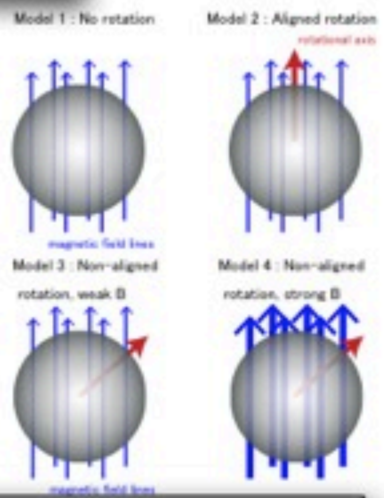
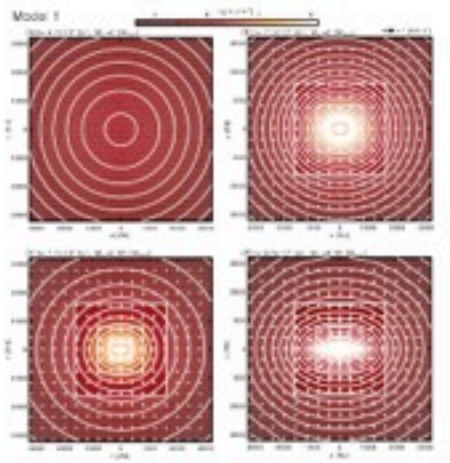
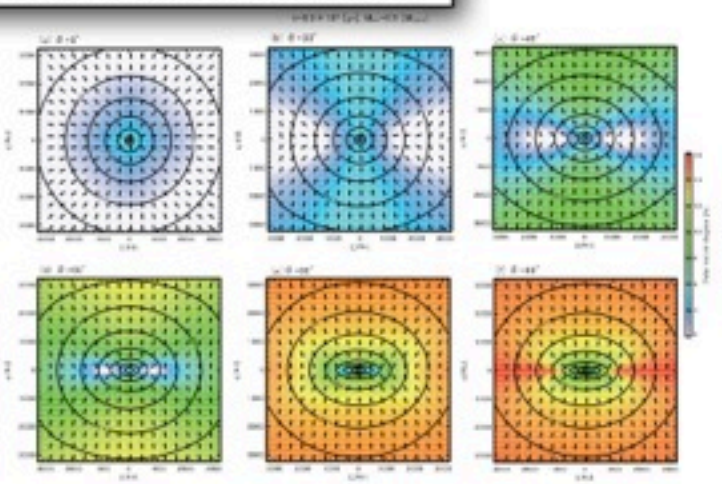
The configuration and evolution of the magnetic field in star-forming cores are investigated in order to directly compare simulations and observations. First, we calculate the evolution of a collapsing magnetized cloud from the prestellar stage until long after protostar formation. Then, we calculate the polarization of thermal dust emission expected from the simulation data. We create polarization maps with arbitrary viewing angles and compare them with observations. Using this procedure, we confirmed that the polarization distribution projected on the celestial plane strongly depends on the viewing angle of the cloud. Thus, by comparing the observations with the polarization map predicted by the simulations, we can roughly determine the angle between the direction of the global magnetic field and the line of sight. The configuration of the polarization vectors also depends on the viewing angle. We found that an hourglass configuration of magnetic field lines is not always realized in a collapsing cloud when the global magnetic field is misaligned with the cloud rotation axis. Depending on the view- ing angle, an S-shaped configuration of the magnetic field (or the polarization vectors) appears early in the protostellar accretion phase. This indicates that not only the magnetic field but also the cloud rotation affects the dynamical evolution of such a cloud. In addition, by comparing the simulated polarization with actual observations, we can estimate properties of the host cloud such as the evolutionary stage, magnetic field strength, and rotation rate.

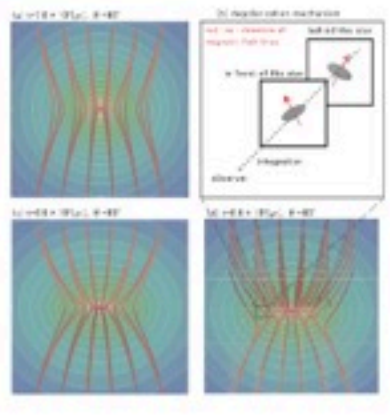
MHD simulation





Observational Visualization : Polarization





Conclusion

- We successfully reproduce the hourglass structure of magnetic field in polarization map from 3D MHD simulation
- We also find S-type structure in polarization maps in some initial conditions and viewing angles.
- These results have good agreements with previous observations.