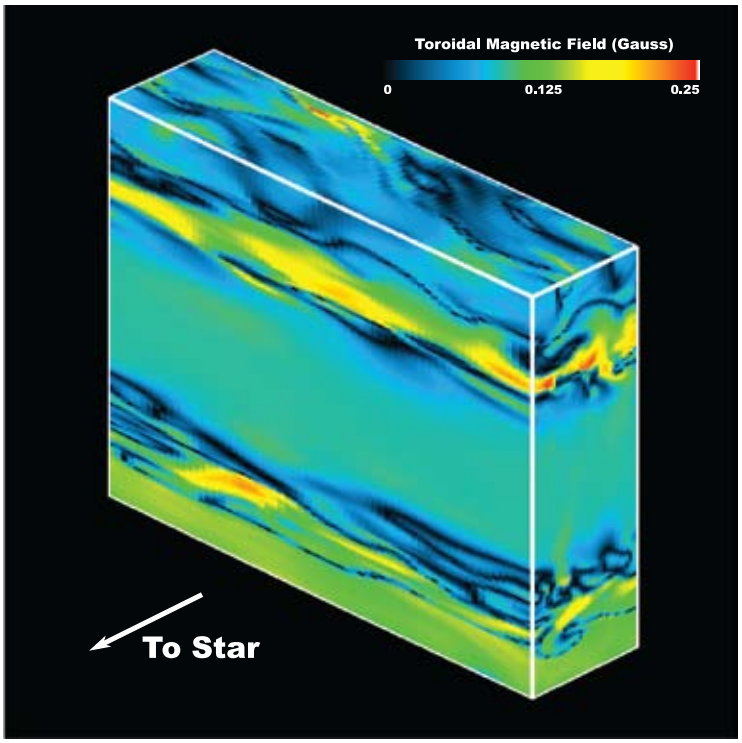
Dead Zone Accretion Flows in Protostellar Disks

This project investigated the environment for planet formation by modeling small patches of the flattened disk of gas and dust that orbited the young Sun (they lie at 1 astronomical unit, AU near Earth's orbit and 5 AU near Jupiter). The degree of coupling between magnetic fields and the protostellar gas was determined by the chemical reactions of ionization and recombination.

During this process, the calculations treated the magnetic forces that drove turbulence in the disk. Therefore, the magnetic forces drove a weak flow of material through the interior of the disk toward the star because the interior became weakly ionized as the outer layers absorbed more stellar X-rays and interstellar cosmic rays.

The equations of magnetohydrodynamics with a spatially varying Ohmic resistivity were solved using the method of characteristics and constrained transport. The ionization-recombination reaction network is solved by semi-explicit extrapolation. The models constructed through this project are essential for understanding the data returned from space telescopes and interplanetary probes. By testing such models against the data, we may be able to develop a picture for the origins of Earth and other planets.

Parallel computations used to solve the recombination reaction network of many points for this work were conducted on the NASA Jet Propulsion Laboratory's supercomputers.



Toroidal magnetic field in a model patch of protostellar disk from a 3-D magnetohydrodynamical calculation. The Ohmic diffusion of the magnetic fields through the gas is included, with the Ohmic resistivity computed by solving a time-dependent ionization and recombination reaction network cell by cell. The disk is made up of turbulent top and bottom layers with tangled magnetic fields, separated by a weakly ionized "dead zone" containing a smooth field that drives a residual flow of gas toward the young star.

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