

**SPECIAL JOINT EPS-ASTRONOMY SEMINAR**  
**Wednesday May 23, 4 p.m. (refreshments at 3:30pm)**  
141 McCone Hall

**Bruce Buffett**  
University of Chicago

***Numerical Models of Planetary Dynamos:  
Dealing with the Challenge of Unresolved  
Turbulence***

**Abstract**

Planetary magnetic fields are continually regenerated by dynamo action in the conductive interiors. Numerical models first achieved self-sustaining magnetic fields about ten years ago and the results have been spectacular. Models can successfully reproduce key features of planetary fields, including the dipole dominance and the episodic reversal of polarity. However, it is generally acknowledged that these models are unrealistic in many respects. All of the models currently use physical properties that are very far from Earth-like values. As a consequence, the nature of the dynamics is altered and the potential to address important scientific questions is limited. The challenge for making improvements lies in dealing with the effects of unresolved flow. This unresolved flow interacts with both the temperature and magnetic fields to produce new and interesting effects that have no counterpart in conventional turbulence. Dynamo models currently parameterize the effects of turbulence using simple eddy diffusivities for the turbulent transport of heat and momentum. No account is taken of small-scale interactions between the velocity and magnetic fields. In addition, none of the current models account for the strong anisotropy in turbulent transport caused by the influences of rotation and a strong large-scale magnetic field. In this talk I explore alternative strategies that incorporate the missing interactions and reproduce the expected anisotropy in turbulent transport. Encouraging results are presented for both plane-layer and spherical-shell dynamo models. A summary of the outstanding challenges is given.