Advanced Plasma Physics - Projects

Following is a list of the project titles. These projects require to review, understand, and summarize original research or to carry out and report a limited numerical simulation project. Project topics should use scientific articles on space or laboratory plasma physics which are published in journals or monographs. It is expected that the results are presented in a short (15 minutes/per presentation) seminar in class and in a written report. Projects can be shared by up to 3 students and each should make a 15 minute presentation of his/her work on the project. Project topics can be more general addressing the state of an important science question or specific by focusing mostly on one research paper (more suitable for one individual)

Notes and Hints:

- Use the references in research papers to gain any additional insight needed to understand the topic.
- List the references which you used in your report.
- Make the presentation/report as concise as possible with a careful selection of the material.
- Do not attempt to present all material of an article on a given topic. Present the material you regard as important (and which you understand).

Big Project Topics:

- Major solar eruptions - What are they and how do they work? Are we in danger?
- What heats the solar corona?
- Is magnetic reconnection real? What is our current understanding?
- When will fusion work in a man made device?
- What are geomagnetic substorms?

Little Project Topics (Examples):

- Earth's Magnetospheric Cusps (Smith and Lockwood, *Reviews of Geophysics, No.2*, 233, 1996)
- Open and Closed Magnetospheric Tail Configurations and their Stability (Birn, Sommer, Schindler, *Astrophysics and Space Science, 35*, 398, 1975)
- Selfconsistent Theory of Time-Dependent Convection in the Earth's Magnetotail (Schindler and Birn, *J. Geophys. Res., 87*, 2263, 1982)
- Magnetic Field Reconnection (Sonnerup, in *Solar System Plasma Physics*, ed. Lanzerotti, Kennel, Parker, Vol III, 1979)
- Magnetic Reconnection in the Presence of Sheared Flow and Density Asymmetry: Applications to the Earth's Magnetopause (La Belle-Hamer, Otto, Lee, *J. Geophys. Res., 100*, 11875, 1995)

- Plasma and Magnetic Field Properties Associated with Pressure Pulses and Magnetic Reconnection at the Dayside Magnetopause (Otto, Lee, Ma, *J. Geophys. Res., 100*, 14895, 1995)
- Kelvin-Helmholtz instability at the magnetotail boundary: MHD simulation and comparison with Geotail observations (Otto and Fairfield, *J. Geophys. Res., 105*, 21175, 2000)
- Anomalous Resistivity and Anomalous Diffusion (Treumann and Baumjohann, *Space Plasma Physics*, pp 317)

Simulation Projects:

- Theory and modeling (two-dimensional) of macro-instabilities (Interchange, Kelvin-Helmholtz, Coalescence, Tearing mode, Magnetic reconnection) and waves.
- One-Dimensional MHD Simulation - MHD Waves, Shocks, and Equilibria (Numerical simulation code and visualization tools are available. It is expected to select several applications from the topics: simple wave propagation, MHD discontinuities and shocks, wave interaction with discontinuities and shocks, and MHD equilibria. For the chosen topic a theoretical description of the dynamics is needed to accompany the simulation results.

Homework (due 4/5/2012): Start the project by searching for and identifying material for your project. Generate a plan for your goals and the execution. Provide a motivation for your choice and write a two page summary of the project goals and steps you took to get the project started.