IFSR-971 - October 2003

Laser *Z*-Pinch Dipole-Target Experiments to Simulate Space Physics Acceleration Processes

W. Horton and C. Chiu

Abstract

Laboratory experiments using a plasma wind generated by laser-target interaction are proposed and analyzed to investigate the creation of shock in front of the magnetosphere and the dynamo mechanism. Magnetic dipoles are placed in the plasma wind and measurements of the electron fluxes bombarding the spheres surrounding the dipoles are recorded. The experiments are to be analyzed with the methods used in theoretical simulation of the solar-wind-driven magnetosphere interactions. The proposed experiments, which involve measurements on the creation of the shock front due to the impact of the supersonic plasma wind on the magnetosphere, and the subsequent generation of energetic electrons, are thought to be relevant to understanding the acceleration mechanisms at work in shock-driven magnetic dipole confined plasma.

IFSR-945 - April 2002

Substorm Classification with the WINDMI Model

W. Horton, R.S. Weigel, D. Vassiliadis, and I. Doxas

Abstract

The results of a genetic algorithm optimization of the WINDMI model using a substorm data set are presented. A key result obtained from a computational search for convergence of the prediction over the database is the finding that there are three distinct types of VB_s-AL wave forms.Ý Type I and III substorms are given by the internally-triggered WINDMI model. The WINDMI analysis identifies an additional type of event, called a type II substorm, that requires an external trigger as in the northward turning of the IMF model of Lyons (1995). Intrinsic database uncertainties in the relative timing between the ground based AL electrojet signal and the arrival time at the magnetopause of the IMF data measured by spacecraft in the solar wind prevent a sharp division between type I and II events.Ý Within these timing limitations we find that the fraction of events is roughly 40% type I, 40% type II, and 20% type III.

IFSR-915 - 2000

Low Frequency Stability of Geotail Plasma

H. Vernon Wong, W. Horton, J.W. Van Dam, and C. Crabtree

Abstract

The release of stored energy in the magnetosphere during magnetic storms may be triggered by plasma instabilities. We investigate the local stability of a simple but representative model of the flux surfaces of the Earth's magnetosphere in the MHD and drift frequency regimes. Magnetospheric flux surfaces at 6-10

Earth radii, with plasma beta ~ 5, are stable to MHD ballooning modes unless k_v x_p < 2/5 where x_p is the plasma gradient scale length and k_v the vacuum field line curvature at the equatorial plane. Drift modes may also be unstable unless h ~ 2/3, where h is the density gradient scale length divided by the temperature gradient scale length.

IFSR-910 - 2000

Stability Properties of High-Beta Geotail Flux Tubes

W. Horton, H.V. Wong, J.W. Van Dam, and C. Crabtree

Abstract

Kinetic theory is used to investigate the stability of ballooning-interchange modes in the high pressure geotail plasma. A variational form of the stability problem is used to compare new kinetic stability results with MHD, Fast-MHD, and Kruskal-Oberman stability results. Two types of drift modes are analyzed. A kinetic ion pressure gradient drift wave with a frequency given by the ion diamagnetic drift frequency w_{*pi}, and a very low-frequency mode $|w| << w_{*pi}$, w_{Di} that is often called a convective cell or the trapped particle mode. In the high-pressure geotail plasma a general procedure for solving the stability problem in a 1/b expansion for the minimizing $dB_{||}$ is carried out to derive an integral-differential equation for the kinetically valid displacement field x^y for a flux tube. The plasma energy released by these modes is estimated in the nonlinear state. The role of these instabilities in substorm dynamics is assessed in the substorm scenarios described in Maynard etal (1996).

IFSR-869 - 1999 or 2000?

The Solar Wind-Driven Magnetosphere-Ionosphere as a Complex Dynamical System

W. Horton, J. P. Smith, R. S. Weigel, C. Crabtree, I. Doxas, B. Goode, and J. Cary

Abstract

The solar--wind driven magnetosphere--ionosphere system is a classic example of a complex dynamical system (CDS). The defining properties of a CDS are (1)~sensitivity to initial conditions; (2)~multiple space--time scales; (3)~bifurcation sequences with hysteresis in transitions between attractors; and (4) ~noncompositional. Noncompositional means that the behavior of the system as a whole is different from the dynamics of its subcomponents taken with passive or no couplings. In particular the dynamics of the geomagnetic tail plasma depends on its coupling to the dissipative ionospheric plasma and on the nature of the solar wind driving electric field over a suitably long (many hours) previous time interval. These complex dynamical system features are shown here in detail using the known WINDMI model for the solar wind driven magnetosphere--ionosphere (MI) system. Numerous features in the bifurcation sequence are identified with known substorm and storm characteristics.

WINDMI Optimization and Performance Validation

R.S. Weigel, W. Horton and I. Doxas

Abstract

An optimization study of the prediction performance for the substorm model WINDMI is presented. The model is based on the Earth's magnetospheric dynamics and provides a low order description of the nightside energy loading and unloading that takes place during the substorm process. Previous studies of this model on isolated substorms have indicated that it can be a good predictor of solar wind driven substorm activity as measured by fluctuations in the AL index for selected substorms. Because the model is based on a set of VB_s driven nonlinear ordinary differential equations which can exhibit bifurcation and catastrophe like behavior, an optimization of the model using conventional minimization techniques over a large data set does not work well. For such systems the genetic algorithm method of optimization is more efficient at exploring the parameter space. We present the results of a genetic algorithm optimization of WINDMI using the Blanchard--McPherron and the Bargatze data set and test statistically alternative forms of the model which include the effects of ionospheric conductivity enhancements and region 2 coupling. A key result from the large scale computations used to search for a uniform convergence of the prediction over the 117 substorm database, is the finding that there are three distinct types of VB_s-AL wave forms characterizing the substorms in the Blanchard--McPherron database. Two types are given by the internally triggered WINDMI model and the third type requires an external trigger such as the northward turning of the IMF model of Lyons 1995.

Preliminary Analysis of the GEM Challenge Magnetospheric Storms - July 2003

S. Seibert and W. Horton

Abstract

The downloading and processing of the solar wind, aurora and ring current datasets for the seven GEM magnetospheric storms is described. First runs of the WINDMI model with the solar wind data and with physics idealization of the data are presented.

Anisotropic Geotail Equilibria- November 2003

H. Vernon Wong and W. Horton

Abstract

A high-plasma pressure equilibrium with anisotropic pressures $p_\perp\ne p_\|$ is calculated analytically in the local approximation. The local approximation requires that the system well inside the central plasma current sheet and sufficiently far from the Earth that $B_z\simeq\rm const$ is valid. The key parameter $\alpha=(R_c/L_p)(\mu_0 p_0/B^2_z)$ determines if the equilibrium tends toward mirror mode or the firehose instability. Here the Earthward pressure gradient defines L_p^{-1} through $d_x\ell n\, p_0(x)=1/L_p$ and R_c is the radius of curvature of the field line at the equatorial plane.

POSTERS

Calibrating a Magnetotail Model for Storm/Substorm Forecasting

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AGU Fall Meeting 2003, San Francisco December 8-12, 2003, Invited Talk SM42E-05