

Theoretical and Numerical Physics-Based Models with Focus on the Issue of Modelling Fundamental Processes Crossing Multiple Scales (Kinetic to MHD)

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Abstract

We review the application of simulation techniques to the mathematical modeling of space weather events. We focus especially on the methods designed to overcome the difficulties created by the tremendous range of time and space scales present in the physical systems.

We review the aspects of the derivation of the particle in cell (PIC) method relevant to the discussion and we summarise the explicit formulation highlighting its severe limitations due to the presence of stability constraints.

Next we introduce implicit methods designed to remove such constraints.

We describe both fully implicit methods based on the use of non-linear iteration solver and semi-implicit methods based on the linearisation of the coupling and based on simpler linear solvers.

We focus the discussion on the implicit moment method but remark the its differences from the direct implicit method.

The application of adaptive methods within PIC is discussed and the use of fluid, kinetic and hybrid methods is addressed.

Finally practical considerations about the implementation of the implicit PIC method on massively parallel computers to conduct studies of space weather events are given.

The lecture will introduce the use of a simple but complete MATLAB program for PIC simulations and will allow the students to practice on it.

Date: Tuesday 19 October 2010

Time: 09:00-13:00

Room: Kastler Lecture Hall @ Adriatico Guest House