Exponential Propagation Iterative (EPI) Methods and Magnetohydrodynamic (MHD) Modeling of Plasma Dynamics

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Many phenomena arising in science and engineering involve complex interaction of widely ranging temporal scales and can be described by a large nonlinear systems of ordinary differential equations. In a majority of such problems solving this systems analytically is impossible and numerical solution is the only viable path. However, even numerically integration of such systems is a challenging task since standard techniques are too computationally expensive for these types of systems. I will discuss a new class of numerical algorithms called exponential propagation iterative (EPI) methods and explain the advantages such techniques offer.

As an application, for which exponential propagation methods offer computational savings, I will discuss modeling large-scale plasma behavior using resistive MHD equations. In order to describe processes such as the eruptive activity in the solar corona or the dynamics in fusion experiments one has to understand self- organization of large-scale plasma configurations. I will present results of a three-dimensional numerical model which describes plasma as a time-dependent driven system. The results of the simulations suggest new structure of plasma configurations that form in the course of evolution of solar coronal arcades or laboratory plasmas.