Waves and Turbulence in Astrophysics; Applications to the Heliosphere

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Abstract

This thesis deals with numerical studies of astrophysical plasmas, in particular simulations of circularly polarised Alfvén waves in the heliosphere. It consists of six papers and an introduction.

The introduction is meant to serve both as a background to the papers, and also as a brief review of some of the open questions in the field. It starts with a short review of numerical simulations in astrophysics and the structure of the heliosphere. The mathematical models of Alfvén wave propagation in different geometries are given in chapter 3 in addition to some important aspects of the dynamics of Alfvén waves in the heliosphere.

A review of some of the important observational results of waves and turbulence in the heliosphere are covered in chapter 4 together with the open questions that stem from it. This is followed by a review of parametric decay, which is a mechanism that explains some of the features of these observations. Numerical studies for parametric decay are then reviewed. Papers II-IV are examples of such simulations.

A comparison between the dynamics of circularly and linearly polarised Alfvén waves is made in chapter 6 with examples of simulations for the two different cases.

The last part of the introduction looks at future work using multi-dimensional simulations and the parallel computing that is needed to get there. A description of a parallelisation project using Message Passing Interface is also given in this part together with comparisons of different methods of parallelisation.