Dr. F. Valentini

Title: The Vlasov equation: theory and simulation

Abstract.

The Vlasov mean-field model describes the kinetic dynamics of a collisionless plasma. Within this approximation, the micro-fields associated to each single particle are replaced by the mean field that all particles produce at a given spatial point. In this model, the statistical information about the plasma state is provided by the distribution function which represents the probability density in phase space. The Vlasov-Maxwell equations then describes the time evolution of the distribution function for each plasma species, under the effects of the self-consistent electric and magnetic fields. Analytical solutions to the Vlasov-Maxwell equations are available in a few simplified linear cases, but the nonlinear regime, including the most interesting physical phenomenology, must be investigated numerically.

In this Lecture, we will discuss the Vlasov theory of wave-particle interaction in both linear and nonlinear regime, particularly focusing on the entropy conserving properties of the Vlasov plasmas and on the phenomenon of wave plasma echoes. Then, an introduction to the Eulerian approach for the numerical solution of the Vlasov equation will be given together with an overview on the applications of the Vlasov numerical calculations to the problem of turbulence in space plasmas.