Introduction to Kinetic Models of Collisionless Plasmas

Collisionless plasmas arise in a variety of settings, ranging from magnetically confined plasmas to study thermonuclear energy to space plasmas in planetary magnetospheres and solar winds. The two fundamental models that describe such phenomena are comprised of complicated systems of nonlinear partial differential equations known as the Vlasov-Maxwell (VM) and Vlasov-Poisson (VP) systems. We will derive these kinetic models and discuss the possibility of shocks arising from an initially smooth distribution of particles. In particular, we will gain some intuition about shock formation by reviewing a few problems which are related, but simplified, including the famous inviscid Burgers' equation. Finally, time permitting, we will describe recent results concerning the long-time asymptotic behavior of solutions to these systems.