Prof. Nathaniel J. Fisch Symposium "Solved and Unsolved Problems in Plasma Physics", March 28-30, 2016
Alumni Session

Who Sits between Darwin and Maxwell?

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The Vlasov-Poisson (VP) and Vlasov-Darwin (VD) systems are Hamiltonian Galilean-invariant approximations of the Vlasov-Maxwell (VM) system. The small parameter used to justify these approximations is the ratio of a typical particle velocity to the speed of light. VP is obtained from VM in the limit where this parameter tends to zero; VD contains the next-order corrections. Are there systems that contain higher-order corrections than VD while still being 'simpler' than VM in some sense? I will argue that systems 'between' Vlasov-Darwin and Vlasov-Maxwell may be obtained by identifying an appropriate slow manifold of the Vlasov-Maxwell system. This slow manifold is a dynamically invariant subset of the Vlasov-Maxwell phase space. For states in this invariant subset, the electric and magnetic fields are determined completely by the single-particle distribution function. Higher-order approximations of the Vlasov-Maxwell system correspond to higher-order parameterizations of the slow manifold. Can these higher-order approximations be cast in Hamiltonian form? Do these higher-order approximations possess Galilean invariance, or perhaps some modified invariance principle?