# THEORETICAL STUDIES OF LAMINAR SHOCKS: A HAMILTONIAN APPROACH

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The standard way to describe the shock is as a standing solitary shockwave in magnetohydrodynamics (MHD); a boundary layer at which the stream passes from supersonic to subsonic velocities. Low-Mach number conditions exist for which the shock appears to display laminar flow. Although relatively rare, laminar shocks are much studied since the shock mechanism can be investigated without the complication of turbulence. Moreover the flow is at very low density and essentially collisionless. The MHD assumptions do not actually hold within the shock region itself, because the shock width is narrow compared to the gyration radius of ions. A second approach of studying the density using the Vlasov equation expresses the fields as functions of the density, thus yielding a nonlinear partial differential equation, which is not easily solved. A third approach has been to use dynamic particle simulations, but these make simplifying assumptions and introduce anomalous dissipative terms to account for the heating. The authors have been studying the structure of lamina shocks using a much simplified particle dynamic model, in which the magnetic and electrical fields are assumed known and superimposed. The flow in this model is Hamiltonian, and displays interesting statistical physics and thermodynamics. The shock transition is adiabatic (in the thermodynamic sense - the magnetic moment is not preserved) and isentropic. Temperature increase occurs without thermalisation as a purely dynamic effect: as a result the system is driven out of thermodynamic equilibrium. Although this is with prescribed fields, under steady state conditions the fields are constant and so cannot contribute to the entropy. Now an interesting property of Hamiltonian systems is that, even if the underlying dynamical system is nonlinear, the particle density created satisfies a linear partial differential equation. The challenge is thus to create a model which preserves the Hamiltonian structure and from which the fields and shock structure can be analysed or calculated. A possible approach is the MZ method