Outstanding issues in plasma Riemann problem

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The Riemann problem is an initial value problem for a given physical system (such as the hydrodyanmcis (HD), magnetohydrodynamics (MHD), or plasma in general) in which the initial conditions consist of two constant states forming a discontinuity. Obviously, it has numerous applications in space plasma, e.g., the formation of planetary bow shocks, magnetopause, interplanetary shocks, heliopause, and termination shocks. Despite the importance of the problem, there remain several issues remain unsolved. In particular, the solution of the MHD Riemann problem is not always uniquely determined due to the presence of intermediate shocks (Wu, 1987; Takahashi and Yamada, 2014). In this presentation, first we will briefly review our current understanding of the MHD Riemann problem and then will propose a method to determine the solution. For practical applications to space plasma, we will also comment on how plasma kinetic effects may modify the solution qualitatively.

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