HYDROMAGNETIC DRIVEN WAVES IN DUSTY INTERSTELLAR CLOUDS

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ABSTRACT

Shock waves in molecular clouds in the interstellar medium, through rapid compression and heating, drive interesting types of chemistry and physics. An understanding of how multifluid, magnetohydrodynamic (MHD) waves propagate is critical to understanding these shocks. This thesis presents an analysis of wave propagation in a plasma containing ions, electrons and charged dust grains, how these waves are generated in response to a shock, and what effect they have on the time evolution of a shock. I model the ions, electrons, and charged grains as separate fluids that interact electromagnetically with each other, and collisionally with an external fluid of neutral particles. By solving the special case of linearized equations of motion, a disturbance can be accurately modeled for short time scales. This is presented as an example calculation, with two molecular clouds colliding and forming outward-moving discontinuous shocks. It is found that at the earliest of time scales, waves in the ions dominate the time evolution. At slightly later times, diffusion in the ions is most prevalent, and at the very latest times, propagating waves which take charged grains into account become substantial. The most striking effect of MHD waves in shocks is the formation of a magnetic precursor, where charged particle motions ahead of the shock learn about and respond to a shock before the front has reached them, which can smooth out the discontinuous shock if the wave speeds in the ions are large enough. It is found that in models with or without dust grains, a magnetic precursor will form; however, in the former, electrical interactions between grains and ions have the tendency to substantially limit the domain and effect of the precursor.