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Applications of shock wave equations from aerospace to astrophysics

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The study of the problem of shock waves in bubbly liquids to account for bubble drag and inertia, thermal dissipation in bubble oscillations, and collective oscillatory effects and a model of hydrodynamic cavitation equations for spacecraft pumps were investigated to minimize the spending of energy from the turbo pumps. Different from this work, we applied very complicated shock equations and turbulence effects for critical mediums such as astrophysical plasmas by using, this time, magnetohydrodynamic (MHD) equations. This application was for solar coronal holes to investigate the effect of viscosity, parallel (and perpendicular) heat conduction on the propagation of shock waves for one-fluid structure. The author used the "Lagrangian Remap Code (Lare Xd)" numerical code in which the MHD equations are in the Lagrangian form and conservation laws are in the finite difference scheme. All grid points move with local flow speed. The constants in the code are the width of initial current sheet, the upstream shock angle, the plasma beta and the adiabatic index. It calculates automatically the continuity of mass, momentum and thermal energy. It can easily capture the shocks, calculate the local temperature and other non-hyperbolic physical values such as resistivity, viscosity, radiation, thermal conduction, gravity etc. The code uses a staggered grid in which the variables (rho, inertial energy and velocity) are not defined at the same grid location. Velocity is in the cell boundaries, rho is the cell-averaged density at the cell center and magnetic field is on cell faces. The results are second order accurate in space and time. This research explores the effects of high-energetic particles on Earth's magnetosphere and ionosphere by calculating the speed of the solar wind. We could determine the intensity and amount of charged particles blasted off during the flare.

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