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Plasma Effects in Spherical Implosions[1] CLAUDIO BELLEI, PETER AMENDT, SCOTT WILKS, Lawrence Livermore National Laboratory — A remarkable self-similar solution to the problem of a spherically converging shock was published by Guderley in 1942 [1]. Being applicable to an ideal gas, this solution neglects viscosity, thermal conduction and radiation losses and presents singularities when the shock reaches the origin. Radiation hydrodynamic codes include the effects of non-ideality (with artificial viscosity in place of real viscosity), ensuring that the solution is well-behaved at all times. However during an ICF implosion, separation of the electron and ion species occurs at the shock front. For the high Mach number ($M > 10$) incoming (coalesced) shock that is typical of ICF scenarios, the width of the plasma shock front is comparable to the ion-ion mean-free-path $\lambda_{ii} \sim 1$ μm and much larger than the shock front width in an unionized gas at the same density ($\sim 10^{-2}$ μm). Ahead of the plasma shock front, electrons pre-heat the inner gas over distances $\lambda_{ei} \approx (m_i/m_e)^{1/2}\lambda_{ii} \sim 70\mu$m. This decreases the strength of the incoming shock and lowers the temperature behind the rebound shock, a phenomenon analogous to the non-ideal gas effects found in hydro-codes.

[1] Zel'dovich and Raizer, Physics of shock waves and high-temperature phenomena, edited by Hayes and Probstein (Dover, Mineola, NY 2002).

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