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Collision between Radiative and Adiabatic Supersonic Flows

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Shocks can be produced in several astrophysical sources and in controlled laser plasma experiments. They are well-known mechanisms to Cosmic Rays (CRs) generation. Most of the astrophysical and laboratory shock scenarios are a two-shock structure, composed of a reverse and a forward shock. These two shocks can be of different nature, as it is the case for Stellar bow shocks or stellar jets both composed of an adiabatic and a radiative thin shock. This two-shock configuration has never been investigated, and could be very interested regarding possible gamma-rays and neutrinos emission due to the interaction of CRs produced in the adiabatic shock, with the dense compressed layer formed by the radiative shock. The self-similar dynamics of the collision between radiative and adiabatic supersonic planar flows are performed assuming homogeneous radiation cooling. New self-similar solutions relevant to both astrophysical objects and laboratory experiments are derived. Numerical simulations investigate the formation of the radiative cooling shock in the interstellar medium and laboratory Xenon plasma to demonstrate the self-similarity of the interaction in the special case of balanced ram pressure. When the radiation cooling is inhomogeneous, the flow can become thermally unstable and deviate from the self-similar solution. The radiative shock has been found to decelerate because of the cooling effect and the contact discontinuity to accelerate in order to sustain the pressure equilibrium between the adiabatic and radiative downstream shock region. A contact discontinuity subject to a positive acceleration from a light (adiabatic) to a denser (radiative) medium is expected to experience the Rayleigh-Taylor (RT) instability, leading to particle mixing which is promising for gamma-ray and neutrino emission by inelastic proton-proton (pp) collisions and via relativistic Bremsstrahlung. This project belongs to the general framework of High Energy Density Laboratory Astrophysics (HEDLA).