The Role of Thin Shell Mixing in X-ray Production from Massive Star Wind Shocks

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Oblique Collision of Planar Flows

Superimposing advection from bottom to top with a planar collision of flows from left and right transforms temporal evolution of the shock into spatial variation along the vertical axis, as shown in figure 3. This mapping of time variation to spatial variation also produces a cooling oscillation structure as described by Chevalier and Imamura, 1982. The general trend is a suppression of X-ray emission with increasing age of the shocked material. Localized regions of hot, dense plasma also form and contribute significantly to X-ray emission. In figure 3, inflow parameters are at a 45 degree angle with x and y components of the velocity at 10^8 cm/s. Lengths in these snapshots are measured in cooling lengths (Owocki et al., 2013), defined to be $L_c = 1/\kappa_\rho$, where $\kappa$ is an effective cooling opacity and $\rho$ is the pre-shocked density.

Direct Collision of Expanding Flows

In describing the nature of a shock in the head on collision between two expanding flows, a useful parameter is $\chi$, defined by Stevens et al. 1992 to be the ratio of time it would take for a parcel of gas in a shock to cool to the escape time for a parcel of gas from the shock ($t_c / t_{escape}$). By using a model of identical, radially-symmetric winds which collide (see figure 4 for initial conditions) and varying mass loss rate as a proxy for $\chi$, shocks can be placed at a specific $\chi$. The X-ray emissivity of shocks is examined in each of the three regimes, namely adiabatic ($\chi > 1$), radiative ($\chi < 1$), and the transition between the two ($\chi = 1$). In figure 5, snapshots of the models in log(density), temperature, and pressure are shown for three values of $\chi$. From these snapshots, X-ray spectra are synthesized, shown in figure 6.

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References