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Supernova Wind Breakout

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One aspect of Supernova (SN) explosions that has received attention is the shock breakout, which occurs when the radiation from the shock caused by the explosion starts to escape. This can happen at the surface of the star, generating a rapid flash, or at much larger radii, if the star has a dense circum-stellar material (CSM) surrounding it, potentially extending the breakout timescale to days or longer. Extended CSM breakouts have been suggested as the source of various powerful transients, including IIn, “double peak”and super-luminous SNe, as well as X-ray flashes, and low-luminosity gamma-ray bursts. However, previous approaches to calculating CSM breakouts have faced challenges due to the formation of a collisionless shock at breakout, the non-steady shock structure and including Inelastic Compton scatterings. As we show, these have a crucial role shaping the light curve and spectrum producing X-ray radiation. Understanding the impact of these physical processes, we plan to derive a self-consistent quantitative description of the optical- X-ray spectra and high energy photon and neutrino emission of CSM shock breakouts in diverse environments. This will enable us to provide useful predictions for the emitted signal, testing the explanations of the related transients, and use observation in order to derive constraints on the progenitors. In this work, we solved numerically the spectral radiation-hydro equations, modeling the SN ejecta as a constant-velocity spherical piston in a ⊠!” “Wind”-type Hydrogen CSM. We show that a collisionless shock must develop at breakout, generating a non-thermal and hot radiation spectrum at typical X-ray (10keV) energies. We provide an analytic estimation of the hard component of this spectrum, and detail our future work intentions.

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