Explosive Fate of Very Massive Stars

Recent observations find the evidence of massive stars with masses greater than 100 M\(_\odot\). Based on stellar physics, the stars with an initial mass of 150 - 250 M\(_\odot\) may die as energetic thermonuclear supernovae, known as pair instability supernovae (PSNe).

Computational Approach

We introduce a new mapping technique for initializing multi-D simulations of stellar explosions with 1D stellar evolution models and imprint them with velocity perturbations that reproduce the Kolmogorov energy spectrum expected for highly turbulent convective regions in stars. Our simulations considering nuclear burning can calculate the nucleosynthesis and energetic during the explosion.

Shock Breakout

Density at shock breakout: The fluid instabilities driven by reverse-shock have evolved into large scale for R models.

Huge Explosions

Summary of 2D models: We have simulated a suite of progenitor models, containing weak (B) and strong (R) mixing for non-rotating stars with different masses.

Fluid Instabilities and Mixing

When the shock propagates into the hydrogen envelope, we find fluid instabilities start to grow because of the formation of a strong reverse shock that leads to Rayleigh-Taylor instabilities. The future work is to process our simulations into light curves and spectra to produce observational signatures. The expected results will provide useful predictions for PSNe that might soon be examined with the JWST.

References