Pathway to Numerical Simulations of Stripped-Envelope Supernovae

Andrea P. Nagy,
University of Szeged, Szeged, Hungary

Core-collapse supernovae (CCSNe) are among the most intensely studied transients of modern astrophysics due to their significant part in cosmic nucleosynthesis and large-scale distant measurements. Despite that CCSNe play a key role in many astrophysical aspects, we still do not understand some basic features of these objects. Moreover, the determination of the physical properties of SNe (e.g., explosion energy, ejected mass) from observational data is also quite uncertain. Recent high-cadence transient surveys have started to reveal some interesting phenomena of the supernova environment via following the light variation of these objects taken within a few days after the explosion. The observations taken at very early phases provide essential information on the radius of the progenitor star and the properties of the circumstellar matter (CSM). Examining the trace of the CSM could be especially important for stripped-envelope SNe, which lost most of its outer hydrogen and helium layers just before the supernova explosion. They need to get rid of their outermost layers during stellar evolution, but the exact mechanism and timescale of mass-loss processes are not known yet. Thus, numerical simulations are essential to understand better the complex physical nature of these exploding stars.

Moreover, in the past half-century, theoretical studies (e.g., [1], [2]) revealed a discrepancy in the derived ejecta masses from early- and late-time light curve (LC) fits of these objects. To solve this problem, we should consider two different scenarios. First, it is plausible that the mass discrepancy occurs due to the limitations and initial boundary conditions of our semi-analytic models. On the other hand, this mass discrepancy may have a physical cause, such as low-mass, low-density ejecta, or CSM around the supernova remnant. Here, I aim to present our recent studies, which may ease the tension between the estimated ejecta masses and get closer to solving the long-lasting mass-discrepancy problem of stripped-envelope SNe.

[1] A. Clocchiatti, J. C. Wheeler, On the Light Curves of Stripped-Envelope Supernovae, *Astrophysical Journal* **491** (1997), 375–380.

[2] J. C. Wheeler, V. Johnson, A. Clocchiatti, Analysis of late-time light curves of Type IIb, Ib and Ic supernovae, *Monthly Notices of the Royal Astronomical Society* **450** (2015), 1295–1307.