N15c Probing Detached CSM Properties in NEOWISE-selected CCSNe

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Massive stars are known to undergo intense terminal mass-loss episodes that have wide astrophysical ramifications, influencing the interstellar medium, galactic-scale feedback, and the compact-object mass function. The eruptive mass loss years or decades before the core-collapse supernova (CCSN) has become increasingly recognized through interacting SNe, which is characterized by strong interaction of the SN ejecta with dense circumstellar material (CSM). Recently, however, systematic search of the NEOWISE project, which is a mid-infrared (MIR) survey mission, revealed a CCSN population exhibiting late-time MIR rebrightening >1000 days post-explosion, indicating CSM interaction with intense mass loss centuries to millennia before explosion – a virtually unknown phase of stellar evolution.

To investigate the mass, energetics, and geometry of these ancient CSM shells, we have initiated a coordinated multi-wavelength follow-up program. We systematically searched MIR-rebrightening SNe from the NEOWISE-archived data, and obtained >50 candidates showing the delayed CSM interaction. Since panchromatic coverages are essential for constraining the physical properties, we now combine (i) MIR light curve modeling for the NEOWISE data, (ii) ongoing HST/UV imaging measuring the shock-powered UV luminosity, and (iii) ongoing Keck/LRIS spectroscopy to probe the kinematics and ionization state of the shocked/unshocked gas. To maximize the synergy of UV – optical – IR data, we develop a dust emission model including light-travel delays to constrain the geometry, and use optical line profiles to break the degeneracy with covering fraction.