The Peculiar Thermonuclear Transients

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Abstract

Thermonuclear (Type Ia) supernovae are key astrophysical laboratories, yet many members of this family show peculiar and diverse characteristics and remain poorly understood. The most frequent among these peculiar thermonuclear supernovae are Type Iax supernovae, also known as Type Ia 2002cx-like supernovae. Their wide range of luminosities, spectral features, and timescales highlights the need for detailed, multi-wavelength studies of individual events. Such observations are critical to constrain explosion physics, progenitor systems, and their contribution to the transient Universe. We present extensive photometric and spectroscopic observations of the Type Iax supernova SN 2022eyw. The event was monitored from the pre-maximum rise through the post-maximum decline, yielding one of the most comprehensive datasets for this class. Analysis of the bolometric light curve indicates the synthesis of a significant amount of radioactive Ni, while the spectroscopic evolution reveals moderate expansion velocities and rich line features. Radiative transfer modeling with TARDIS provides additional constraints on the chemical composition, ionization structure, and velocity distribution of the ejecta, offering valuable insights into the explosion physics. Together, these properties provide stringent constraints on the explosion energetics and ejecta structure. This study underscores the importance of systematic, multi-wavelength follow-up of thermonuclear transients. By adding a well-observed case to the growing sample of peculiar explosions, our work contributes to the broader effort of mapping the diversity of stellar deaths—an endeavor central to the BRICS initiative on multi-messenger and multi-wavelength transient phenomena.