PHYSICS & ASTRONOMY
THE UNIVERSITY OF TEXAS AT SAN ANTONIO

Dissertation Defense

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Location: **RB 1.204**

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Advisor: **Dr. Pete Roming**

Abstract

Interpreting UV/Optical Type In Supernova Light Curves using a Simple Modeling Approach

The demise of massive stars enriches the universe with heavy elements as the core of these stars collapse. This thesis focuses on unraveling the physics behind the pivotal moment between the death of a star and the birth of a supernova using a simple supernova modeling technique to replicate SN light curve trends. In recent years, due to the uncertainty behind the type of massive star that evolves into the different types of core-collapse events, there has been an increase in core-collapse supernova (CCSNe) surveys aiding the advancement of numerical supernova simulations that explore the properties of the star before the explosion. Early X-ray and ultraviolet supernova emissions carry the information needed for an accurate determination of the properties of the progenitor star and the dynamics of the explosion, but unfortunately are rarely observed, hindering the advancement in supernova research. The general light curve properties of CCSNe (rise, peak, and decay) by sub type are diverse, but appear to be homogeneous within each subtype, with the exception of Type IIn. This work presents early mid-ultraviolet and optical observations of Type IIn supernovae observed by Swift Ultraviolet-Optical Telescope (UVOT). Since most of our observations were detected post-maximum luminosity, we introduce a method for estimating the date of peak magnitude. We use a simple semi-analytical SN model in order to understand the effects of the explosion environment on IIn UV observations. These simplified SN models can be processed quickly in order to explore the properties of the progenitor star along with explosion mechanism and circumstellar medium. We are able to rapidly explore the diversity of the SN light curves by studying the effects of various explosion and progenitor star parameters including: stellar mass and radii, explosion energy, shock temperature and velocity using this 'simple' calculation technique. Furthermore, we compare UV and optical modeled light-curves to Swift UVOT IIn observations to identify the general initial conditions which enable the difference between SN 2009ip and SN 2011ht light-curve properties. Our results indicate that the peak light-curve is dominated by the shock temperature, and explosion energy, whereas the shape depends on the mass of the ejecta, and the explosion energy. Based on this modeling approach, the comparison SN light curves are a product of processes occurring after shock breakout, but before 56Ni decay. In general, the diversity between SN 2009ip and SN 2011ht can be explained by the differences in the outer ejecta mass, and the explosion energy. By including the effects of shock velocities during shock breakout, we deduce the rapid rise and decay of IIn UV light curves is the product of higher shock breakout velocity, which depends on the explosion energy, and the density of the outermost SN ejecta shell. Understanding the UV characteristics of nearby IIn supernovae during an early phase can provide valuable information about the environment surrounding these explosions, leading us to evaluating the diversity of observational properties in this subclass.

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