

THE IMPACT OF HOST GALAXY ENVIRONMENT ON THE PHOTOMETRIC PROPERTIES OF TYPE IA SUPERNOVAE

Abstract

by

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For more than a decade observations and analyses of type Ia supernova (SNe Ia) explosions have resulted in profound insights into the nature of our universe. However, in spite of the amazing discoveries, the list of fundamental things that we still do not understand about SNe Ia is quite long. We attempt to address a few of these questions through an analysis of the galaxies in which they are hosted. We study the effect of environment on the properties of SNe Ia by analyzing the integrated spectra of a sample of local SN Ia host galaxies. We deduce from the spectra the metallicity, current star formation rate, and star formation history of the host and compare these to the supernova decline rates, an indicator of their peak magnitude. Our results indicate a statistically insignificant correlation in the direction that higher metallicity spiral galaxies host fainter type Ia supernovae. However, we present qualitative evidence suggesting progenitor age is more likely to be the source of variability in supernova peak luminosities than is metallicity. Additionally, we compare the host properties to the difference between the derived supernova distance and the distance determined from the best-fit Hubble law. From this we investigate possible uncorrected systematic effects inherent in the calibration of type Ia supernova luminosities using light

curve fitting techniques. A tenuous correlation is observed between the supernova Hubble residuals and host galaxy metallicities. However, further host galaxy observations will be needed to refine the significance of this result. Furthermore, we characterize the environmental property distributions for type Ia supernova host galaxies through a comparison with two larger, more general distributions of field galaxies using Kolmogorov-Smirnov tests. Distribution discrepancies are presented and used to place a lower limit of ~ 2.0 Gyrs on the SN Ia characteristic delay time. In addition, we present a host galaxy study focused solely on the environmental properties of early type host galaxies. Our narrow focus allows for the simultaneous measurement of both global age and metallicity, further allowing for a direct identification of possible dependences between both SN peak magnitude and Hubble Residual on host galaxy age and metallicity. We find evidence for either or both age and metallicity effecting the peak V-band magnitudes of SNe Ia, and we discuss the difficulty in differentiating between a real correlation and one arising from the degeneracy of age and metallicity. We also find an $\sim 2\sigma$ detection of a trend between early type host galaxy metallicity and Hubble Residual. Moreover, we compare the early type host galaxy age and metallicity distributions to corresponding distributions of elliptical galaxies from SDSS via KS-tests and make predictions on the relative SN Ia rate based on a detailed comparison between the age distributions of the Ia hosts and SDSS galaxies. Finally, we present an analysis of the star formation rate distribution of high-z ESSENCE SN Ia host galaxies through a global comparison to the low-z sample of host galaxies and a sample of high-z field galaxies.