Type Ia Supernovae are Good Standard Candles in the Near-Infrared: Evidence From PAIRITEL


Abstract

We have obtained 1065 near-infrared (NIR; JHK_s) measurements of 19 Type Ia supernovae (SNe Ia) using PAIRITEL, the 1.3-m Peters Automated Infra Red Imaging TELescope at Mount Hopkins, Arizona. These data double the number of well-sampled NIR SNe Ia light curves and strengthen the evidence that SNe Ia are excellent standard candles in the NIR, even without correction for light-curve shape or for reddening. We construct fiducial NIR templates for normal SNe Ia from our sample, excluding only the two known peculiar SNe Ia, SN2005hk and SN2005ke. The H-band absolute magnitudes in this sample of 17 SNe Ia have an uncorrected intrinsic RMS of only 0.14 mag, as small as the scatter in luminosity distance measurements based on optical light curves after corrections for light-curve shape and dust absorption. Combining the homogeneous PAIRITEL measurements with 17 SNe Ia from the literature, these 34 SNe Ia have standard H-band magnitudes with an RMS scatter of 0.15 mag. We present a nearby NIR Hubble diagram that shows no correlation of the residuals with light-curve properties. However, future samples that account for optical and NIR light curve shapes, absorption, spectroscopic variation, or host-galaxy properties will likely improve the use of SNe Ia as distance indicators.

Observations

The robotic PAIRITEL 1.3m telescope, formerly used in the 2MASS project, uses the same camera and filter system, providing convenient photometric calibration from the 2MASS catalogue (Bloom et al. 2006, Cutri et al. 2003). Since January 2005, PAIRITEL has dedicated ~30% of its time (~2-3 hours a night) to follow up a nearby (z < 0.02) sample of 47 SNe Ia, 19 of which are presented in Wood-Vasey, Friedman et al. 2008, astro-ph/0711.2068v1. Simultaneous JHK_s observations and nightly cadence allow for densely sampled light curves reaching $K_s$ < 17 mag, from as many as ~15 days before max. to ~50 days past max., covering the first two IR peaks.

Sample JHKs Light Curves, Templates

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