A Confounding Class of Peculiar Type Ia Supernovae?

with
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Accretion and Explosion: The Astrophysics of Degenerate Stars
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How peculiar is peculiar?

Phillips et al. (2007) - 2005hk

![Graph](image-url)

The black triangle in each panel corresponds to SN 2005hk.
SN 2002cx and SN 2005hk

Li et al. (2003); Phillips et al. (2007)
These are Type Ia Supernovae

These are Type Ia Supernovae

*hot at early times*

*velocities are ½ normal*

Chornock et al. (2006)
SN 2005hk light curves

- relatively fast decline in B,V
  $\Delta m_{15}(B) \approx 1.6$ mag (unlike 91T)
- broad, plateau-like in R
- no second peak in IR
- slow decline after the knee

SDSS late-time light curve
slow late-time decline
0.014 mag day$^{-1}$
SN 2002cx Late-Time Spectra

Jha et al. (2006)
SN 2002cx Late-Time Spectra

Jha et al. (2006)
SN 2002cx: full of iron

Li et al. (2007, in prep)
SN 2005hk observed even later

- unprecedentedly low velocities
- still dominated by permitted Fe
- no sign of [O I] 6300 Å
- good density diagnostics: [Ca II]/Ca II, [Fe II]/Fe II, $\geq 10^2$-$10^3$ higher than normal SN Ia

Chornock, Foley, & Filippenko (2006)

Li et al. (2007, in prep)
The SN 2002cx-like Subclass

- Like normal SN Ia, 2005hk has low polarization (Chornock et al. 2006)
- very low velocities and luminosities
- all in blue, late-type hosts

Jha et al. (2006)
The SN 2002cx-like Subclass


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• cosmological implications?

• progenitor models:
  • mixed layers, low $^{56}$Ni mass
  • low-velocity unburned material
  • weak 3-d deflagration?
  • high mass and density at low velocity: “failed” SN Ia? CC?

• peculiar objects may be the key to understanding normal SN Ia!

Jha et al. (2006)
A Hubble Bubble?

a 6% difference in the expansion rate at a radius of 100 Mpc, roughly isotropic

Jha, Riess, & Kirshner (2006)
A Hubble Bubble?

- a real local void?
- K-corrections?
- photometric offset?
  - new data vs. Calán/Tololo?
  - morphology/extinction?

*a potentially huge systematic* 
→ test with more nearby objects!
Comparing light-curve fitters

MLCS2k2 and SALT2 give tightly correlated light curve parameters!

Small (few percent) differences arise in converting these parameters to distances.

Conley et al. (2007, in prep)
Comparing light-curve fitters

a strong change in color excess across the low-redshift sample

the Hubble Bubble signature depends critically on the luminosity/color-excess correction

using the same correction, all the light-curve fitters (MLCS2k2, SALT, SALT2, and SIFTO) agree.

Conley et al. (2007, in prep)
What's the correct correction?

Conley et al. (2007, in prep)

empirical fits: \( \beta \approx 2 \)

normal dust: \( \beta \approx 4 \)

So what's the answer?

Weird dust, even in cases with low extinction? (e.g., scattering: Wang 2005)

A second parameter? Luminosity correlated with an intrinsic color excess?

A combination of normal dust, weird dust, intrinsic variations!!