A Peculiar Class of Slow-Speed Supernovae from the Palomar Transient Factory

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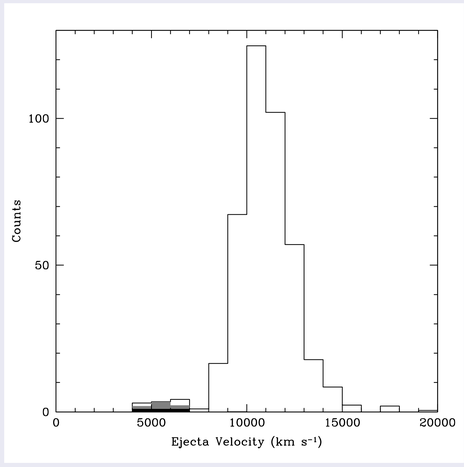
June 2013

Goals

- *Identify* unusual SNe Ia
- *Classify* all such transients
- Understand *origins* through classification

Type Ia Velocities

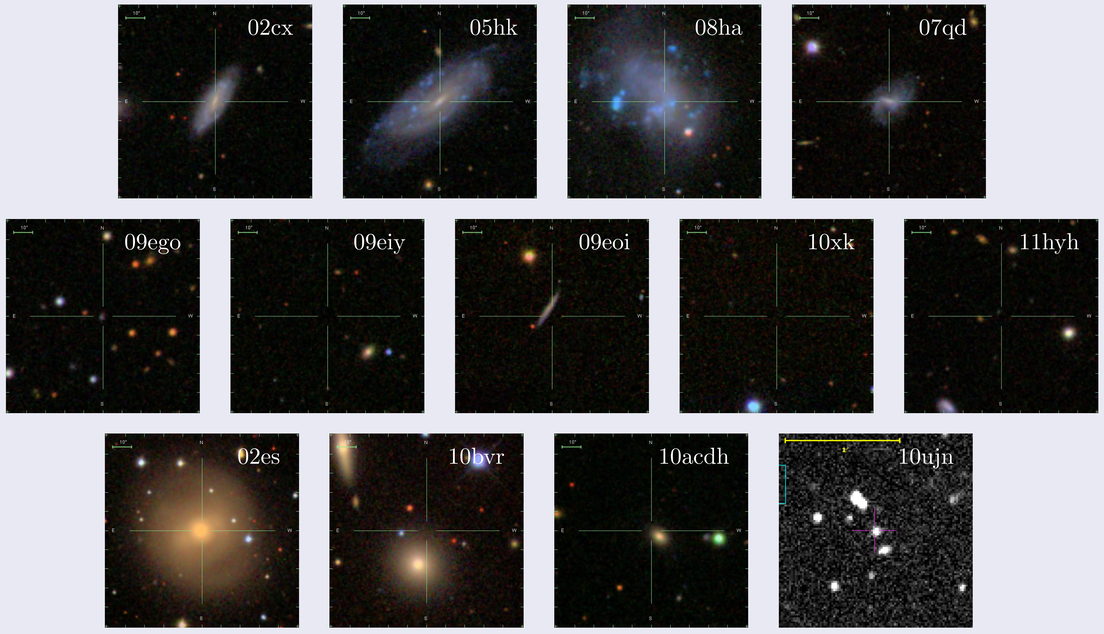


Question: Are these low-velocity events the tail end of a distribution, or do they constitute a separate class?

Slow-Speed Properties

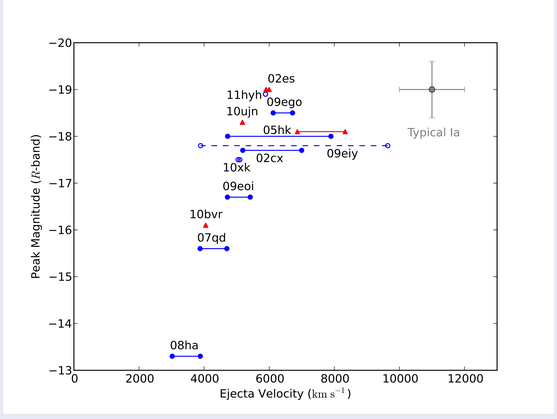
- Ejecta velocities $\sim$ 6000 km s^{-1}
- Two distinct classes: 02cx-like and 02es-like
- Peak luminosities somewhat low (02es) or possibly very low (02cx)
- Ejecta mass $\gtrsim$ 1 (02cx) or $\sim$ 0.6 (02es) $M_\odot$
- 02cx specifics: No Ti II trough; blue spiral or dwarf hosts
- 02es specifics: Ti II signature; red elliptical hosts

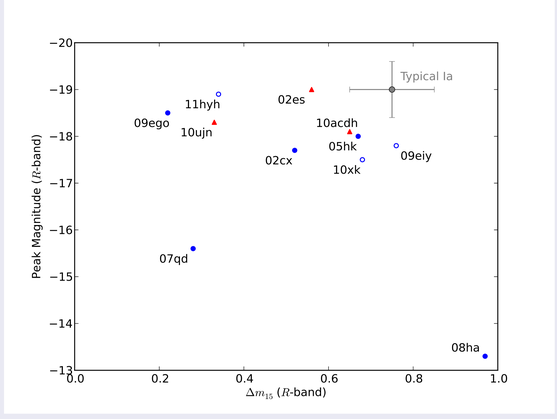
The Slow-Speed Sample



Above are the hosts for the sample found in the PTF data, along with prototypical members from the literature. While the sample is still small, it already shows signs of a dichotomy in hosts. 02cx-like objects (first two rows) tend to come in dwarf and/or star-forming hosts, while 02es-likes are associated with redder galaxies. (All but last image from SDSS)

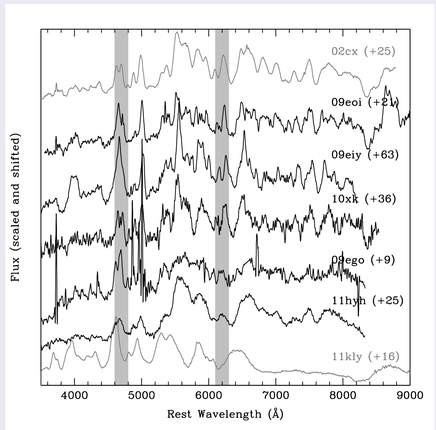
New Parameter Space





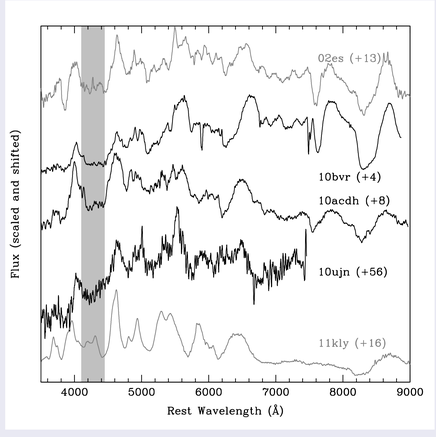
02cx- and 02es-like objects have lower velocities than typical SNe Ia. 02es-likes tend to be slightly underluminous, while 02cx-likes can be very underluminous. They tend to lie off the Phillips relation.

02cx-like Spectra



Optical spectra of slow-speed SNe show similar features, such as splitting of lines. Matches were selected automatically based on entire spectrum and confirmed visually based on key features.

02es-like Spectra



Certain spectra from the sample clearly show a titanium trough. These SNe are not unlike 02cx, but they are closer matches to 02es.

The Future

Upgraded PTF can help make precision statements about the populations.