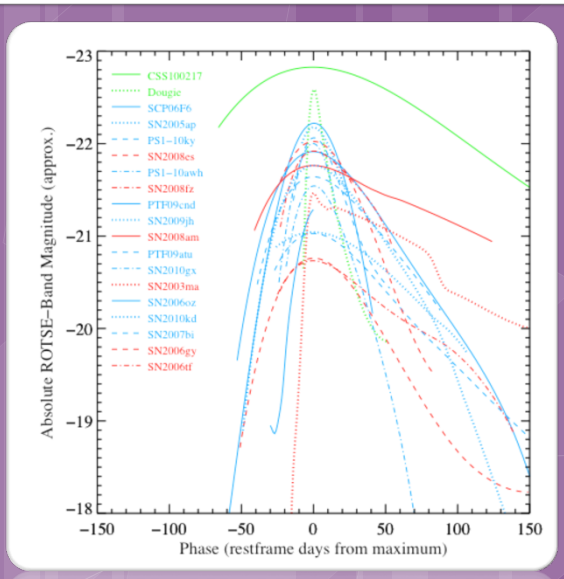
# Peak Magnitude Distributions and Rates of Superluminous Supernovae

Robert Quimby (Kavli IPMU), Fang Yuan (ANU/CAASTRO), Carl Akerlof (Michigan), J. Craig Wheeler (Texas)

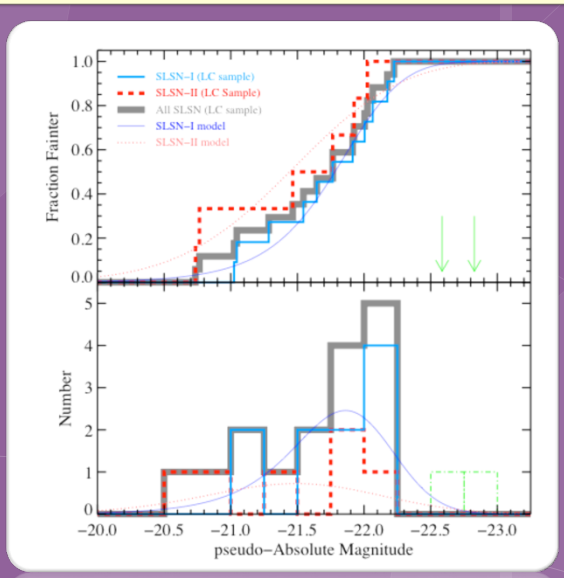
**Step 1:** We construct light curve templates from 19 SLSN-like events with data published in the literature or available in our archives. The observed data are k-corrected to the rest frame ROTSE-III (unfiltered) band pass.

The light curve sample includes: 2003ma (Rest et al. 2011), 2005ap (Quimby et al. 2007), SCP 06F6 (Barbary et al. 2009), 2006gy (Smith et al. 2007), 2006oz (Leloda et al. 2012), 2006tf (Smith et al. 2008), 2007bi (Gal-Yam et al. 2009), 2008am (Chatzopoulos et al. 2011), 2008es (Gezari et al. 2009, Miller et al. 2009), 2008fz (Drake et al. 2010), "Dougie" (Vinko et al. in prep.), PTF 09atu, PTF09cnd, 2009jh (Quimby et al. 2011), CSS100217 (Drake et al. 2011), 2010kd (Vinko et al. in prep.), 2010gx (Quimby et al. 2011, Pastorello et al. 2010), PS1-10awh, and PS1-ky (Chomiuk et al 2011).




**Step 2:** From the light curve templates, we determine the pseudo-absolute magnitude distributions of SLSN-I and SLSN-II. We model each as Gaussian luminosity functions mixed with host exponential absorption distributions.

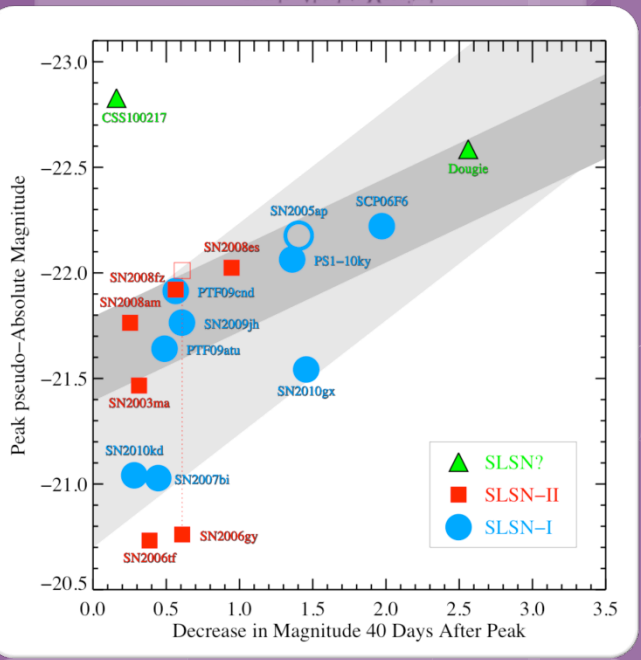
**Result 1:** We find that the available SLSN-I are not inconsistent with an intrinsically tight distribution of peak magnitudes. Specifically, $M_{peak}$ = -22 and $\sigma$ = 0.3 mag.




**Step 3:** Using the light curve templates from step 1 and the pseudo-absolute magnitude distribution models in step 2, we perform a Monte Carlo simulation to determine our survey efficiency, $\varepsilon$, in selecting SLSN-like objects as a function of distance. The rate is then calculated from :

$$R = \frac{N}{\sum_i \varepsilon_i V_i t_i}$$

Our ROTSE-IIIb sample (limited to discoveries prior to February 1, 2009, which excludes SN 2010kd) includes one confirmed SLSN-I (SN 2005ap), and three SLSN-II (SNe 2006tf, 2008am, and 2008es). SN 2006gy was found in a targeted galaxy cluster and is thus excluded. We additionally have one SLSN-like event, Dougie (Vinko et al in prep.).




**Result 2:** Volumetric Rates

| Group | Effective Redshift | Rate (events/Gpc$^3$/yr) |
|---|---|---|
| SLSN-I | 0.18 | $31^{+75}_{-26}$ |
| SLSN-II | 0.15 | $143^{+143}_{-78}$ |
| SLSN-like | 0.17 | $188^{+130}_{-81}$ |

**Bonus Result:** SLSN ***may*** follow a peak magnitude to light curve decline relation! Two caveats to consider: 1) uncertainties in the k-corrections; 2) selection bias