History

Richardson et al. 2002
The dawn of non-targeted surveys

AAS 198th Meeting, June 2001
Session 39. Supernovae
Display, Tuesday, June 5, 2001, 10:00am-6:30pm, Exhibit Hall

[Previous] | [Session 39] | [Next]

[39.02] The Type Ic Hypernova SN 1999as

K. Hatano (Univ. of To)
SN-1999as was an anonymous galaxy, at least nine time b burst.

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SUPERNVAE 1999bc AND 1999bd
P. Nugent, Lawrence Berkeley Lab
Supernova Cosmology Project and the N
project (cf. IAUC 7125, 7120), report
on unfiltered CCD frames:

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Germany et al. 2000

Circular No. 7133
SN 2005ap: A MOST BRILLIANT EXPLOSION

ROBERT M. QUIMBY, GREG ALDERING, J. CRAIG WHEELER, PETER HÖFELICH, CARL W. AKERLOF, AND ELI S. RYKOFF

Received 2007 July 12; accepted 2007 August 29; published 2007 October 2

SN 2006gy: AN EXTREMELY LUMINOUS SUPERNOVA IN THE GALAXY NGC 1260


Received 2006 December 14; accepted 2007 February 27; published 2007 March 6

SN 2006gyc: DISCOVERY OF THE MOST LUMINOUS SUPERNOVA EVER RECORDED, POWERED BY THE DEATH OF AN EXTREMELY MASSIVE STAR LIKE η CARINAE

NATHAN SMITH, WEDONG LI, RYAN J. FOLEY, J. CRAIG WHEELER, DAVID POOLEY, RYAN CHORNOCK, ALEXEI V. FELIPENKO, JEFFREY M. SILVERMAN, ROBERT QUIMBY, JOSHUA S. BLOOM, AND CHARLES HANSEN

Received 2007 February 9; accepted 2007 May 14
SLSN spring: massive wide-field surveys

Letter

*S Supernova 2007bi as a pair-instability explosion*

A. Gal-Yam, P. Mazzali, E. O. Ofek, P. E. Nugent

6 August 2009; Accepted 8 October 2009

Hydrogen-poor superluminous stellar explosions


Received 17 February 2011 | Accepted 01 April 2011 | Published online 08 June 2011

Also: Catalina, PS1, …
Superluminous Supernovae (SLSNe)

Gal-Yam 2012, Science
SLSN-II

SN 2008es; Gezari et al. 2009
SLSN-II: two possible emission models

Gravitational edge of star

Power source remains unknown

Optically thick shell at $10^{15}$ cm

Gal-Yam 2012, Science
SLSN-I

Leloudas et al. 2012
SLSN-I: two possible models

- Gravitational edge of star
- Optically thick shell at $10^{15}$ cm without H
- Power source remains unknown

Gal-Yam 2012, Science
SLSN-R

Gal-Yam 2012, Science
Pair Instability Supernovae (PISNe)
(Shaviv & Rakavi 1967; Barkat, Rakavi & Sack 1967; Heger & Woosley 2002; Waldman 2008 …)

* Helium cores above ~50 solar masses become pair unstable
* In these low-density high-T cores, $\gamma\gamma\rightarrow e^+e^-$ wins over oxygen ignition, heat is converted to rest mass and implosion follows
* Inertial oxygen ignition leads to explosion and full disruption
* “This is a uniquely calculable process” (Heger & Woosley 2002); “this is a trivial calculation” (Barkat 2009); “Pretty neat homework problem” (Gal-Yam 1996)

“Smoking gun”:
Core mass > 50 solar
SN 2007bi
(PTF “dry run”)

* Type Ic SN. No H, He, no interaction, no dust, v=12000 km/s

* Luminous peak (-21.3), slow rise (~77 days), $^{56}$Co decay

* ejected mass ~100 solar, $E_k$~1e53, 4-11 solar masses of $^{56}$Ni (87A)

* Well-fit by models (Kasen)

* Nebular spectra: 4-6 solar mass of $^{56}$Ni; >50 solar total
  (Direct comparison with 98bw; Mazzali models)

Core mass > 50 robustly established;
PTF 10nmn: new results from PTF
(Yaron)

Comparison of Spectra: 10nmn vs. 2007bi

• SN 2007bi lookalike
PTF 10nmn: new results from PTF
(Yaron)

- Complicated light curve, but slow rise (in favor of PISN)
More local examples

Gal-Yam 2012, Science

Nomoto; Moriya model
SLSN hosts

Neill et al. 2010
Rates

- SLSN-I rate at low redshift is \( \sim 10^{-8} \text{ Mpc}^{-3} \) (Quimby); SLSN-II rate is comparable

- SLSN-R rate at low-z is about \( \sim 1 \) per year, these are \( \sim 5 \) times rarer than SLSN-I (roughly).

- Roughly consistent with prediction from stellar runaway collision model (Pan, Kasen & Loeb) \( \sim 10^{-9} \text{ Mpc}^{-3} \)
PISNe at high redshift
(Cooke)

• PISNe are also detected at high redshifts (Cooke; PS1)

Cooke, Sullivan, Gal-Yam+ (submitted)
PISNe at high redshift
(Cooke)

- PISNe are also detected at high redshifts (~4)
- They are also rare there
- Toward Pop III star explosions?
Thanks