The Low Luminosity End of Supernovae in the Local Universe

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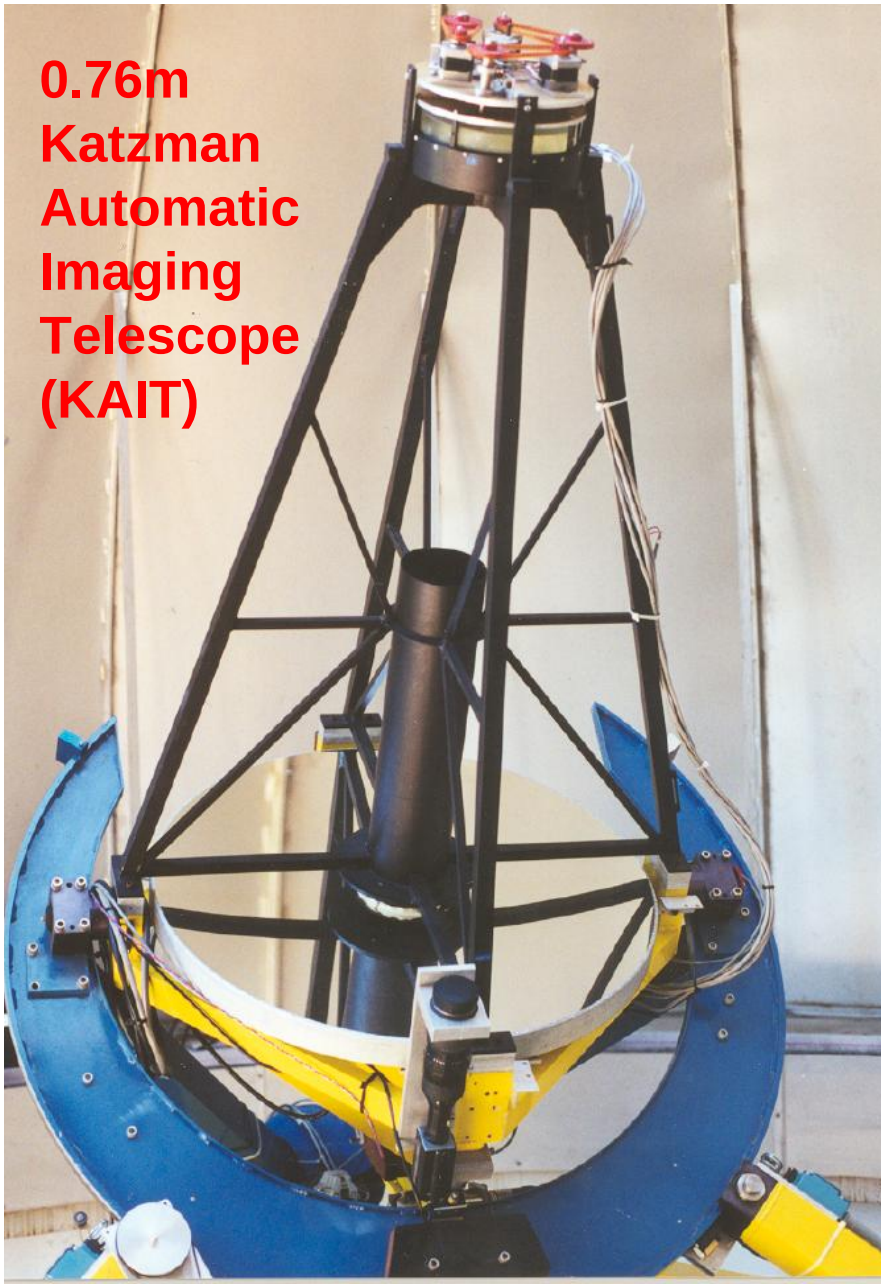
The Plan

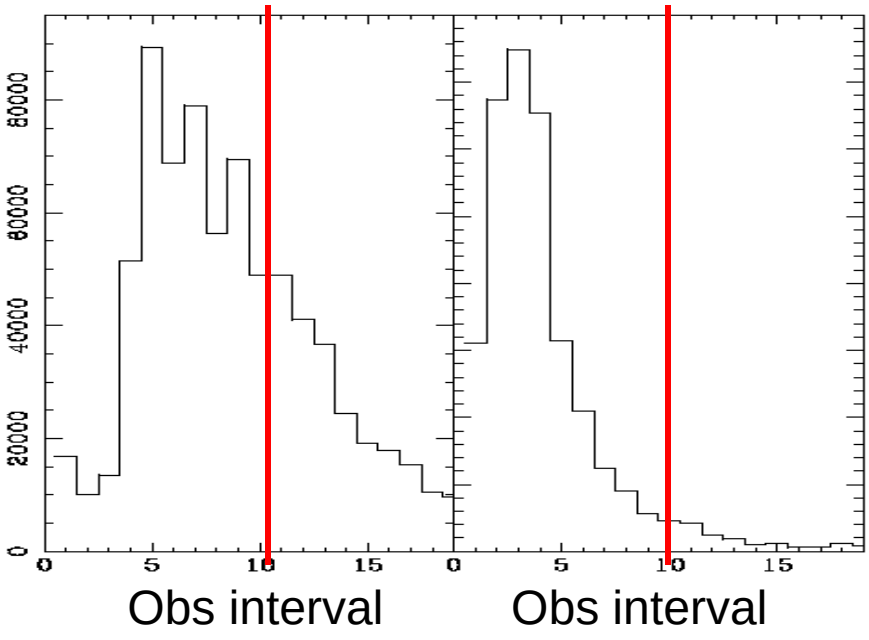
1) Study the statistics of 716 SNe discovered in the LOSS sample galaxies from 1998-2005.
2) Which are the faintest SNe? Why are they faint?
3) Survey completeness/luminosity function of SNe.

Lick Observatory SN Search (LOSS)



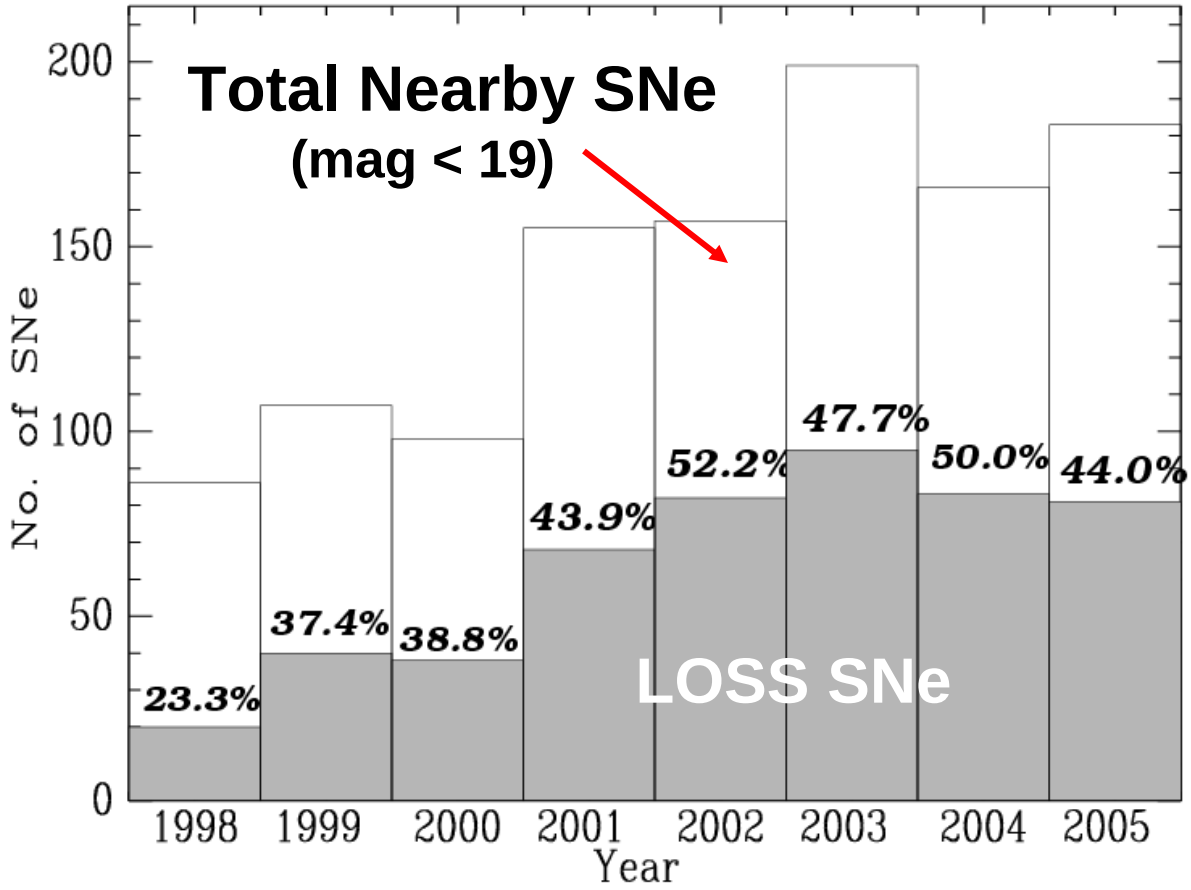
Features:

- Fully robotic observations
- Fully automatic image processing
- SN detection verified by humans
- Monitor 14,000 nearby galaxies
- Maintain small interval



LOSS SN Discoveries

Year	N(SN)
1998	20
1999	40
2000	38
2001	68
2002	82
2003	95
2004	83
2005	82

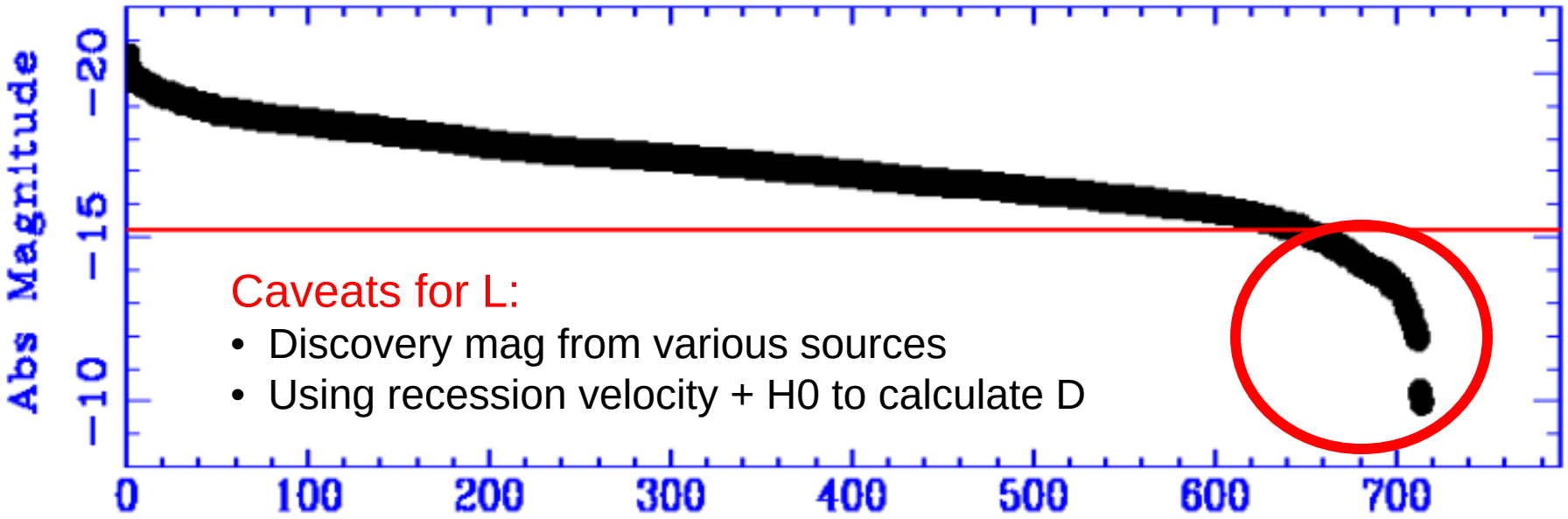


SNe in LOSS Galaxies

- 755 SNe between 1998-2005.
- 508 (67%) discovered by LOSS.
- 716 are used in this study (need z, SN type).

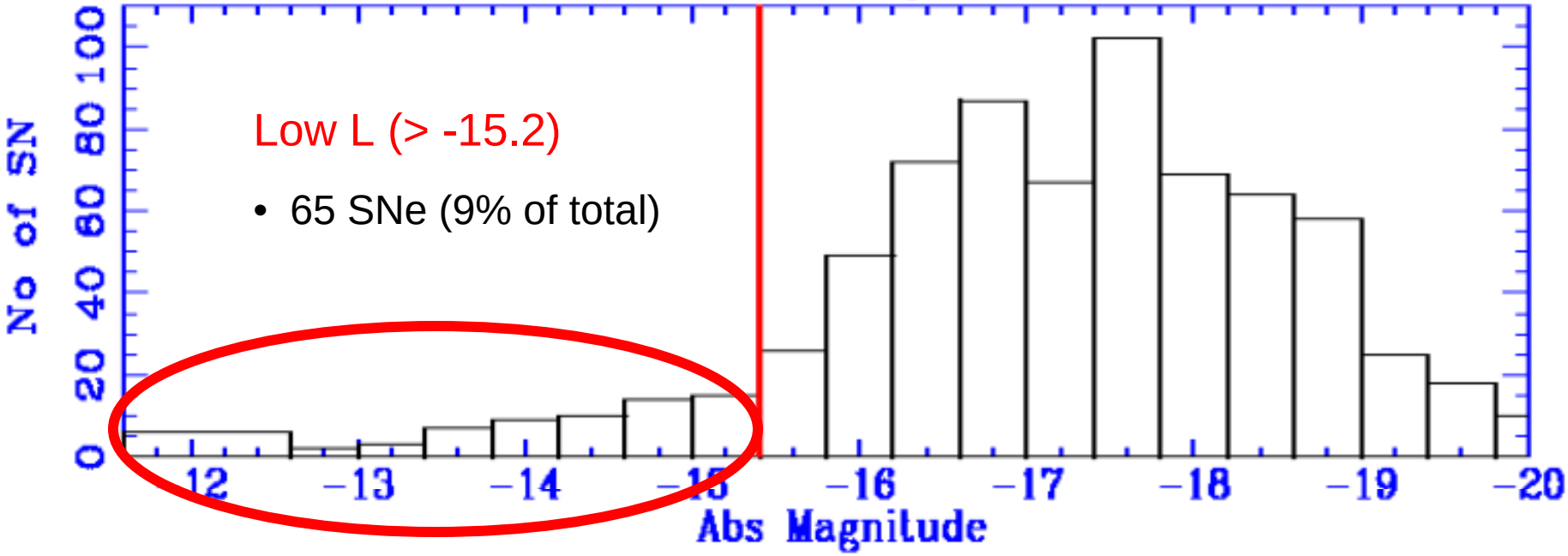
L Distribution

All SNe (716)



Caveats for L:

- Discovery mag from various sources
- Using recession velocity + H0 to calculate D

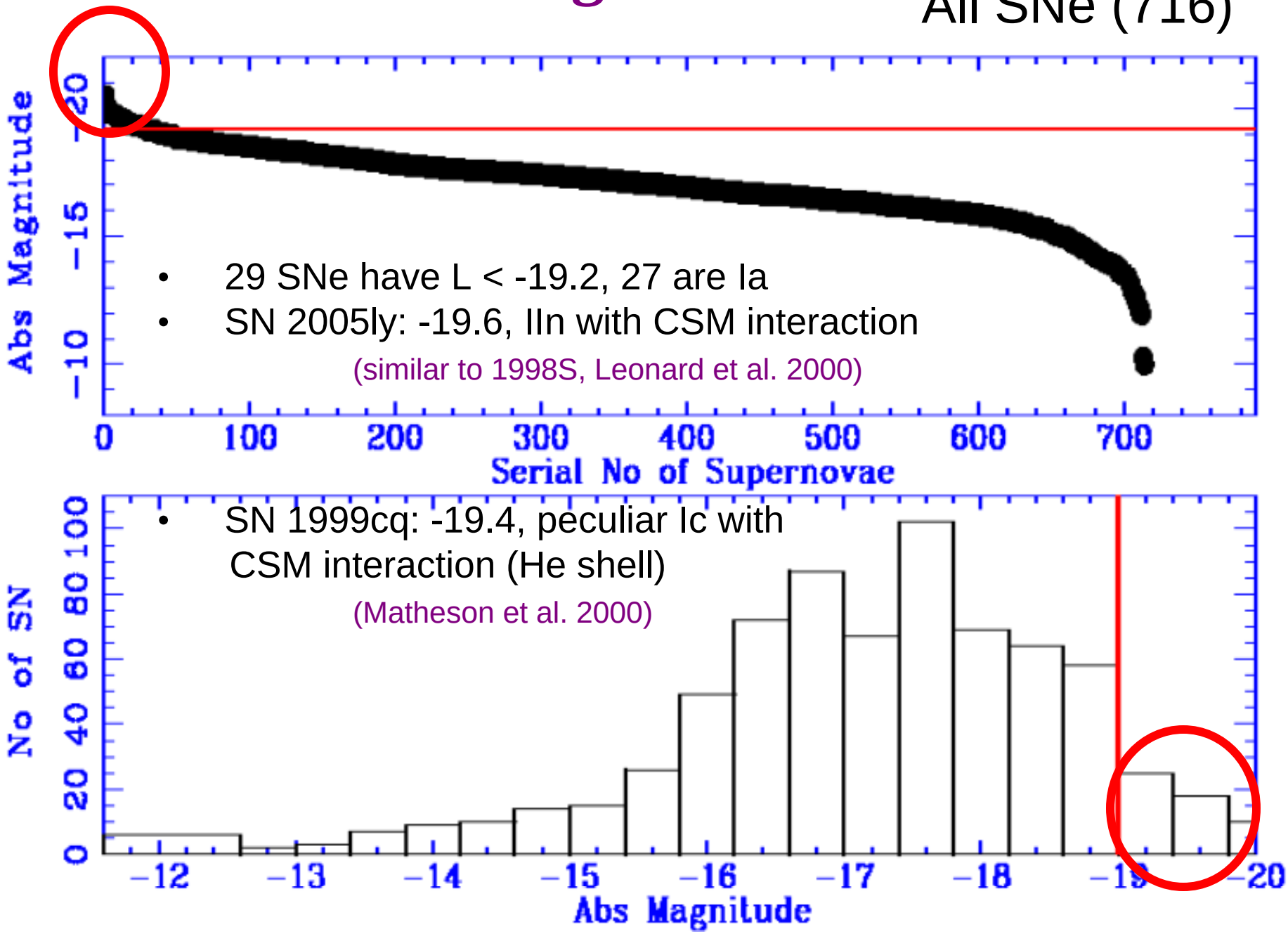


Low L (> -15.2)

- 65 SNe (9% of total)

The Bright End

All SNe (716)



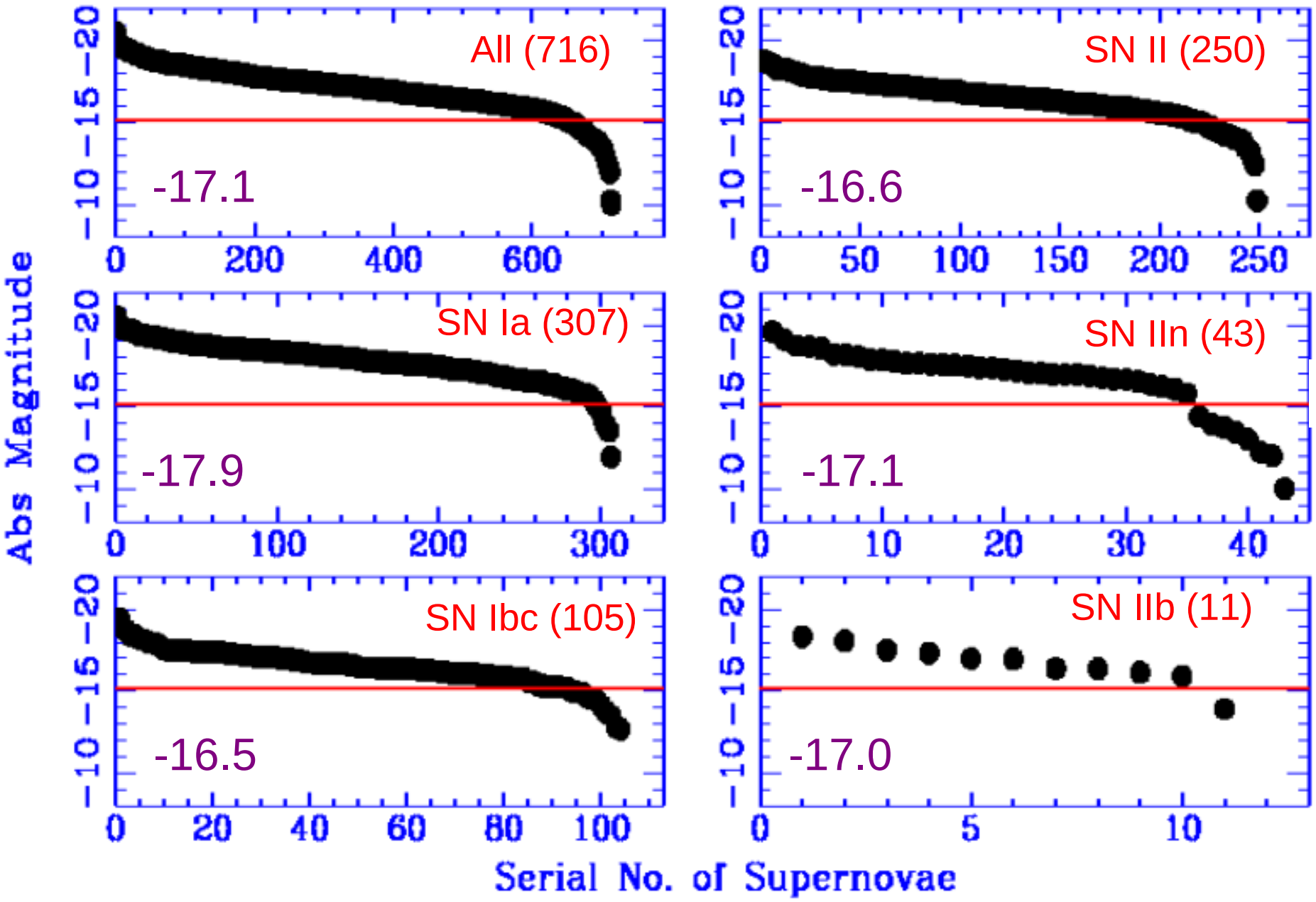
- 29 SNe have L < -19.2, 27 are Ia
- SN 2005ly: -19.6, IIn with CSM interaction

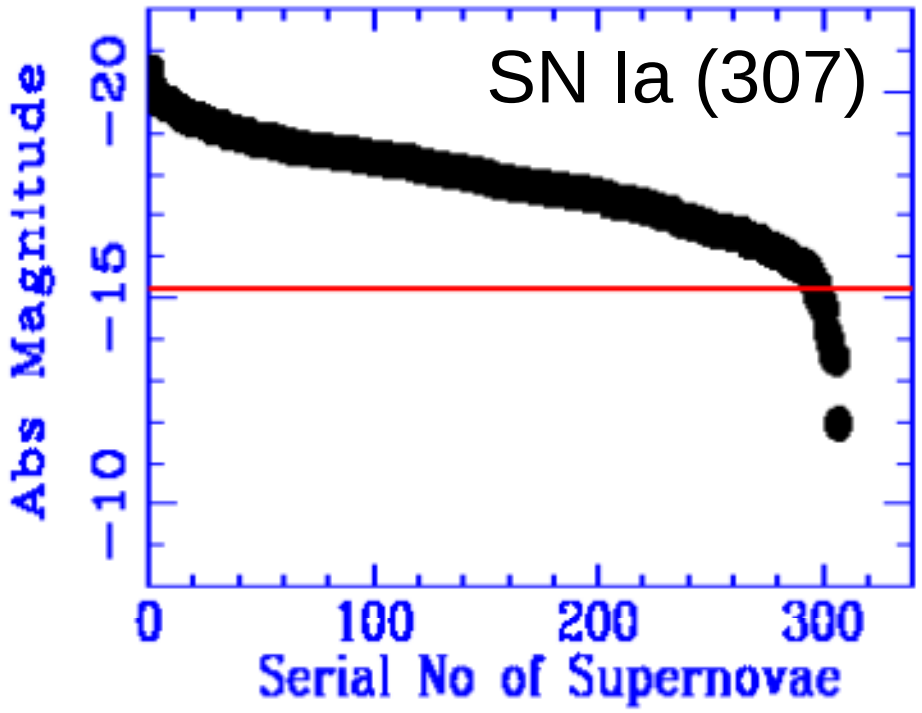
(similar to 1998S, Leonard et al. 2000)

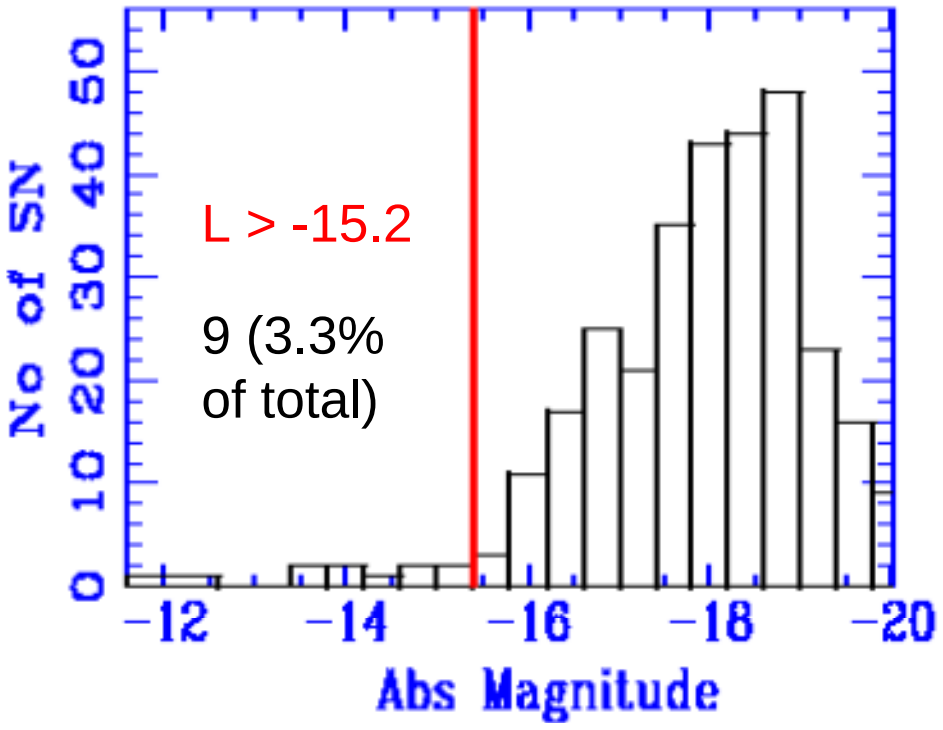
- SN 1999cq: -19.4, peculiar Ic with CSM interaction (He shell)

(Matheson et al. 2000)

L Distribution in Subclasses





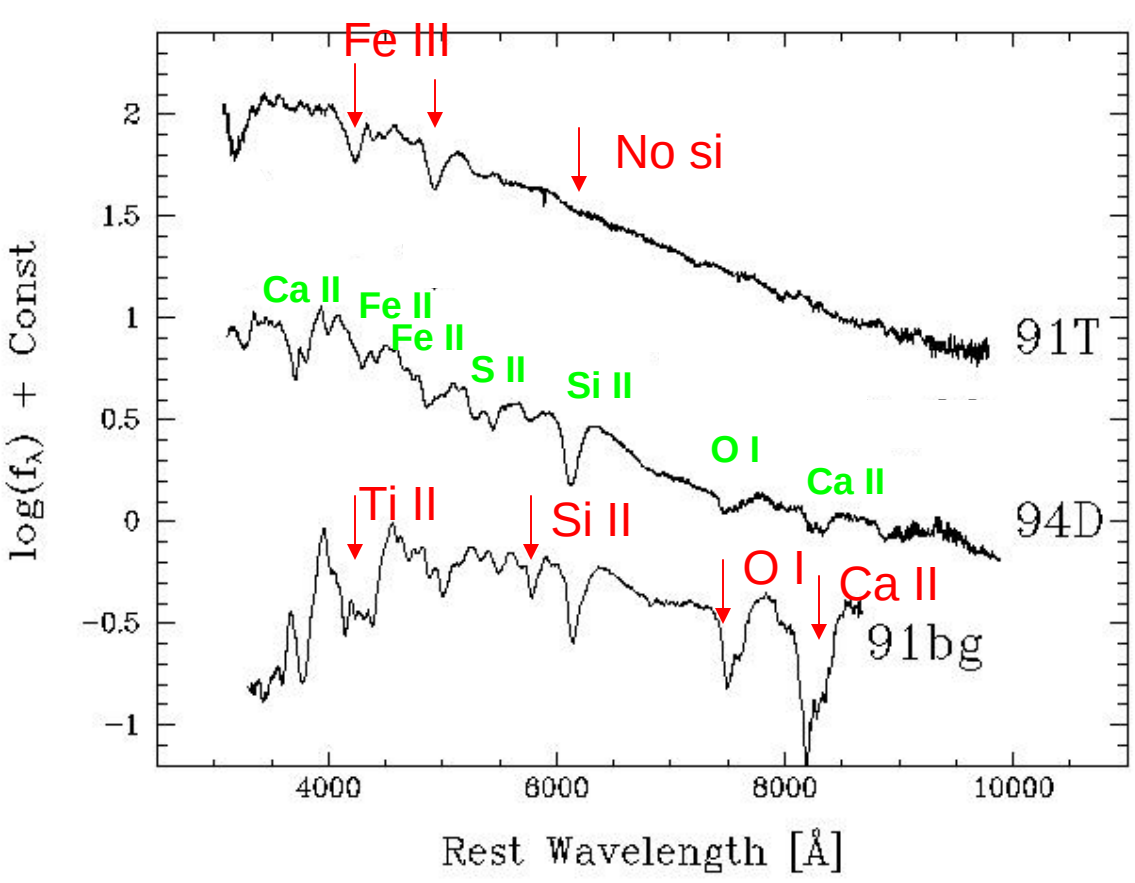


a) 1 baby SN: discovered 4 mag below peak
b) 3 old SNe: discovered after a long break
c) 1 highly reddened SN: Av = 5 mag
d) 4 peculiar subluminous SNe:

1 91bg-like Ia, early discovery
1 91bg-like Ia, late discovery
1 02cx-like Ia, early discovery
1 02cx-like Ia, late discovery

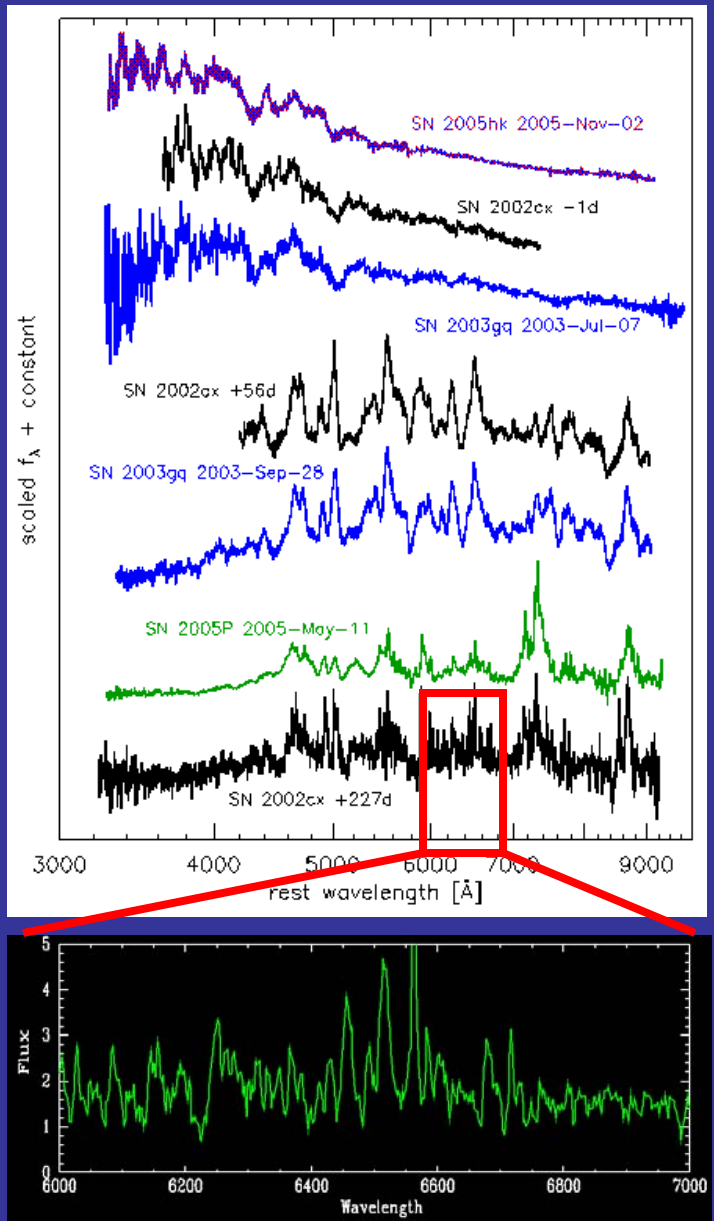
SN Ia diversity

- Normal: a 0.35 mag scatter in L -19.2
- Peculiar: 91T-like (0.5 mag brighter) -19.7
  91bg-like (2 mag fainter) -17.2
  02cx-like (2 mag fainter) -17.2



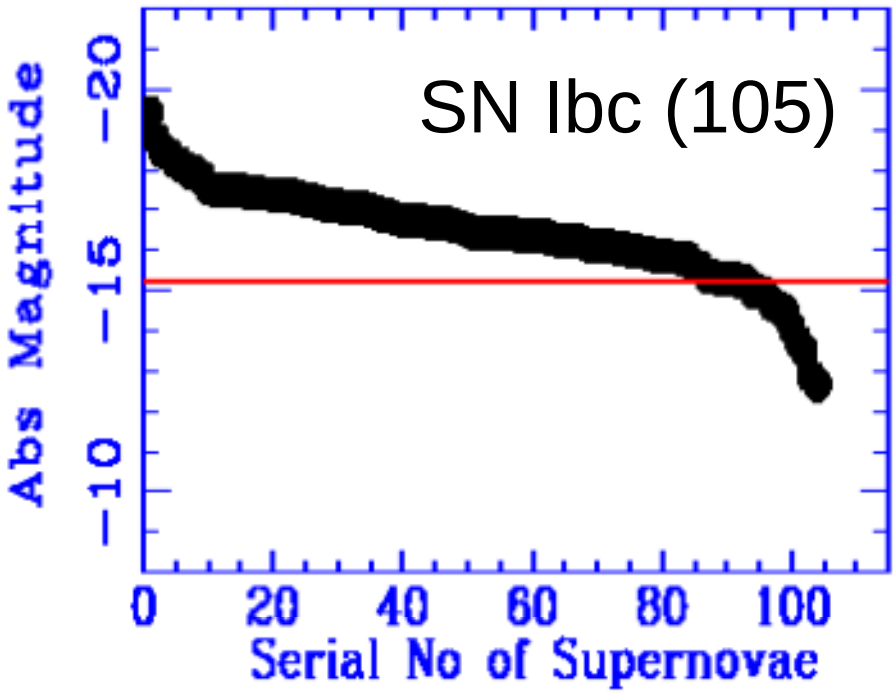
2002cx-like objects

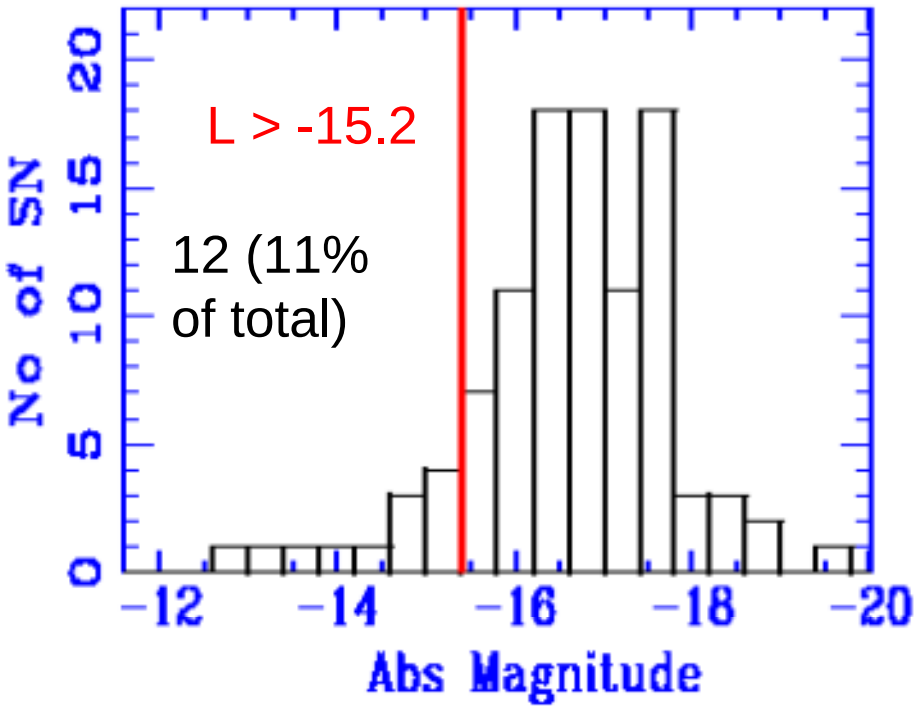
Li et al. 2003; Jha et al. 2006



Why SNe Ia have L > -15.2:

- Early discovery
- Late discovery
- High reddening





a) 1 baby SN: discovered 3 mag below peak

b) 5 old SNe: discovered after a long break

c) 3 highly reddened SNe: Av > 4 mag

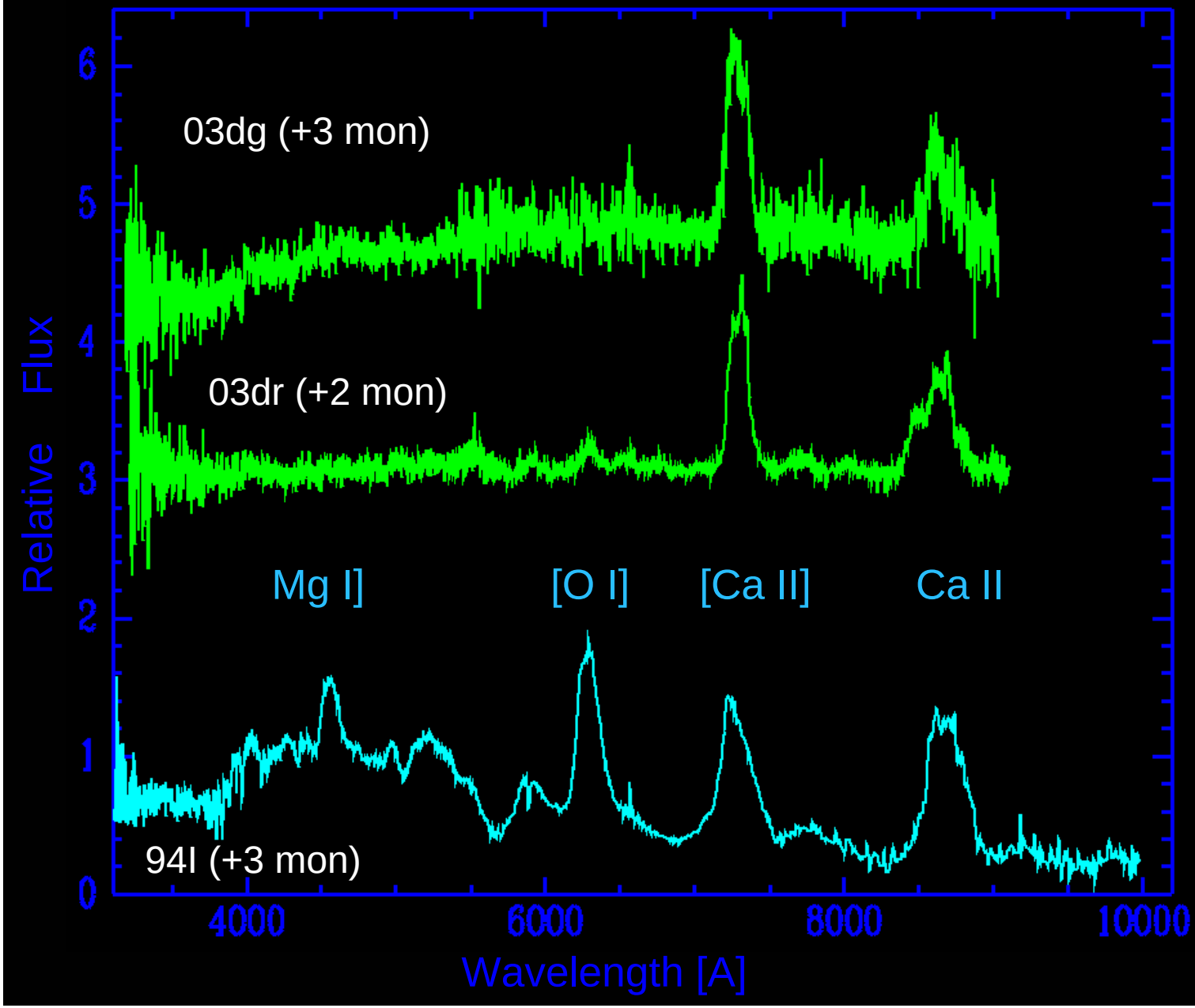
d) 3 peculiar subluminous SNe (3% of total):

Ca-rich Ibc: 2003H, 2003dg, 2003dr

2001co: L = -15.7

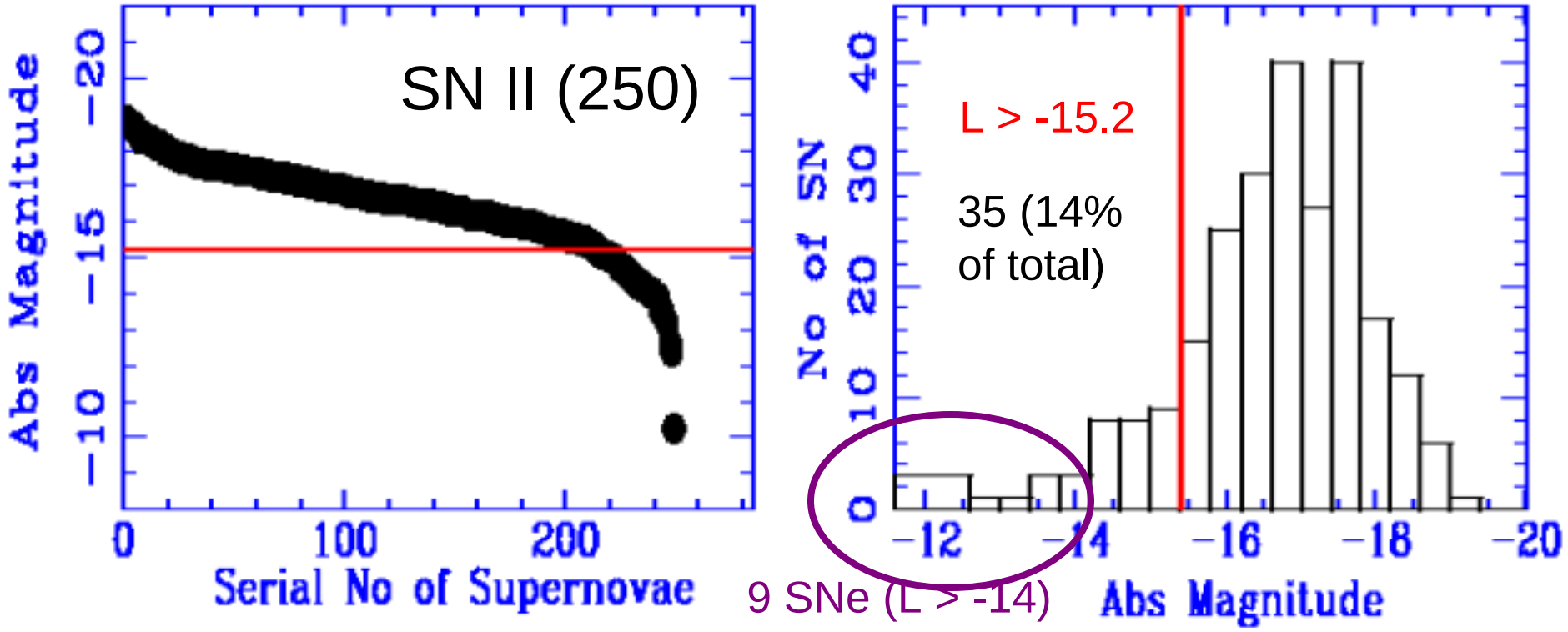
Filippenko et al. 2003 (IAUC 8159)

Ca-rich Ibc


03dg (+3 mon)
03dr (+2 mon)
Mg I]
[O I]
[Ca II]
Ca II
94I (+3 mon)
Relative Flux
0
1
2
3
4
5
6
4000
6000
8000
10000
Wavelength [A]

Why SNe Ibc have L > -15.2:

- Early discovery
- Late discovery
- High reddening
- Intrinsically faint



a) Many of the L > -15.2 SNe: part of the L distribution

b) 2 old SNe: discovered after a long break

c) 4 highly reddened SN: Av > 4 mag

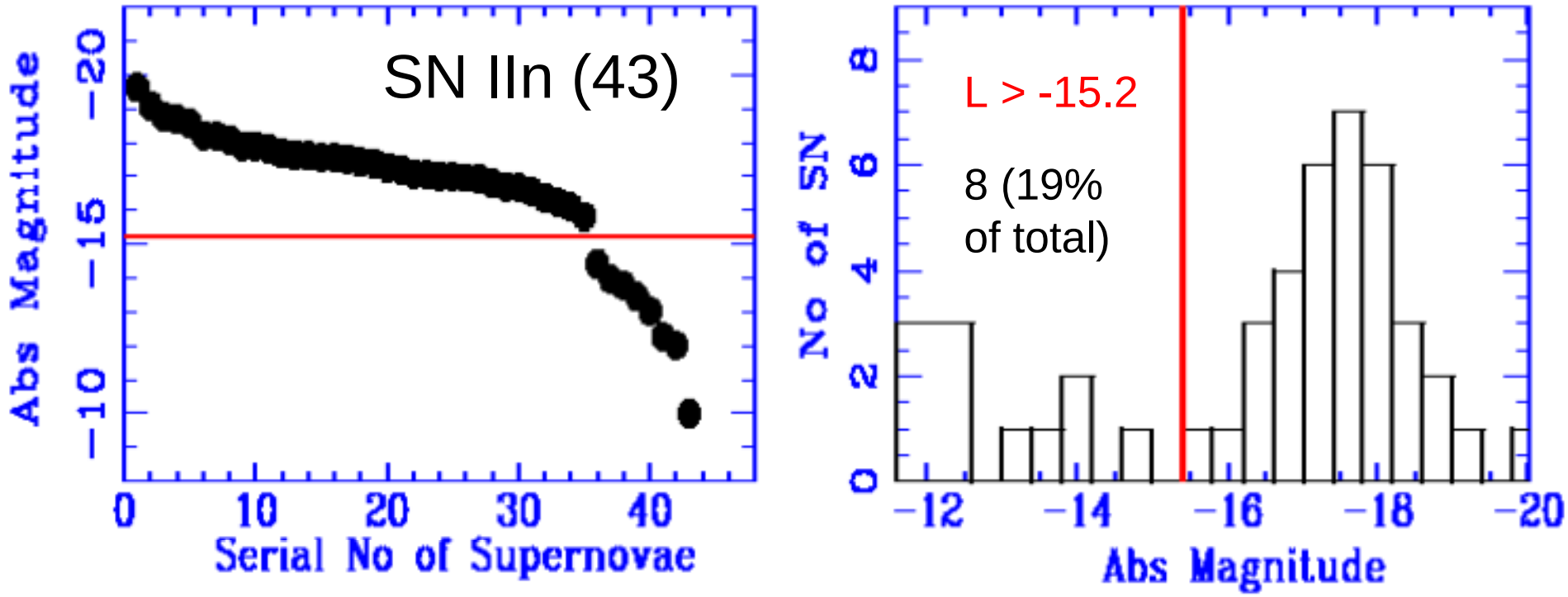
d) 3 peculiar subluminous SNe:

2001dc, 1999gq, 1999br (Pastorello et al. 2004)

- Very low expansion velocity
- Typical plateau phase
- Less energetic, not more massive progenitors (Li et al. 2006)

Why SNe II have L > -15.2:

- Late discovery
- High reddening
- Intrinsically faint



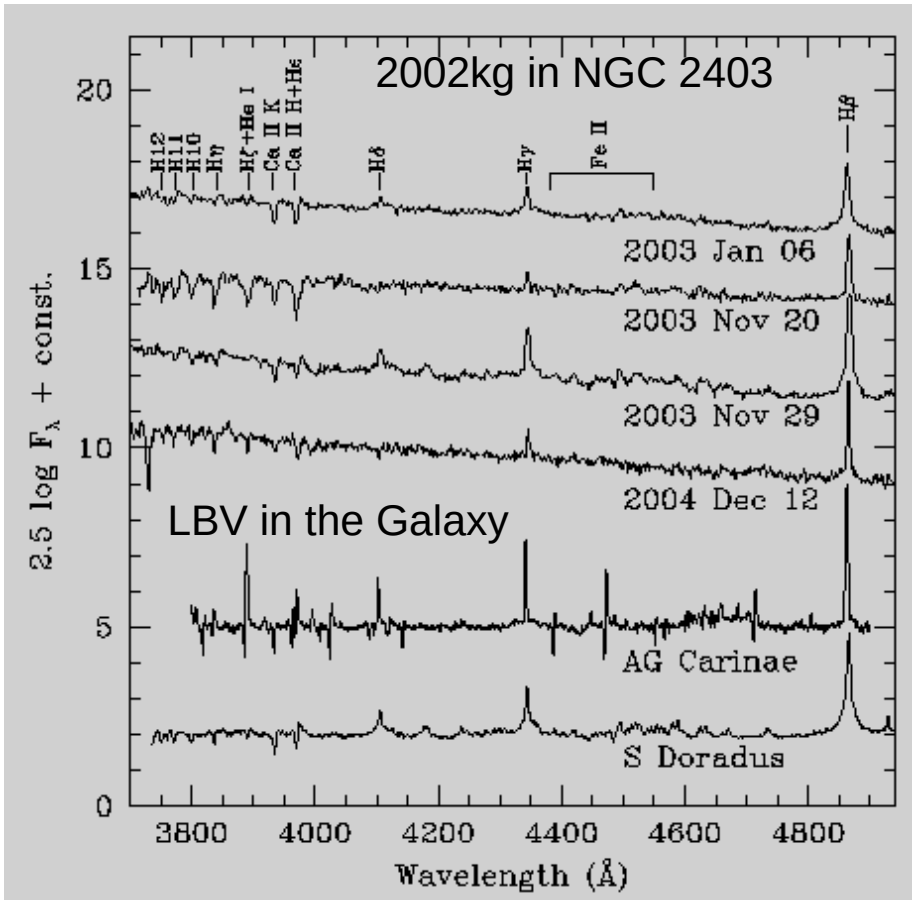
a) 1 old SN: discovered after a long break

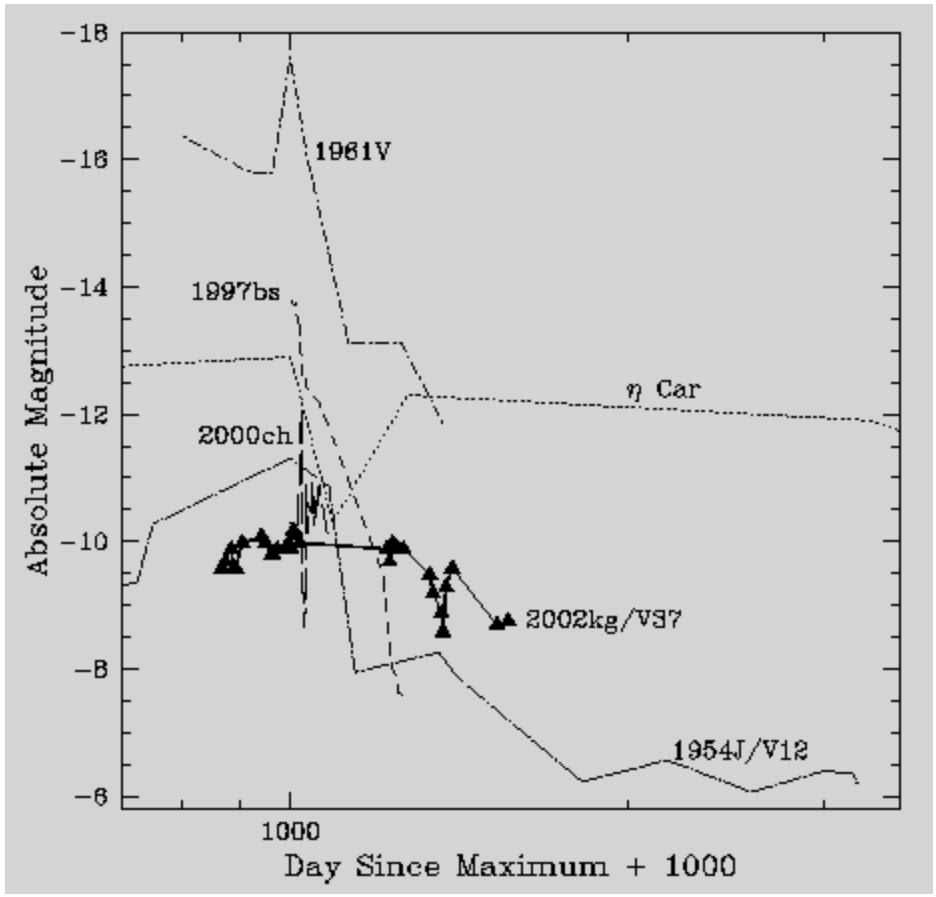
b) 7 LBV-type SN impostors: (L = -10 to -14).

Van Dyk et al. 2000, 2002, 2005, 2006
Wagner et al. 2004
Weis & Bomans 2005
Maund et al. 2006

SN 2002kg: an LBV in outburst

(Van Dyk et al. 2006)





Why SNe IIn have L > -15.2:

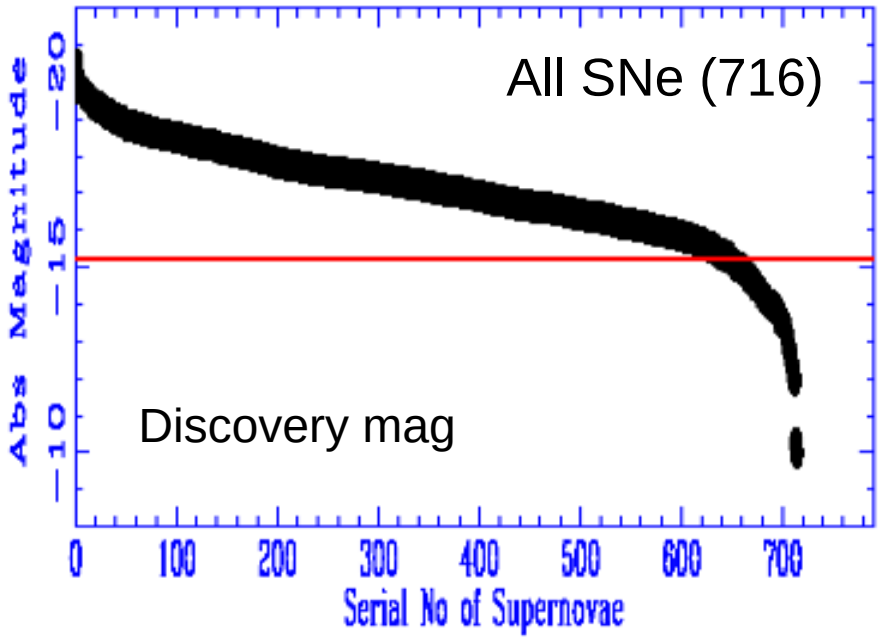
- Late discovery
- SN impostors

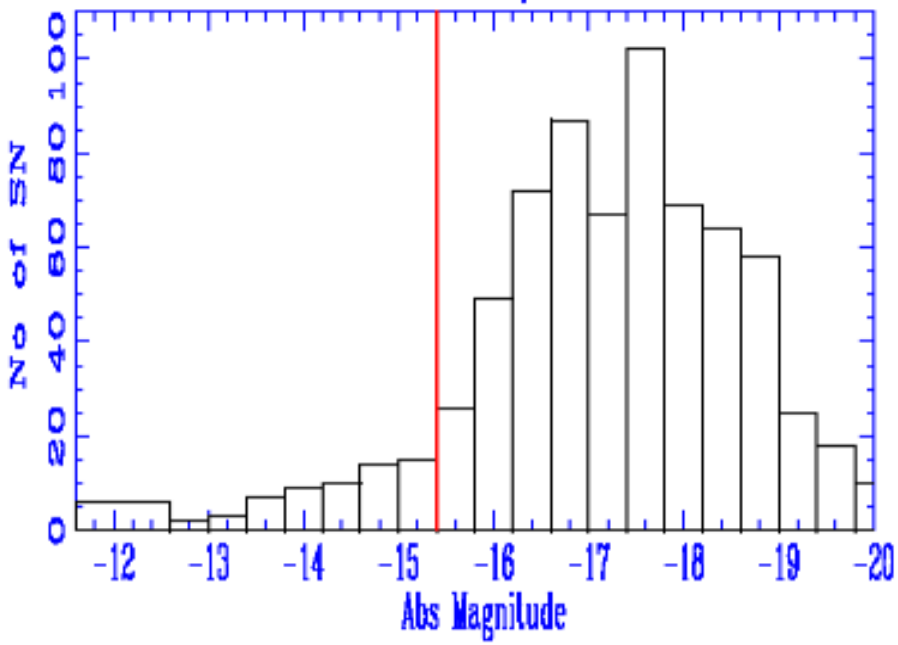
Summary

Why SNe are faint:

- Early discovery (all)
- Late discovery (all)
- High reddening (all)
- Peculiarity (all)
- Part of L distribution (Ibc, II)
- SN impostors (IIn)

Luminosity function of SNe





We have unfiltered light curves for all the 716 SNe from the SN Monitoring data!

a) Discovery mag → peak mag from light curve

b) Monte Carlo completeness simulation of our search

↓

N(SN type, Gal type, L)

Conclusions

SNe are faint due to early or late discoveries, high extinctions, or peculiarity. Some SNe have a relatively low L end distribution (Ibc, II). Most of the faint SN IIn are not genuine SNe. Statistics on the rate, completeness, and luminosity function of nearby SNe (bright or faint) can be derived from a detailed simulation of a long-term SN search.

END