Core-collapse supernova rates from the ASAS-SN survey

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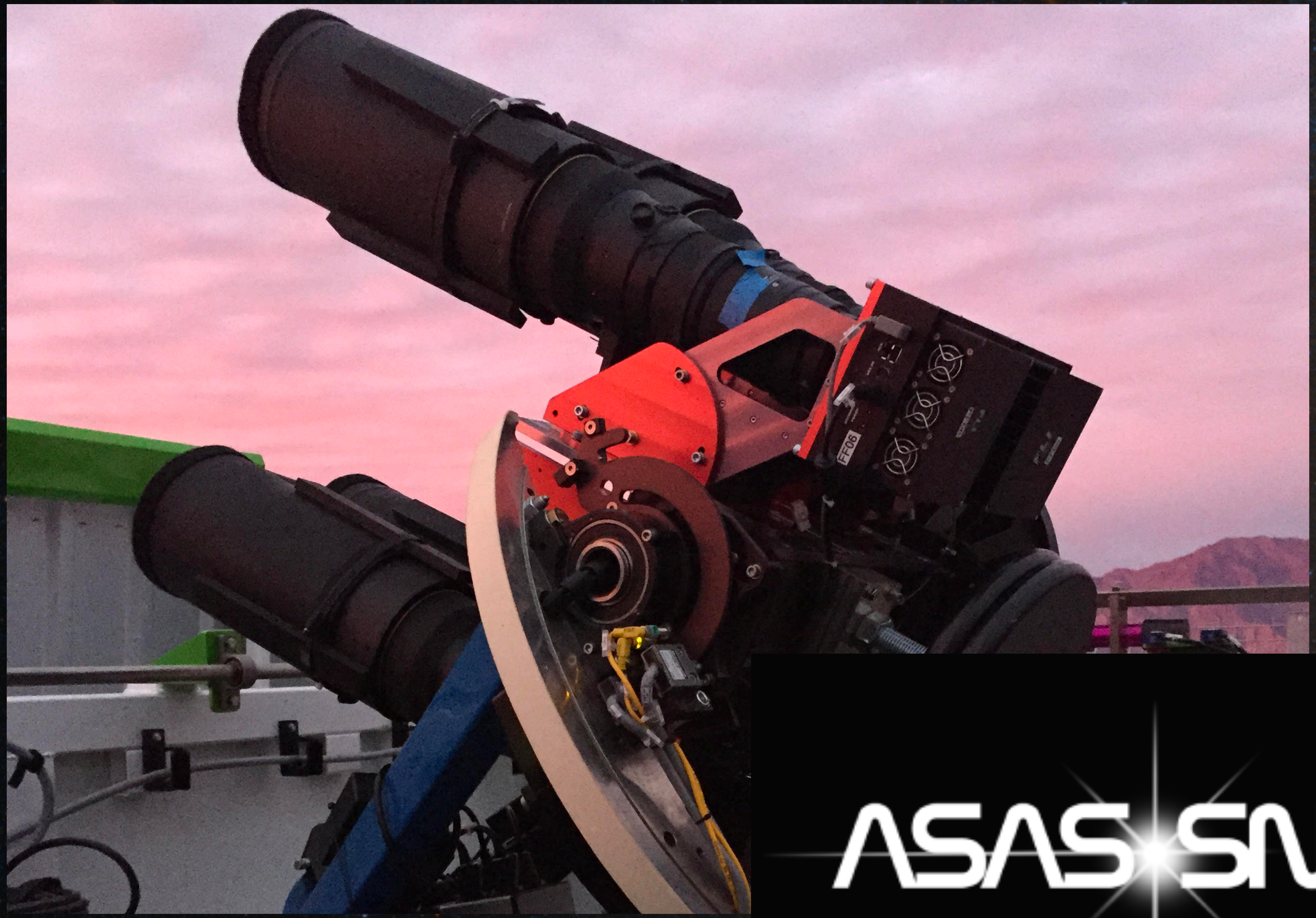
The All-Sky Automated Survey for Supernovae (ASAS-SN)



Credit: T. Holoien

- Untargeted all-sky survey
- 24 telescopes around the globe: Hawaii (2013), Chile, South Africa (2017), China (2018)
- Spectroscopically complete

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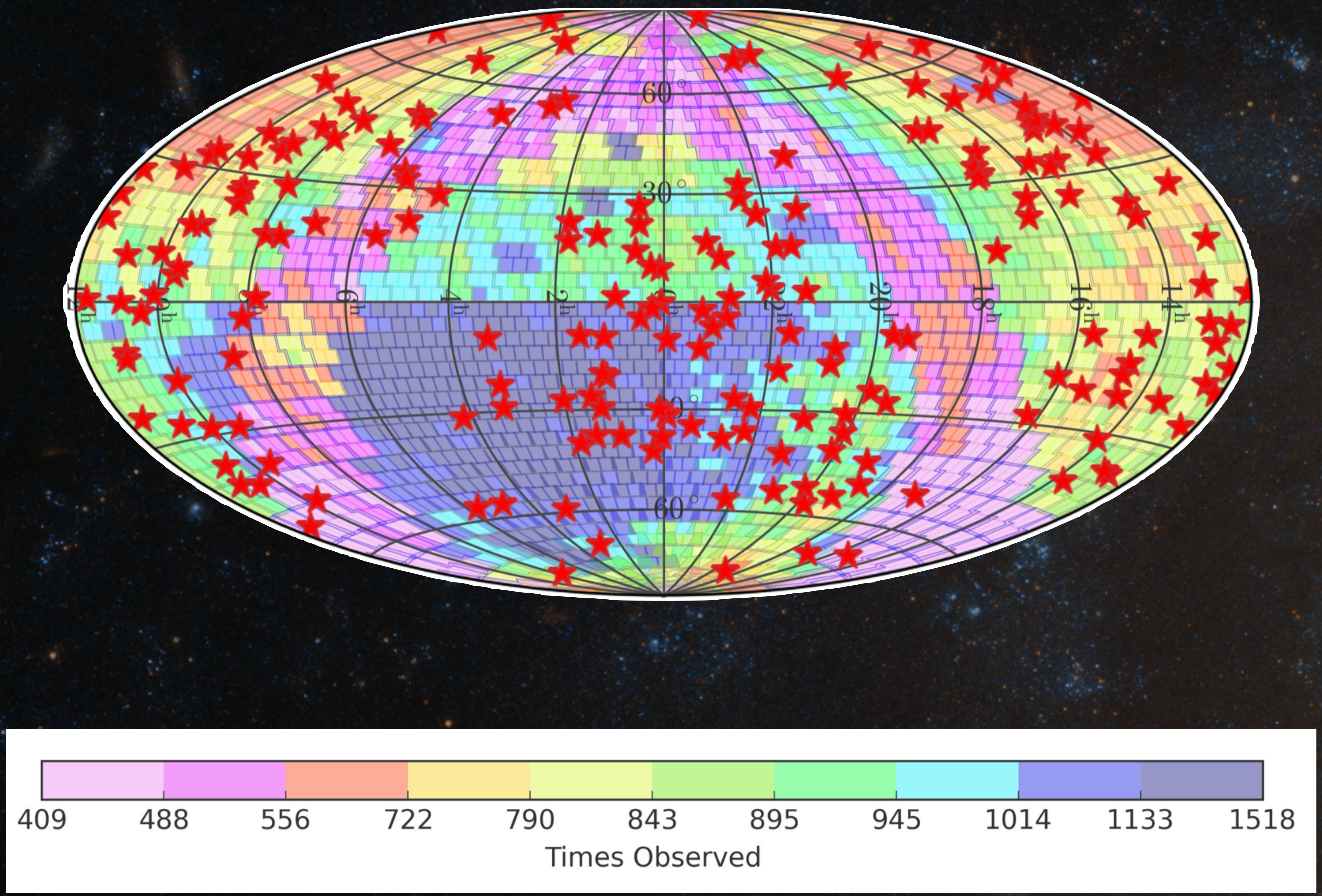
97% of transients classified in 2014-2017

Sample selection

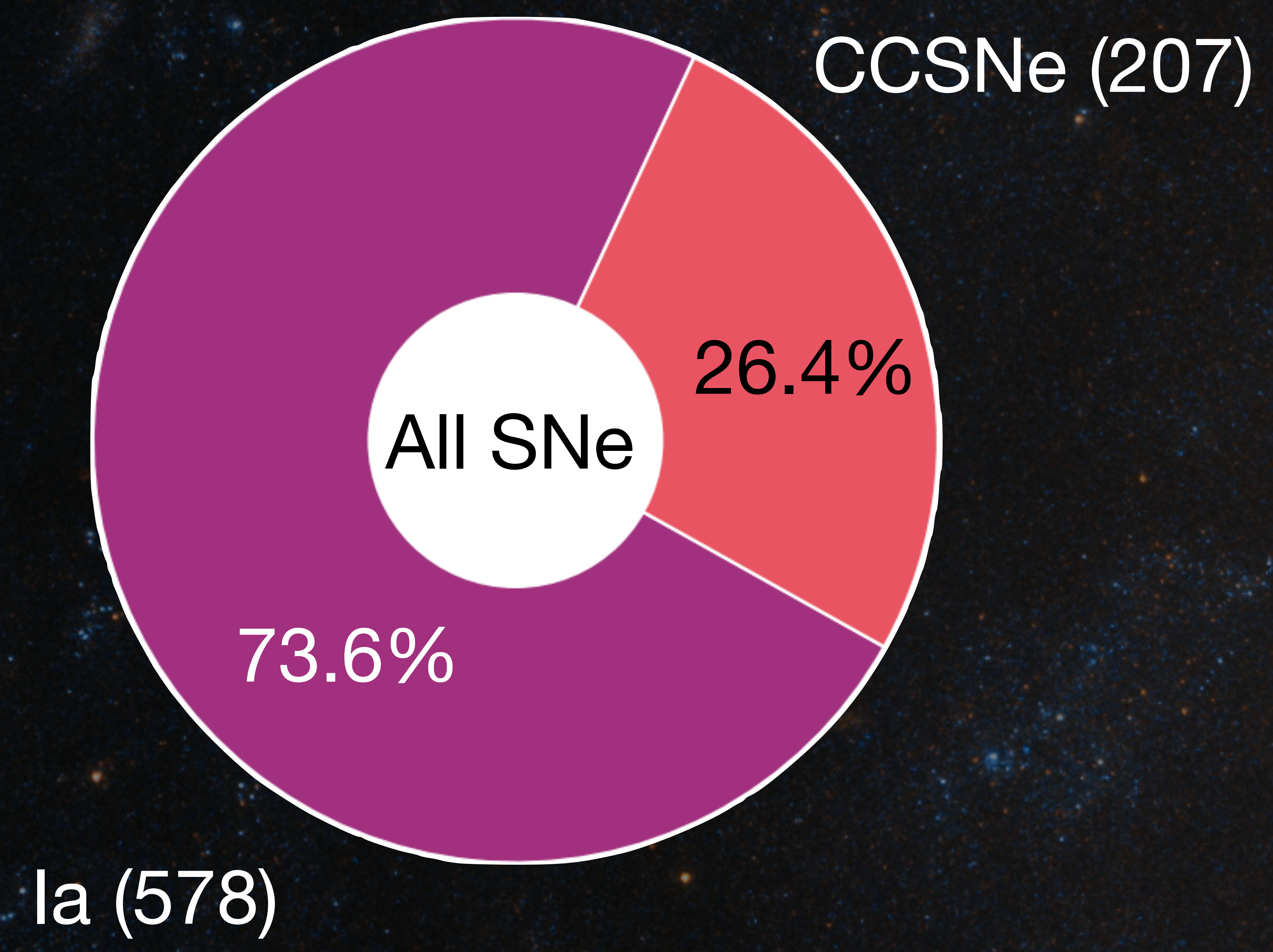


- Initial sample: all the (207) CCSNe discovered or recovered by ASAS-SN between 2014 and 2017

- *V*-band photometry

- Catalogs published in *Holoien et al. 2017a,b,c, 2019*

Sample selection



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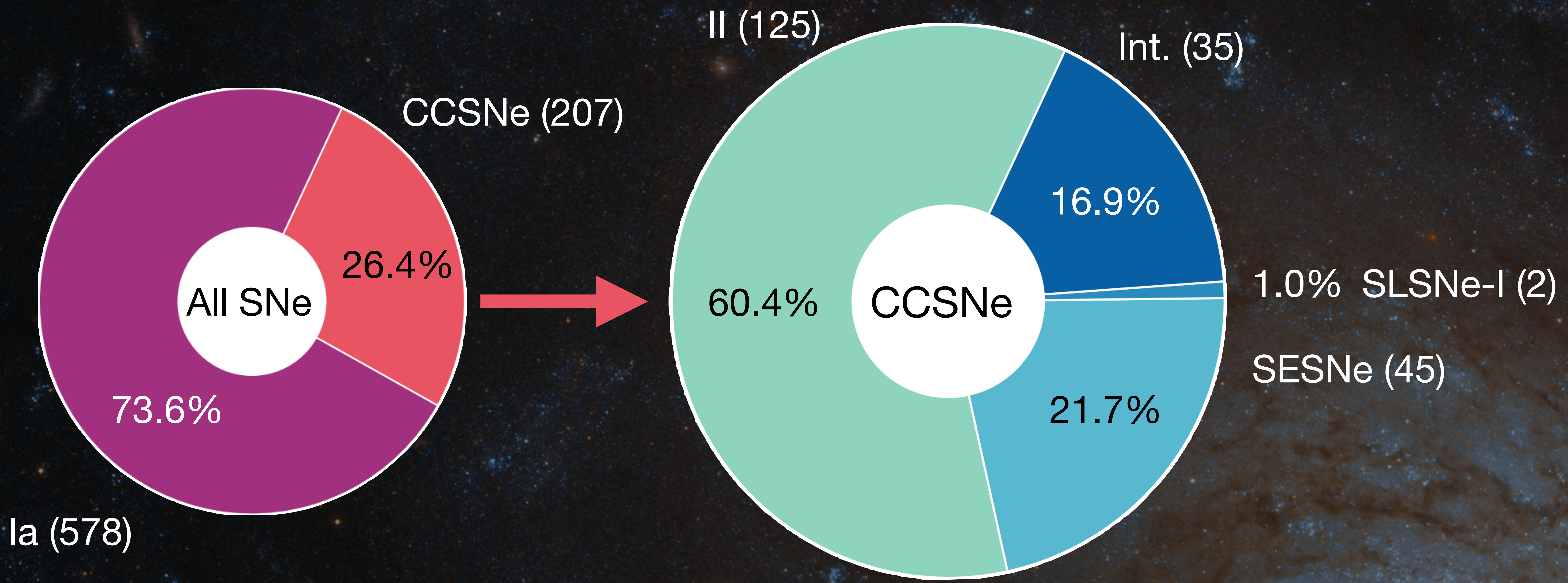

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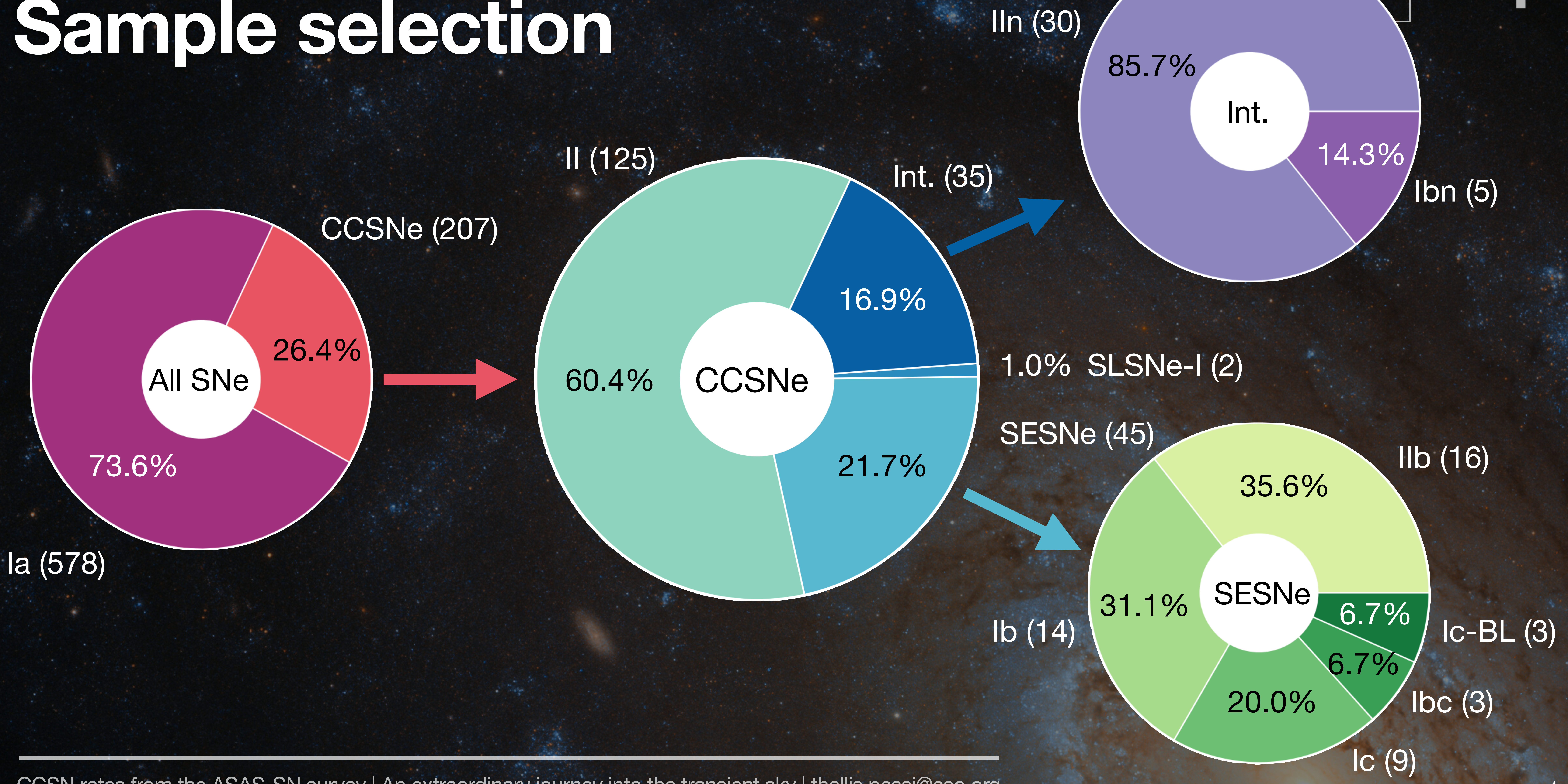


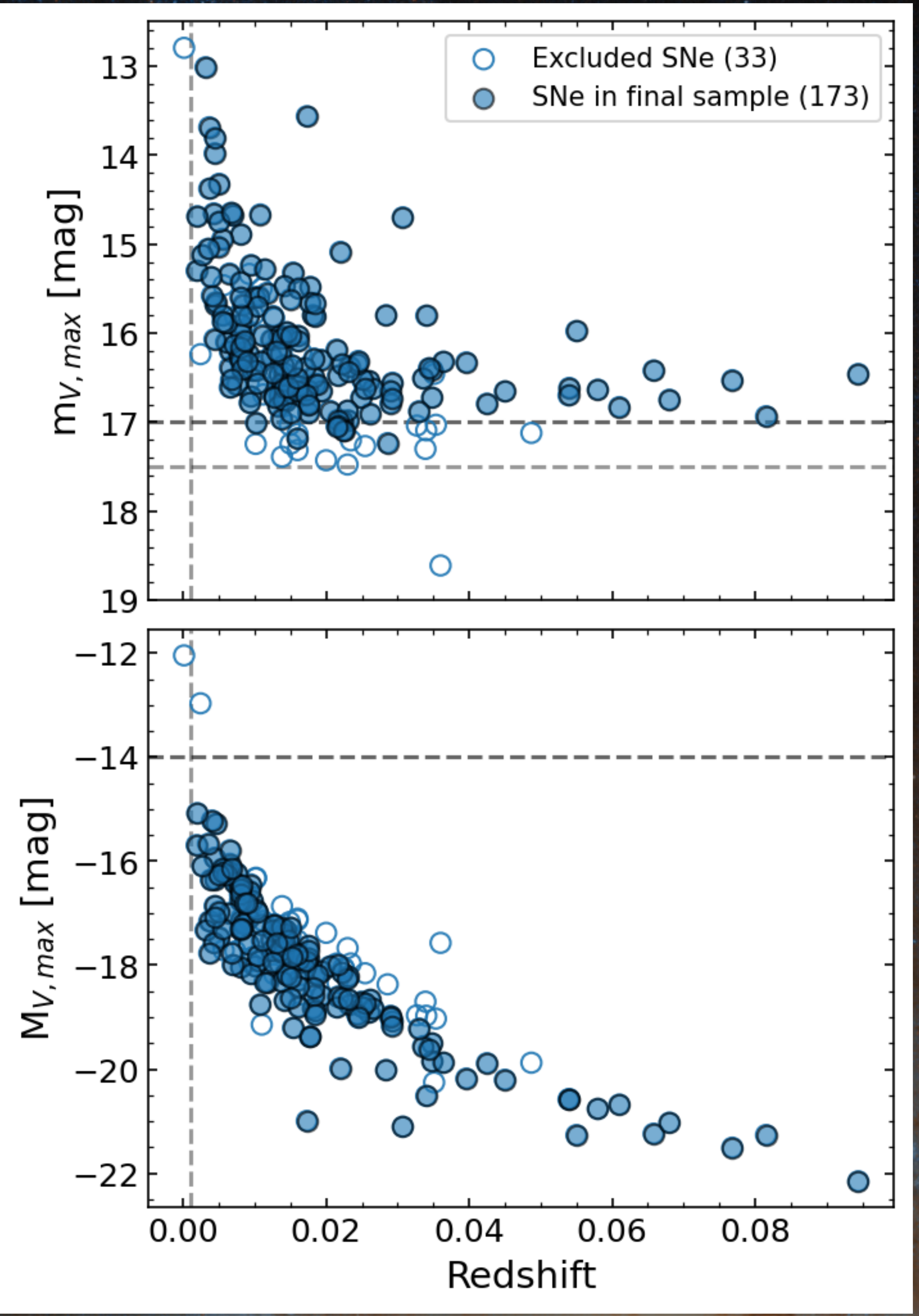
Sample selection

- $m_{V,lim} = 17.0$ mag
  ($m_{V,lim} = 17.5$ for long-duration LCs)

- $|b_{lim}| = 15$ degrees

- $0.001 < z < 0.1$

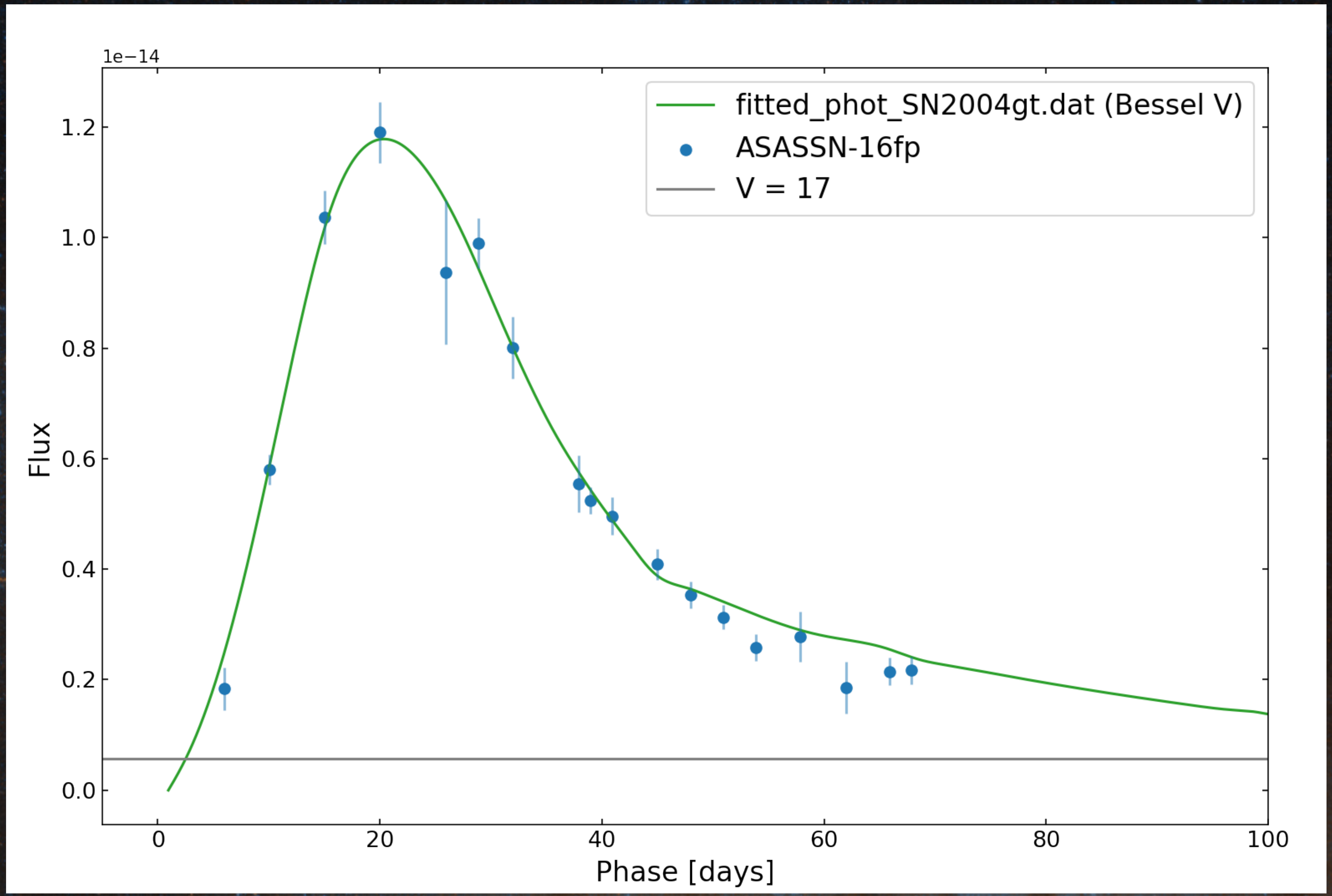
- $M_{V,peak} < -14$ mag



Rate computations

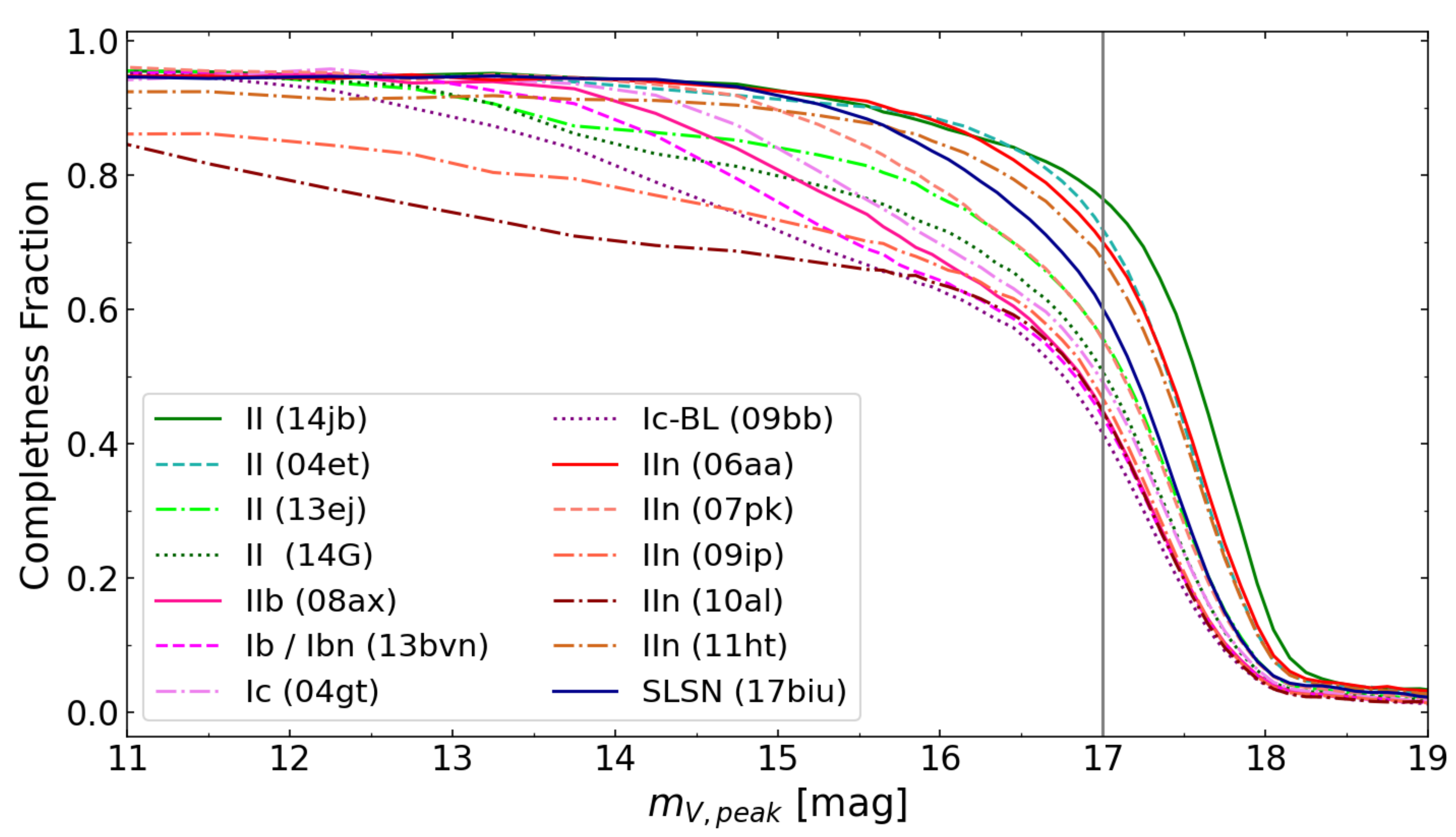
- Light curve fitting
- Injection recovery simulations

$$R = \frac{\sum_{i=1}^{n} w_i}{V \Delta t (1 - \sin b_{lim})}$$

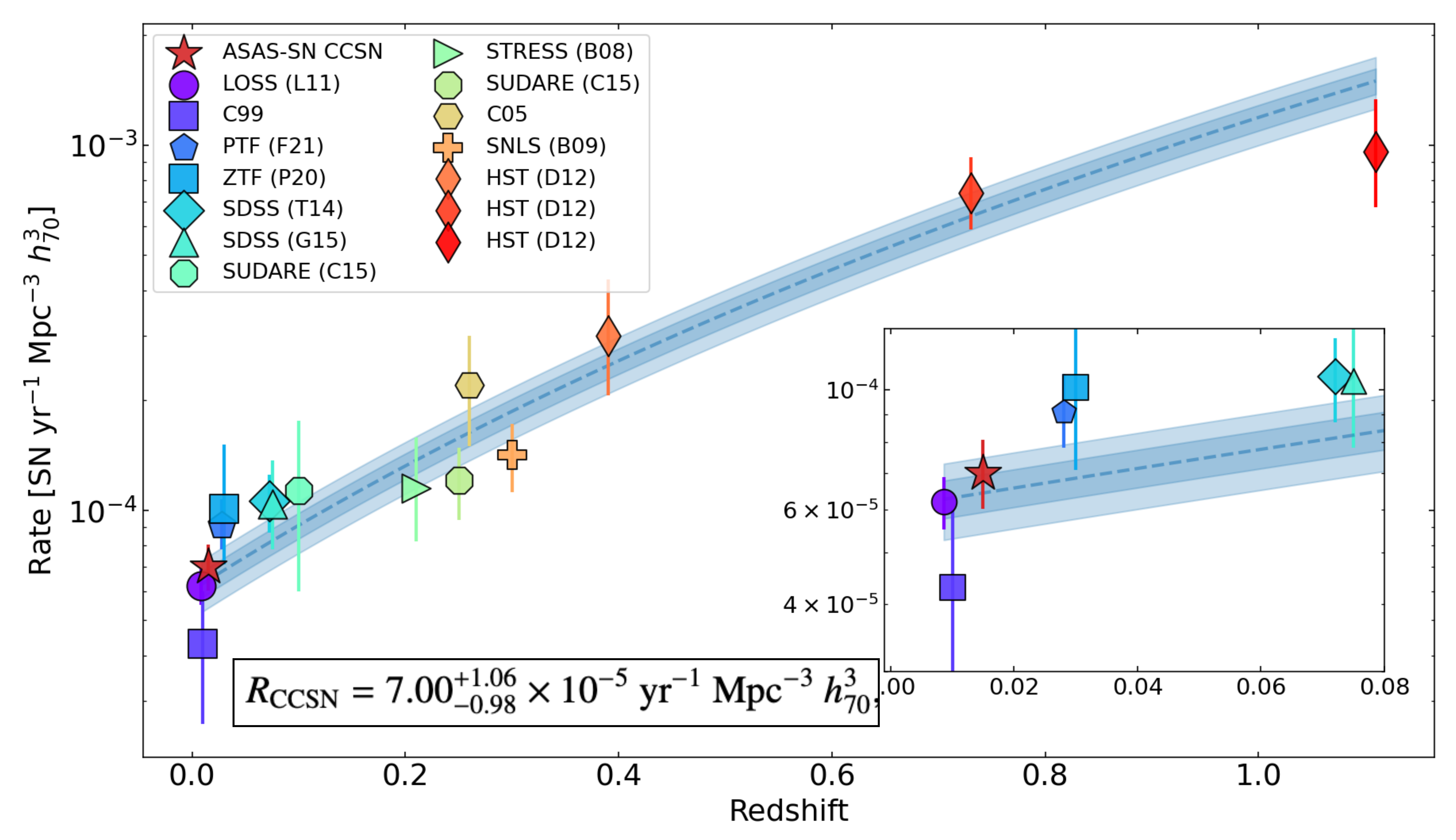


See Desai et al. 2024 for SN Ia rates

Rate computations



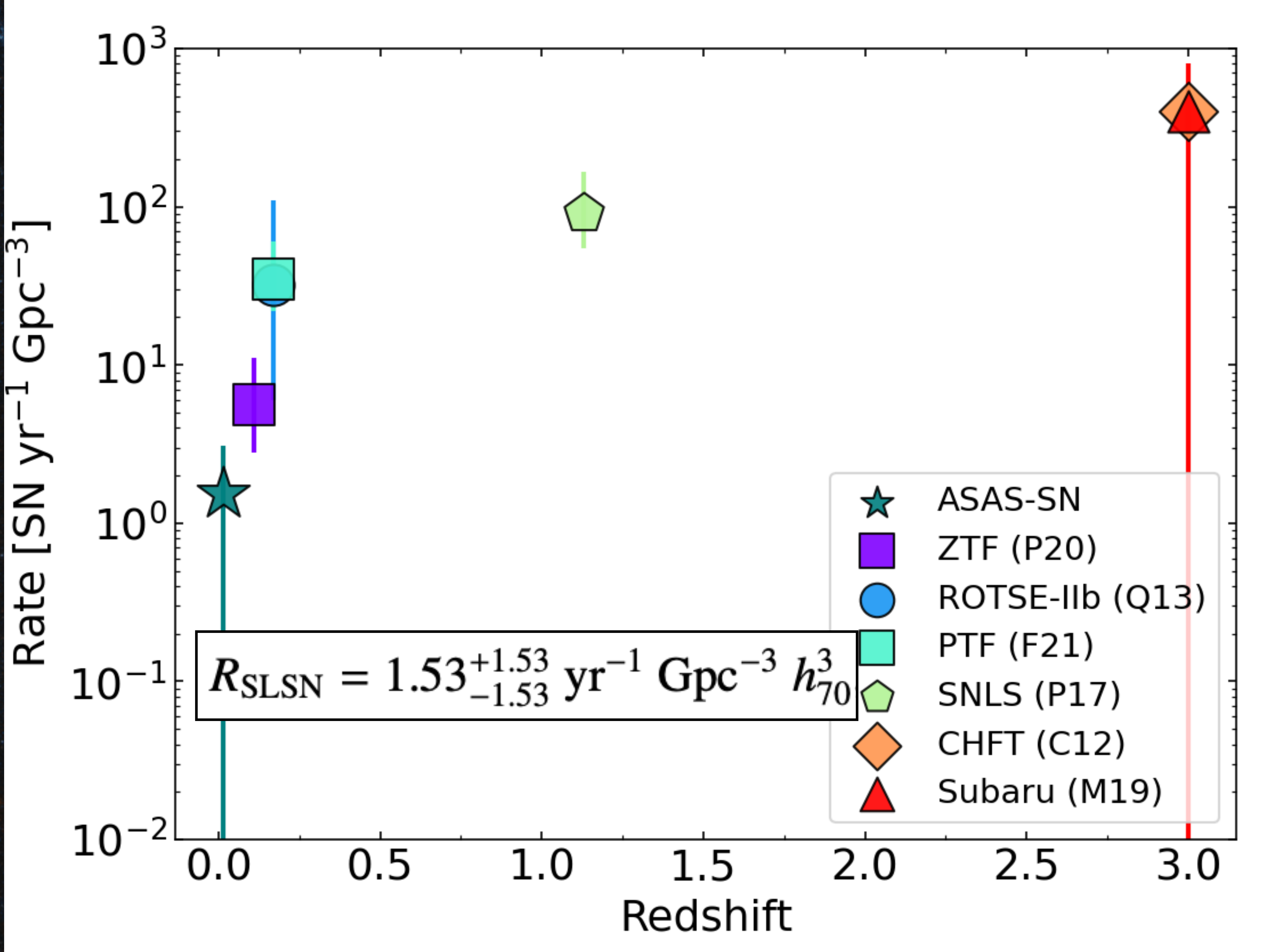
Volumetric CCSN rates



Volumetric CCSN rate fractions

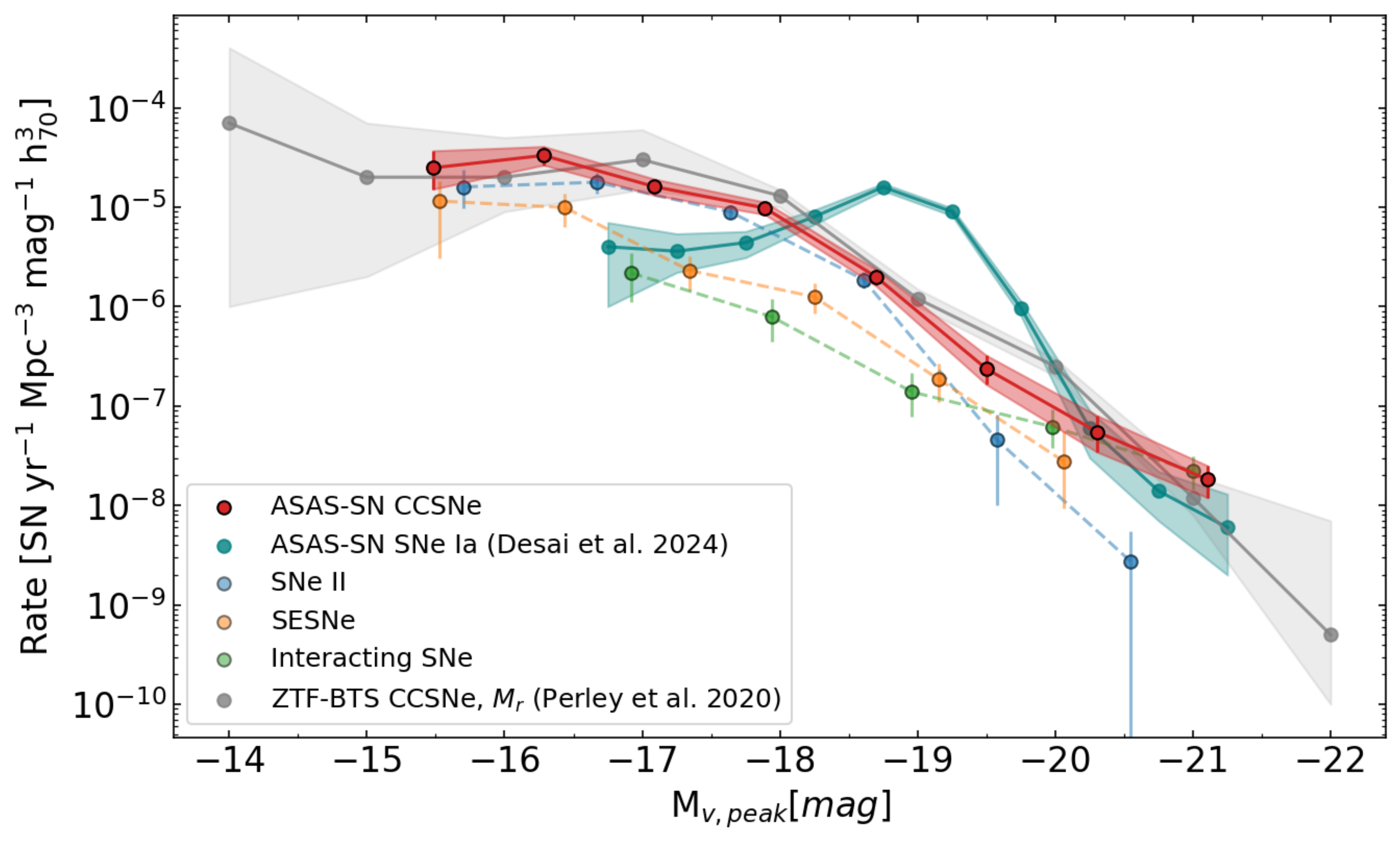
- $R_{II} \approx 2.8 \times R_{SESN}$
- $R_{II} \approx 10.7 \times R_{IIn}$
- $R_{IIb} \approx R_{Ib} \approx 2 \times R_{Ic}$
- $R_{CCSN} \approx 3.6 \times R_{Ia}$

SLSN rates

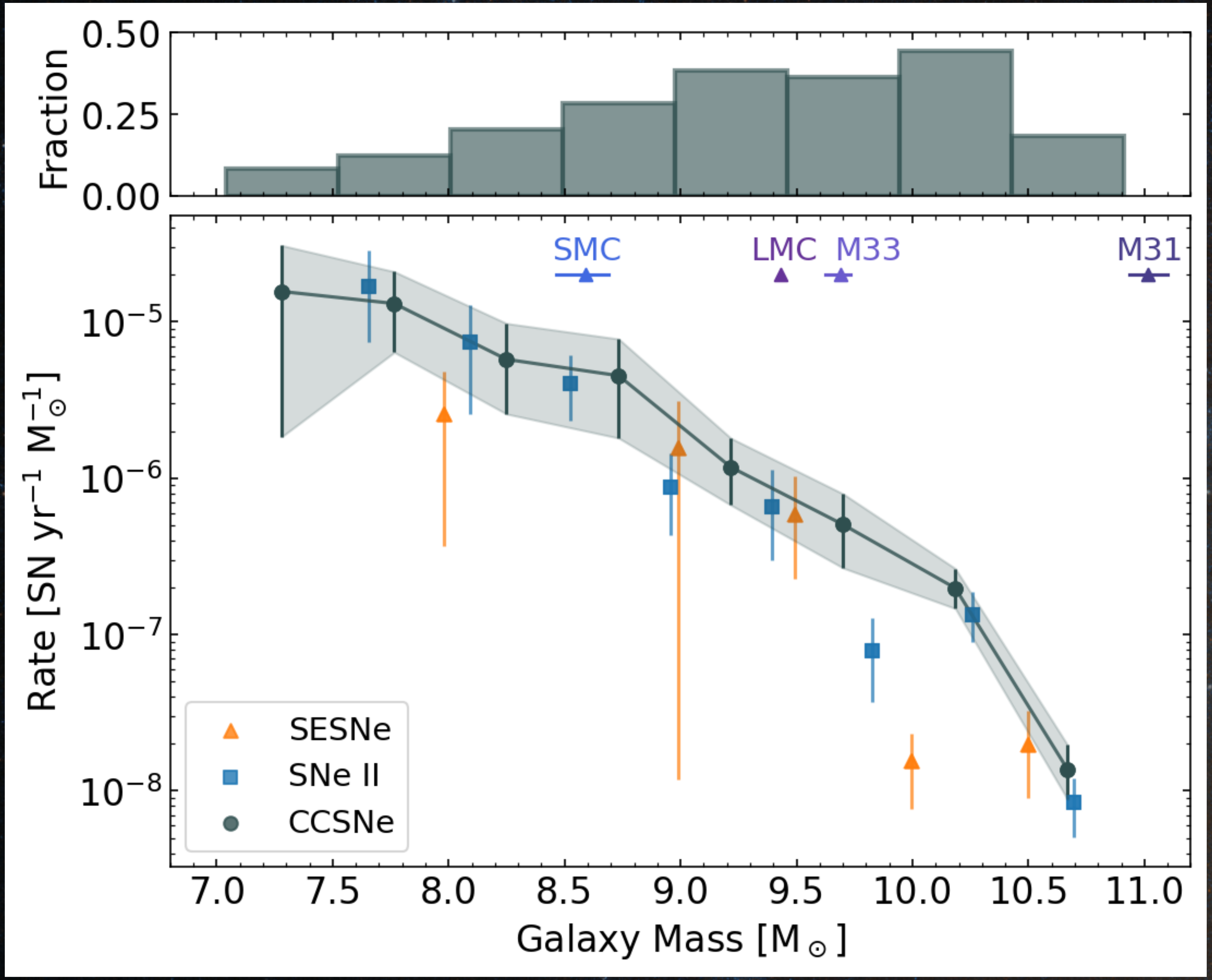


Rate [SN yr^{-1} Gpc^{-3}]
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Redshift
$R_{\mathrm{SLSN}} = 1.53^{+1.53}_{-1.53}\ \mathrm{yr^{-1}\ Gpc^{-3}}\ h_{70}^3$
ASAS-SN
ZTF (P20)
ROTSE-IIb (Q13)
PTF (F21)
SNLS (P17)
CHFT (C12)
Subaru (M19)

Luminosity functions



The CCSN rate as a function of host galaxy stellar mass



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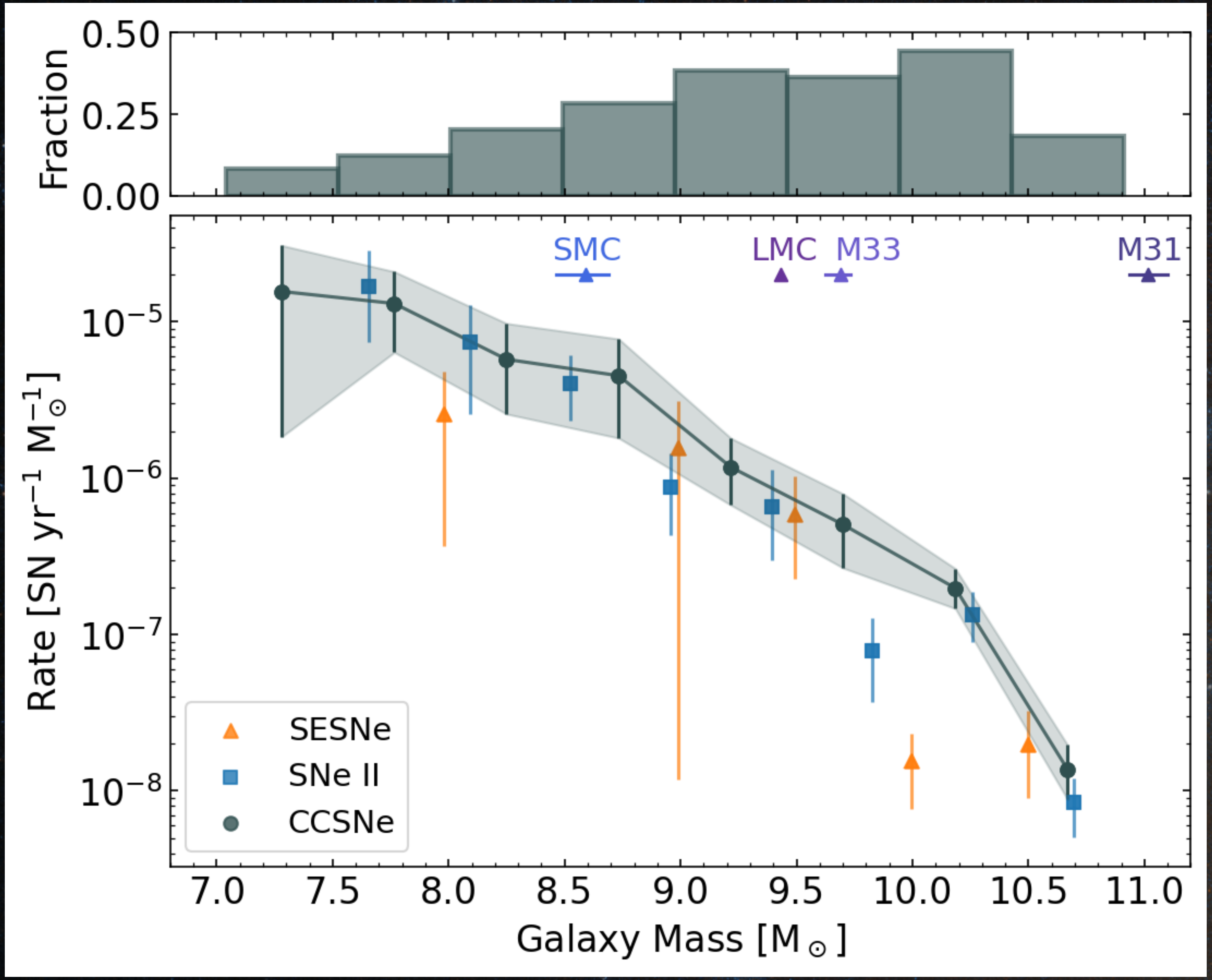

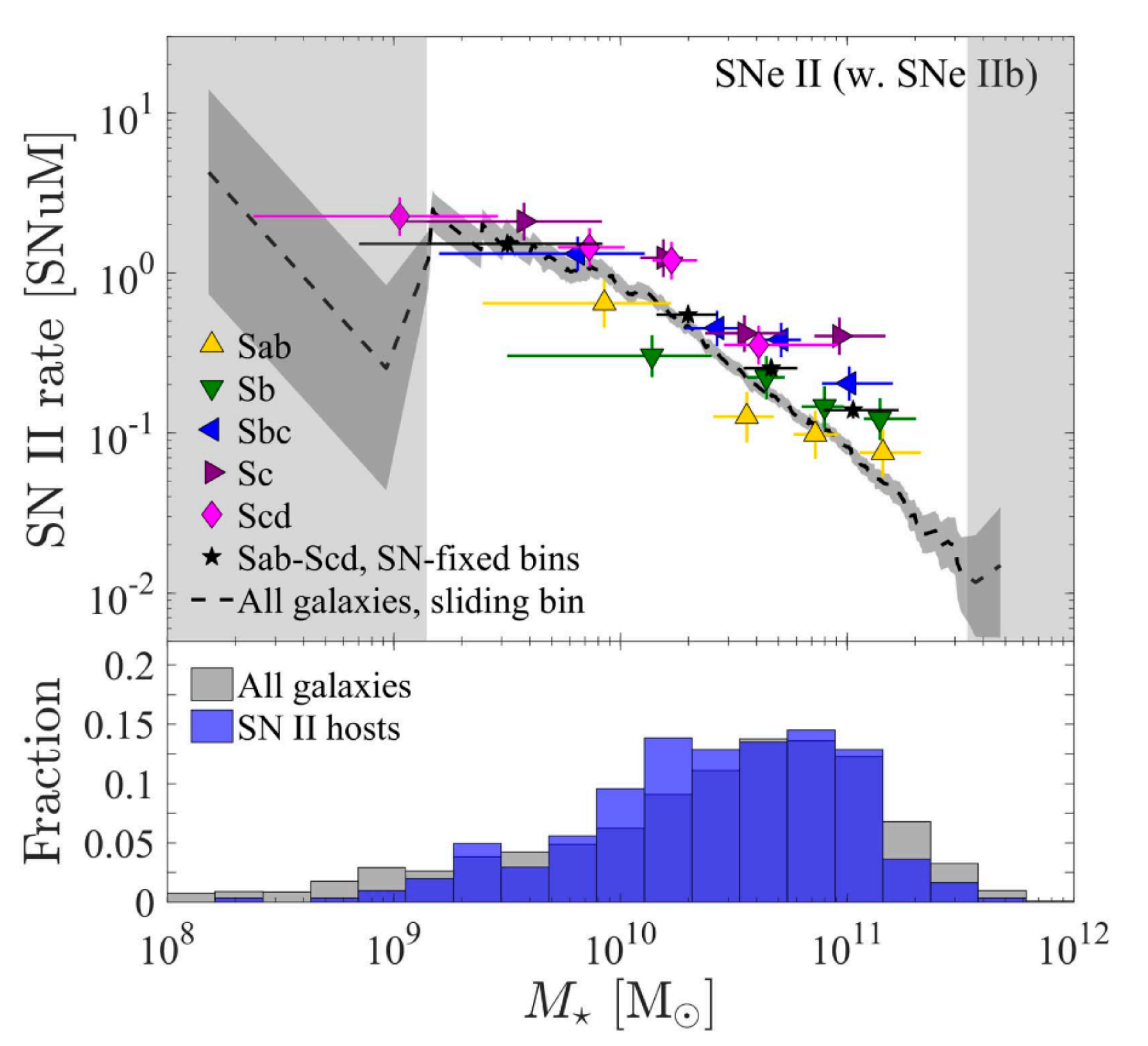

Graur et al. 2017

Summary

- New robust measurement of nearby CCSN rates, with an untargeted and highly spectroscopically complete

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- Rates and fractions of CCSN subtypes, including SLSNe
- Luminosity functions for CCSNe and their subtypes
- Importance of lower-mass galaxies

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  - 1-4 months
- **Scientific Visitor**

Thank you!