Core-collapse **supernova rates** from the **ASAS-SN** survey

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CONTEXT

- The volumetric rates and luminosity functions of core-collapse supernovae (ccSN) and their subtypes can help us understand the cosmic history of star formation and the buildup of ccSNe products.
- To estimate these rates, we used data of nearby ccSNe discovered by the All-Sky Automated Survey for Supernovae (ASAS-SN) from 2014 to 2017, when all observations were made in the V band.
- The sample is composed of 174 discovered or recovered events, with high spectroscopic completeness from follow-up observations. This allowed us to obtain a statistically precise and systematically robust estimate of nearby rates for ccSNe and their subtypes.
- The volumetric rates were estimated by correcting the observed number of events for survey completeness, which was estimated through injection recovery simulations using ccSN light curves

CCSN RATES

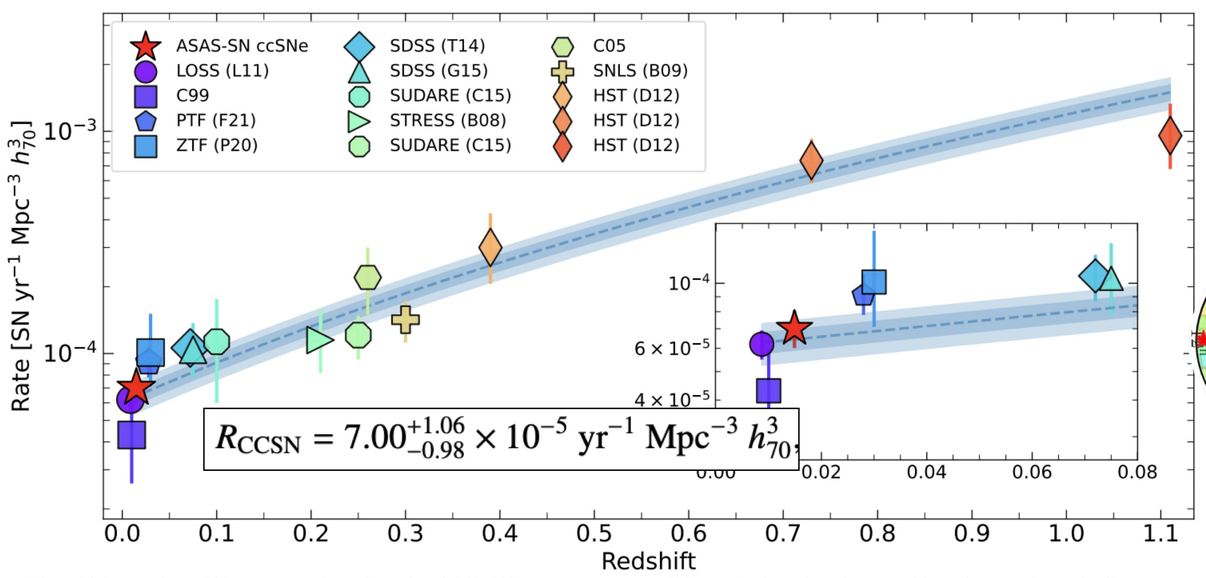
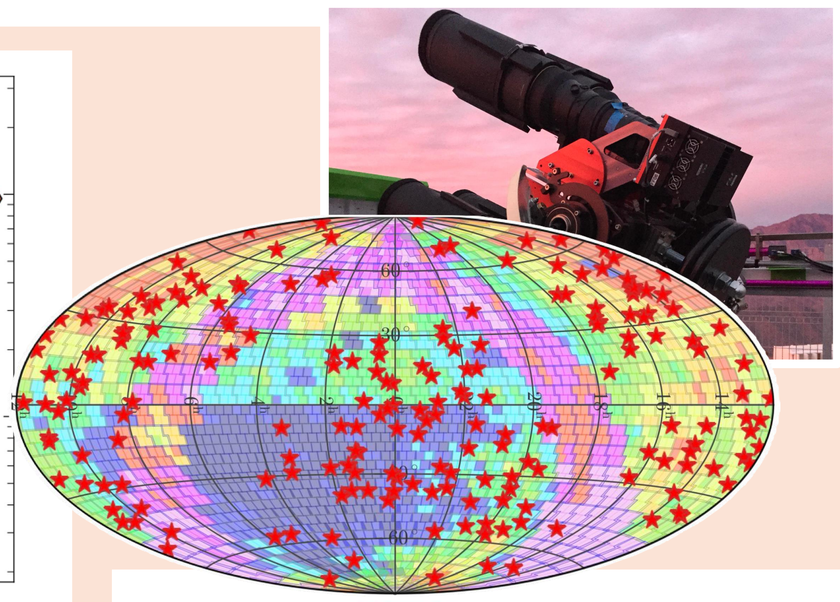


Fig.1: Volumetric ccSN rates as a function of redshift. We compare our ccSN rate (red star) estimate with estimates from the literature. The dashed blue line is an SFH model scaled to these ccSN rates. The inset zooms in on the ccSN rates for the nearby universe (z < 0.08).



LUMINOSITY FUNCTIONS

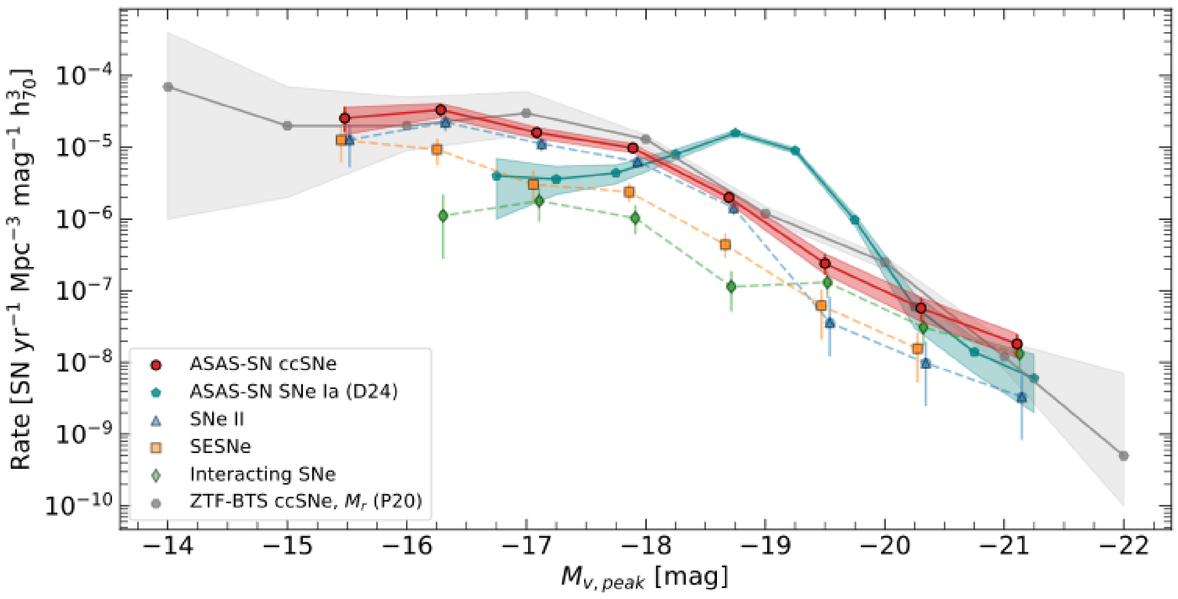


Fig.2: Luminosity functions of ccSNe. The solid red distribution shows the V-band LF considering all the ccSNe in our sample, while the dashed blue, orange, and green lines show the V-band LFs for SNe II, SESNe, and Interacting SNe, respectively. We also show the ASAS-SN V-band LF for SNe Ia from Desai+25, and the r-band ZTF-BTS ccSN LF from Perley+20.

FRACTIONS OF VOLUMETRIC RATES

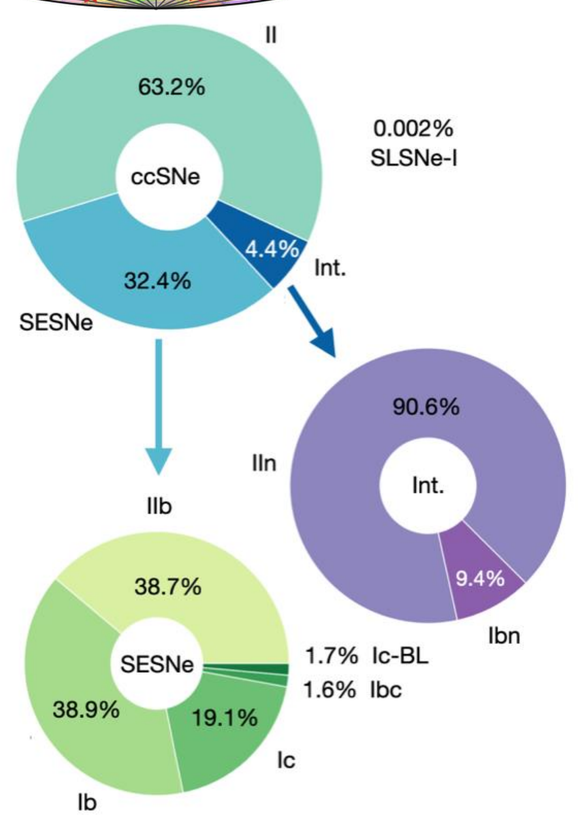


Fig.3: Fractions of the volumetric rates associated with different ccSN subtypes. Fractions are shown for SNe II, SESNe and its subtypes (SNe Ib, Ic, IIb, Ibc, and Ic-BL), and interacting SNe (Int.) and its subtypes (SNe IIn and Ibn).

CONCLUSIONS

- We find a total volumetric rate for ccSNe of $7.0^{+1.0}_{-0.9} \times 10^{-5}\ yr^{-1}\ Mpc^{-3}\ h_{70}^3$, at a median redshift of 0.0149. This result agrees with the local volumetric rates found in previous studies.
- We obtained rates for the different ccSNe subtypes in our sample, including SNe II, IIn, IIb, Ib, Ic, Ibn, and Ic-BL. We find that SNe II comprise 63.2% of all ccSNe, which is ~2.8 times higher than the occurrence rate of SESNe (a volumetric rate of $2.2^{+0.8}_{-0.6} \times 10^{-5}\ yr^{-1}\ Mpc^{-3}\ h_{70}^3$), and ~22.9 times higher than the occurrence rate of SNe IIn (a volumetric rate of $3.0^{+1.2}_{-1.0} \times 10^{-6}\ yr^{-1}\ Mpc^{-3}\ h_{70}^3$).
- We also estimated the volumetric rates for SLSNe to be $1.5^{+4.4}_{-1.1}\ yr^{-1}\ Gpc^{-3}\ h_{70}^3$, over the redshift range 0.001 < z < 0.1.
- We built the LFs of ccSNe and several subtypes in bins of peak V-band absolute magnitudes. The ccSN rates steadily decline for high luminosities, with no turnover at the faintest luminosities. Type Ia SN rates are higher near $M_{V,peak} \approx -19.0$ mag.

SLSN RATES

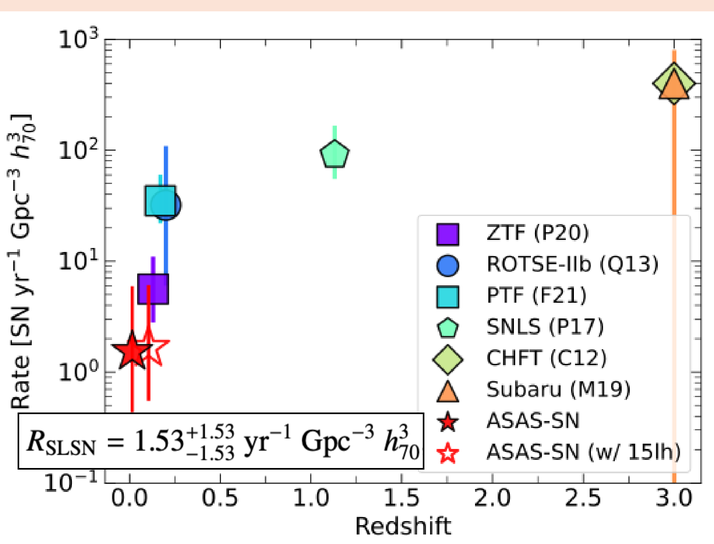


Fig.4: Volumetric superluminous supernova (SLSN) rates as a function of redshift. Our SLSN rate estimates are shown as the filled and empty red stars.

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THE RATES PAPERS

ccSNe — Pessi+25

SNe Ia — Desai+24

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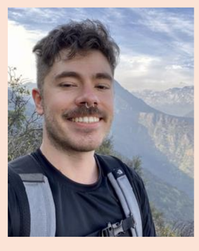

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