Measuring the Redshift Completeness Fraction of Nearby Galaxies

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Background

- **Exotic Transients** (i.e. Gravitational Waves) provide unique insights to evolution of stars.
- **Electromagnetic counterparts** of sources require **timely** observations and are **difficult to find** (localizations ~500 deg^2).

- One way to narrow down the location of Exotic transient hosts is to find **the Redshift Completeness Fraction (RCF)** within a localization.
  - **RCF** - fraction of Galaxies whose redshifts are known
  - Measured by finding the fraction of supernovae (SNe) hosts whose galaxies are known prior to SNe discovery

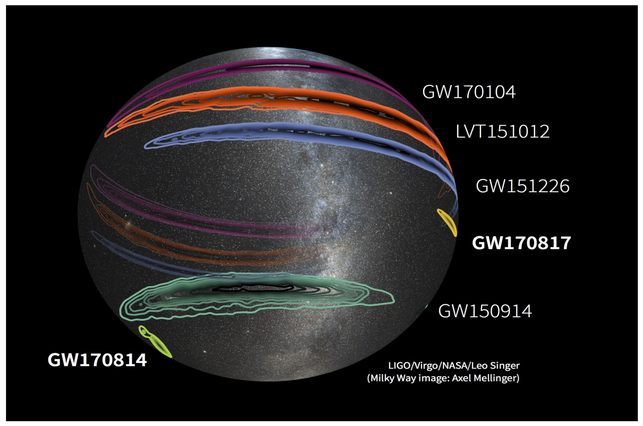

Figure 1 shows the localizations of GW sources. Notice how these localizations take a large portion of the sky. Image credit: LIGO collaboration

To calculate RCF we utilize:

- SNe data from the Bright Transient Survey (BTS) by the Zwicky Transient Facility (ZTF)
- Redshift data from the NASA/IPAC Extragalactic Database (NED) and Dark Energy Spectroscopic Instrument (DESI)
- Photometry from WISE

There are Changes in RCF and Magnitude Distribution as compared to Previous Studies

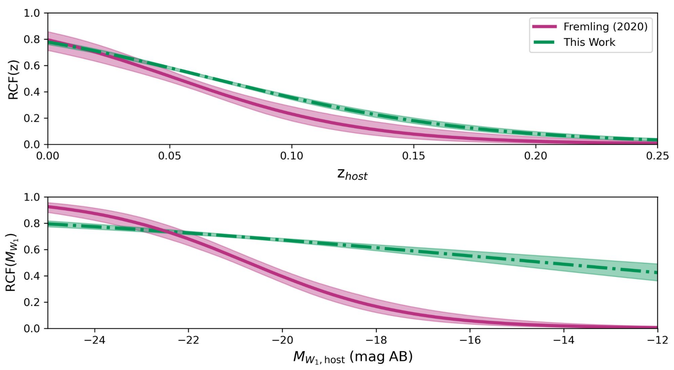

Figure 2: (top) Compares RCF vs. Redshift curve between Fremling 2020 (pink) and RCF data from SN Ia data in this work (green). While the curves do not vary significantly, **the RCF curve from this work seems to be consistently higher than that of Fremling (2020). This suggests that the introduction of DESI did increase the overall RCF.**

(bottom) Compares RCF vs. Absolute W1 magnitude curve between Fremling 2020 (pink) and RCF data from SN Ia data in this work (green). **The green curve seems to be much shallower than that of the pink curve.**

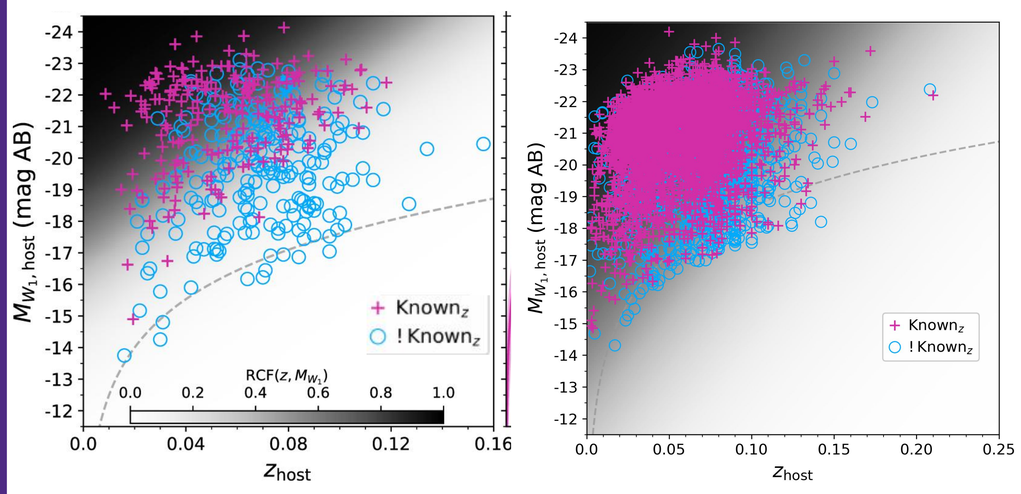

Figure 3: shows redshift vs. Absolute W1 from Fremling (2020; right) and this work (left). Symbols indicate if the host galaxy's redshift is known (pink pluses) or unknown (blue circles).

The figure on the right seems to show that galaxies marked as **"Known$_z$" has lower redshifts and higher luminosities** compared to that of galaxies marked as **"!Known$_z$".** This is consistent with what was found in Fremling (2020) sample. However there was **more overlap** between SNe hosts marked as **"Known$_z$"** and **"!Known$_z$"** in the SN Ia sample from this work that that of the Fremling (2020) sample.

References and Acknowledgements

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Type of SNe used to calculate RCF does appear have an effect RCF curve

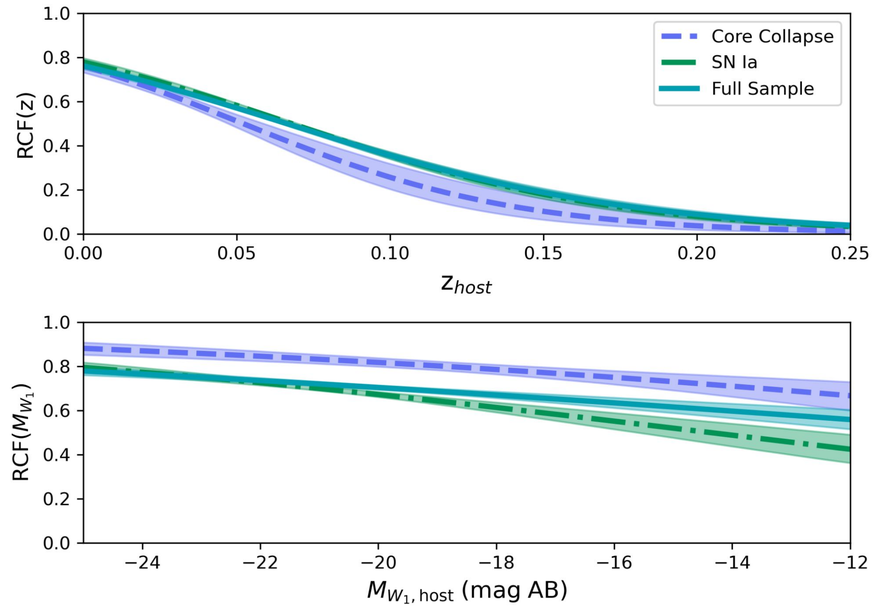

Figure 4: (top) Compares RCF vs. Redshift curve between Core Collapse sample (dashed blue line) , SN Ia sample(green), and the combined sample (teal solid line). We find that the RCF vs. Redshift curve seems to be lower with the core collapse sample as compared to the SN Ia sample. This not surprising since Core Collapse SNe are less luminous compared to SN Ia. The combined and SN Ia sample seem to be identical since the vast majority of SNe in the full sample are SN Ia hosts.

(bottom) Compares RCF vs. Absolute W1 magnitude curve between Core Collapse sample (dashed blue line), SN Ia sample (green), and the combined sample (teal solid line). The Core Collapse RCF is consistently higher than that of the SN Ia RCF function.

RCF Distribution on the Sky

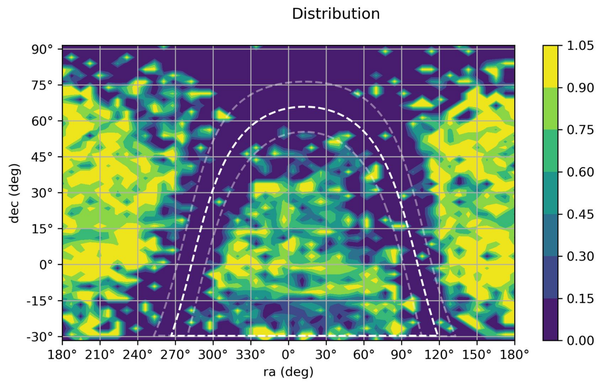

Figure 5: Shows the RCF as a function of position in the sky. The white dashed lines shows the projection of the Milky way on the night sky.

The areas with the greatest RCF seem to be concentrated with a **Dec. ~ -30° to 75°** and an **RA ~ 120° - 270°**. This portion of the sky is where most of the SDSS and DESI observations are.

Conclusions and Next Steps

- The RCF is higher in this work compared to other studies (see Figures 2 and 3).
  - **newer surveys**, such as DESI, **found redshifts of more galaxies than before**
- **SNe used to calculate RCF seems to affect RCF calculations** (see Figure 4).
  - May suggest we have a better understanding of star-forming galaxies vs. quiescent (low star formation) ones.
    - Core Collapse SNe traces star-forming populations.
    - SN Ia traces galaxies mass. Massive galaxies also tend to be older and redder.
  - In the future, we can add Core Collapse and low luminosity galaxies to sample in the future see RCF changes
    RCF is **unreliable** at **low luminosities** (No SNe hosts $M_{W1} > -14$).
- RCF distribution is uneven throughout the sky (see Figure 5)
  - There are no data below -30° Dec due to limits of ZTF
  - Compare RCF Sky distributions with Type Ia and Core Collapse samples