Undetectable fraction of core-collapse supernovae in luminous infrared galaxies

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The undetectable fraction of core-collapse supernovae in luminous infrared galaxies

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II. GSAOI/GeMS dataset

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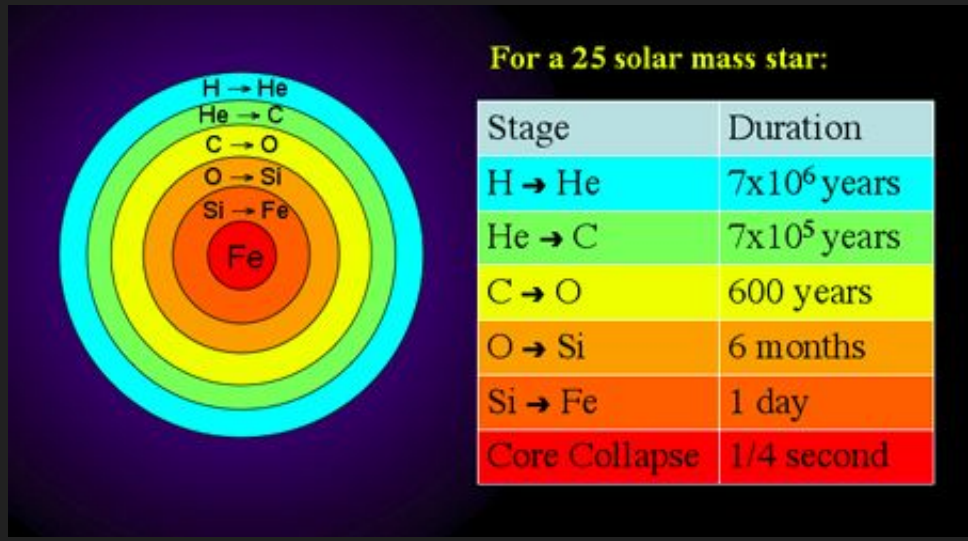
Core-collapse supernovae (CCSNe)

- Stars with masses > 8 $M_\odot$ explode as supernovae at the ends of their lives.
- These stars “only” live 3-42 Myr (single stars), which on scales of galaxy ages are “instant”.
- With only a small approximation, CCSNe explode where they are born, and rates of CCSNe directly correlate to star formation rate



Luminous infrared galaxies (LIRGs)

- Defined as galaxies with $L_{IR} > 10^{11} L_{\odot}$
- Source of huge IR brightness is from reprocessing of high energy photons.
- Most of them are post-mergers or actively merging (see image)
- The violent merging triggers extreme star formation (10 to 100 times of Milky way)

Arp 299, Image from: Wikipedia

The problem - Where are the supernovae?

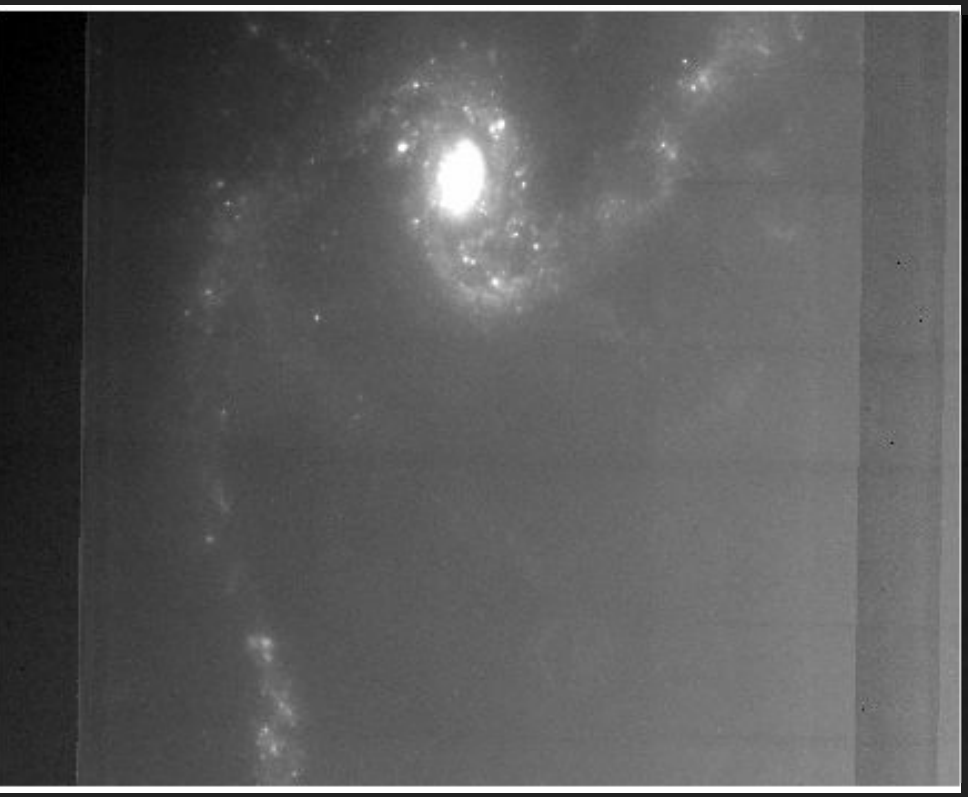
<- This LIRG, Arp 299 should host ~1.5 CCSNe per year, according to models.

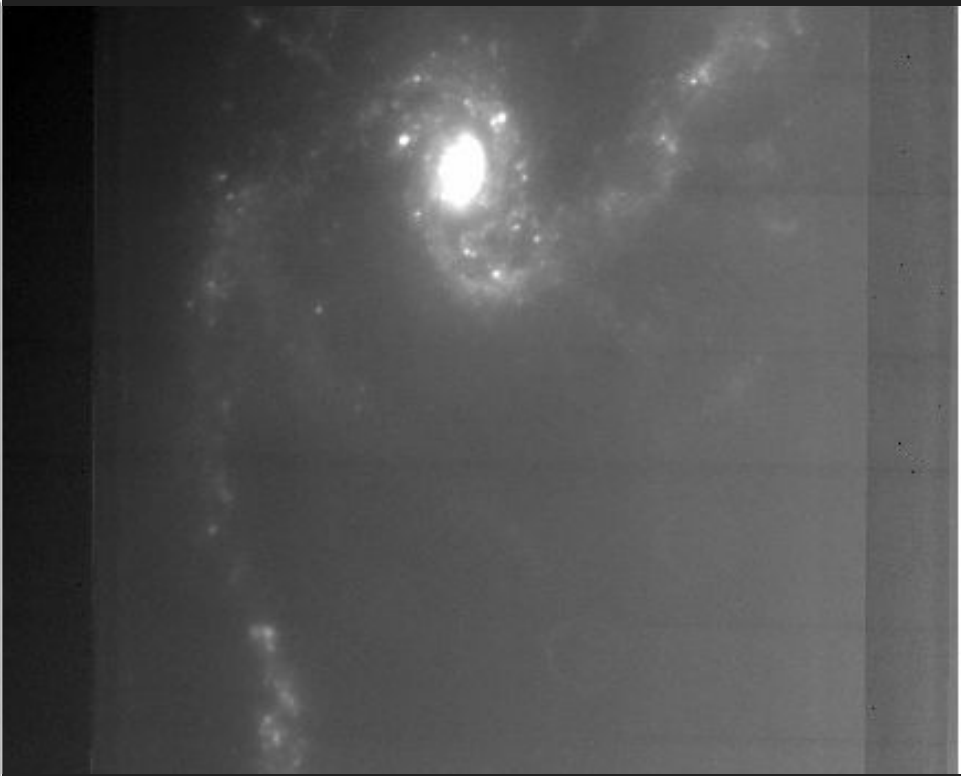
- 14 year survey found 5,
- 14*1.5 = 21 >> 5, ~80% missed

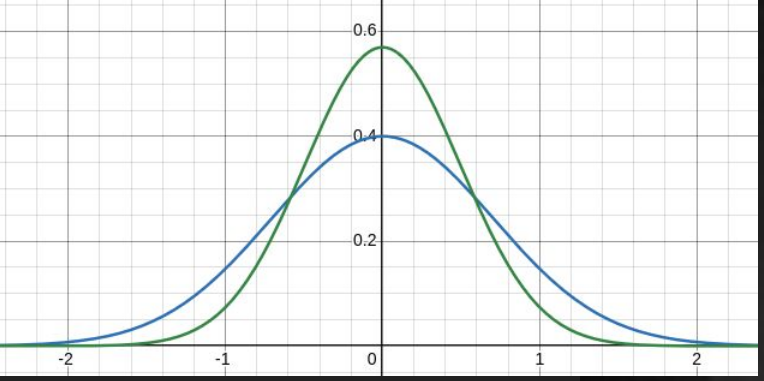
Undetectable fraction

- Even though CCSNe are amongst the most energetic events in the Universe, we still might fail to see many of them.
- List of explanations includes: Bad weather, too low cadence of observations, bad luck, poor performance of analysis programs. Models wrong?
- Most important is the nigh impenetrable gas and dust clouds that the CCSNe and their progenitor stars reside in.
- Disentangling these effects is our main science goal.

Template subtraction

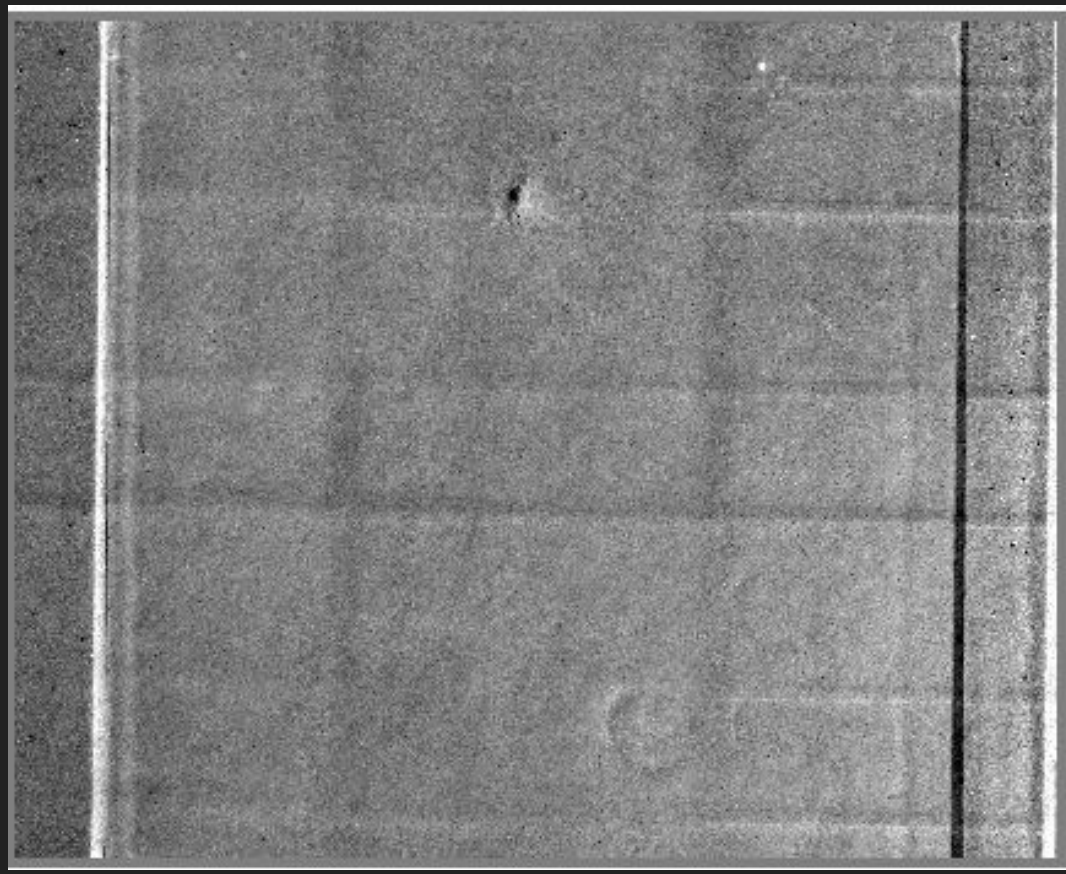




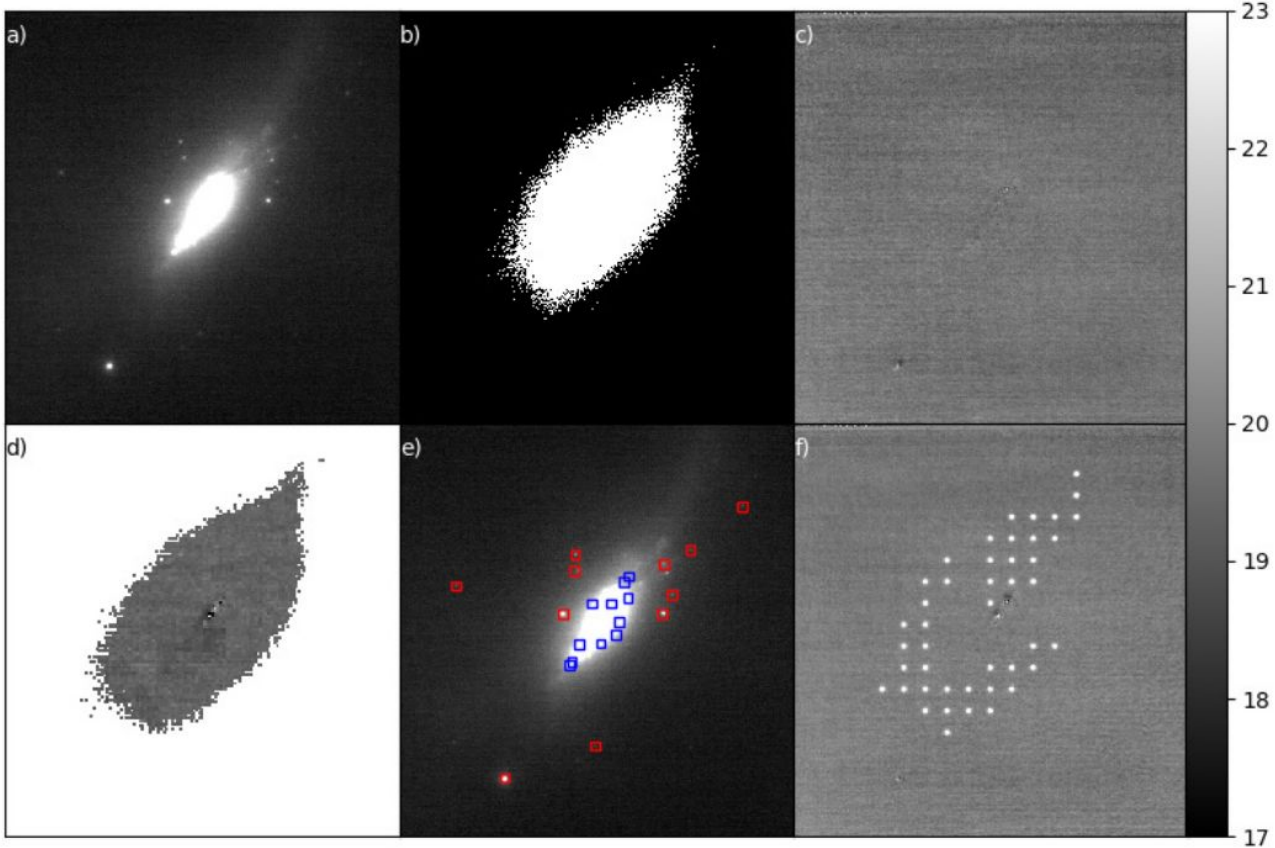

0.6
0.4
0.2
-2
-1
0
1
2

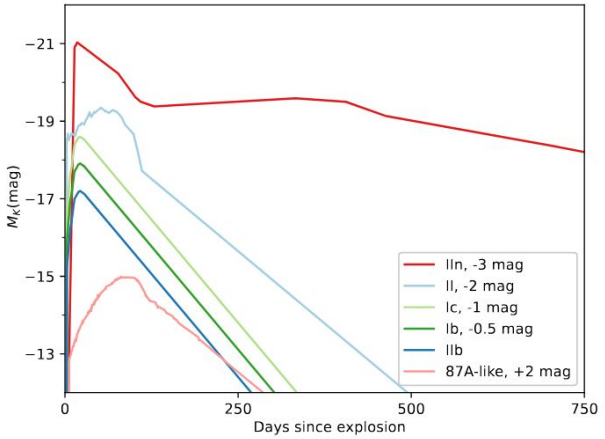
Caveats:

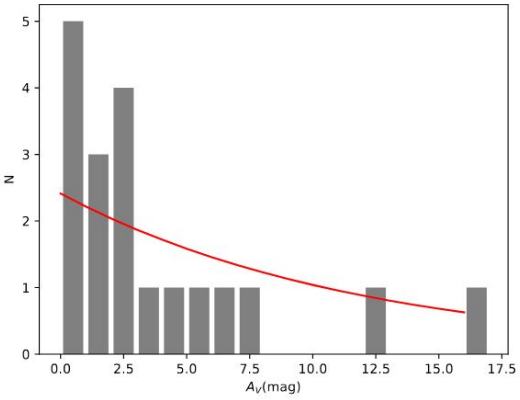
- Areas used for kernel calculation may contain faint transients that get erased.
- Artefacts may cause false positives and negatives
- The galaxy is assumed to stay constant between epochs, e.g. TDE and AGN may break this assumption.



Monte Carlo simulation subparts

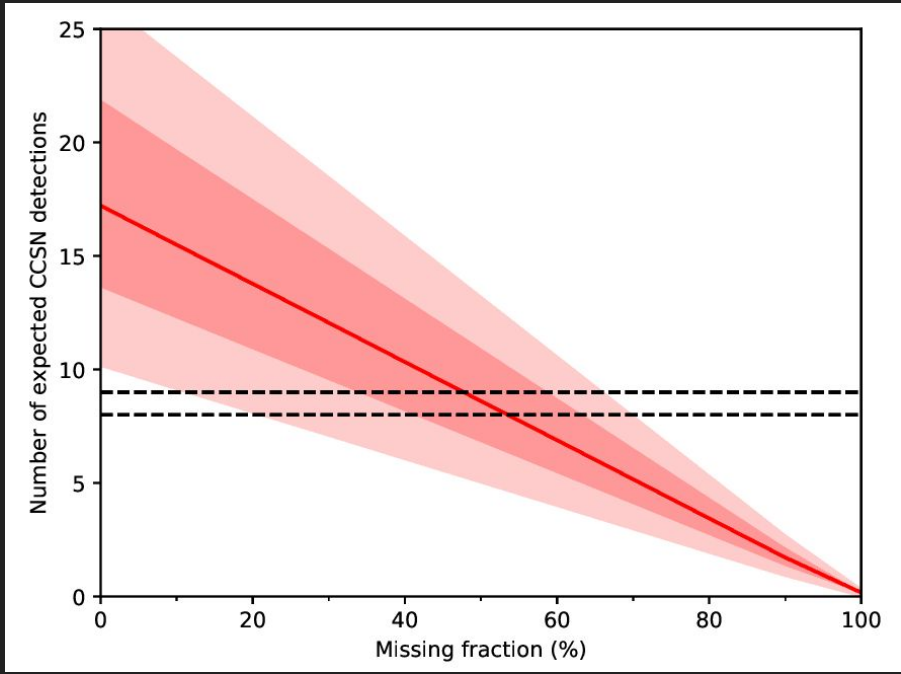






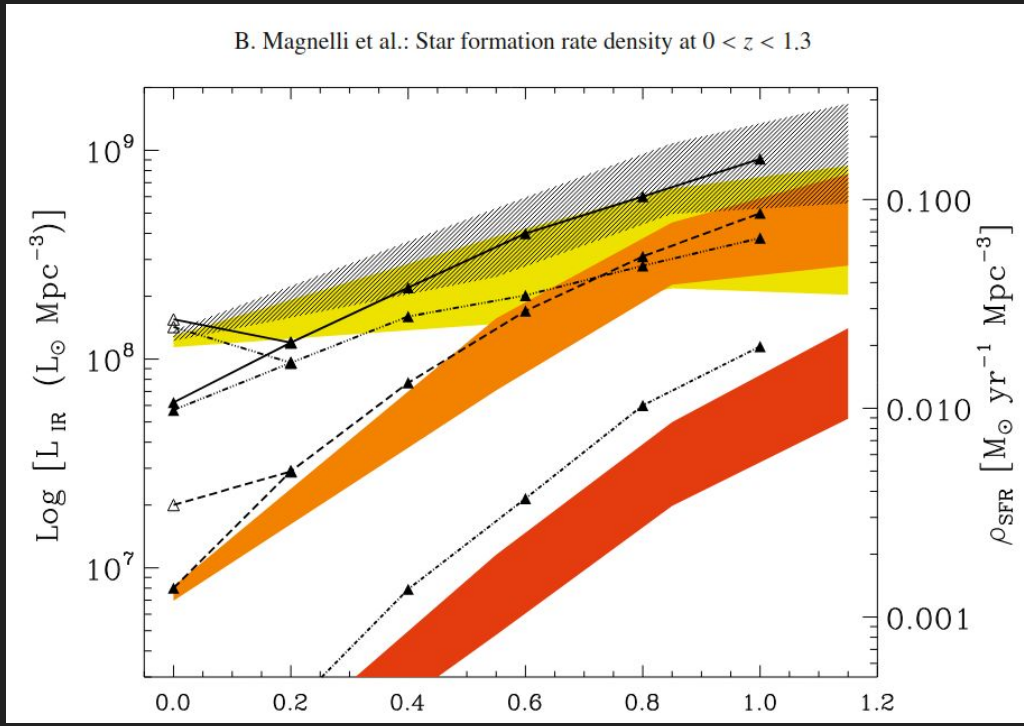
Monte Carlo simulation

- Simulates a “SN survey” with varying parameters and calculates the expected numbers of detected CCSNe
- Finally we compare expected CCSNe to the real detections in the dataset (image)
- VIS = 88.3+2.6-3.2
- NIR = 61.4+8.5-10.6



Why? and future work

- While LIRGs are rare in the local Universe, they were more prominent in the past (aka. at longer distances).
- Studying CCSNe through the cosmic time requires understanding of LIRGs.



Thanks

Questions?