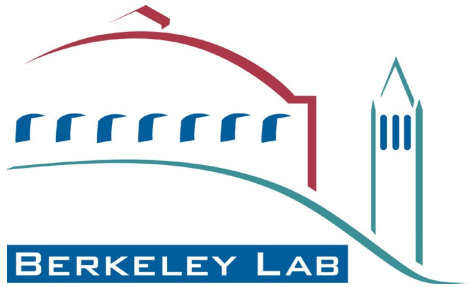
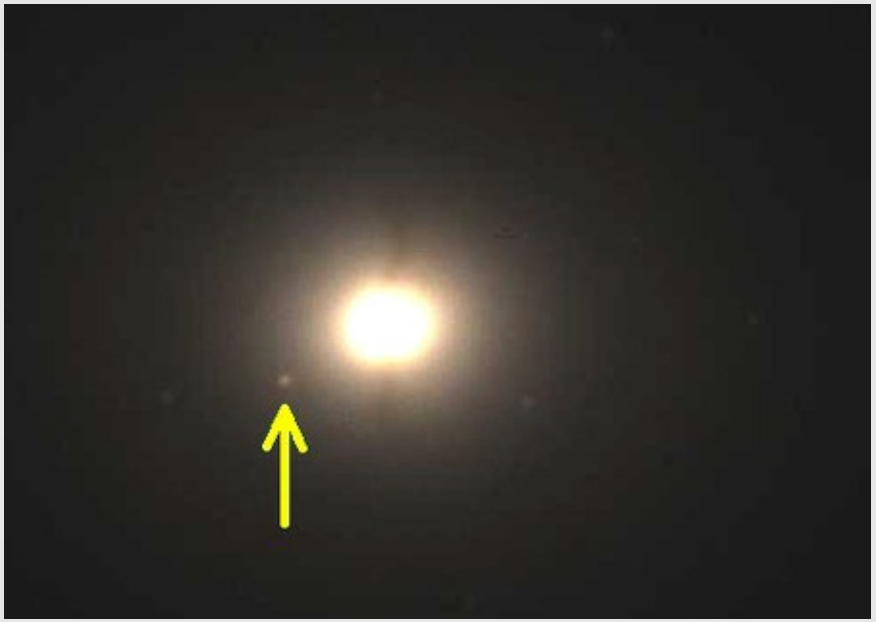
Type Ia Supernova Rates in Galaxy Clusters

Kyle Barbary
Supernova Cosmology Project
UC – Berkeley, LBNL

Cosmology In Northern California
22 October 2010



SNe Ia have a wide range of “delay times”



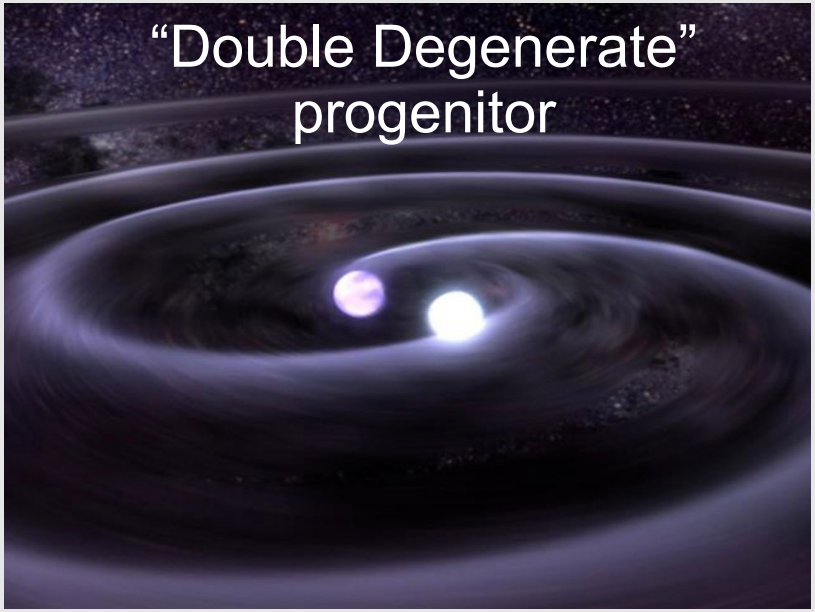
- SNe Ia come from old stellar systems...

- … and also from young systems!

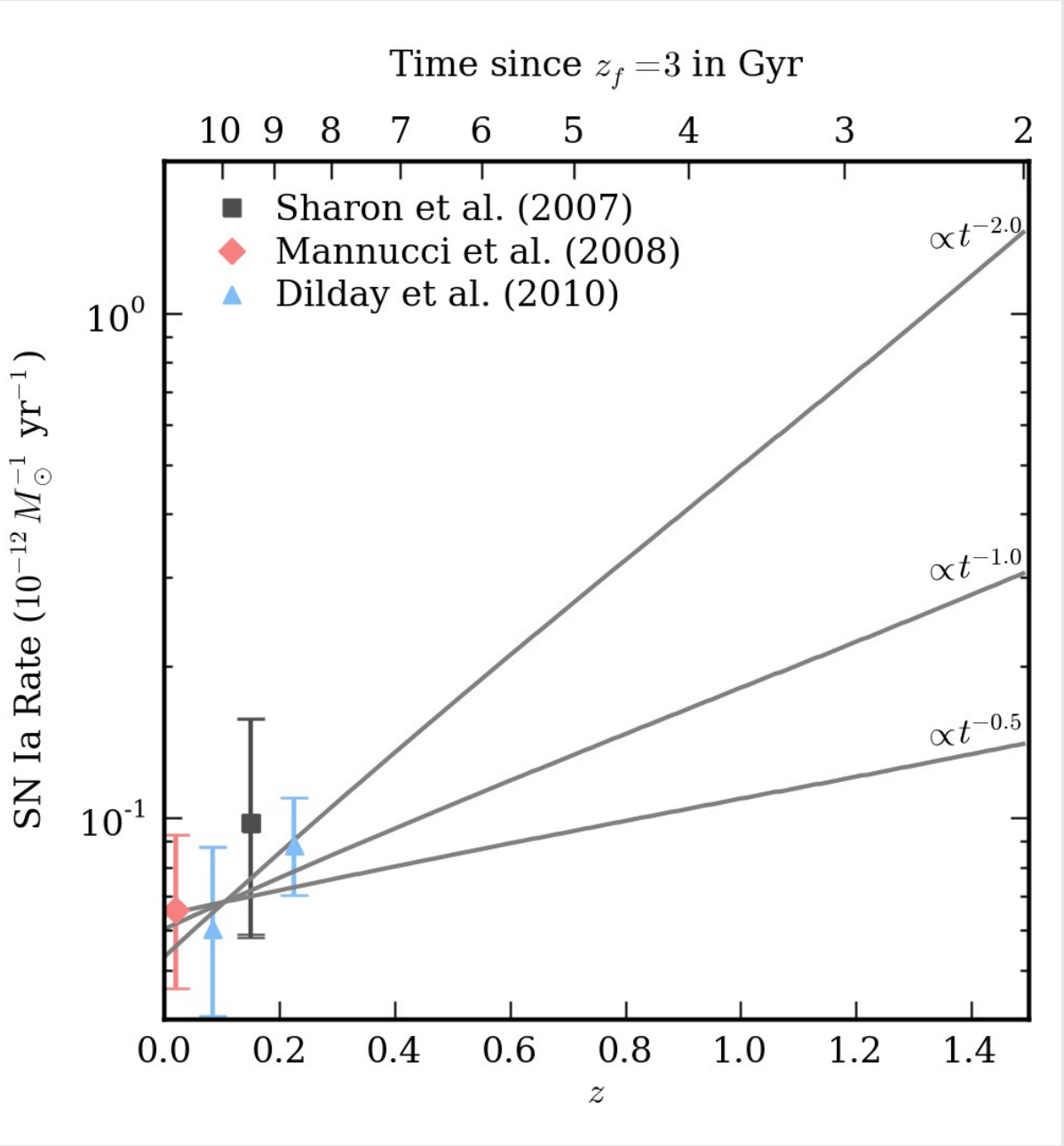
Delay time ranges from <100 Myr to many Gyr

SN Ia progenitor

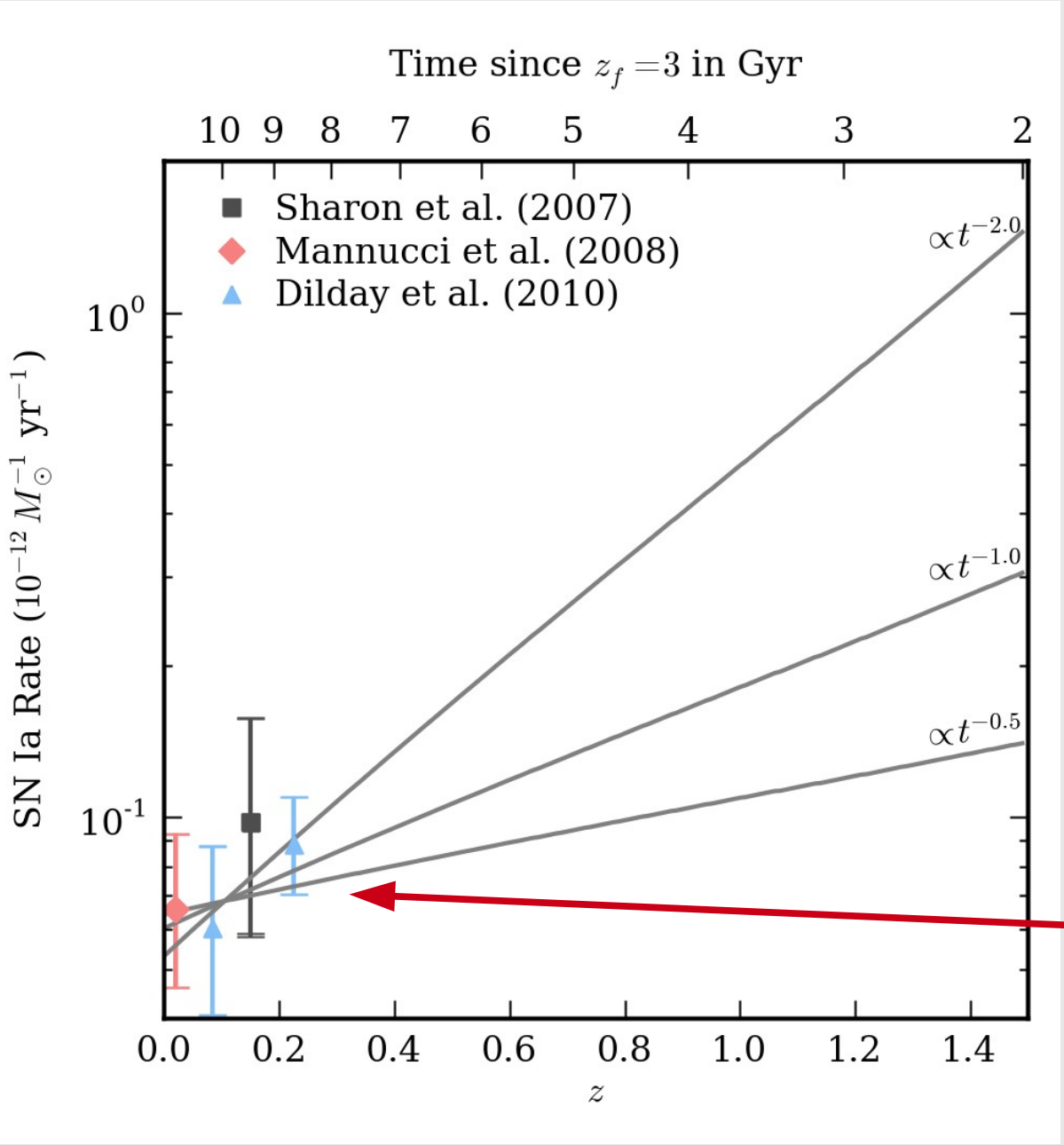
- SN Ia: thermonuclear explosion of white dwarf in a binary system
- How does the binary evolve? What is the companion star?
- Distribution of delay times can tell us!



SN Rates in Galaxy Clusters



SN Rates in Galaxy Clusters

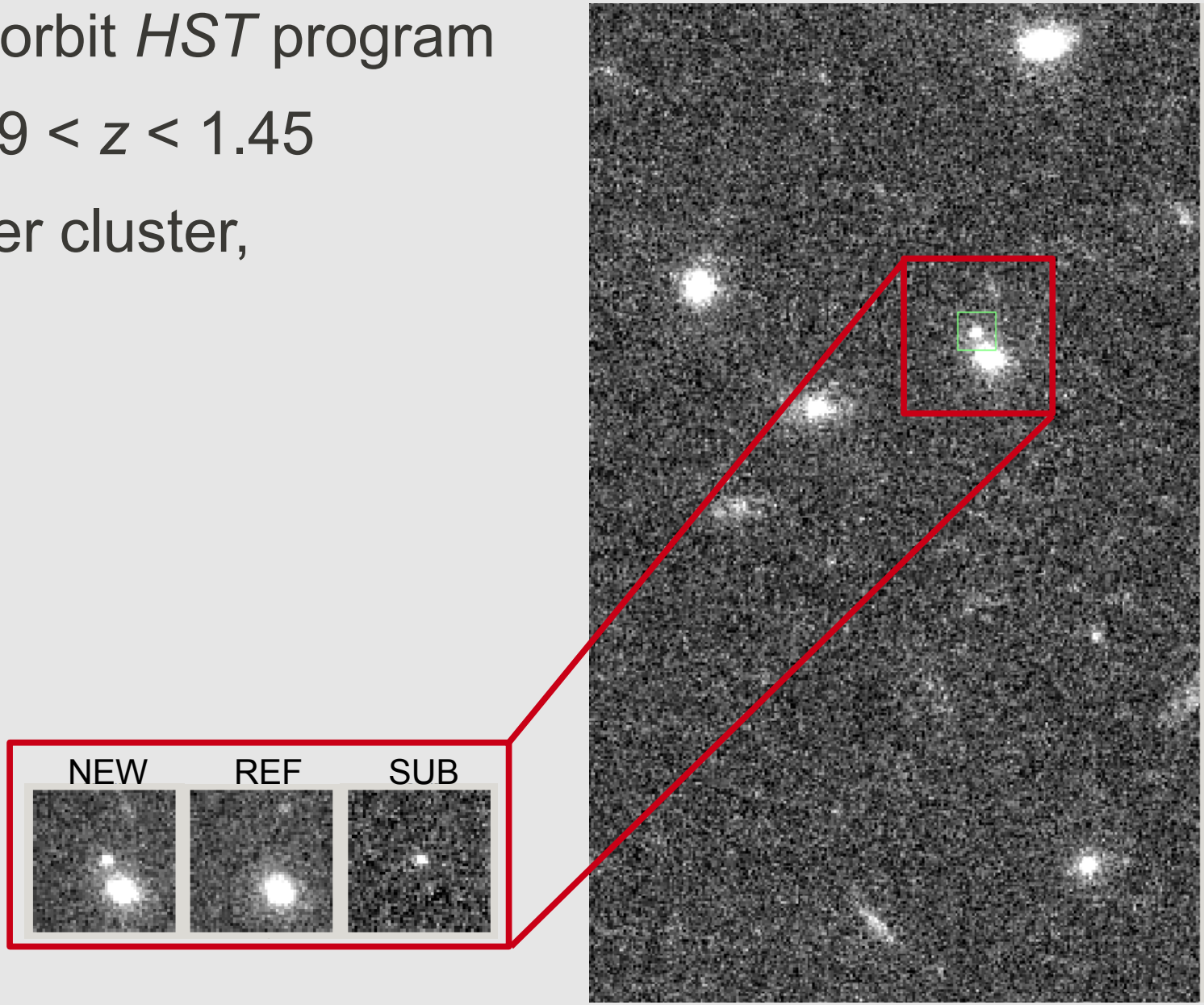


High-z clusters:
rate at ~3 Gyr
- Is it higher?
- By how much?

Low-z clusters:
rate at ~10 Gyr

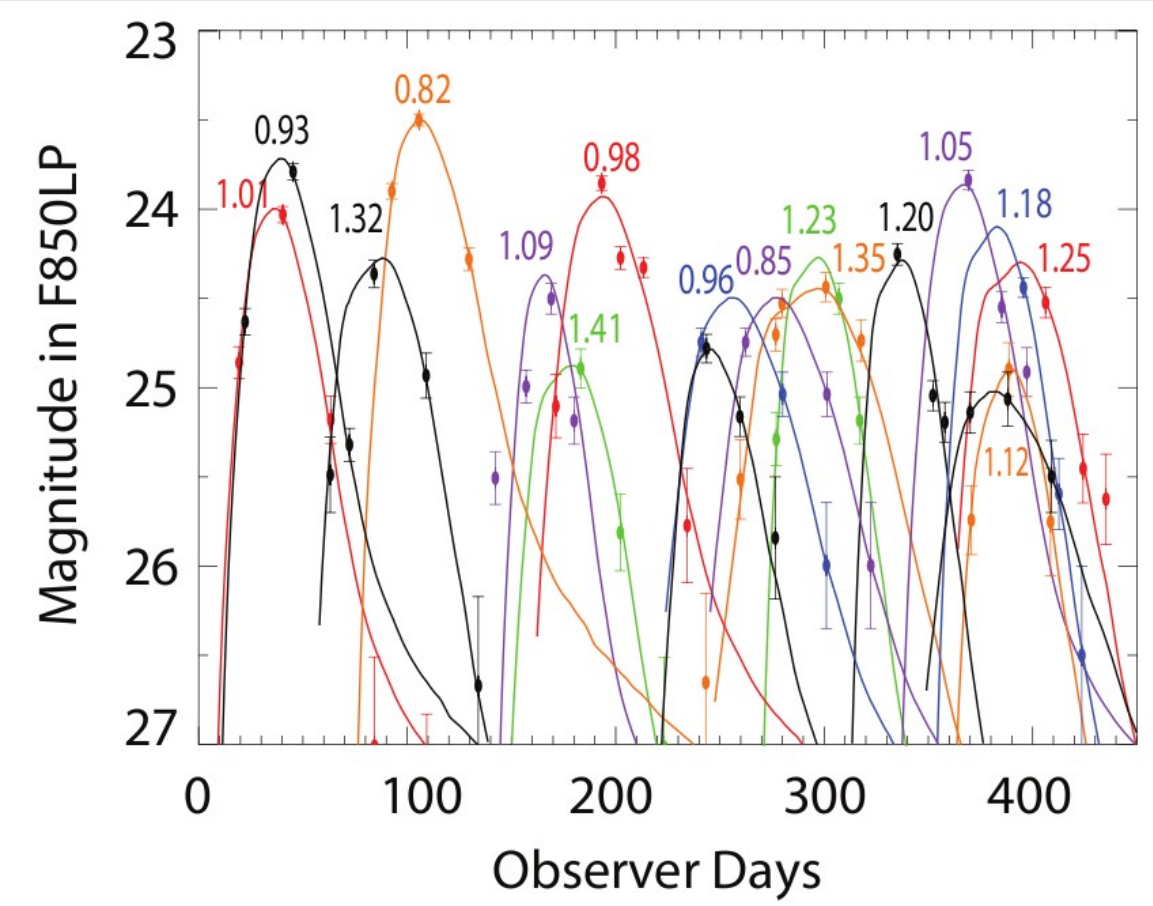
HST Cluster Supernova Survey

- Intensive 219-orbit *HST* program
- 25 clusters: $0.9 < z < 1.45$
- 6 – 10 visits per cluster,
  3 weeks apart



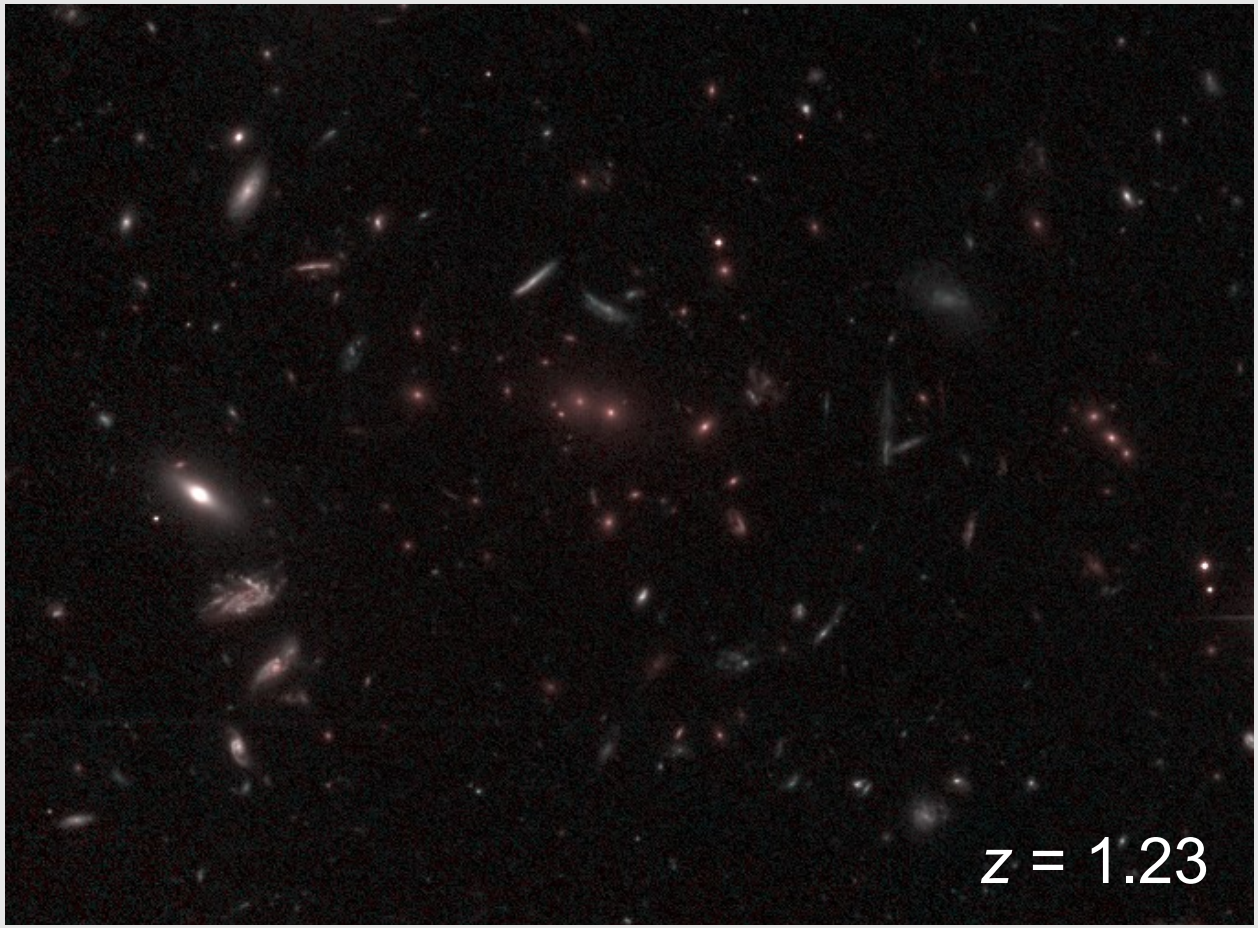
HST Cluster Supernova Survey

- Intensive 219-orbit HST program
- 25 clusters: $0.9 < z < 1.45$
- 6 – 10 visits per cluster,
  3 weeks apart

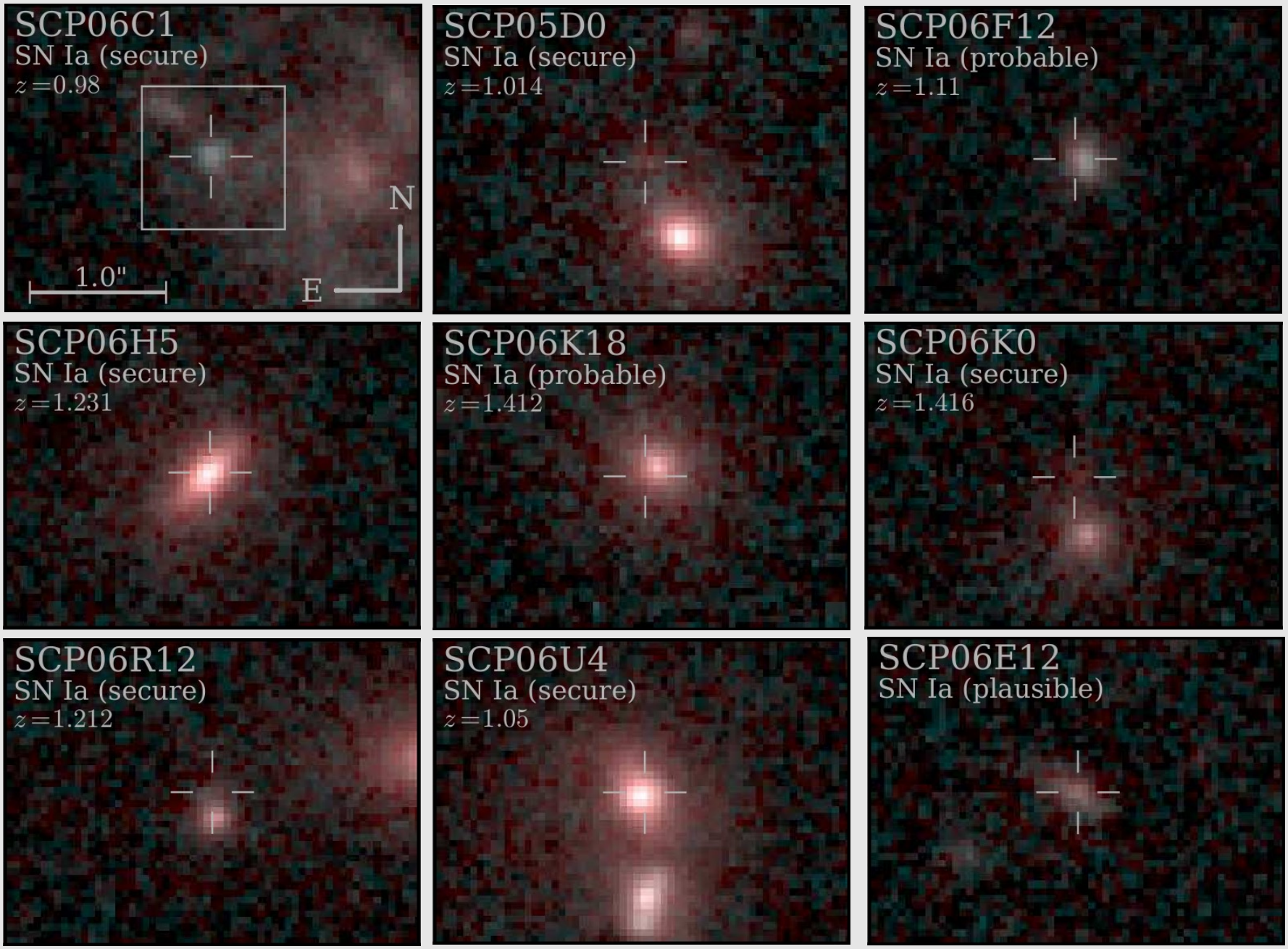


HST Cluster Supernova Survey

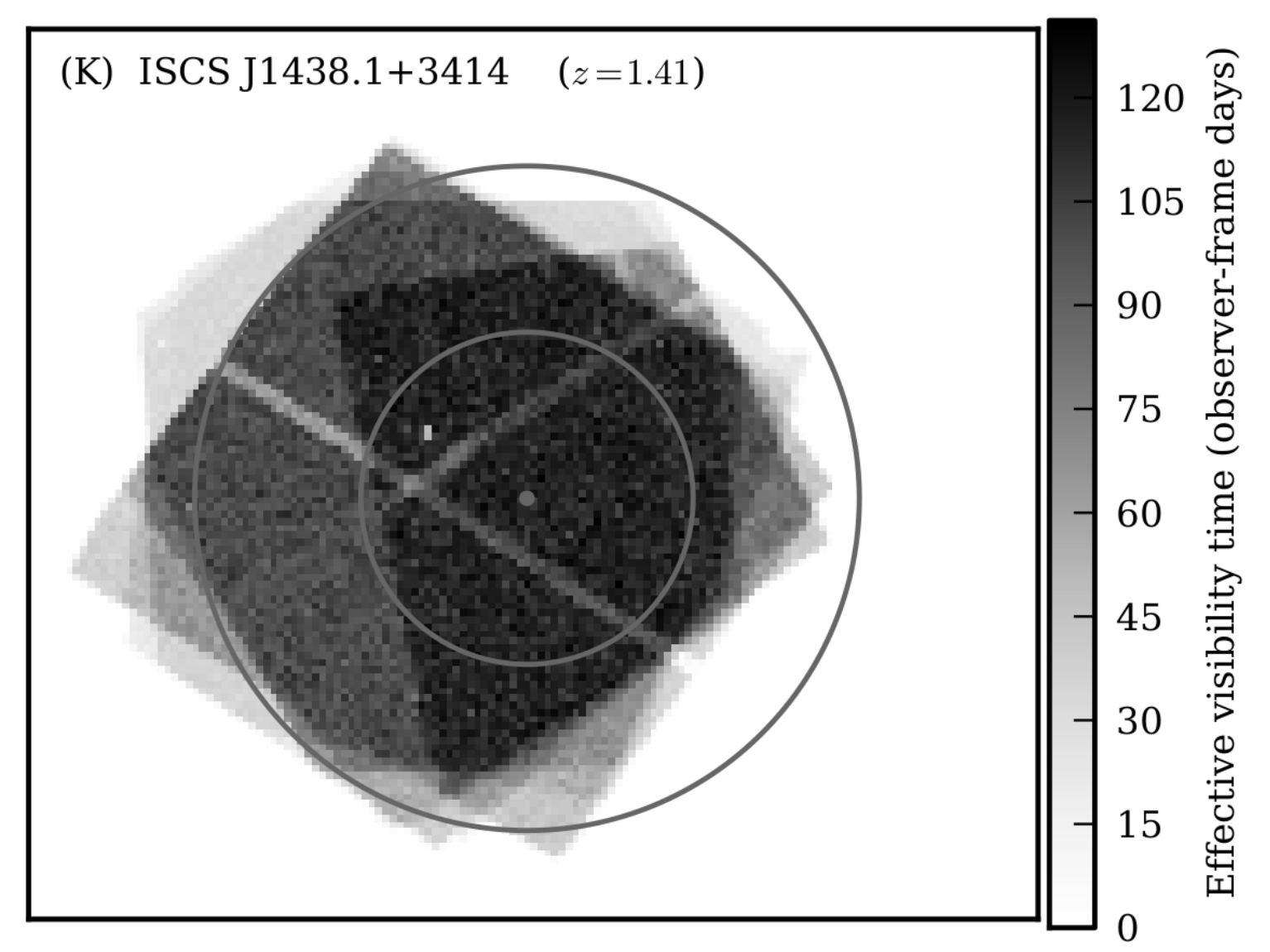
- Intensive 219-orbit HST program
- 25 clusters: $0.9 < z < 1.45$
- 6 – 10 visits per cluster,
  3 weeks apart



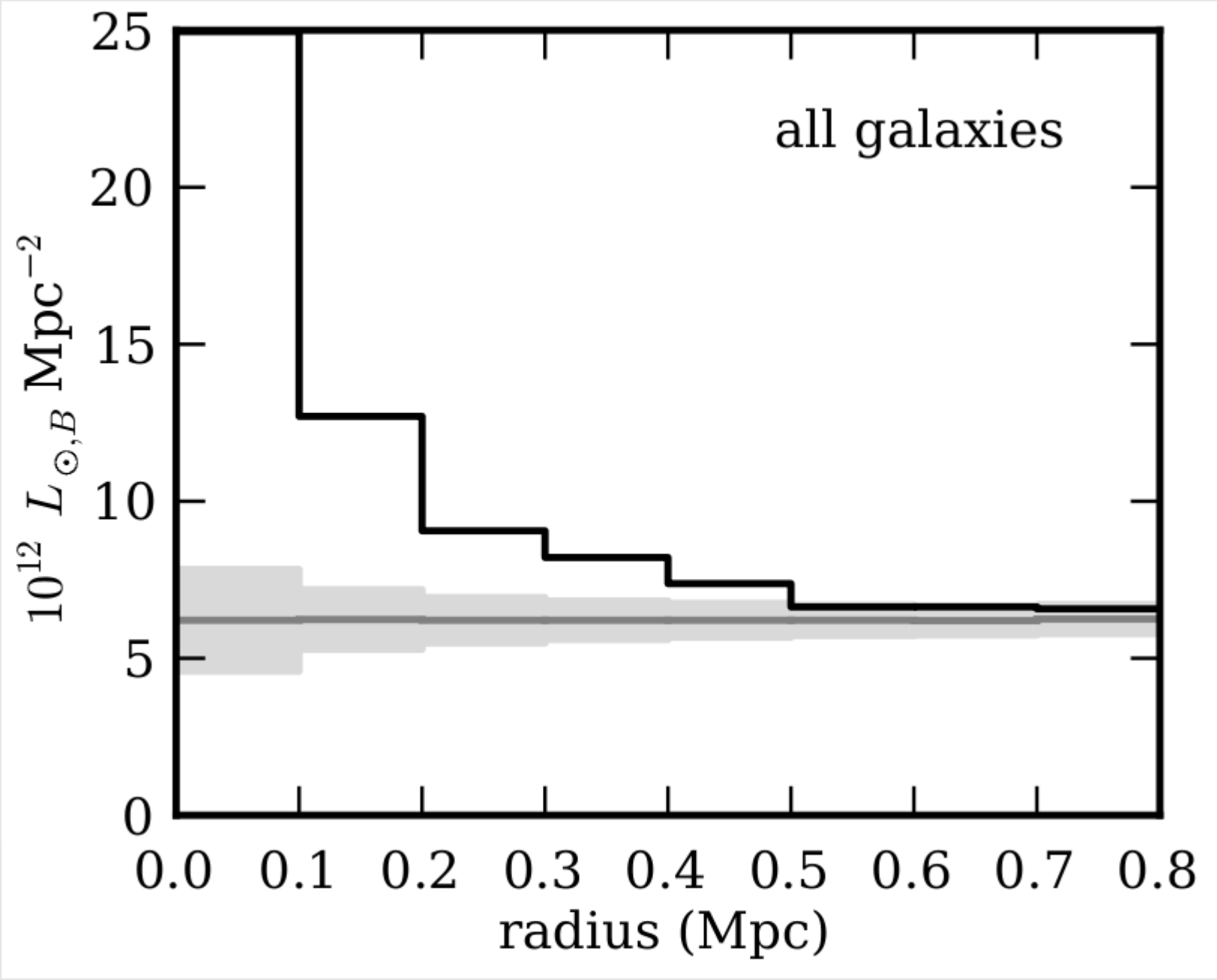
Cluster Supernovae Ia Discovered



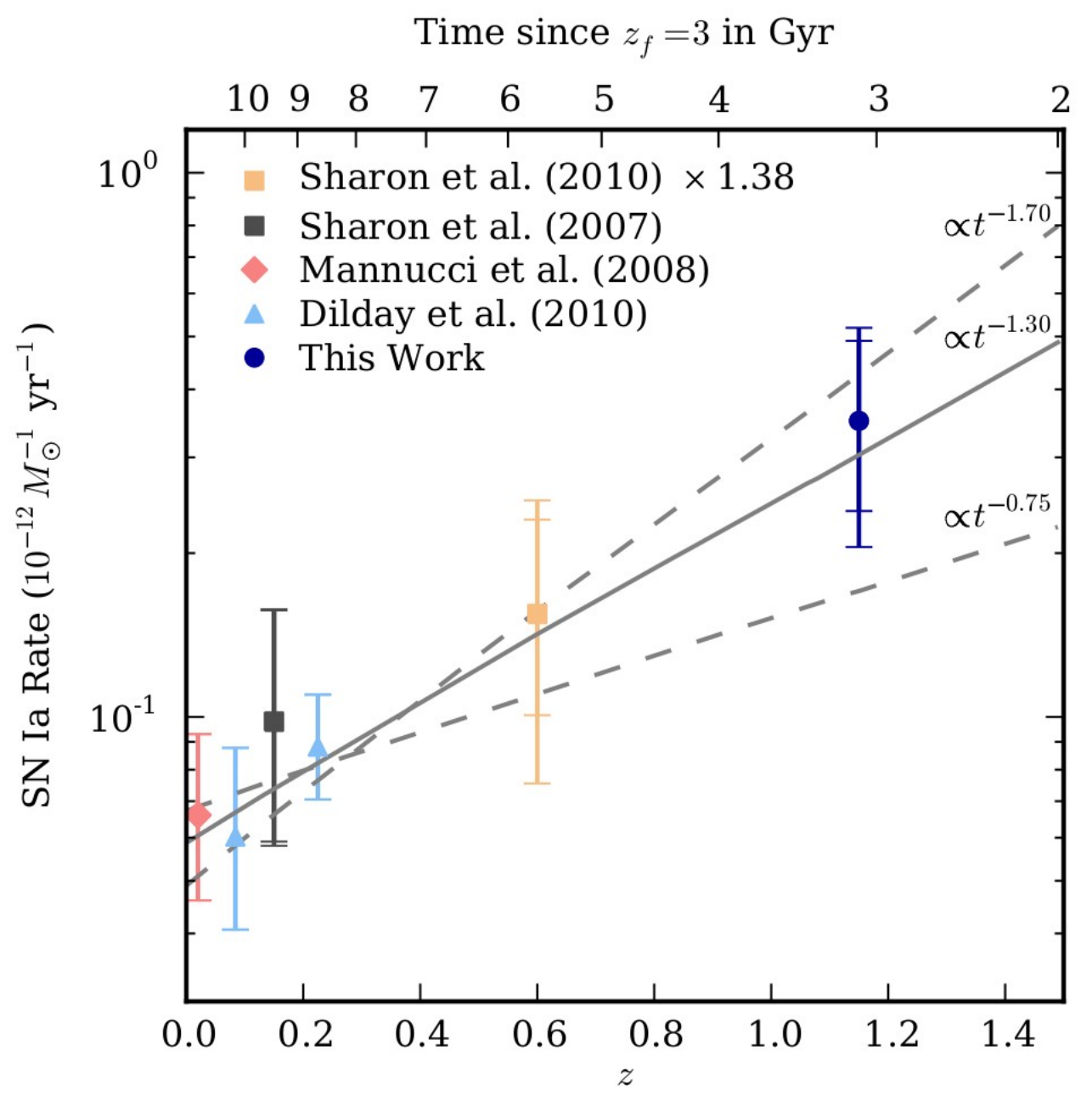
Normalize by Time and Stellar Mass



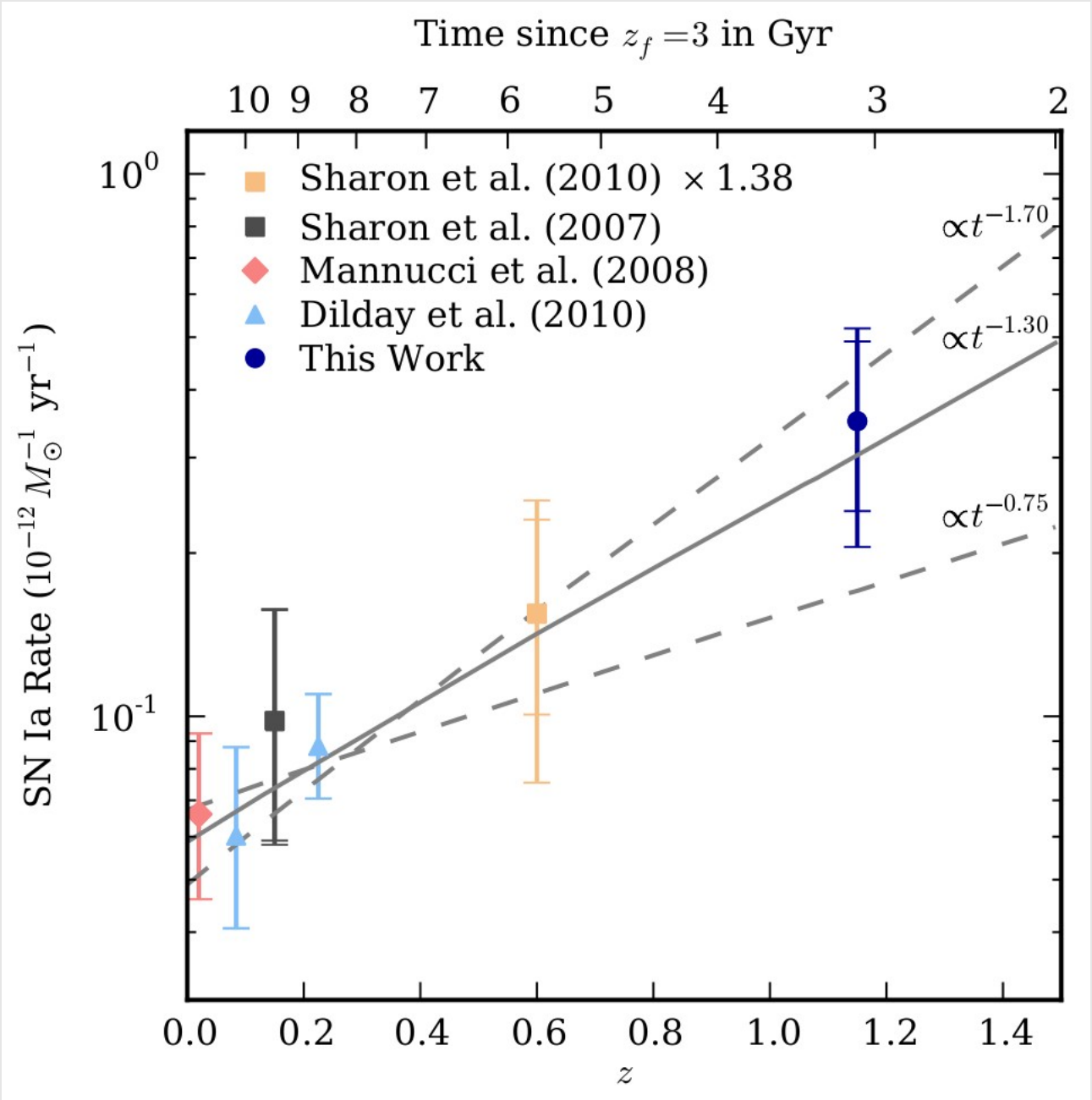
Normalize by Time and Stellar Mass



Results: Rate Increases with Redshift



Results: Rate Increases with Redshift



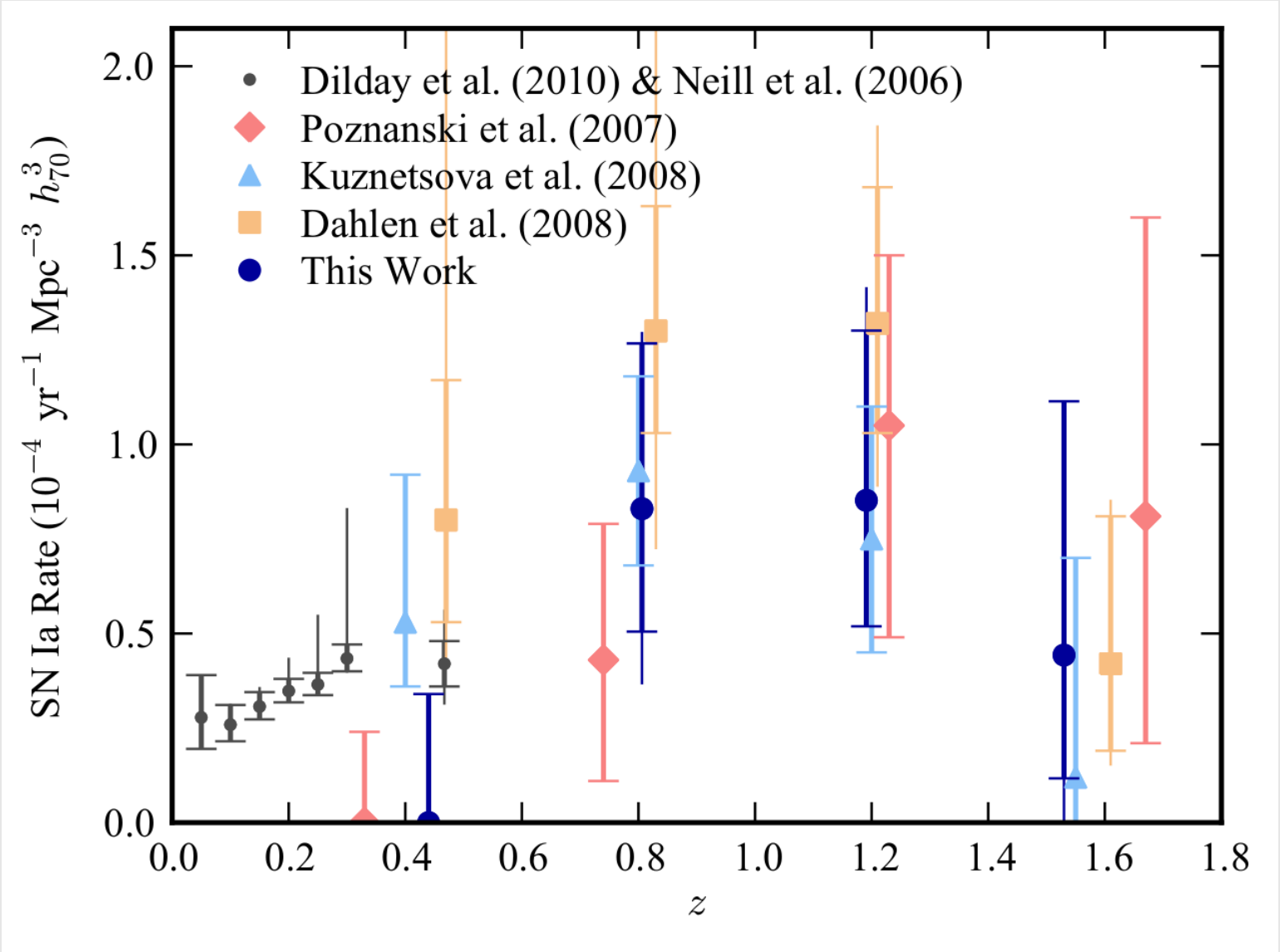
Factor of 5 increase over low-redshift rate

Conclusions

- Cluster SN Ia rates constrain the delay time distribution at large delay times
- Can be combined with other rate measurements at shorter delay times
- Together, these narrow the allowed parameter space for binary evolution and SN Ia progenitor models

SN Ia Rate in the Field

- 11 field SNe Ia at z > 0.6



Mass-to-Light Ratio