

Superluminous supernovae: beyond standard stellar demises

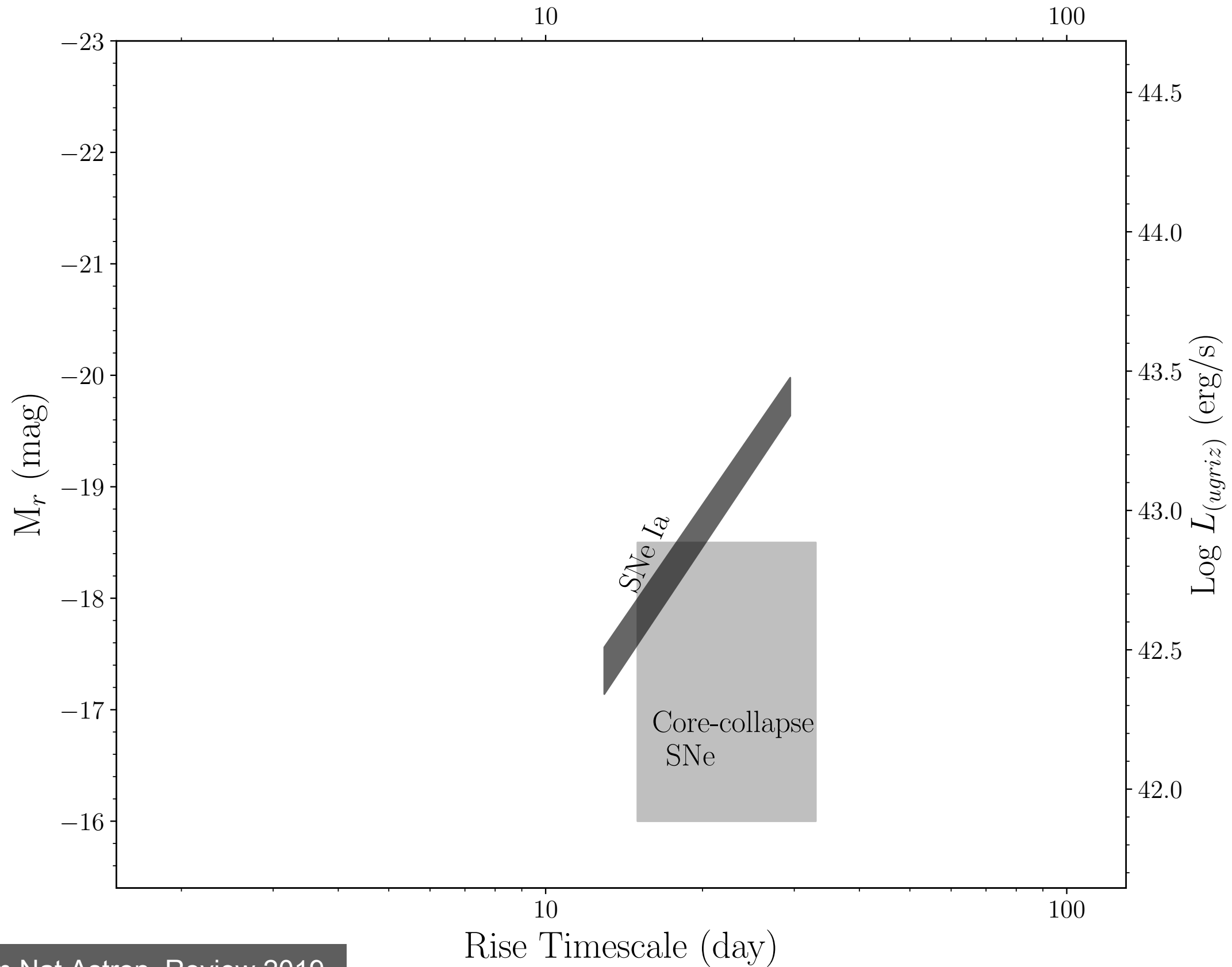
Cosimo Inserra

 <https://www.cardiff.ac.uk/people/view/1385338-inserra-cosimo>

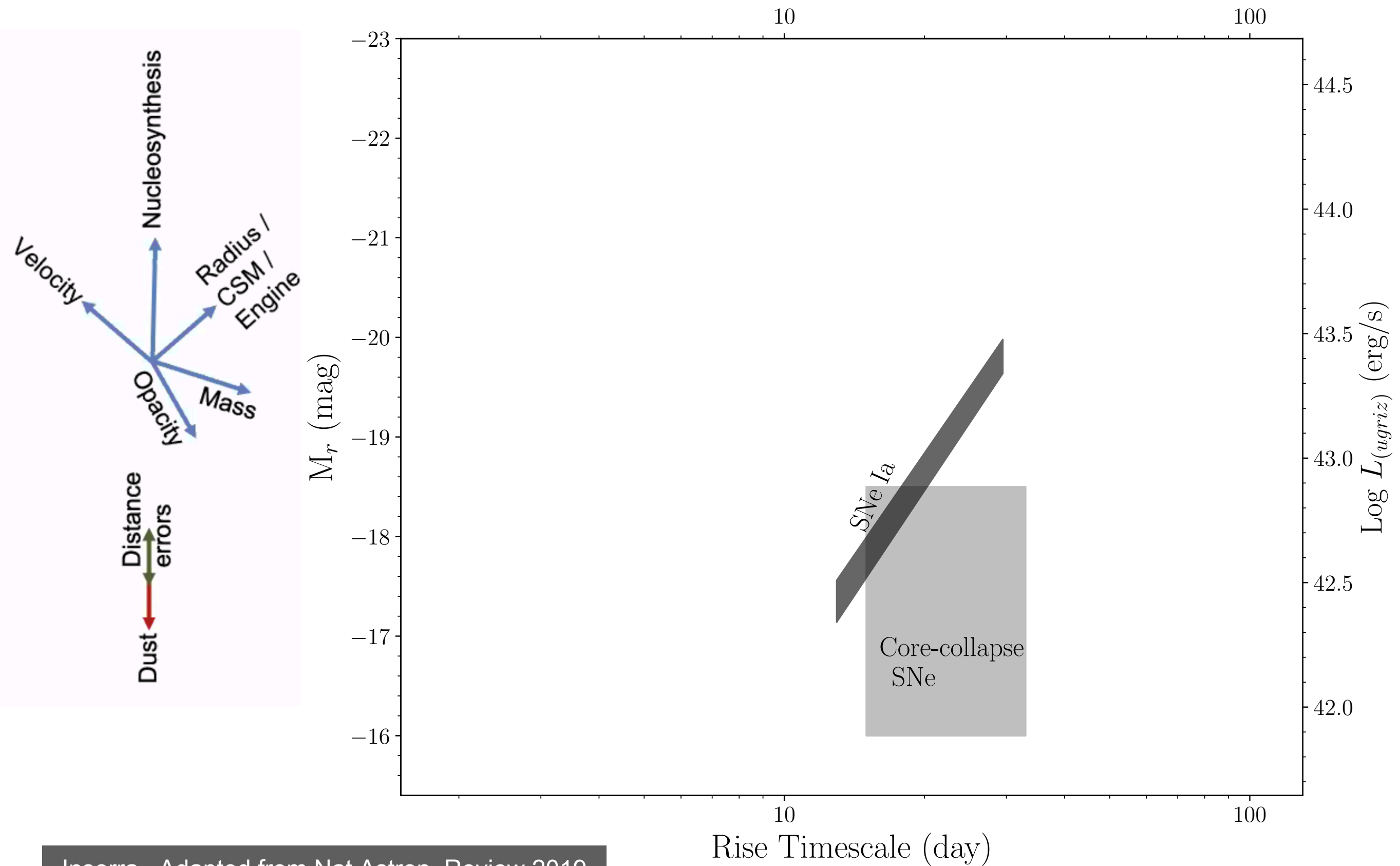


An extraordinary journey into the transient sky - 03/04/2025

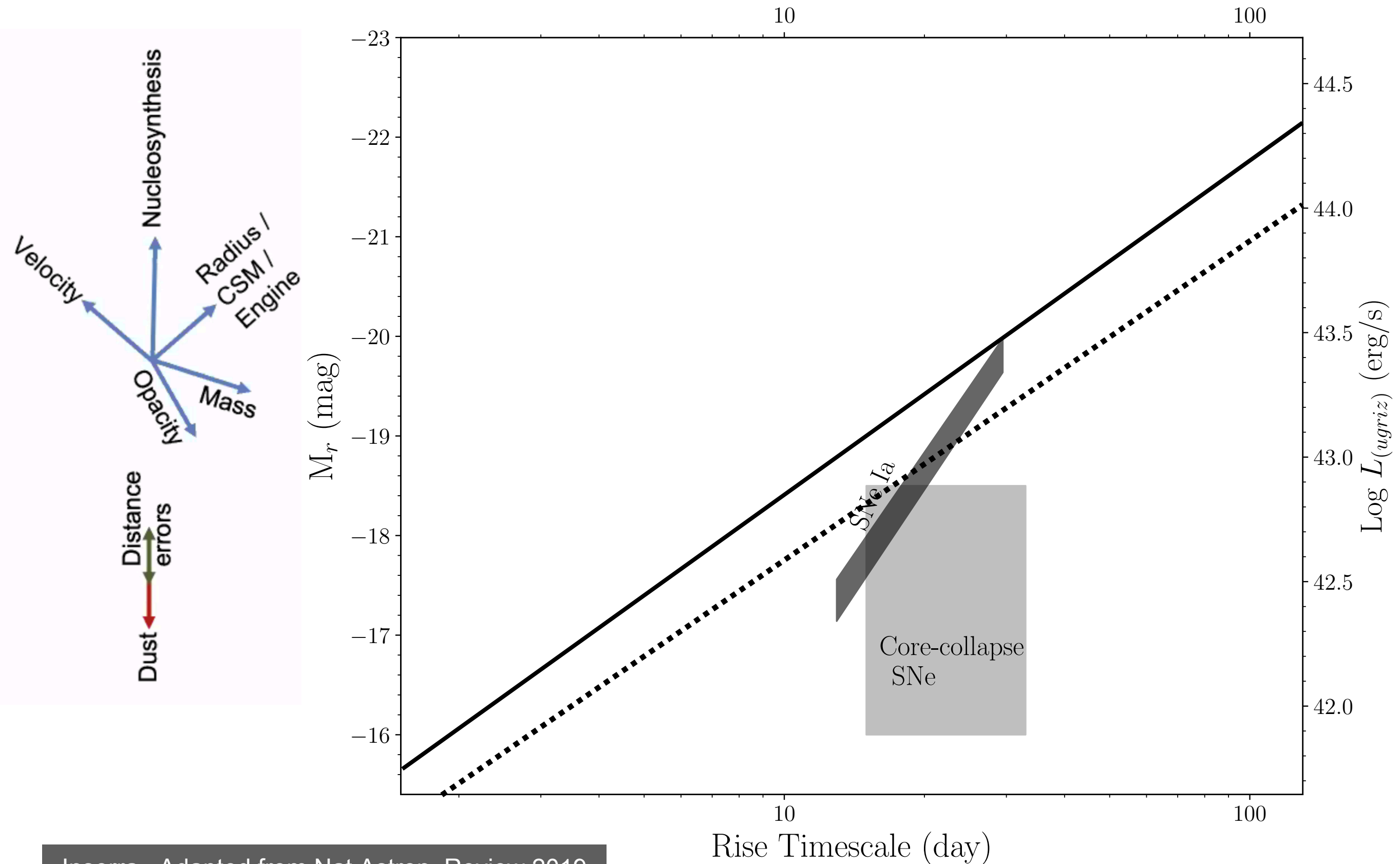
Supernova parameter space



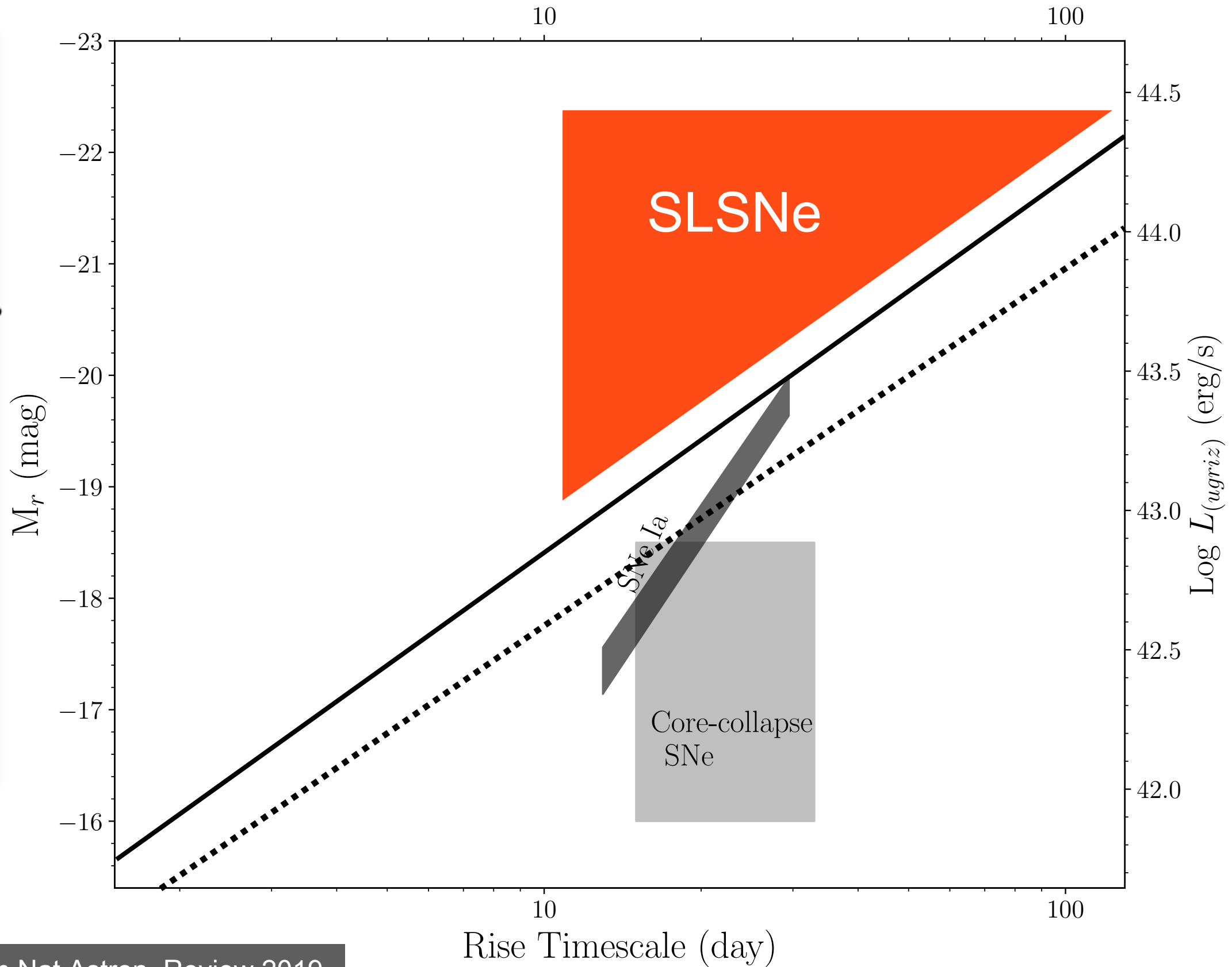
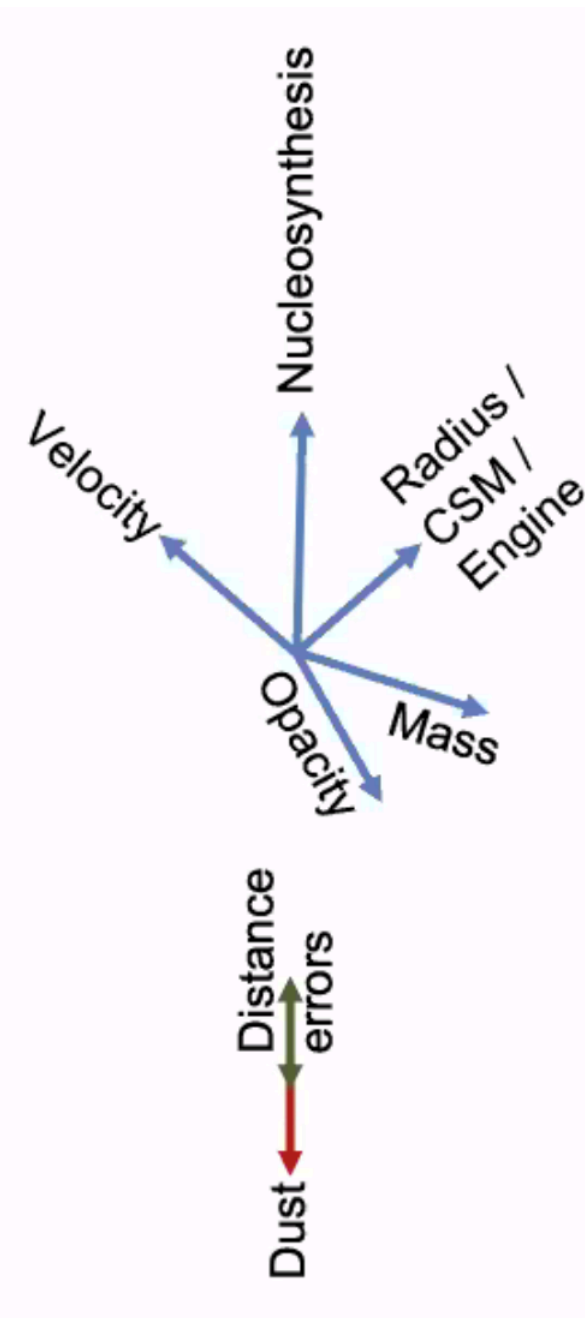
Supernova parameter space



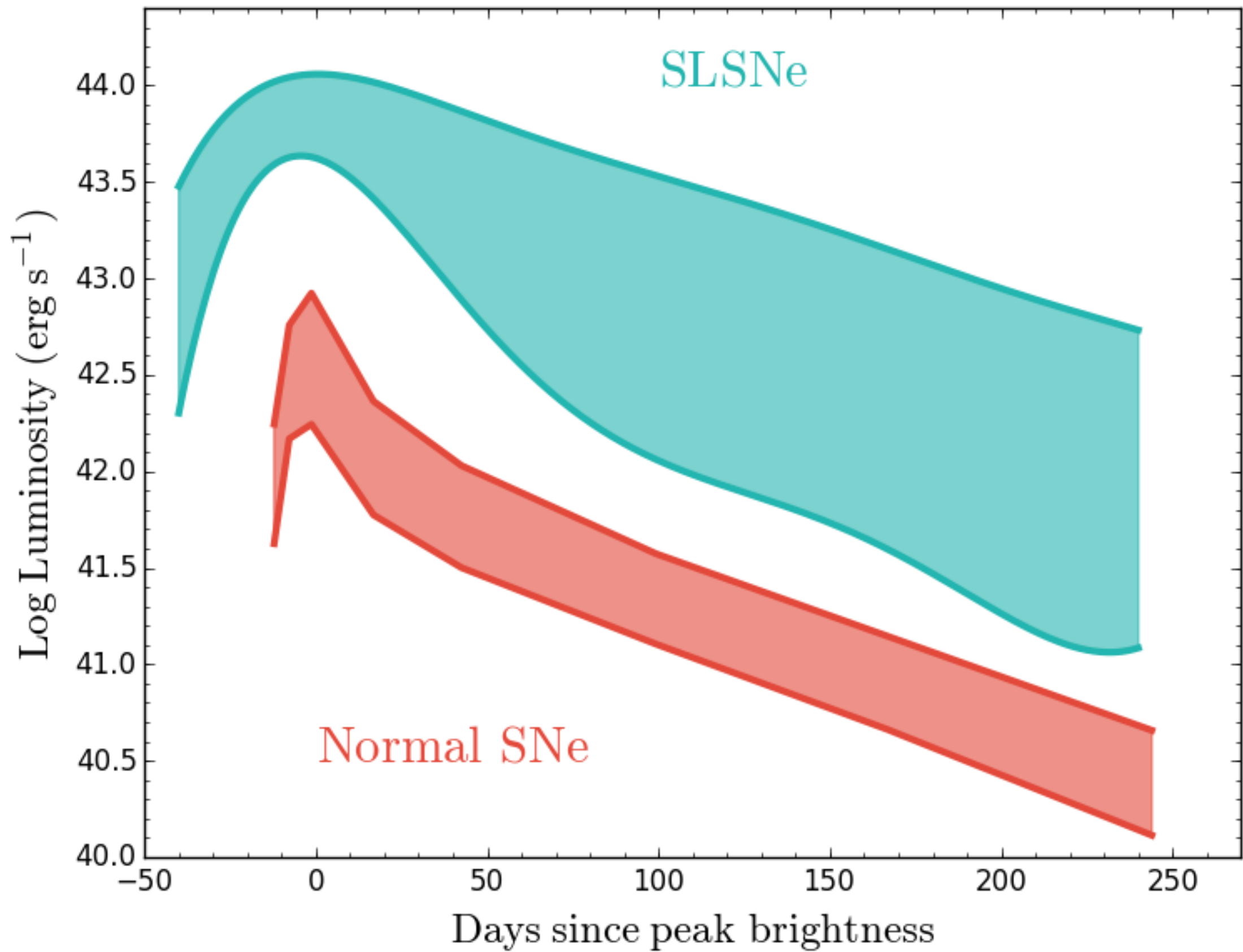
Supernova parameter space



Supernova parameter space

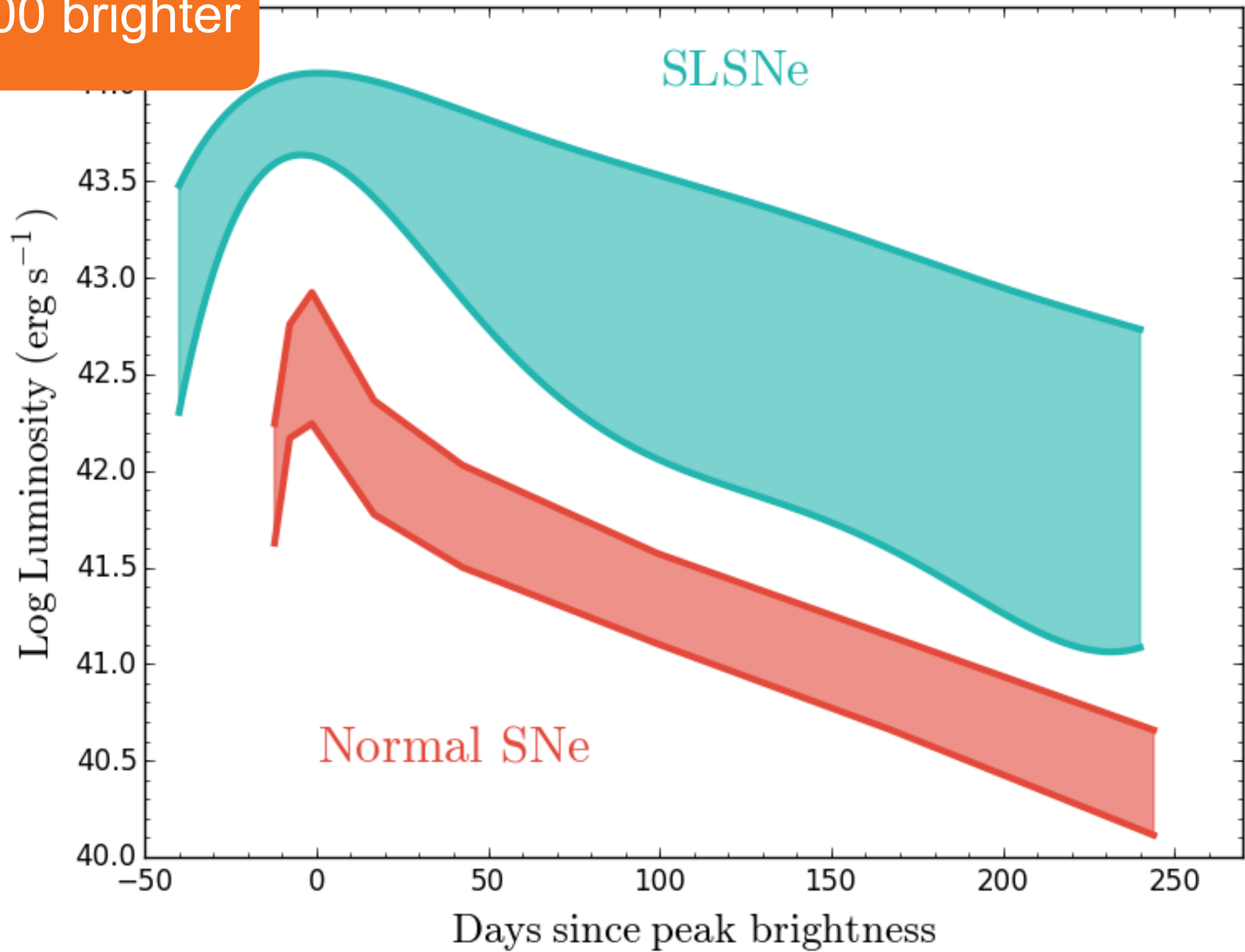


Superluminous supernovae



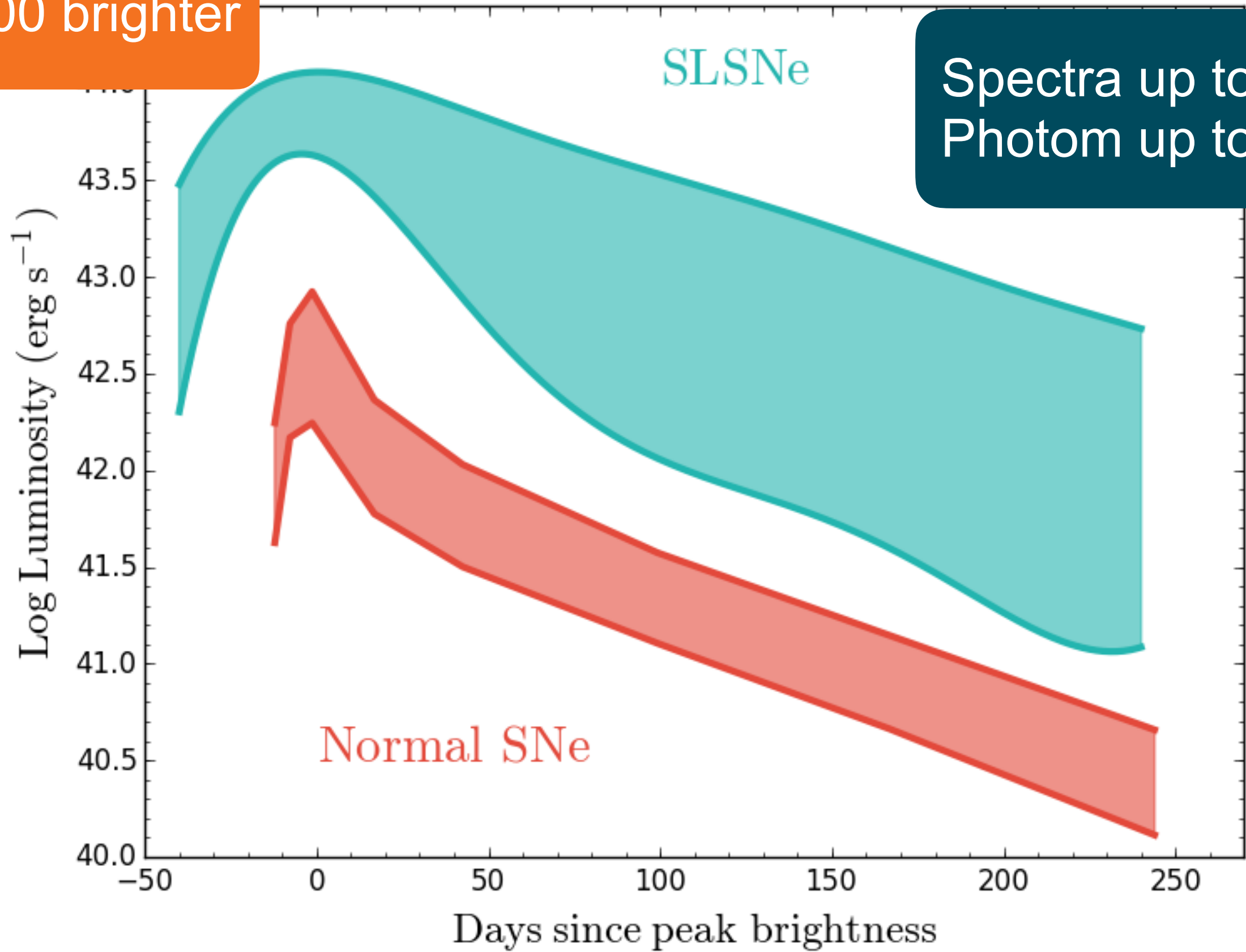
Superluminous supernovae

5-100 brighter



Superluminous supernovae

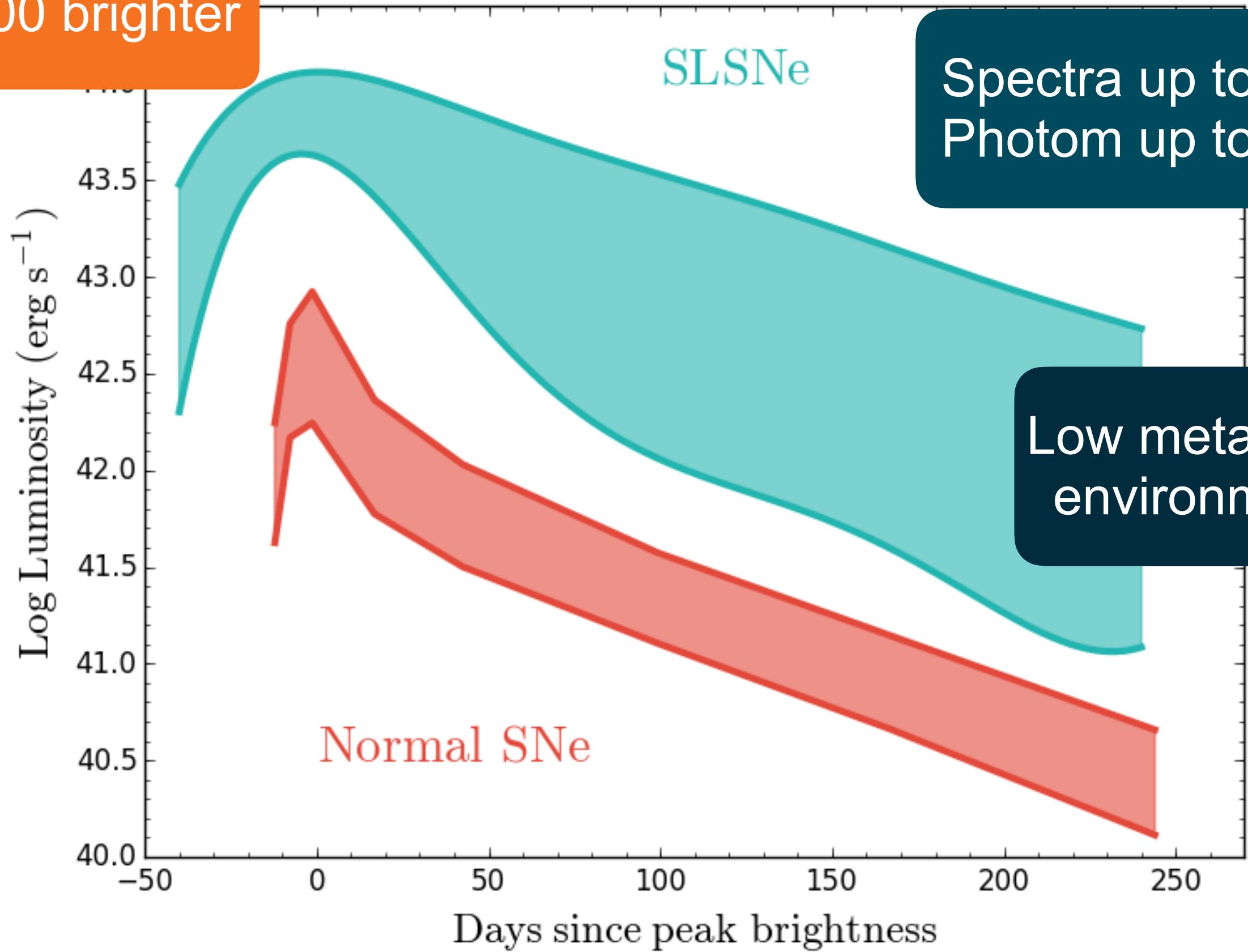
5-100 brighter



Spectra up to $z \sim 2$
Photom up to $z \sim 4$

Superluminous supernovae

5-100 brighter



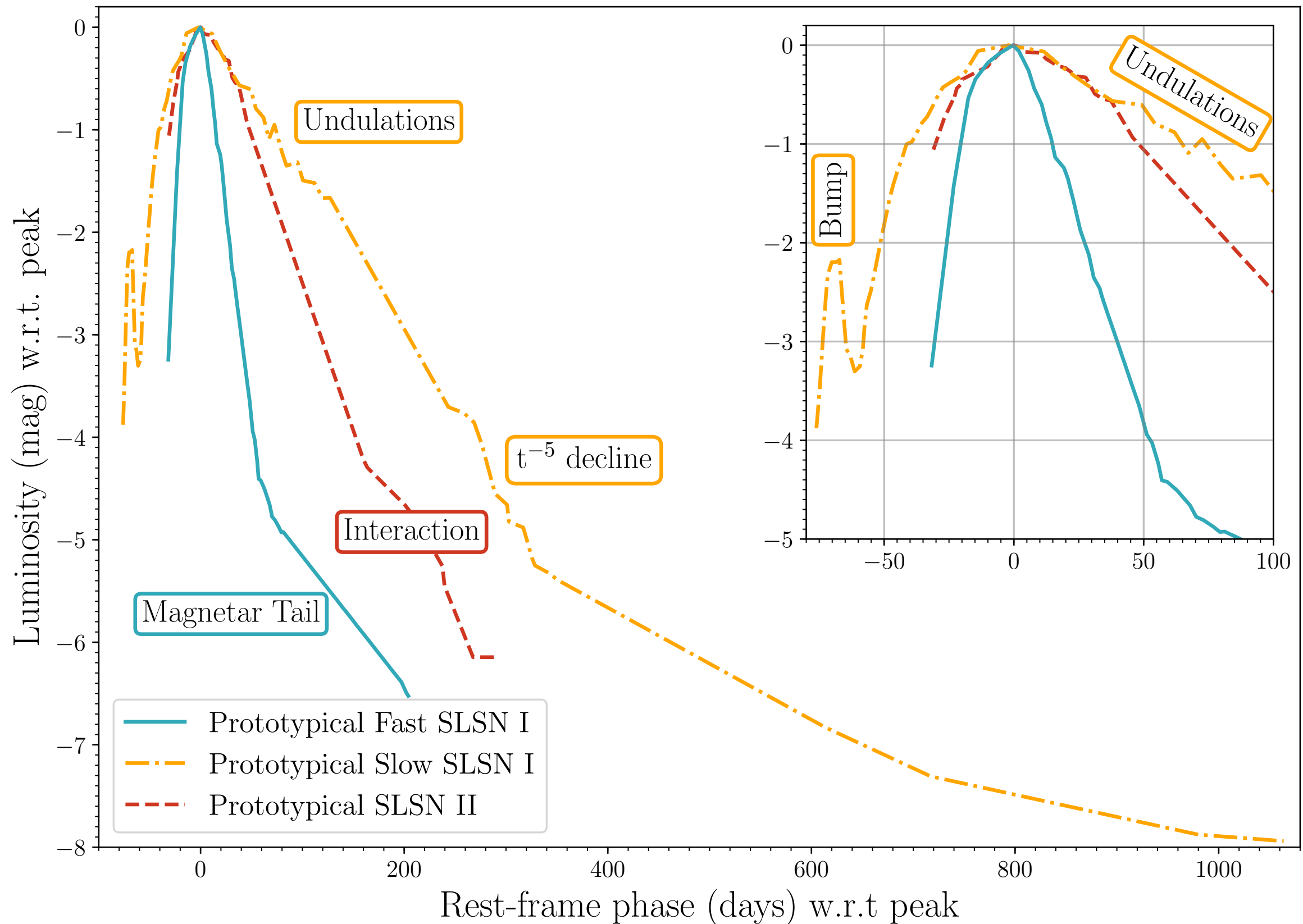
Spectra up to $z \sim 2$
Photom up to $z \sim 4$

Low metallicity
environment

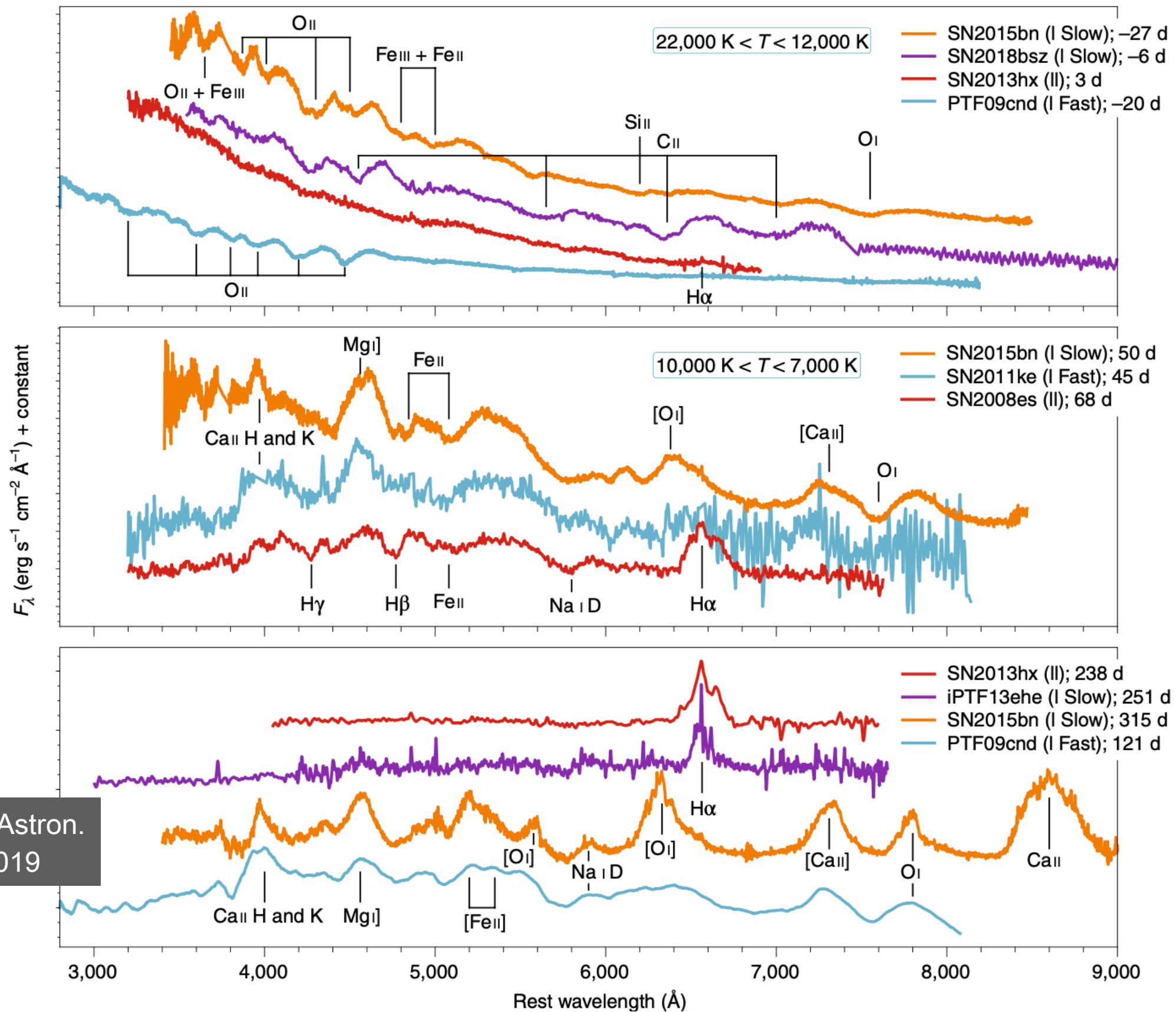
Normal SNe

SLSNe

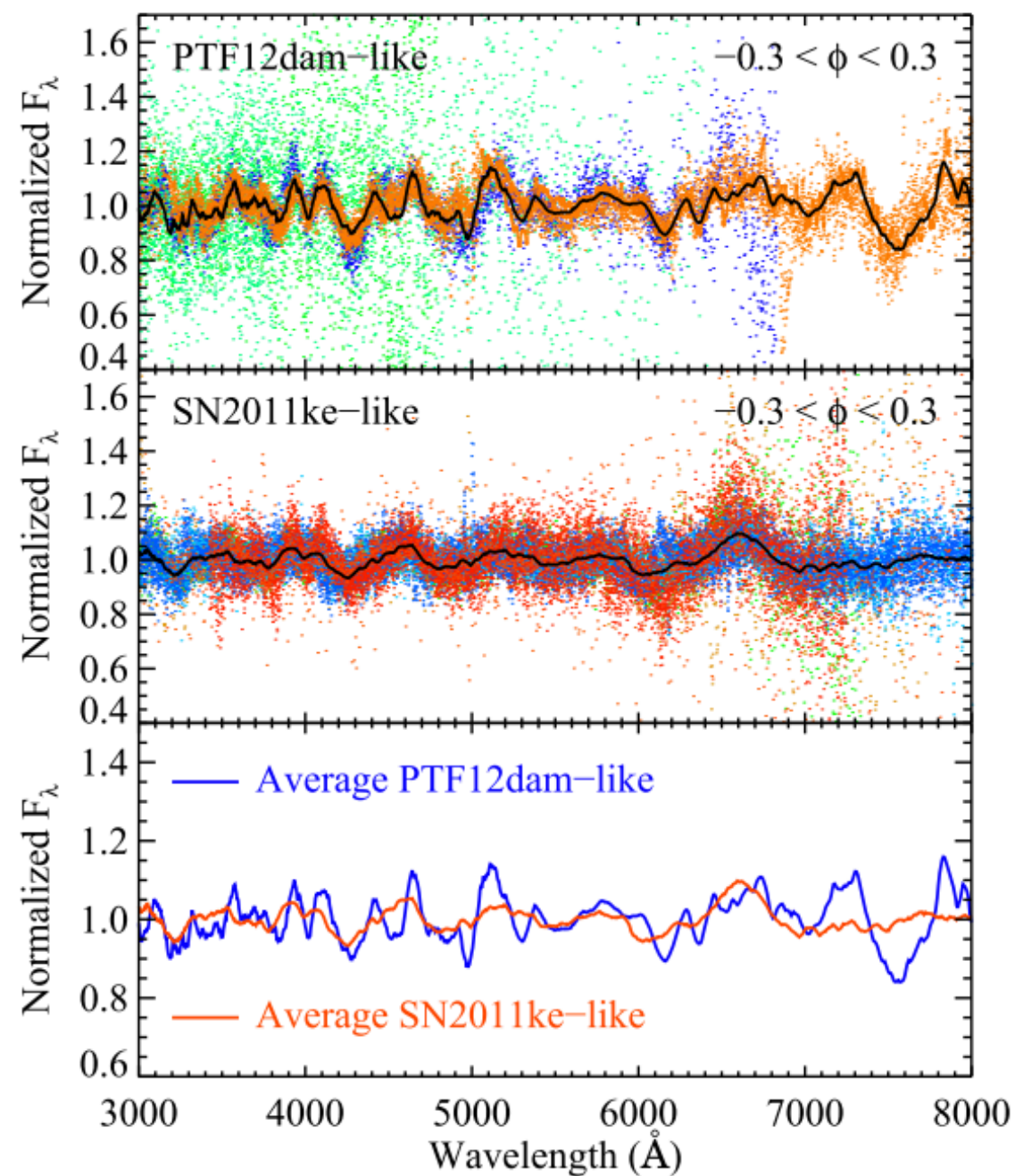
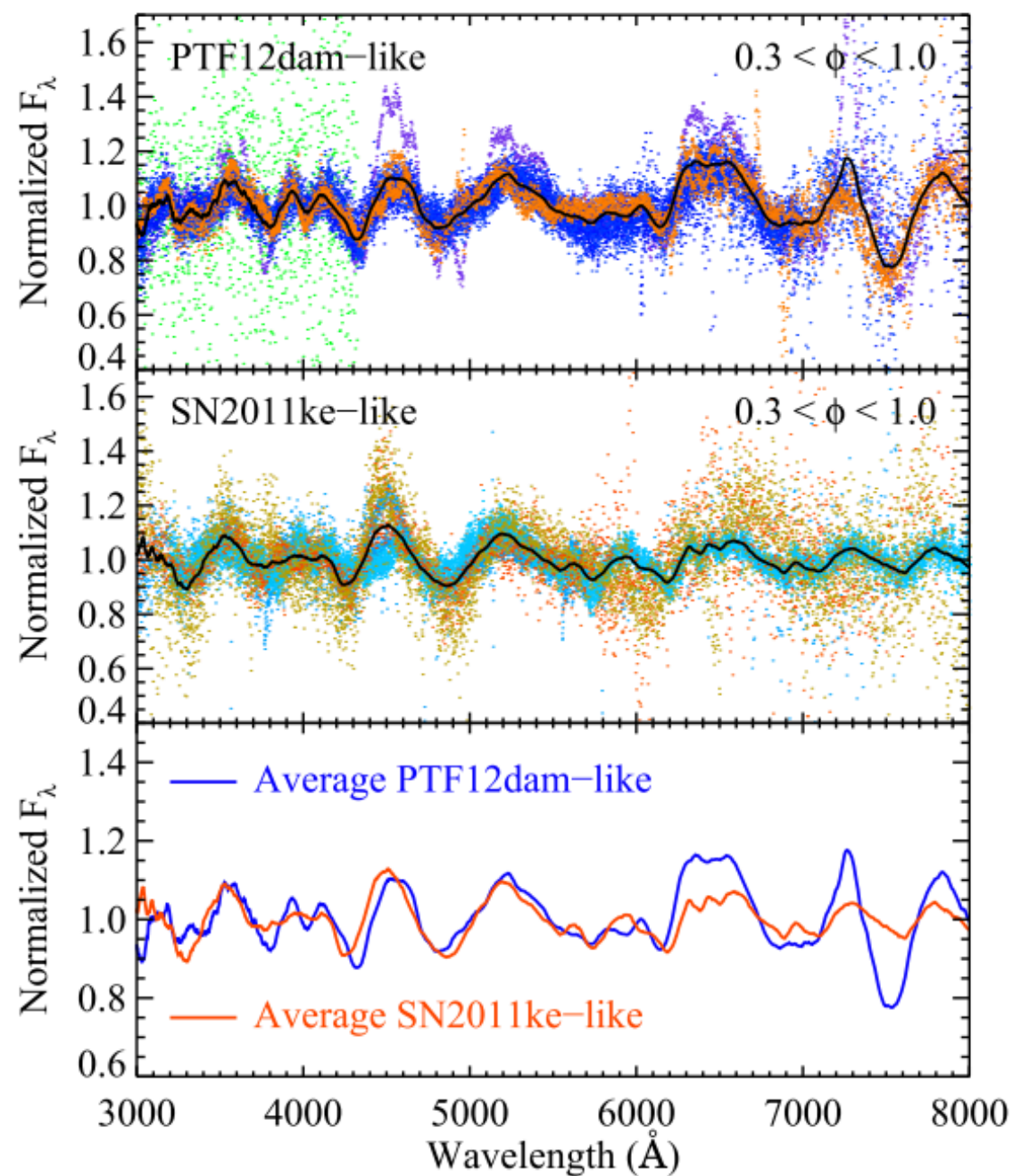
Superluminous supernovae



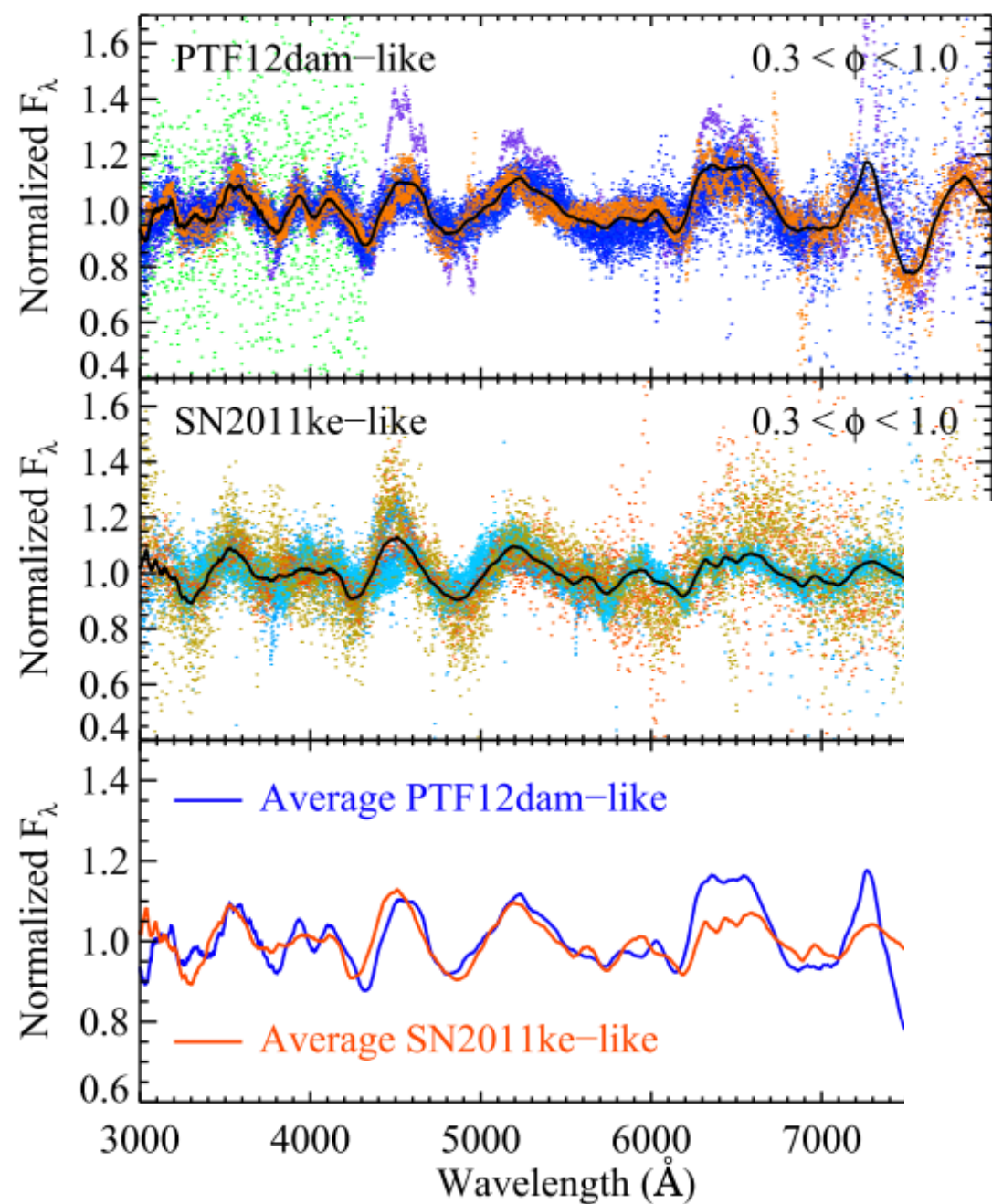
Superluminous supernovae



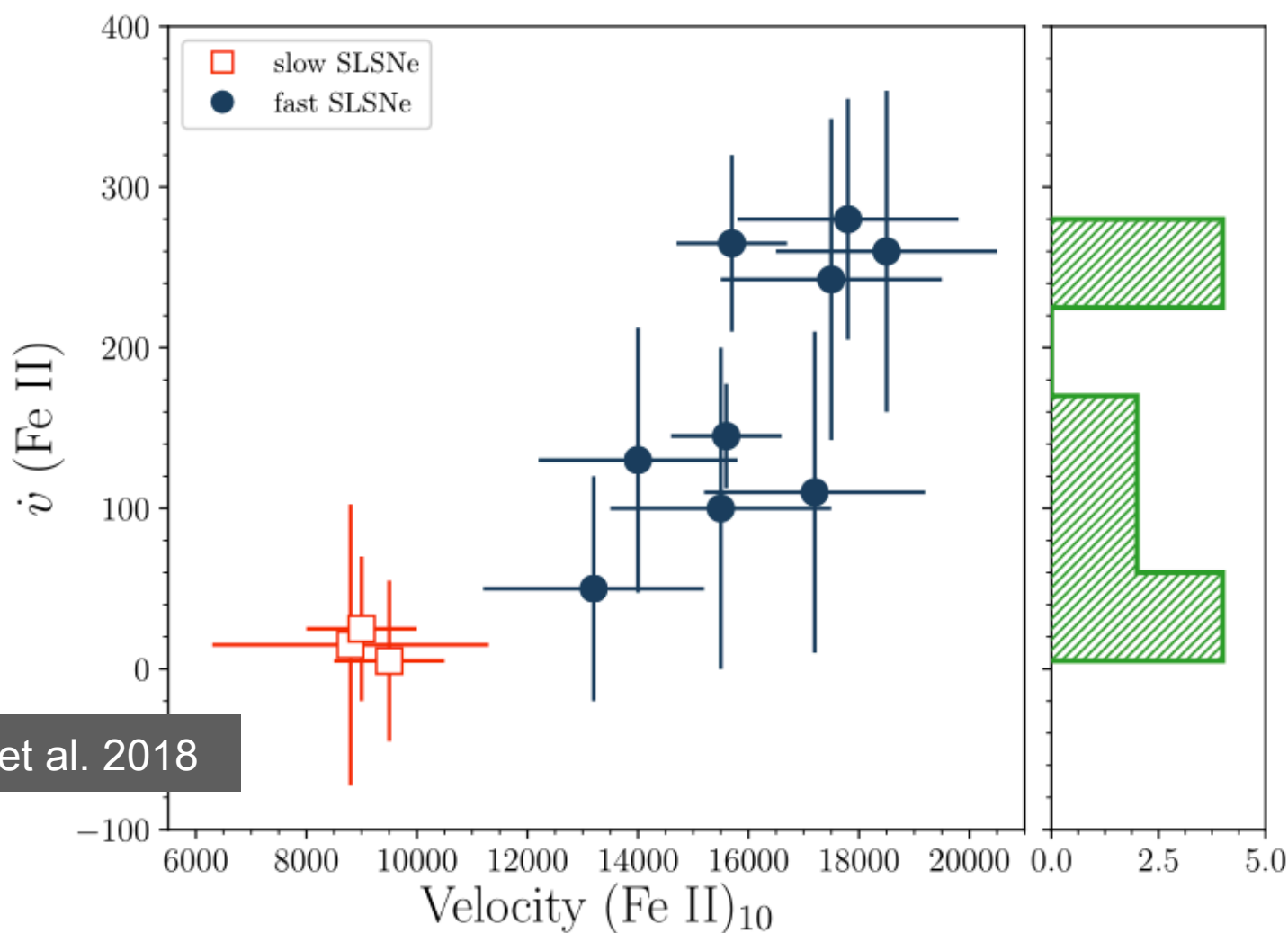
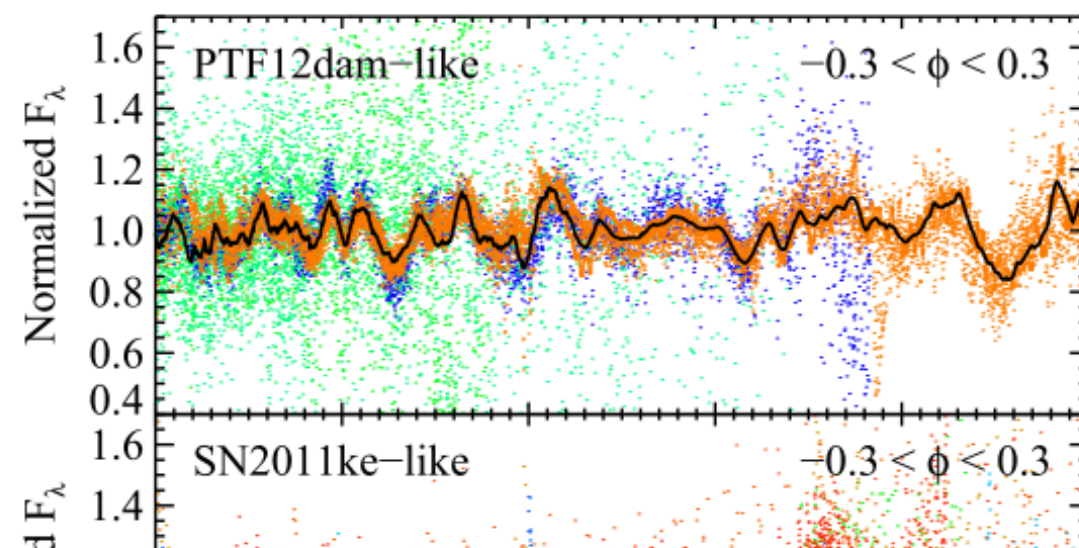
Diversity in superluminous supernovae



Diversity in superluminous supernovae



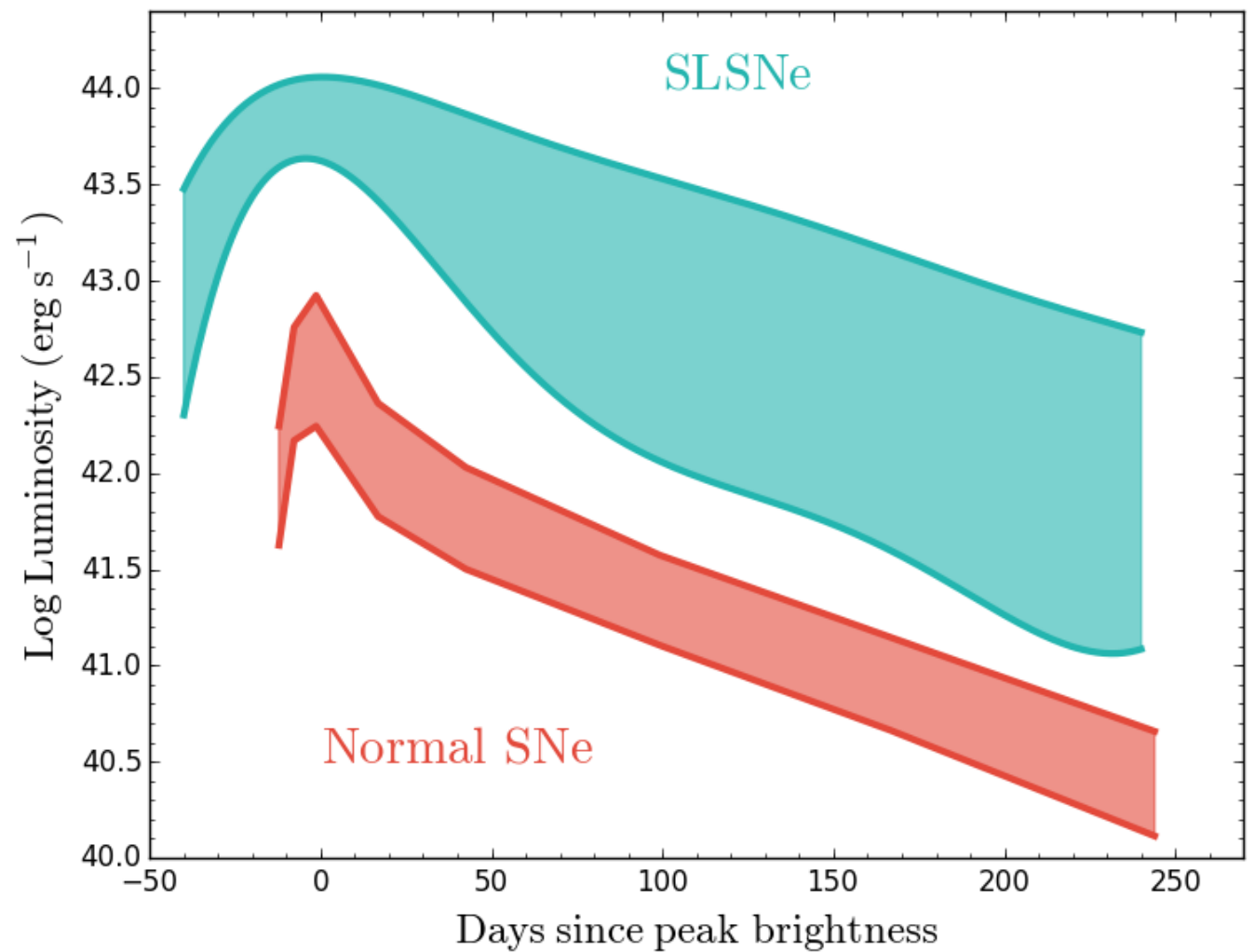
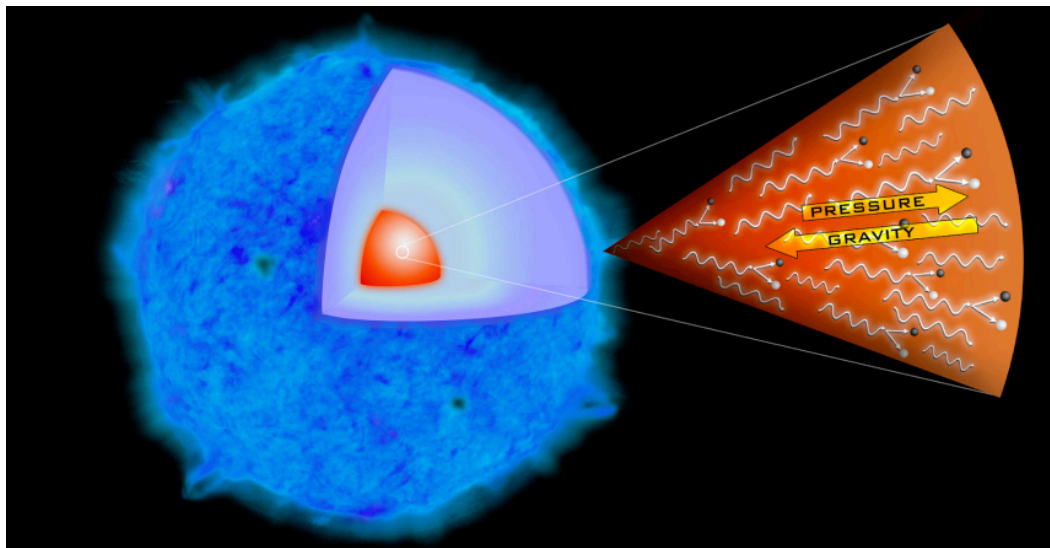
Quimby et al. 2018



Inserra et al. 2018

What does power SLSNe?

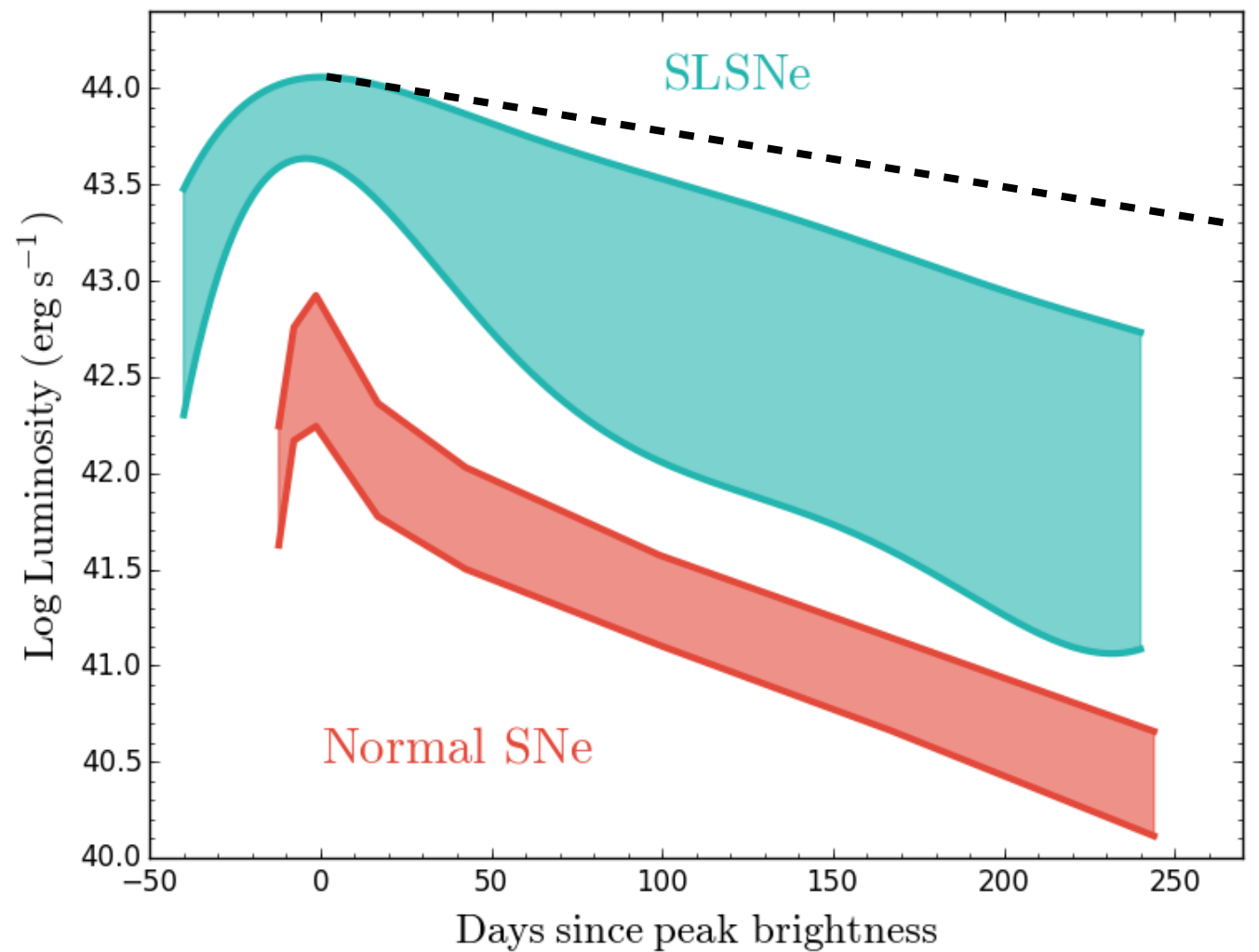
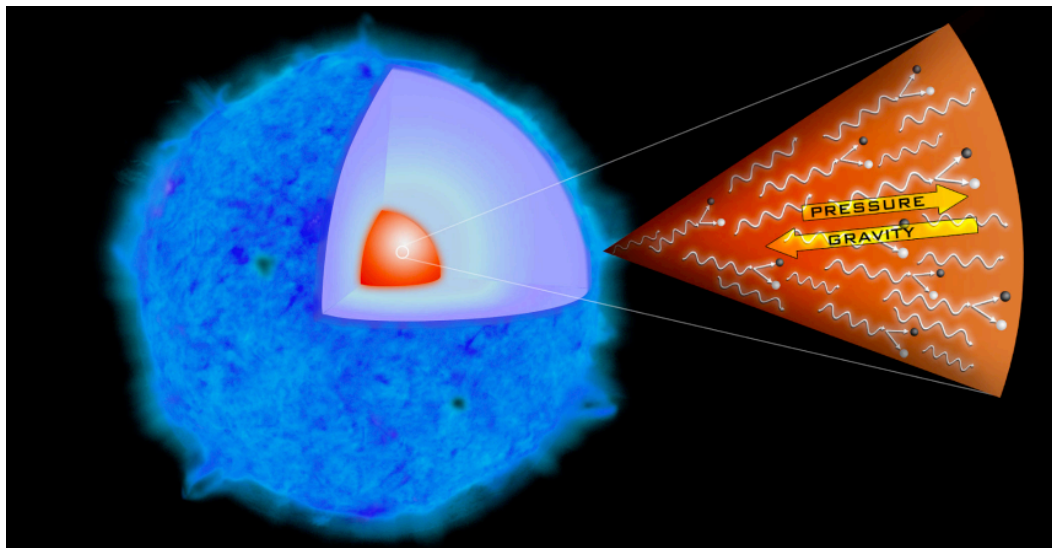
Pair Instability



Barkat, Rakavy, Sack 1967 - Rakavy, Shaviv, Zinamon 1967
Langer et al. 2007 - Woosley et al. 2007

What does power SLSNe?

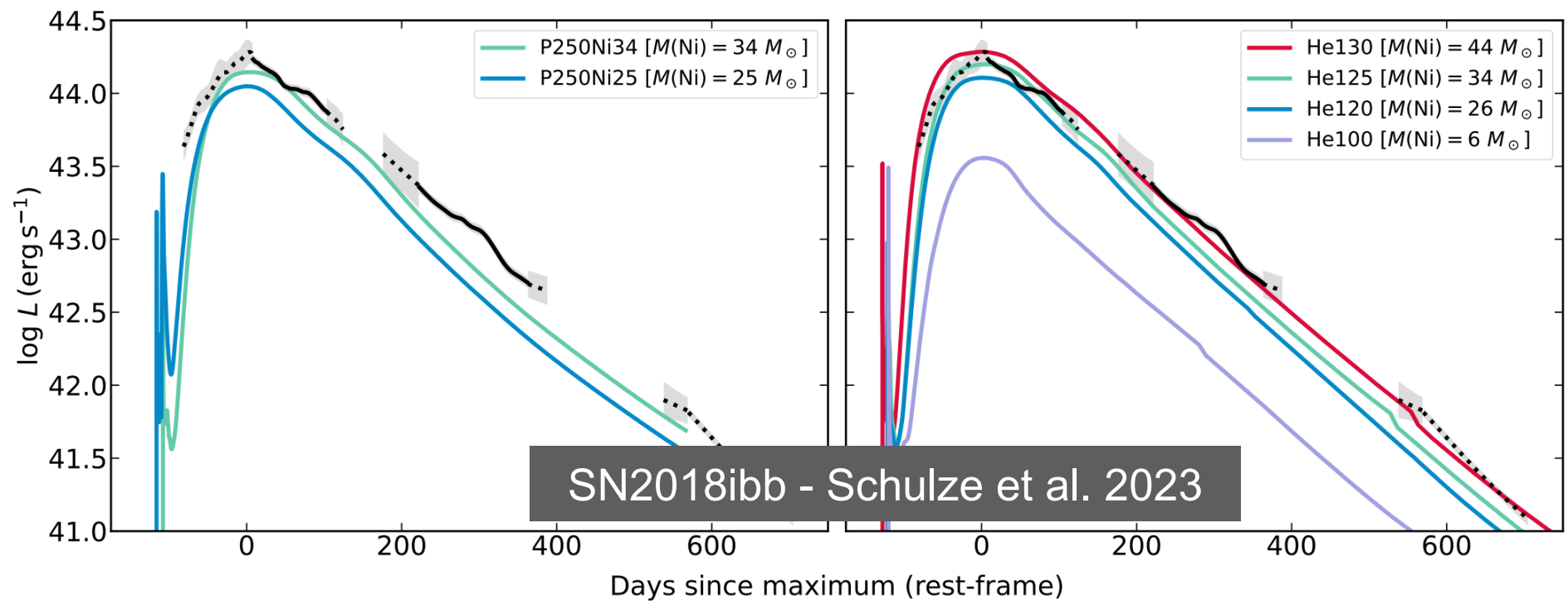
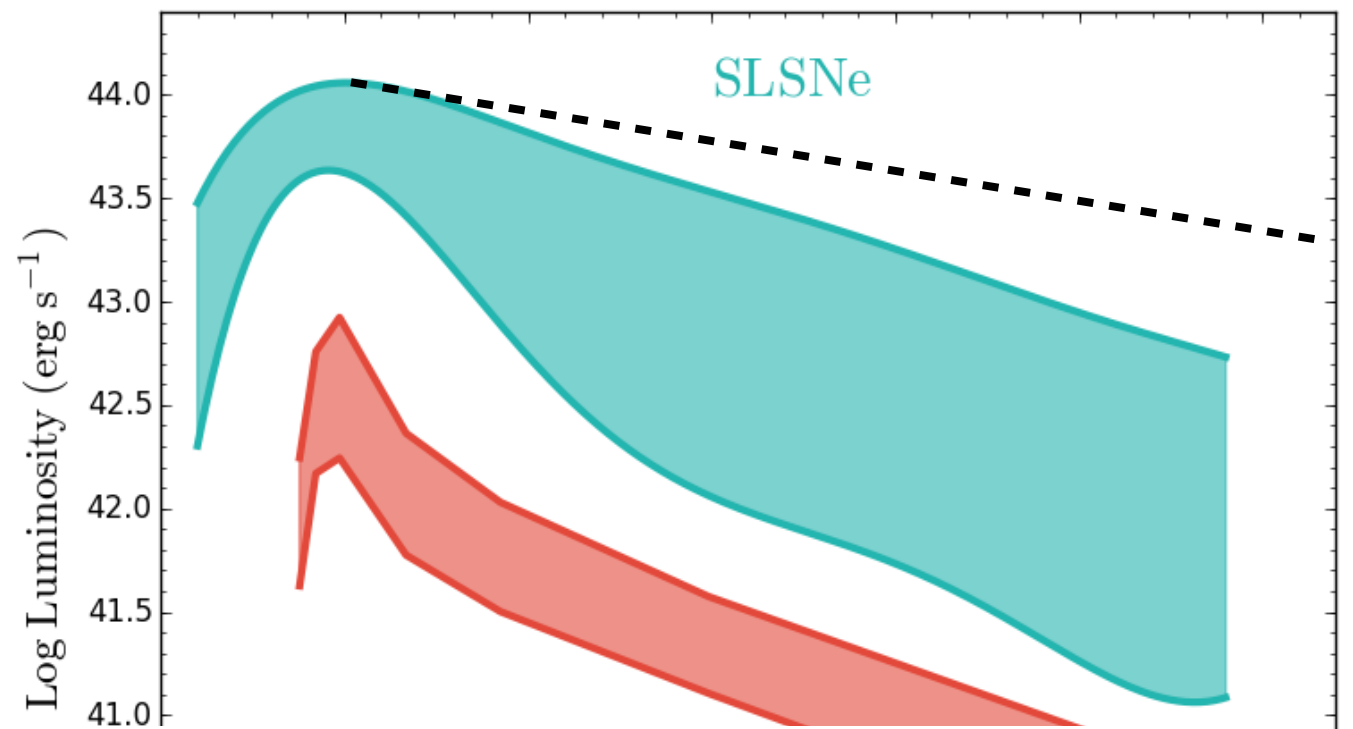
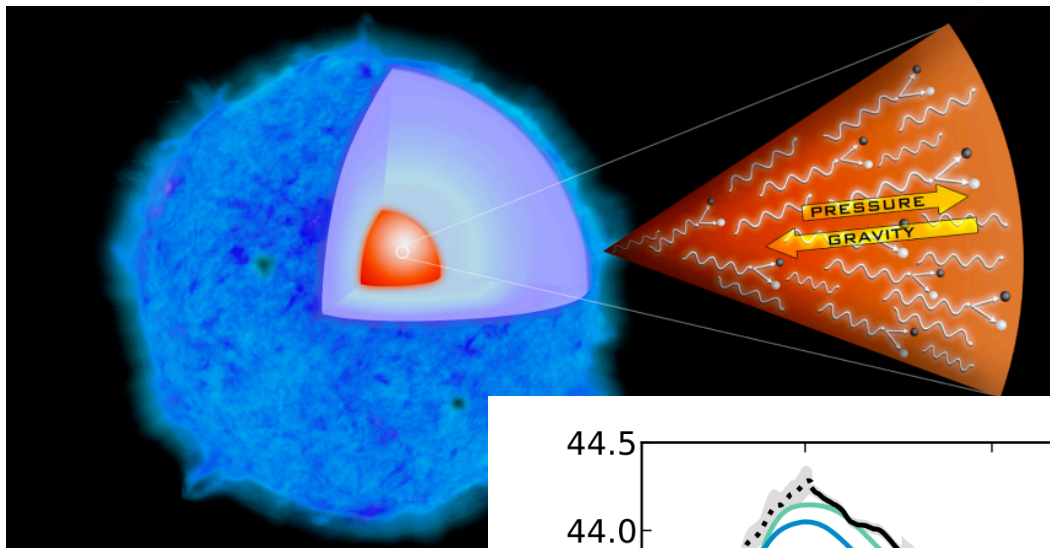
Pair Instability



Barkat, Rakavy, Sack 1967 - Rakavy, Shaviv, Zinamon 1967
Langer et al. 2007 - Woosley et al. 2007

What does power SLSNe?

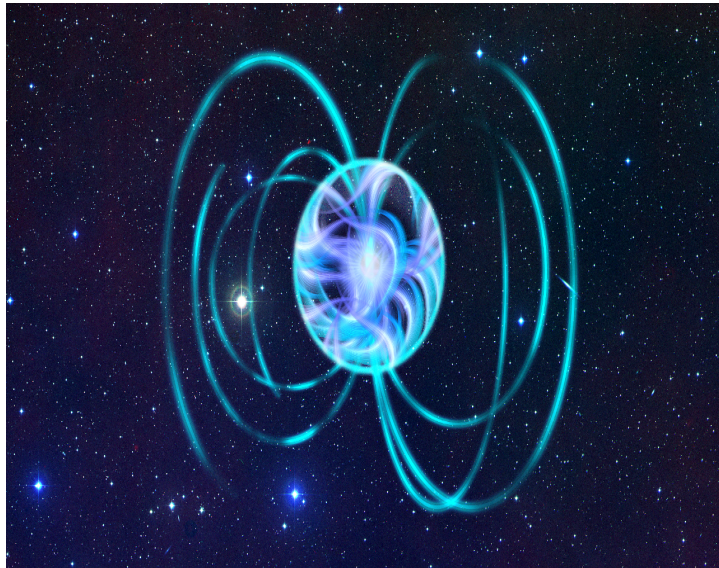
Pair Instability



SN2018ibb - Schulze et al. 2023

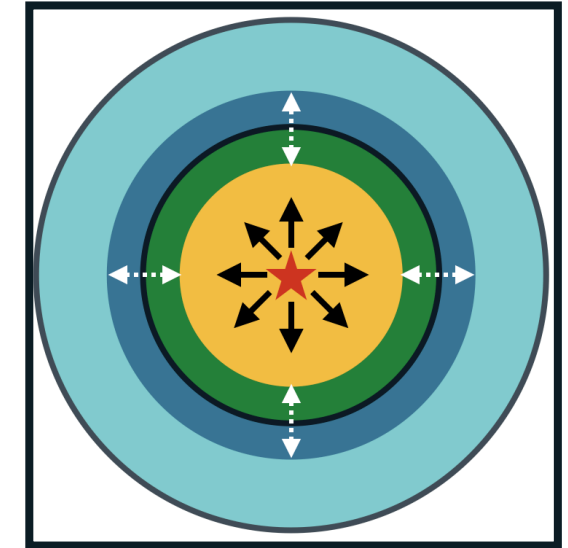
Barkat, Rakavy, Sack 1967 - Rakavy, Shaviv, Zinamon 1967
Langer et al. 2007 - Woosley et al. 2007

What does power SLSNe?



Magnetar

VS

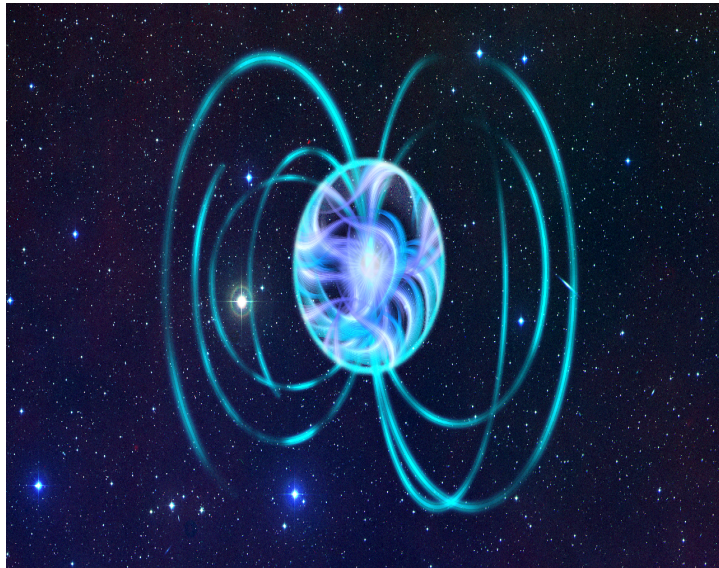


CSM interaction

1. Light Curve *
2. Spectroscopic delay
3. Velocity ev.
4. Temperature ev.
5. Connections to late spectroscopy
6. Geometry evolution

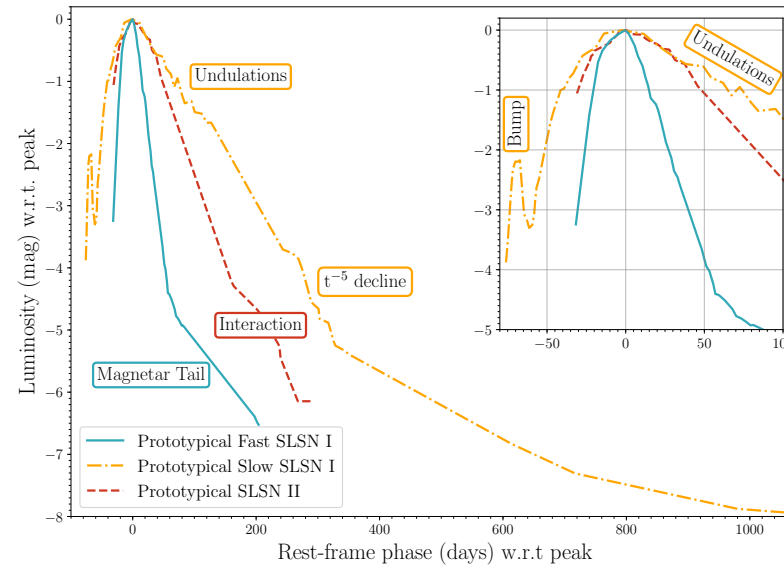
1. Light Curve
2. Temperature ev.
3. Differential velocity

What does power SLSNe?

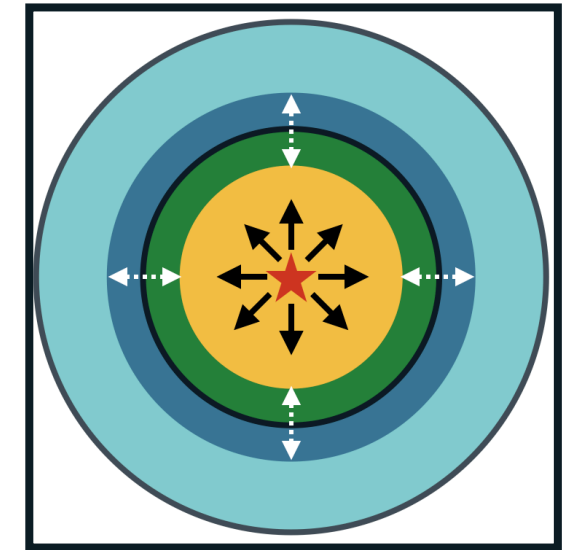


Magnetar

1. Light Curve *
2. Spectroscopic delay
3. Velocity ev.
4. Temperature ev.
5. Connections to late spectroscopy
6. Geometry evolution

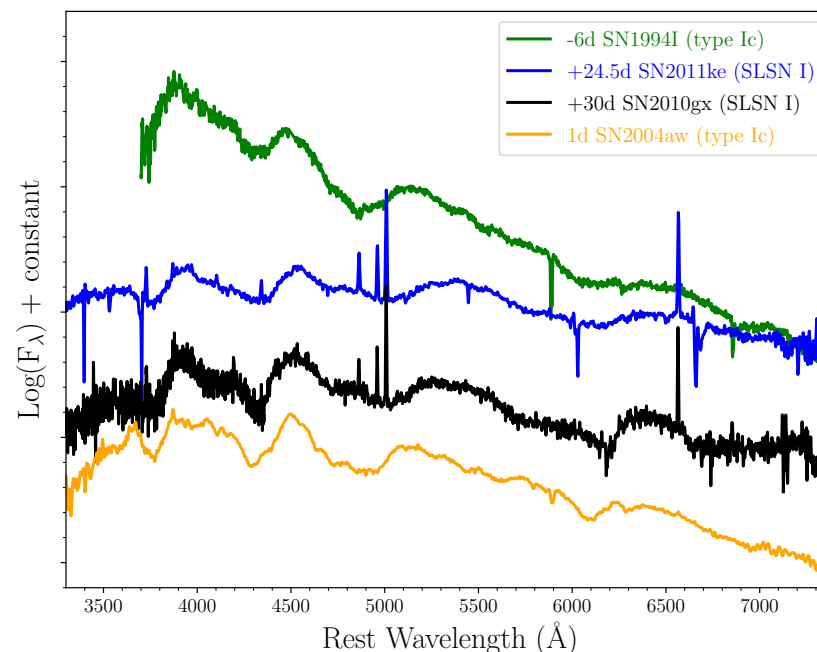


VS



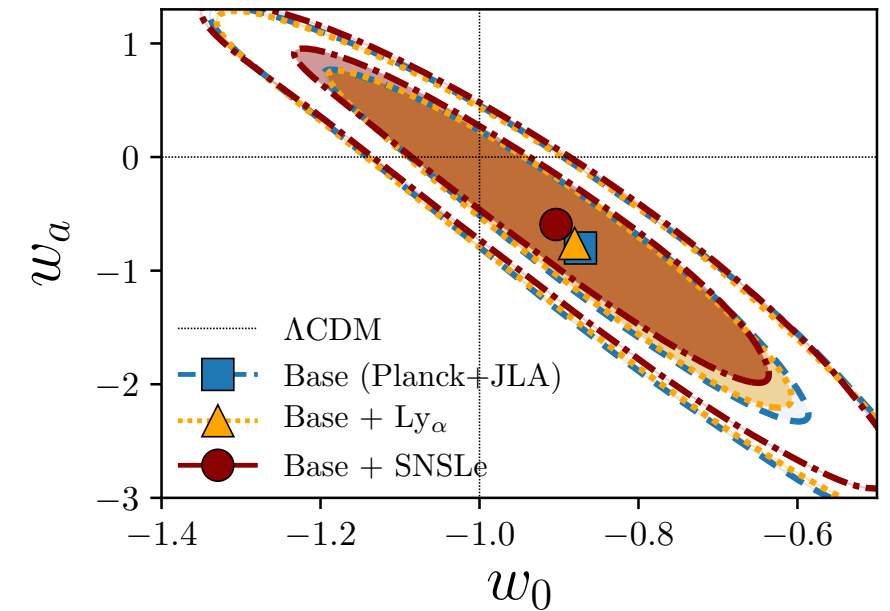
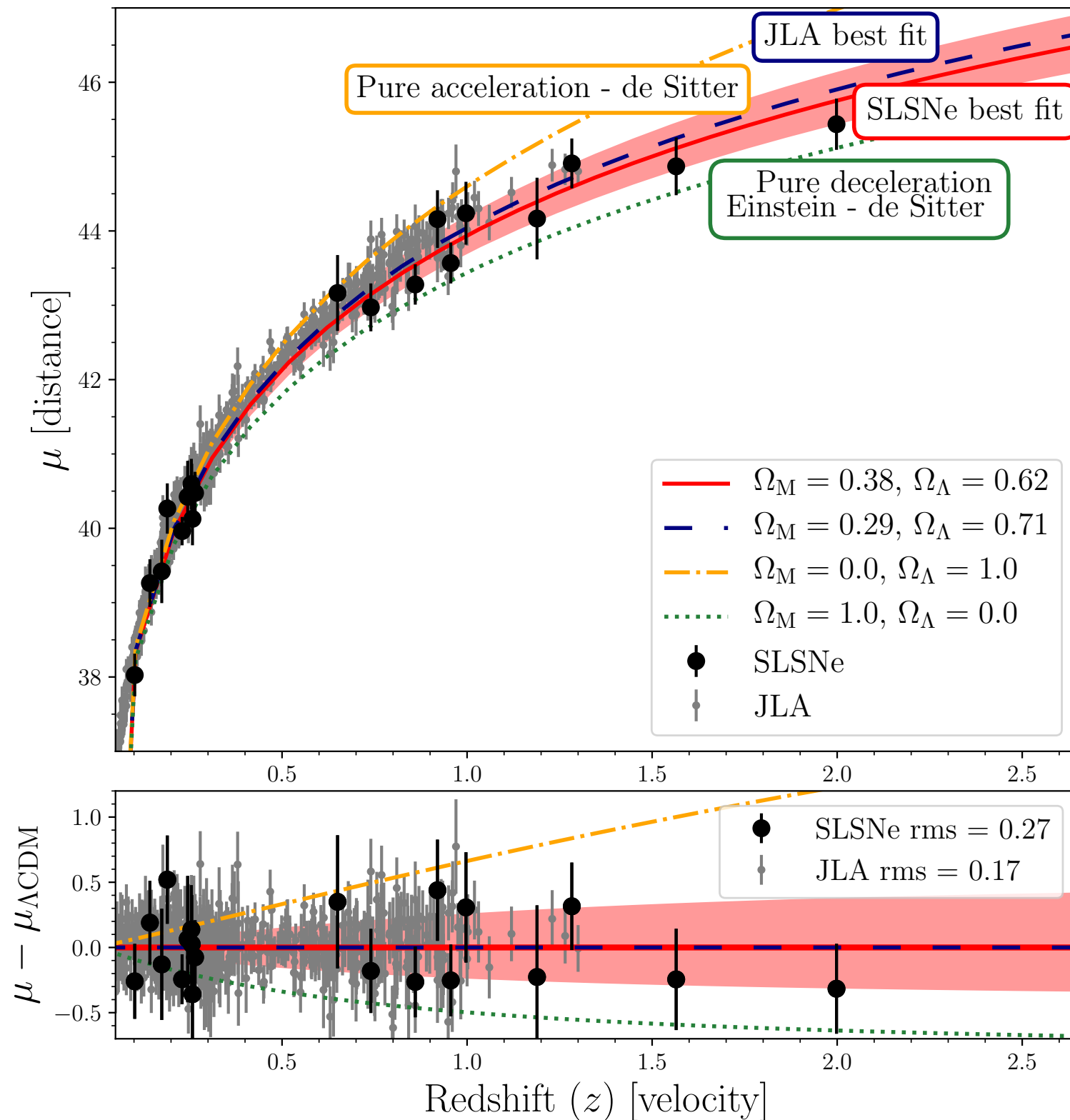
CSM interaction

1. Light Curve
2. Temperature ev.
3. Differential velocity



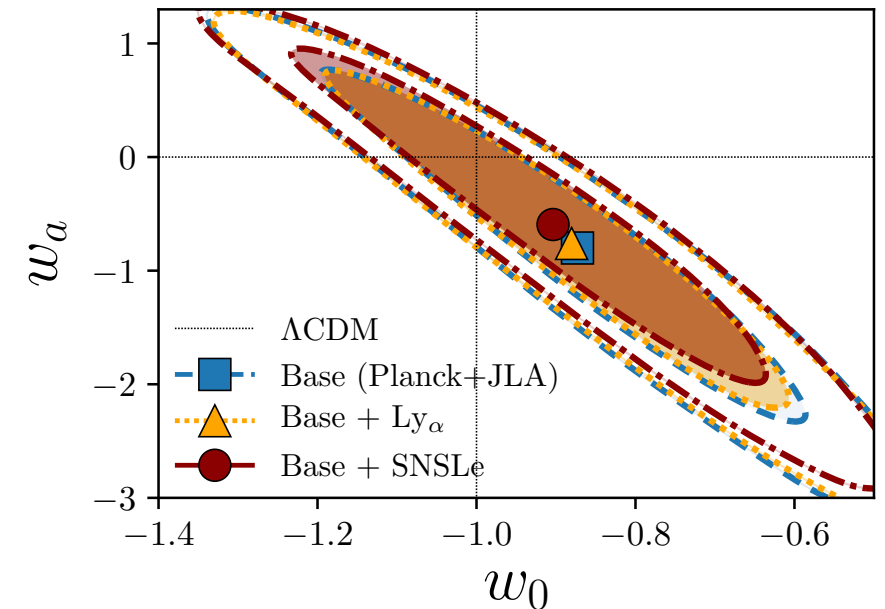
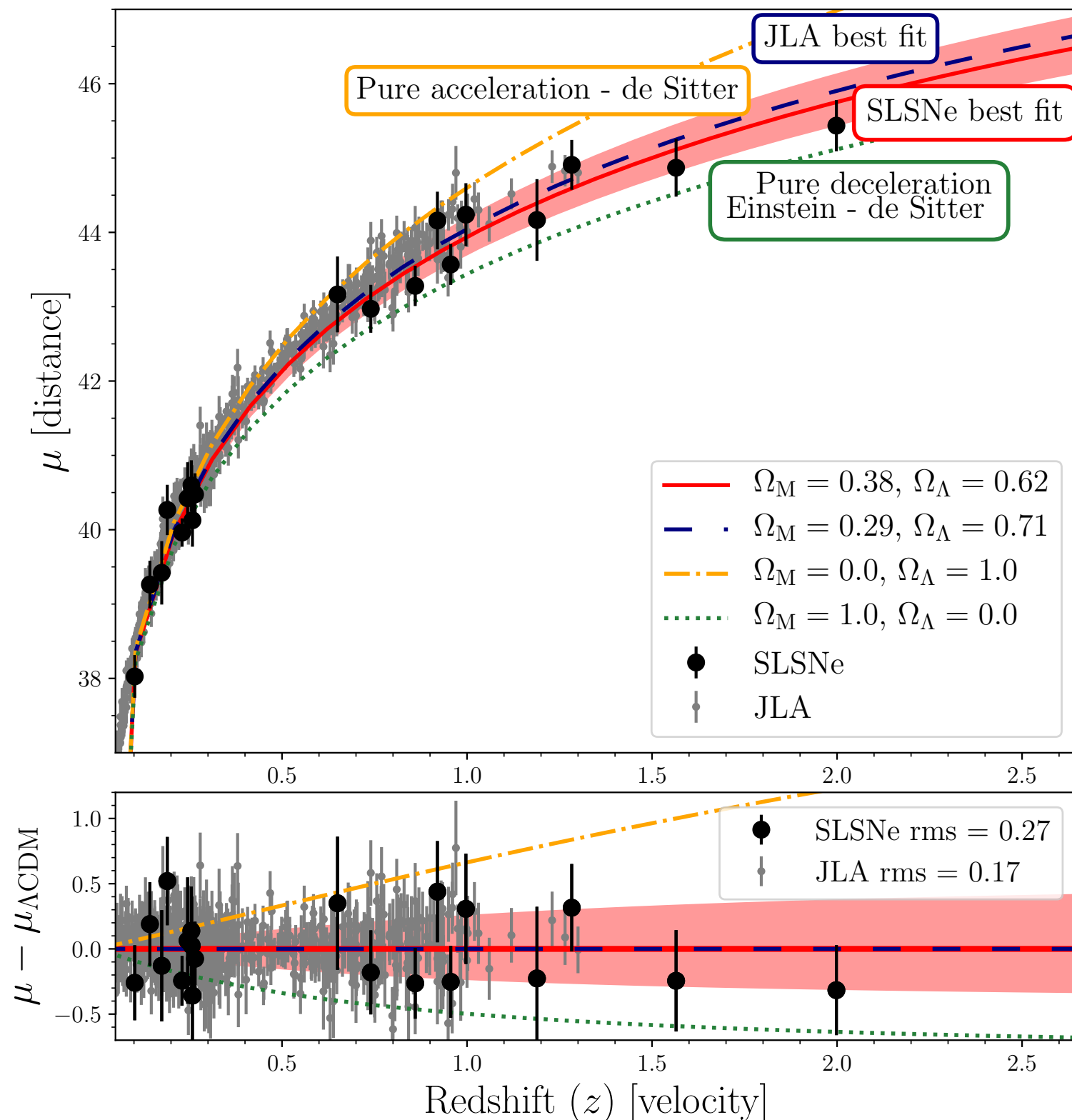
SLSNe - Why are they (still) interesting?

SLSNe - Why are they (still) interesting?



- Peak - decline relation (in 30 days in a 400nm band)
- FoM Base + SLSNe (15.5) vs Base + Ly_α (5.9)

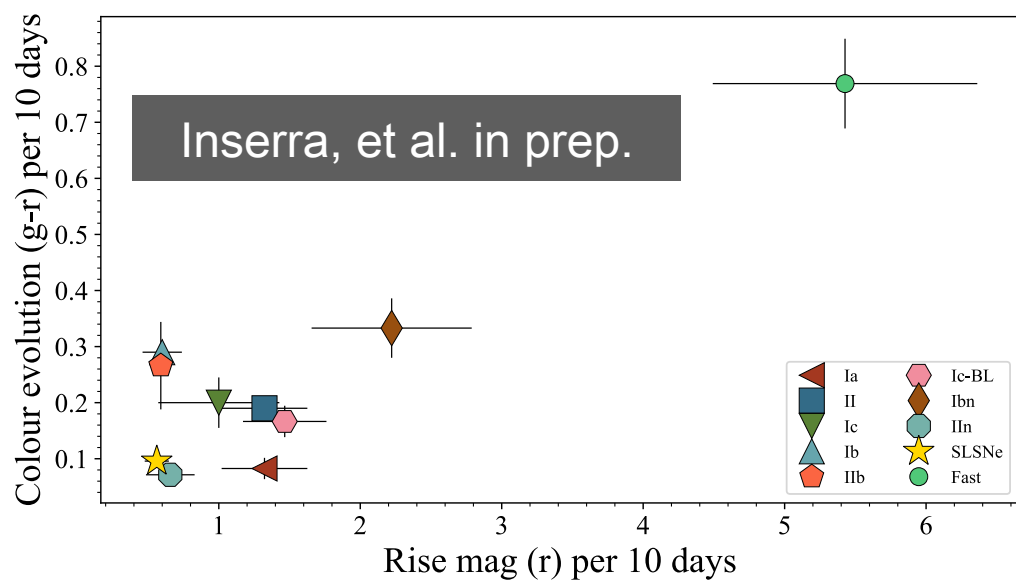
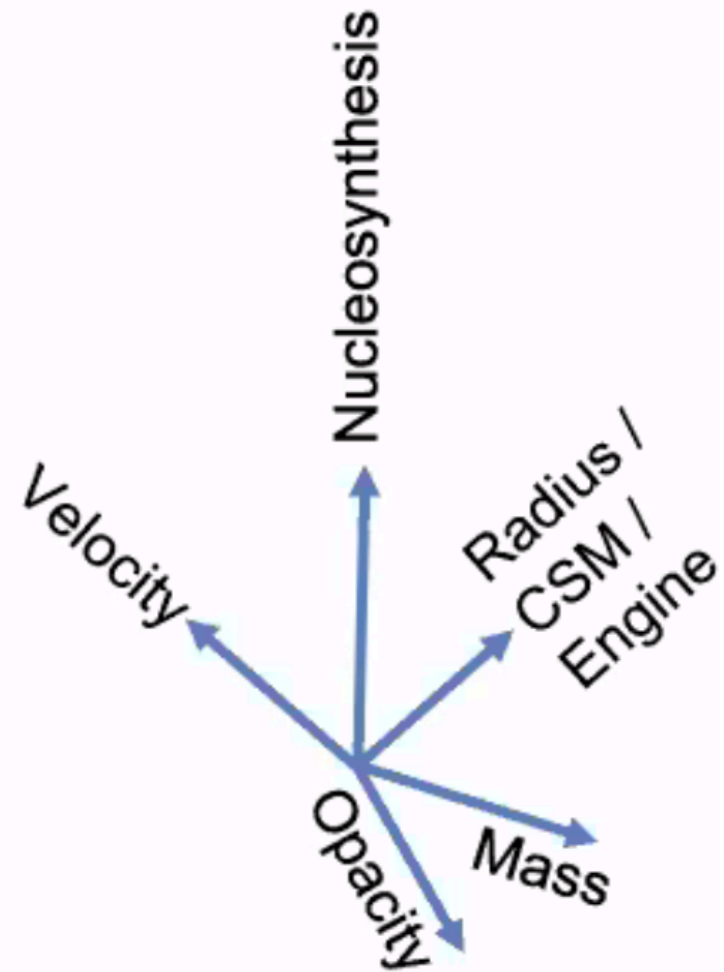
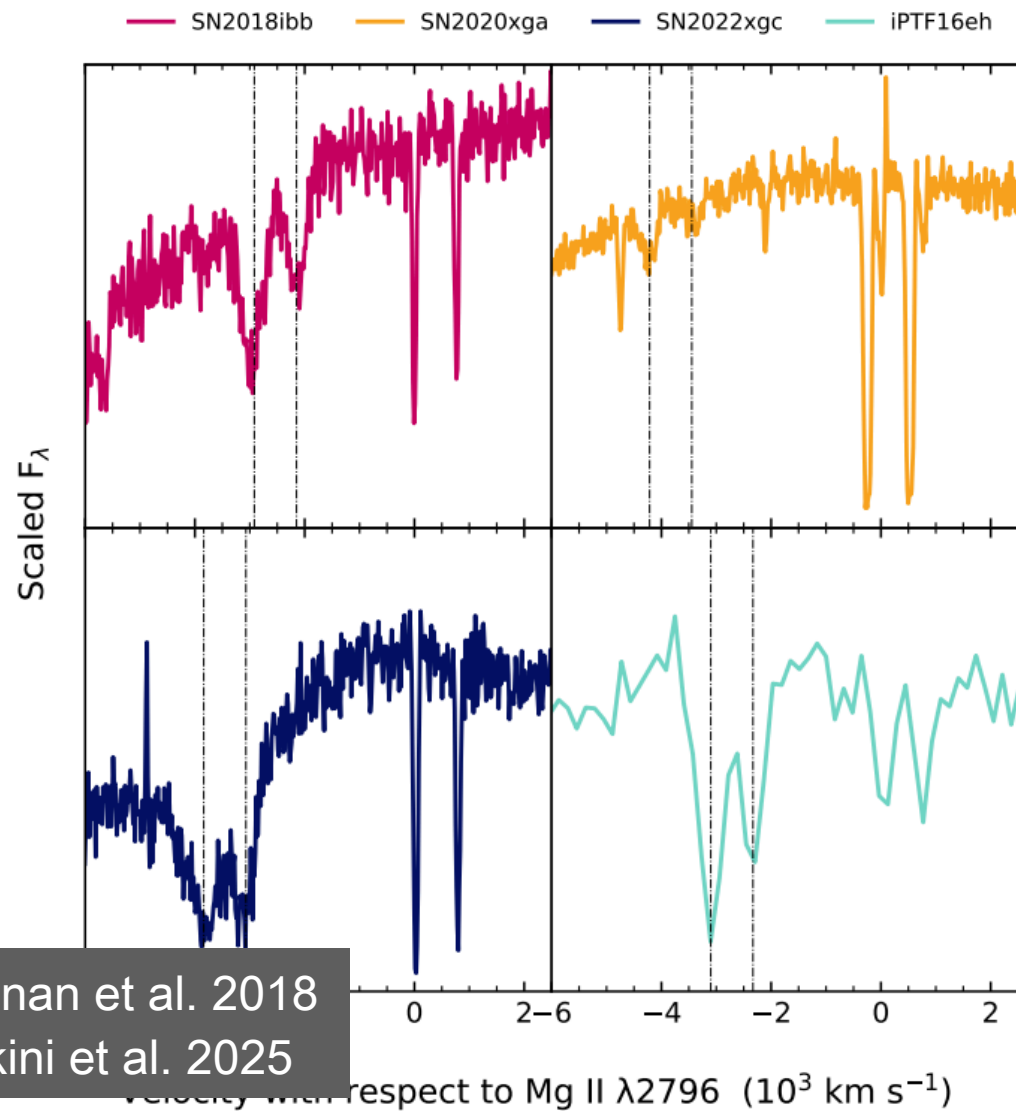
SLSNe - Why are they (still) interesting?



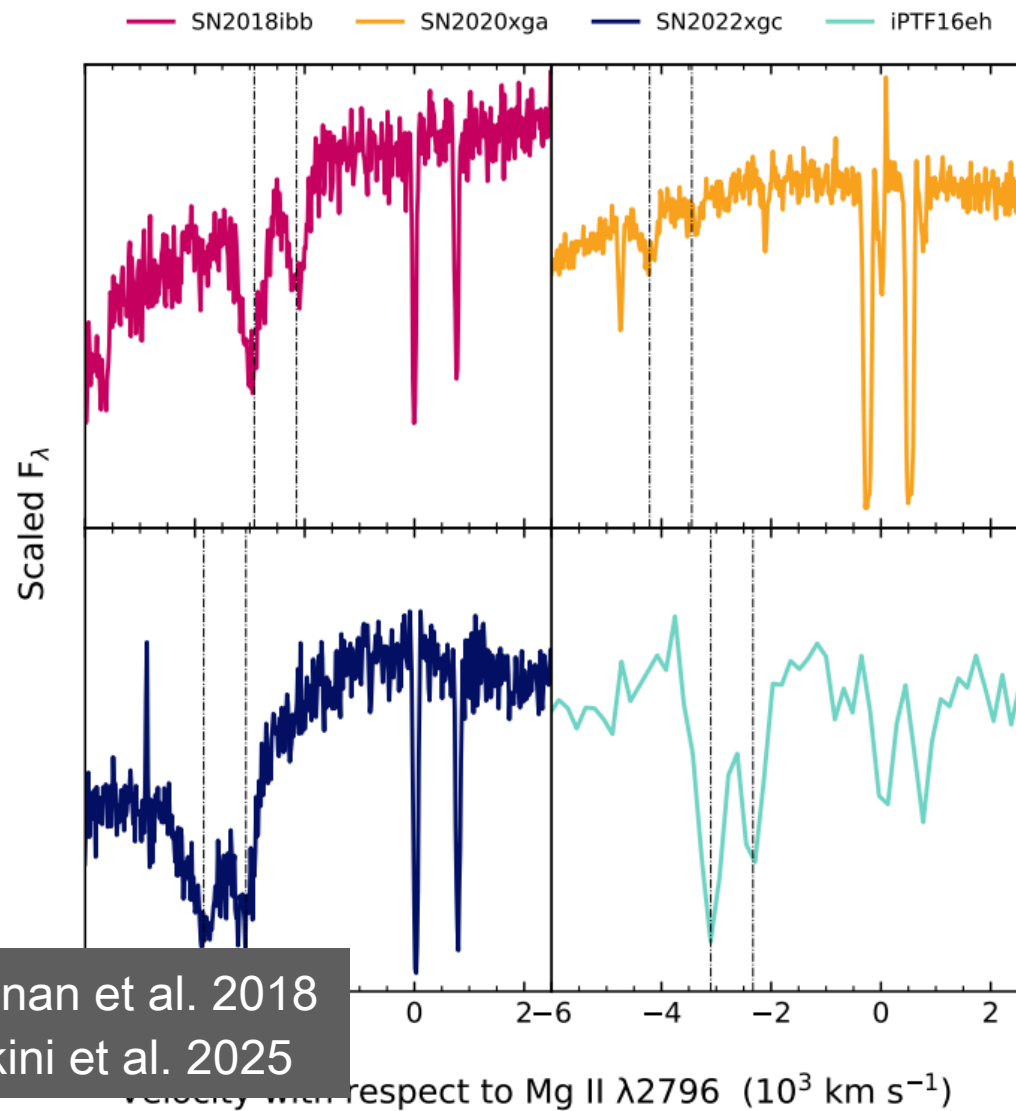
- Peak - decline relation (in 30 days in a 400nm band)
- FoM Base + SLSNe (15.5) vs Base + Ly_α (5.9)

- Horizon $z=10$, a gateway to reionization epoch
- What is the chemical enrichment of the cosmos dominated by Population III stars and first supernovae?

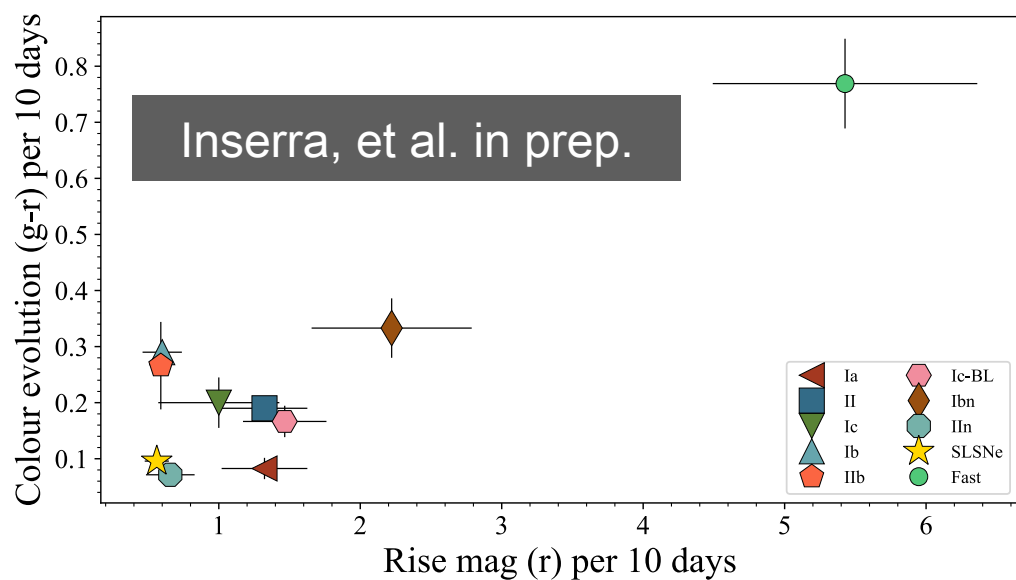
SLSNe - Why are they (still) interesting?



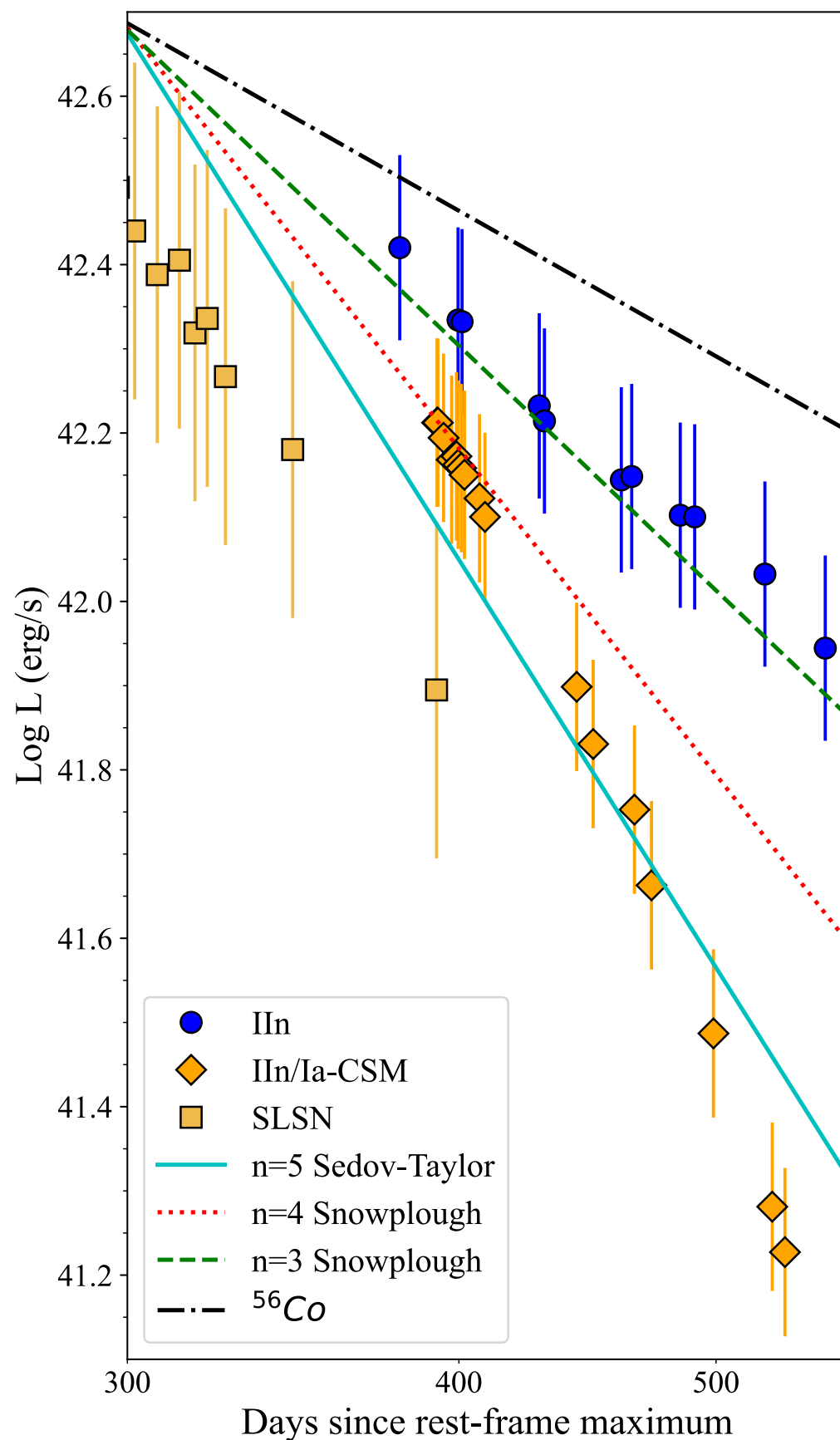
SLSNe - Why are they (still) interesting?



Lunnan et al. 2018
Gkini et al. 2025



Inserra, et al. in prep.



SLSNe - outstanding questions

- What is a SLSN?
- How can we definitively (dis)prove the magnetar scenario as power source?
- What about PISNe, are they wolves in sheep clothing?