Different, but still same:

on the common(?) origin of the peculiar

Type Iax supernovae

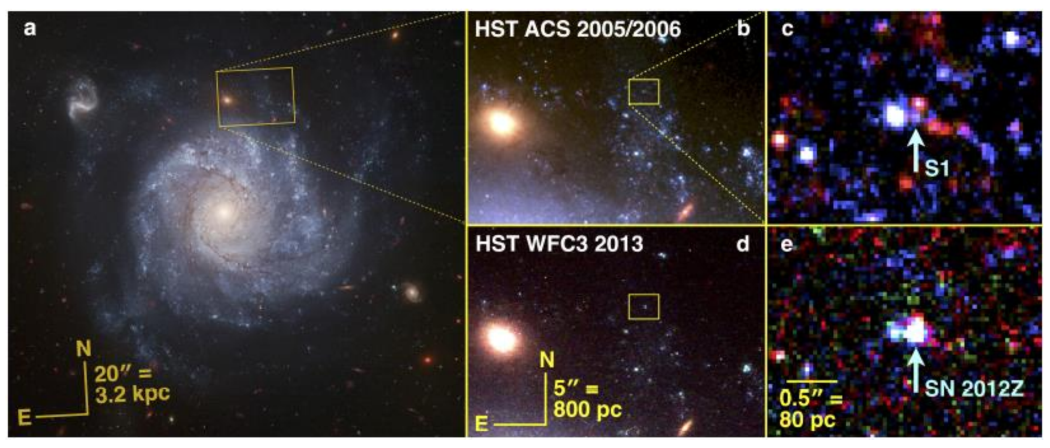
Barnabás Barna & Dominik Bánhidi

bbarna@titan.physx.u-szeged.hu

UNIVERSITY OF SZEGED

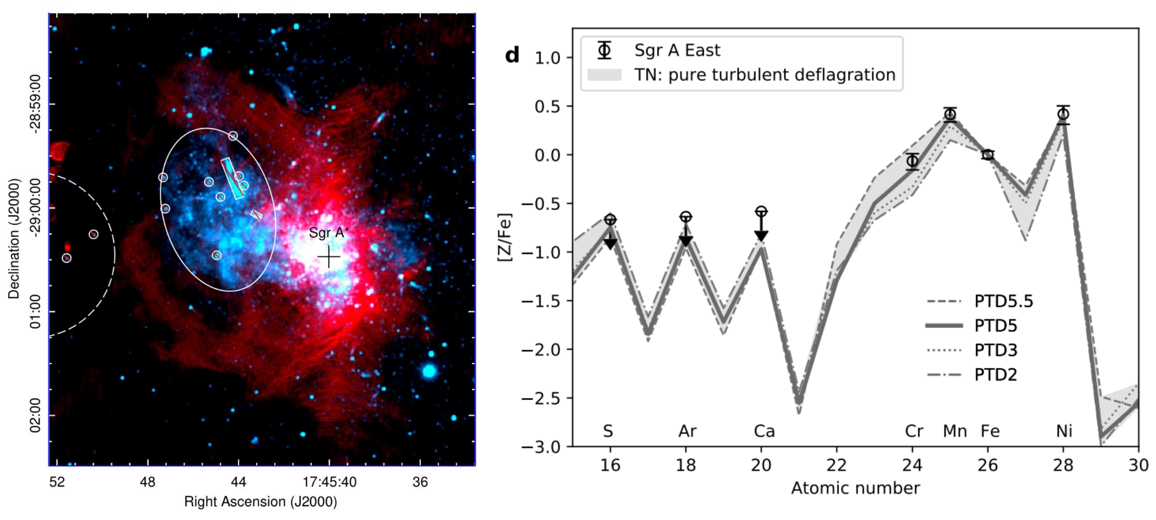
Relatively luminous SNe Iax

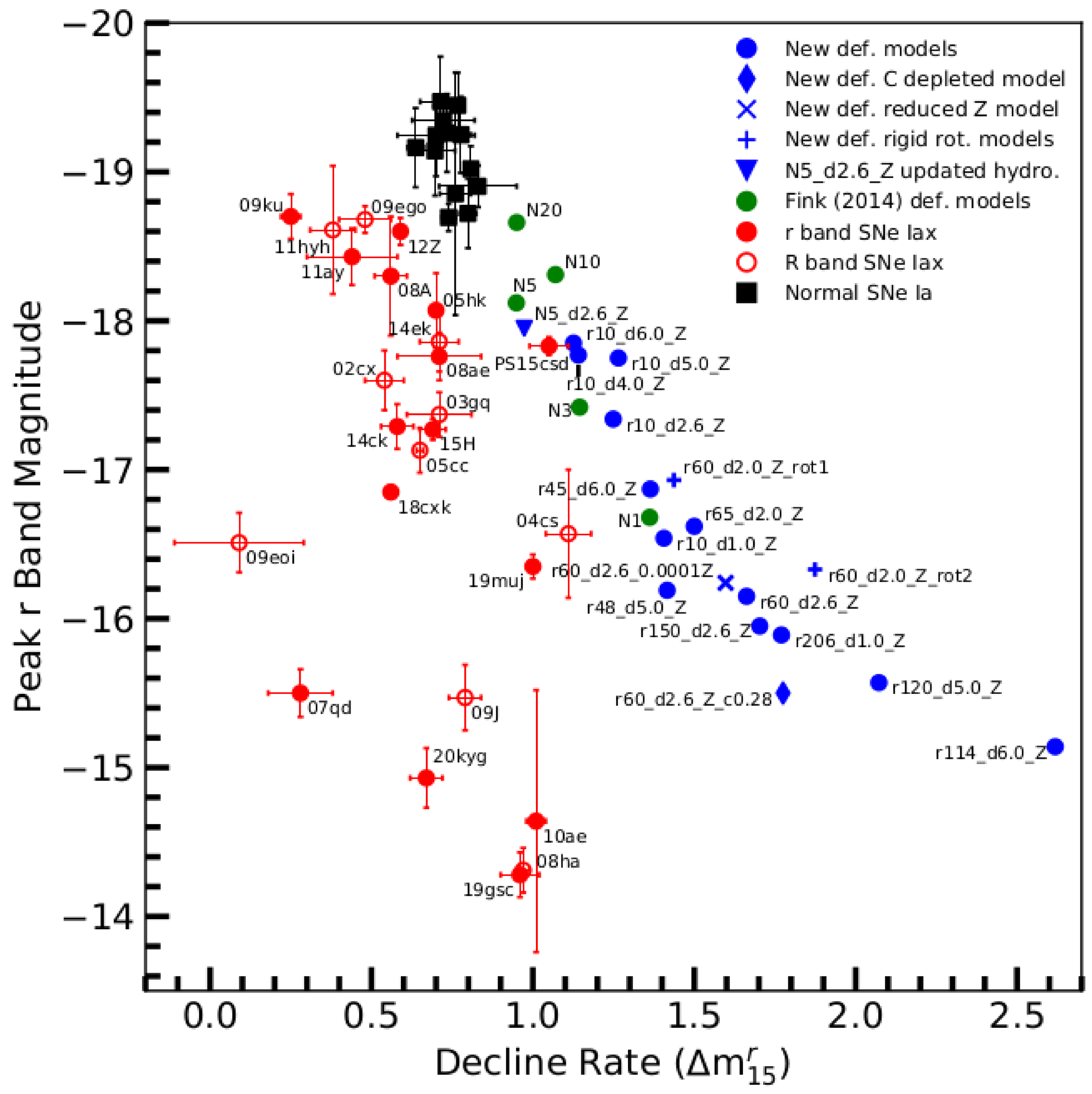
form a well-sampled group matching with deflagration models. SN 2012Z: the only thermonuclear SN for which a progenitor system (He-rich donor: SD scenario) has been detected. [3]



Extremely faint SNe Iax

are the most common of peculiar thermonuclear SNe. SN 1181 & Sgr A East: associated with subluminous Iax SNe based on their kinetic energy and abundances. [4,5]





Key questions:

- **Can deflagration models explain both extremities of the diverse subclass?**
- **Do the physical properties vary continuously over the entire luminosity range?**
- **Do all SNe Iax explode according to the single-degenerate (SD) scenario?**

Studying the objects bridging the luminosity gap may provide answers to the origin of the class.

Deflagration models

successfully reproduce the main observables of the luminous half of the class [6]. The predicted constant chemical abundances can be tested with spectral synthesis of early evolution.

Moderately luminous SNe Iax

- the missing link is evidence of clustering ?
SN 2019muj: the only well-observed object between the two extremeties of the subclass [1]

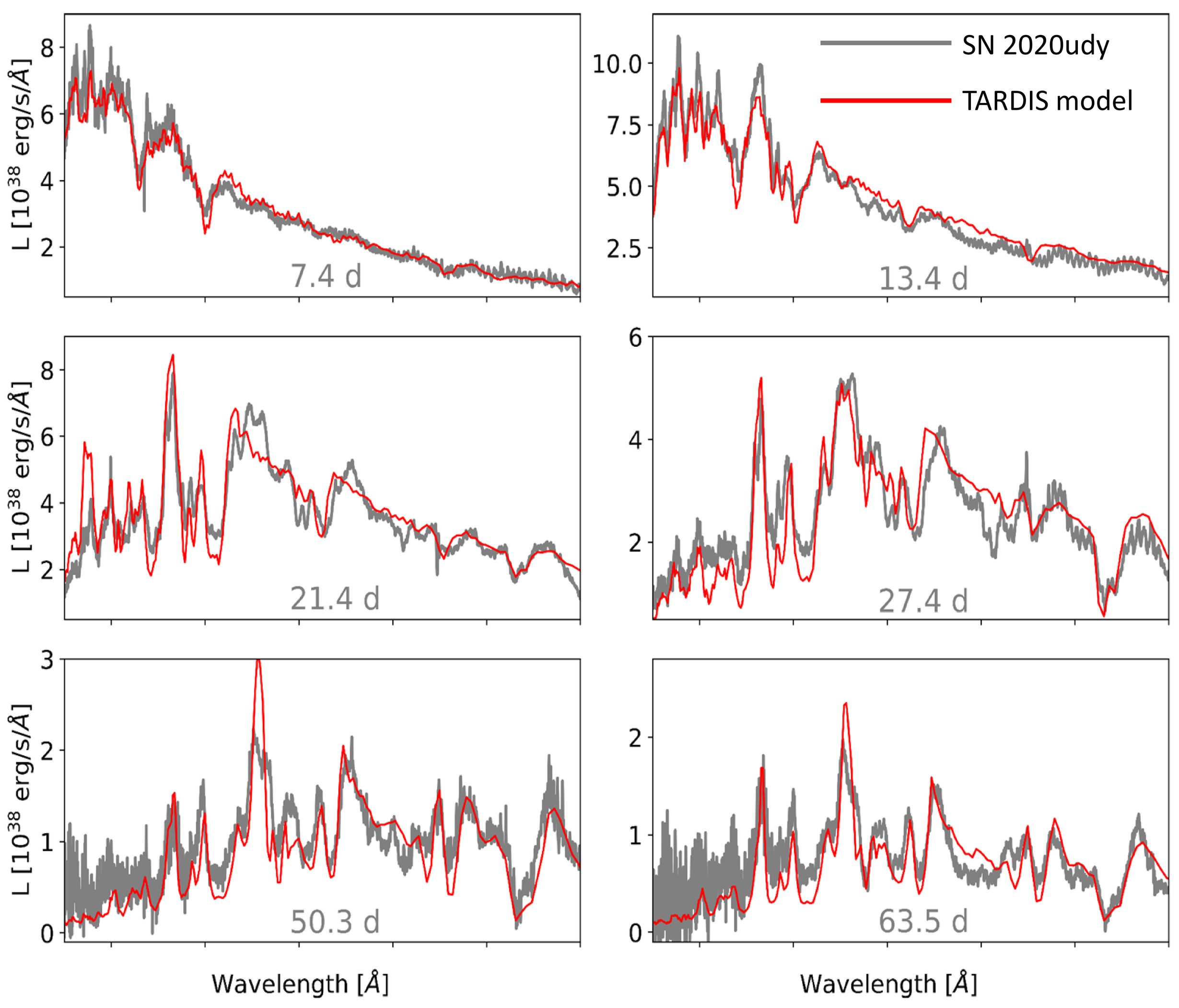
Spectral synthesis with TARDIS [7]

ABUNDANCE TOMOGRAPHY

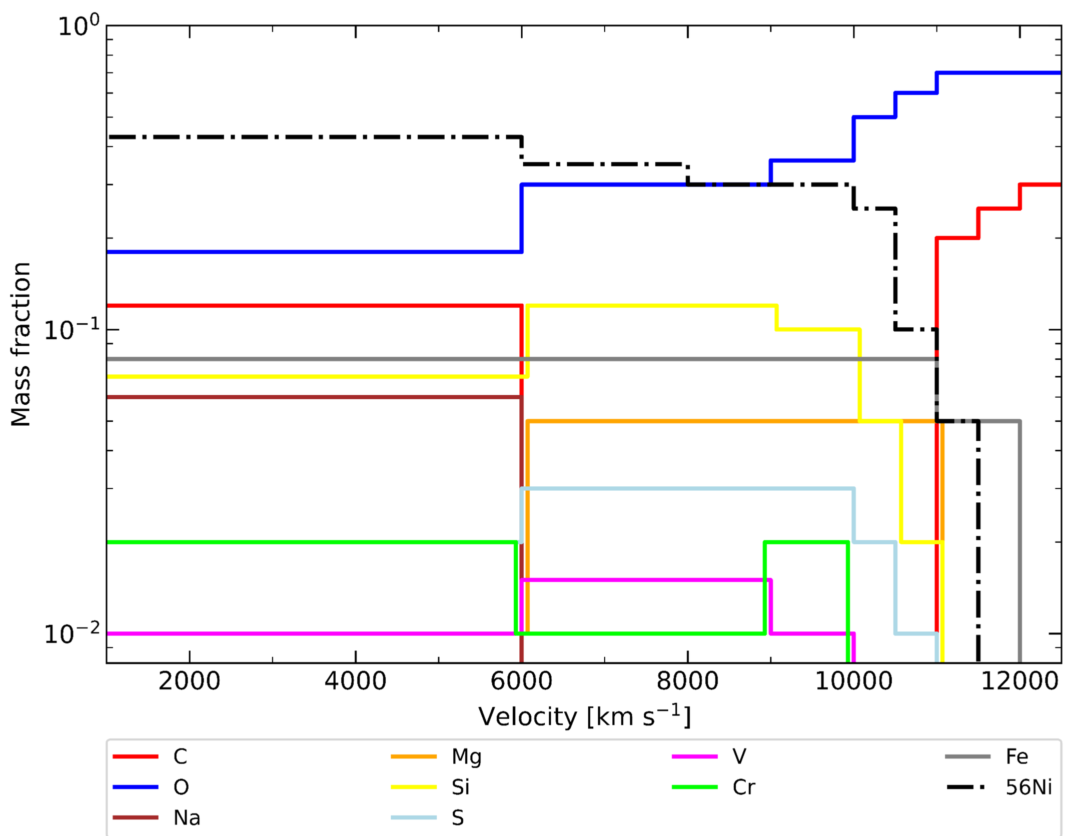
Mapping the properties of the ejecta

- the example of SN 2020udy [2] -

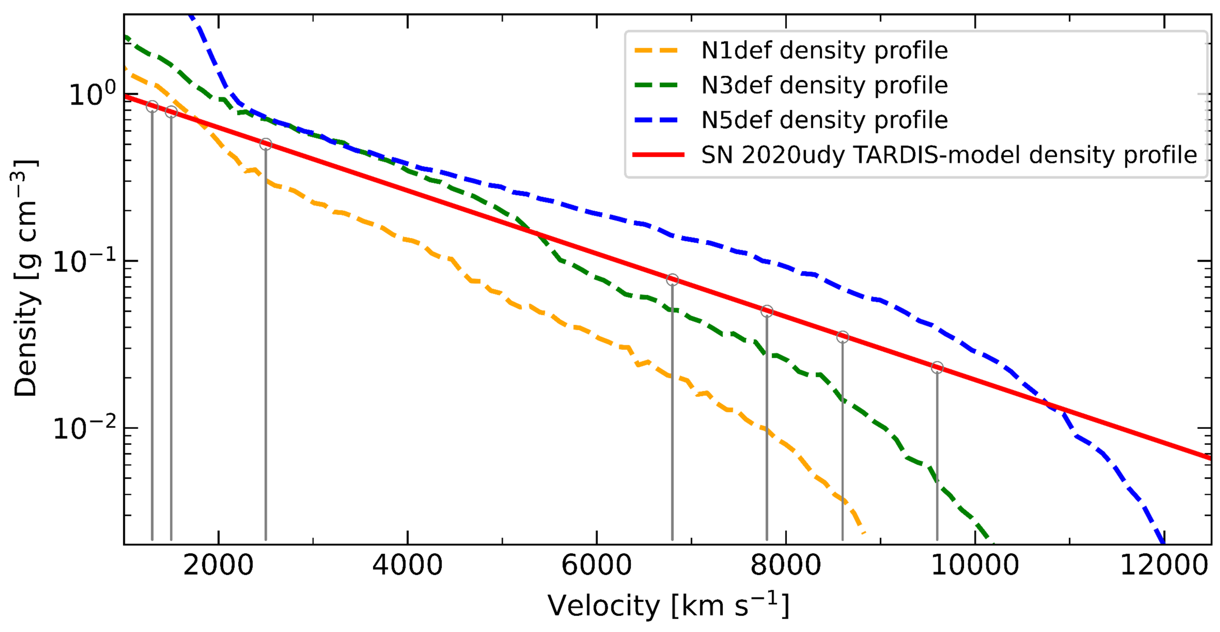
- Good fits even at late-epochs



- Uniform inner abundance structure
- Missing carbon features
- Strongly stratified outer layers?



- Good match with predictions
- Poorly tested outer region
- Precise estimation of photospheric velocity evolution: physical properties at the peak may correlate



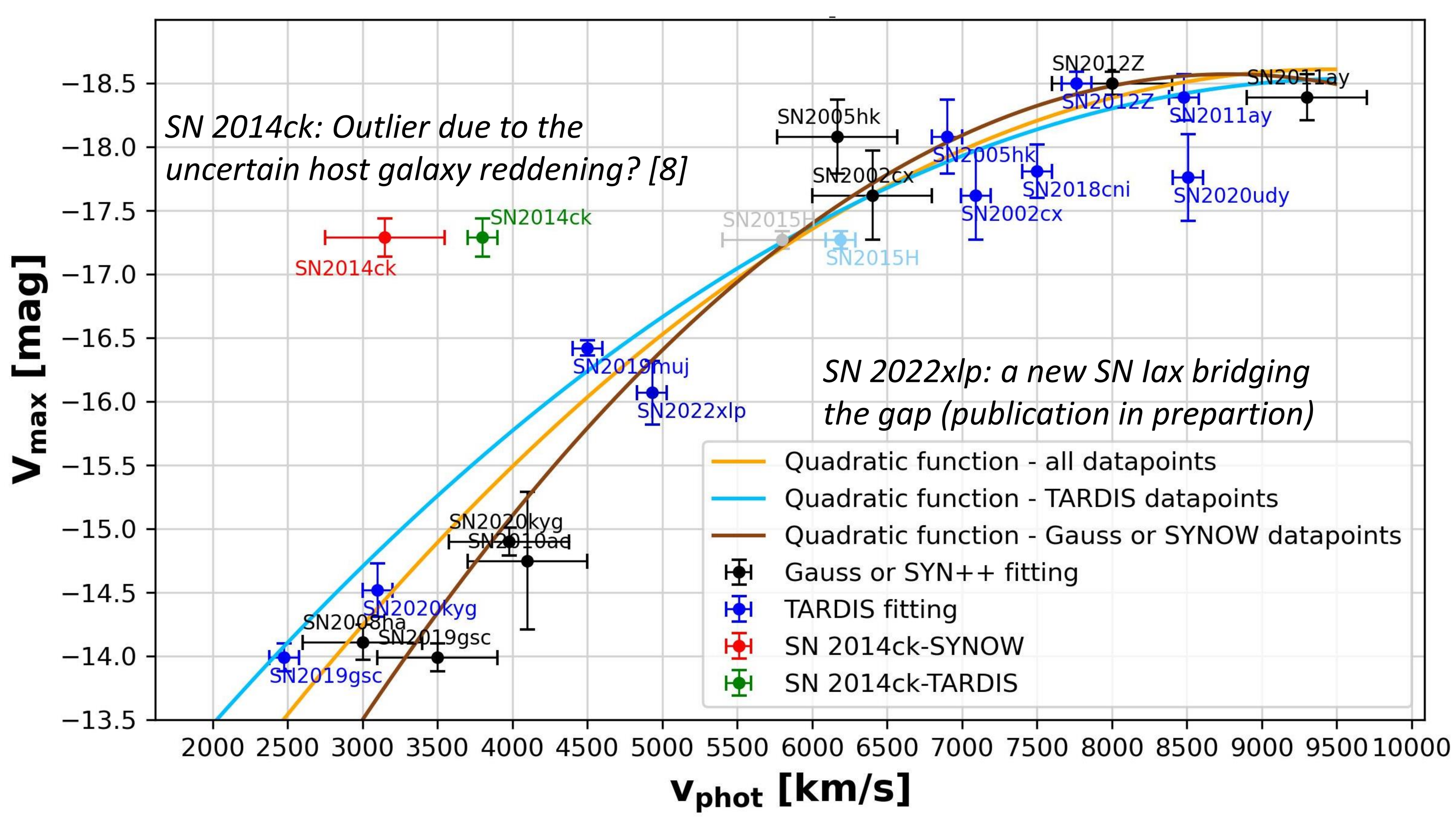
PEAK LUMINOSITY – PHOTOSPHERIC VELOCITY

References

[1] More about the abundance tomography method adopted for SNe Iax: *Singh, M. et al. 2024*

[2] The case of the intermediate luminous type Iax SN 2019muj: *Barna, B. et al. 2021*

[3] McCully C., et al., 2014, Natur, 512, 54
[4] Ritter, A., et al., 2021, ApJL, 918, 33
[5] Zhou, P., et al., 2021, ApJ, 908, 31
[6] Lach F., et al., 2022, A&A, 658, 179
[7] Kerzendorf W. & Sim S., 2014, MNRAS, 440, 387
[8] Tomasella L., et al., 2016, MNRAS, 459, 1018



Conclusions

In-depth and consistent velocity estimation of SNe Iax indicates a tight correlation between the luminosities and photospheric velocities at the moment of maximum light. The continuous distribution is further indirect evidence for the common origin of all SNe Iax. The correlation may also provide a new way of distance measurements.