Constraints on the ejecta properties of SN 2018oh with early excess emission from K2 Observation

Wen-xiong Li
(Department of Physics, Tsinghua University, Beijing, China)
Advisor: Xiaofeng Wang (THU), D. Andrew Howell (LCO/UCSB)

Introduction to SN 2018oh

Two popular scenarios for SN Ia progenitors: (1) an explosion of a WD that accretes materials from a non-degenerate companion; (2) merging explosion of two WDs. Very early observations may distinguish different progenitor models.

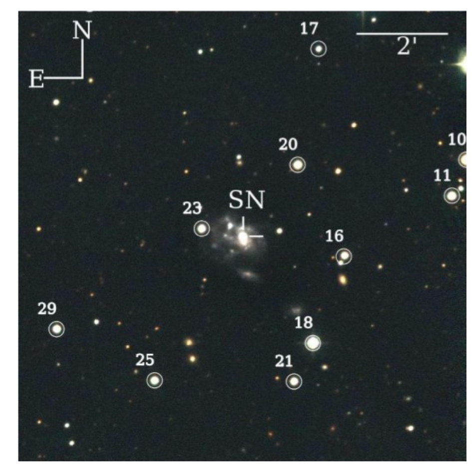

Fig. 1 SN 2018oh in UGC 4780

SN 2018oh (ASASSN-18bt) is the **first spectroscopically-confirmed SN Ia observed in the *Kepler* field** (Fig. 1).

→ A rare opportunity to examine the SN Ia with both continuous *Kepler* data and extensive follow-up.

Overall evolution

T_{bmax} = 18.2 ± 0.3 d
$M_{peak}(B)$ = -19.47 mag
$\triangle m_{15}(B)$ = 0.96 ± 0.03 mag

→ A normal SN Ia

Similar to other normal SNe Ia. (Fig 2, 3)

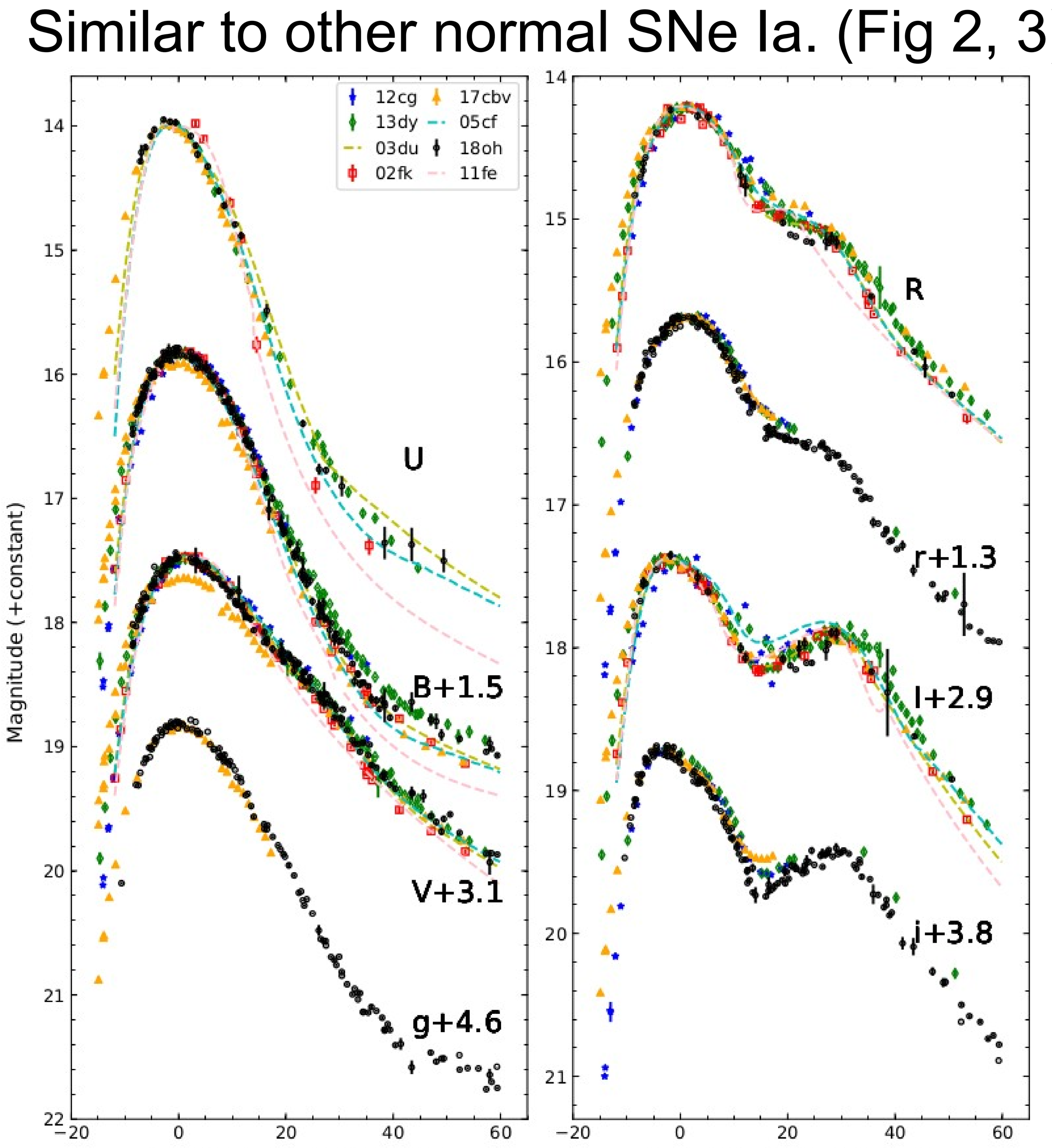

Fig. 2 Comparison of the optical light curves of SN 2018oh to other normal SNe Ia.

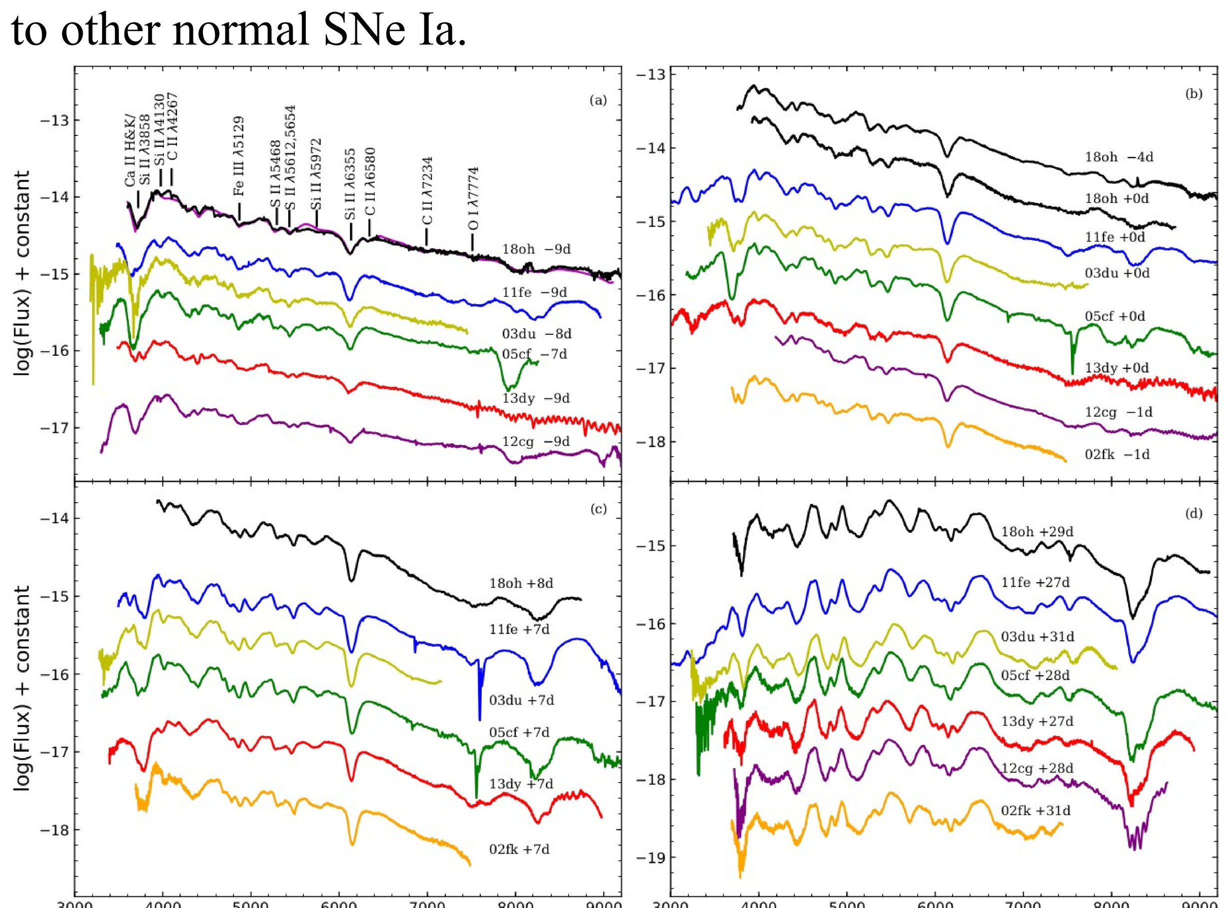

Fig. 3 Comparison of the optical spectra of SN 2018oh to other normal SNe Ia.

Carbon features

Longest-lasting C II absorption in SNe Ia
(~20d after maximum, Fig 4, 5).

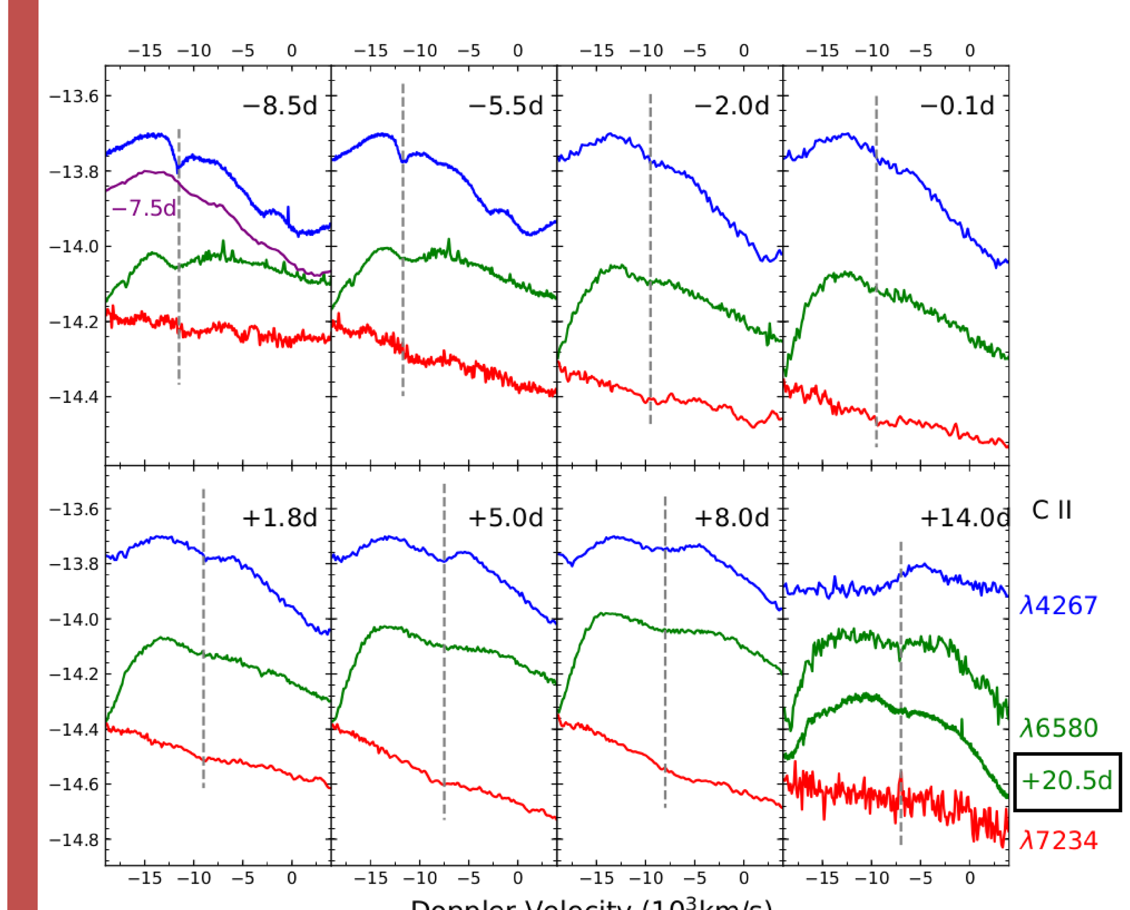

Fig 4. Three C II lines evolution of SN 2018oh in velocity space.

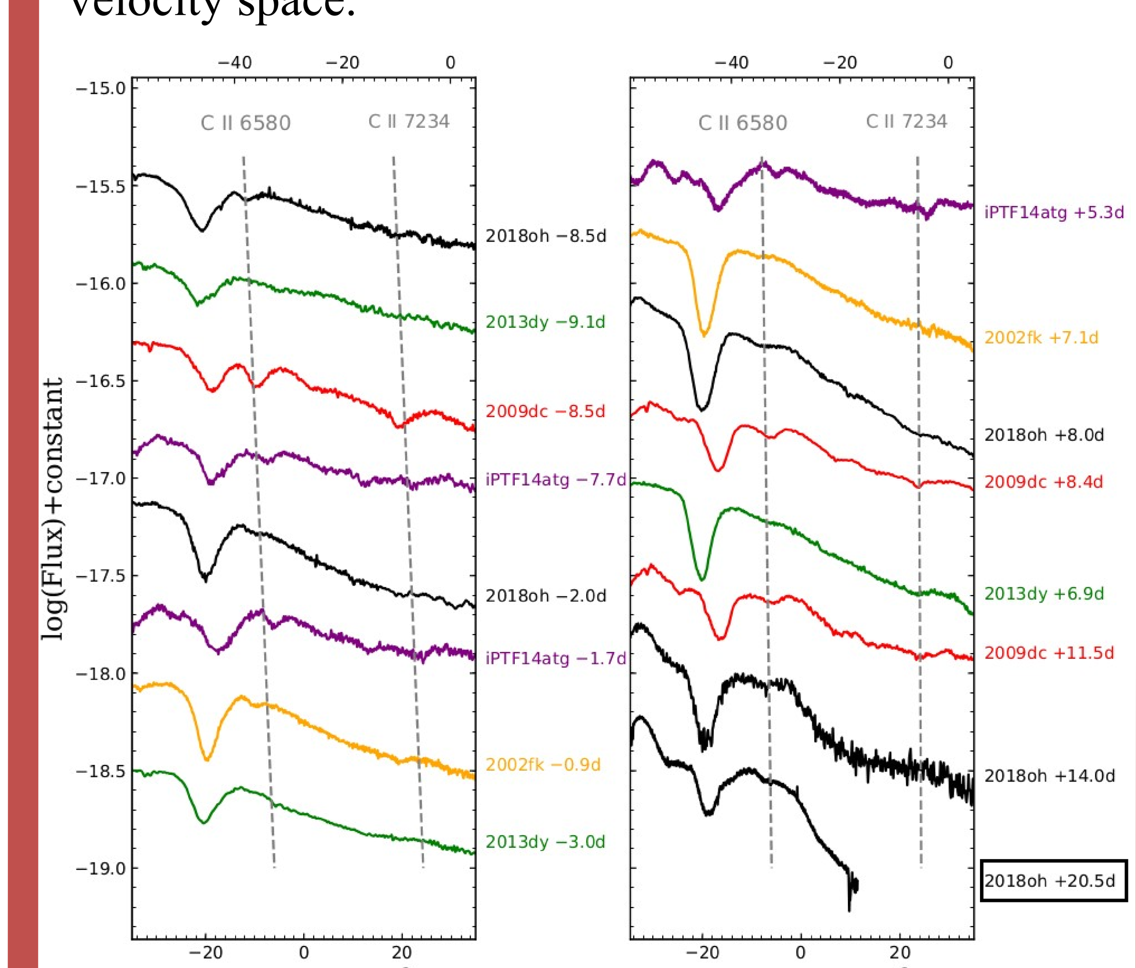

Fig. 5 C II λ6580 evolution of SN 2018oh compared to that of other SNe Ia. The gray dashed lines indicate the trend for the corresponding lines.

The velocity of C II 6580 is down to ~ 8,000 km/s (Fig. 6), suggesting **a strong mixing of carbon in the ejecta.**

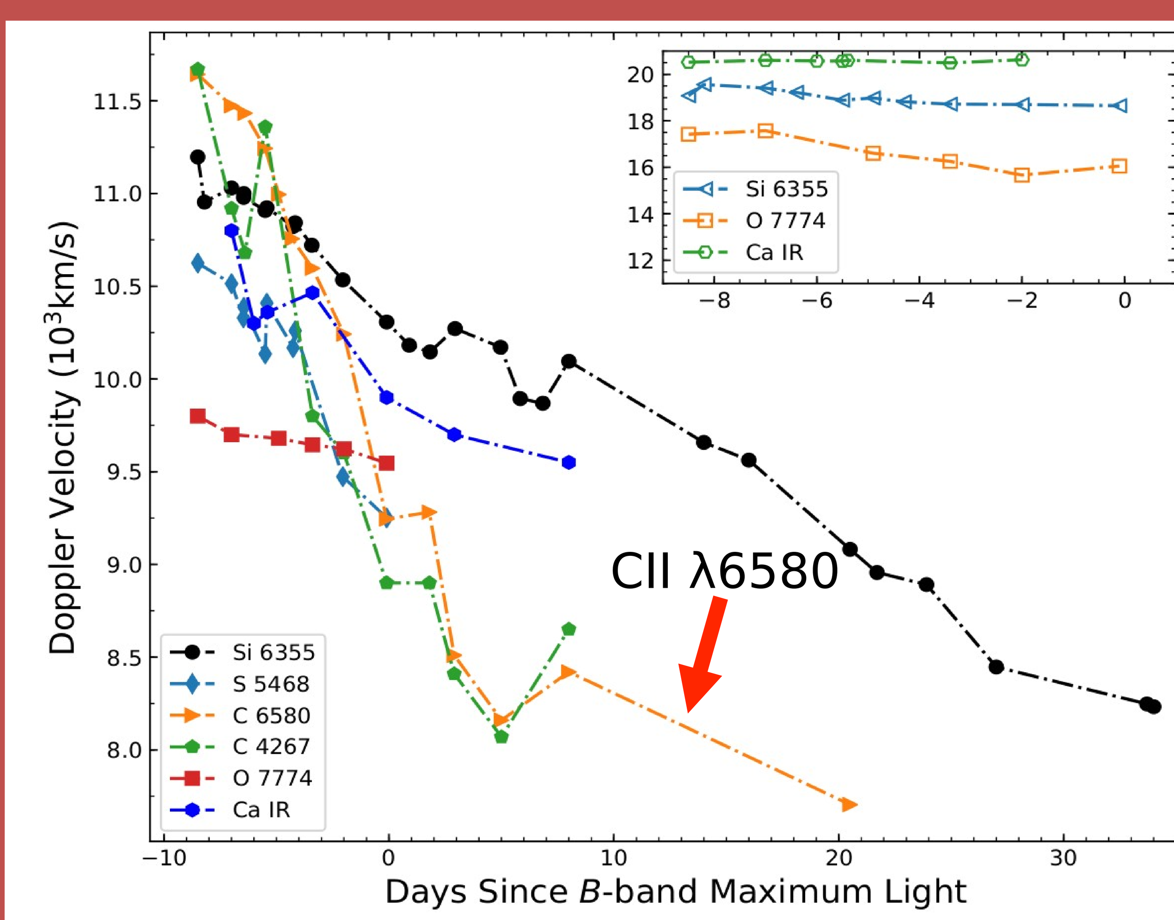

Fig. 6 Evolution of the expansion velocity of different lines.

Bolometric luminosity

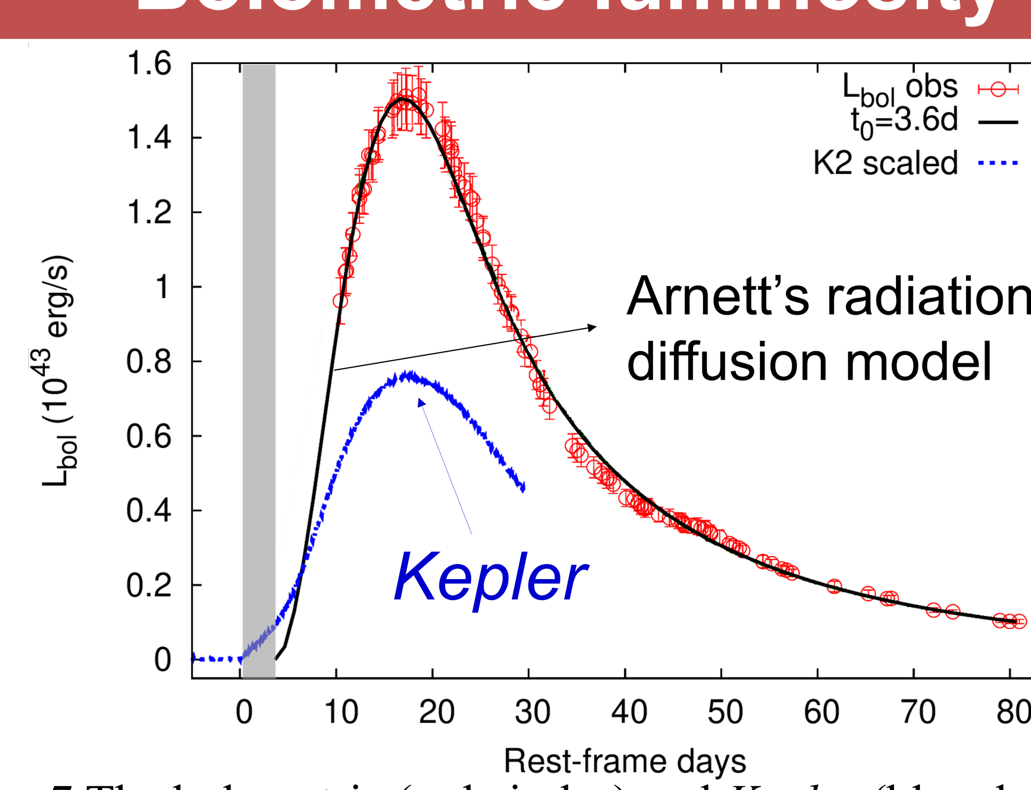

Fig. 7 The bolometric (red circles) and *Kepler* (blue dots) luminosity curve together with radiation diffusion Arnett-model. *Kepler*'s luminosity is lower due to the limited bandpass.

The moment when the luminosity begin to emerge in the radiation diffusion model with centrally distributed ^{56}Ni is found to be +3.85 days after explosion (gray area in Fig. 7), **implying there are other heating sources during the first ~4 days.**

NASA press release of SN 2018oh including our work and two others [1][2].

Summary

SN 2018oh, the first spectroscopically confirmed SN Ia in the *Kepler* field, has the latest detection of carbon ever recorded in a SN Ia. This indicates that considerable amount of unburnt carbon exists in the ejecta.

The fit of the bolometric light curve indicates the presence of other heating sources during the first ~4 days after explosion. It may be interaction with a companion [1][3] or, combined with carbon feature, radioactive energy from ^{56}Ni in the outer part of the ejecta [2][4].

References

[1] Dimitriadis, G., Foley, R. J., Rest, A., et al. 2018, ApJL, 870, L1
[2] Shappee, B. J., Holoinen, T. W.-S., Drout, M. R., et al. 2018, ApJ, 870, 13
[3] Kasen, D. 2010, ApJ, 708, 1025
[4] Piro, A. L., & Morozova, V. S. 2016, ApJ, 826, 96