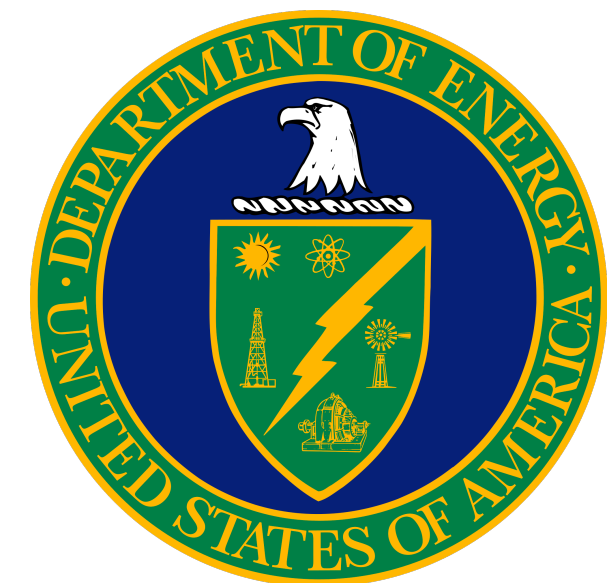


Harris+ 2018 (arXiv:1812.02756), Graham+ 2019 (arXiv:1812.02757)

Which SNe Ia Come from the Single Degenerate Channel? The Answer Will Shock You.

Chelsea Harris

Melissa Graham, Peter Nugent, Assaf Horesh, Kate Maguire, Ori Fox, Joe Bright, Rob Fender, Mat Smith, Nat Butler, Stefano Valenti, Alex Filippenko, Ariel Goobar, Pat Kelly, Ken Shen, Curtis McCully

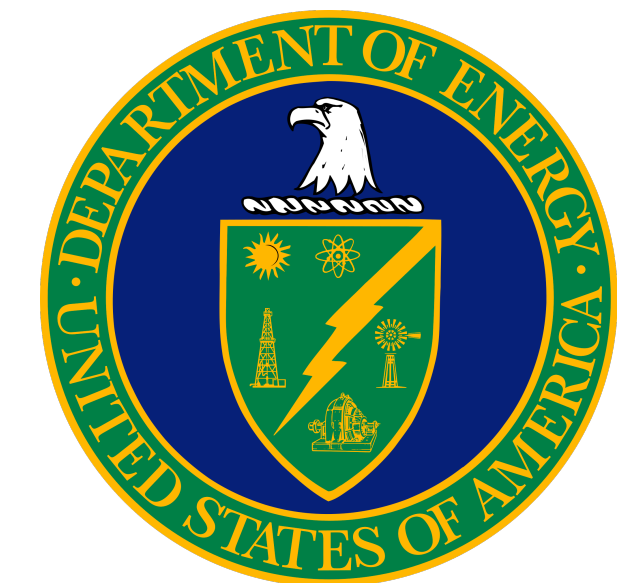


Harris+ 2018 (arXiv:1812.02756), Graham+ 2019 (arXiv:1812.02757)

connecting 91T-like SNe Ia to the single-degenerate channel

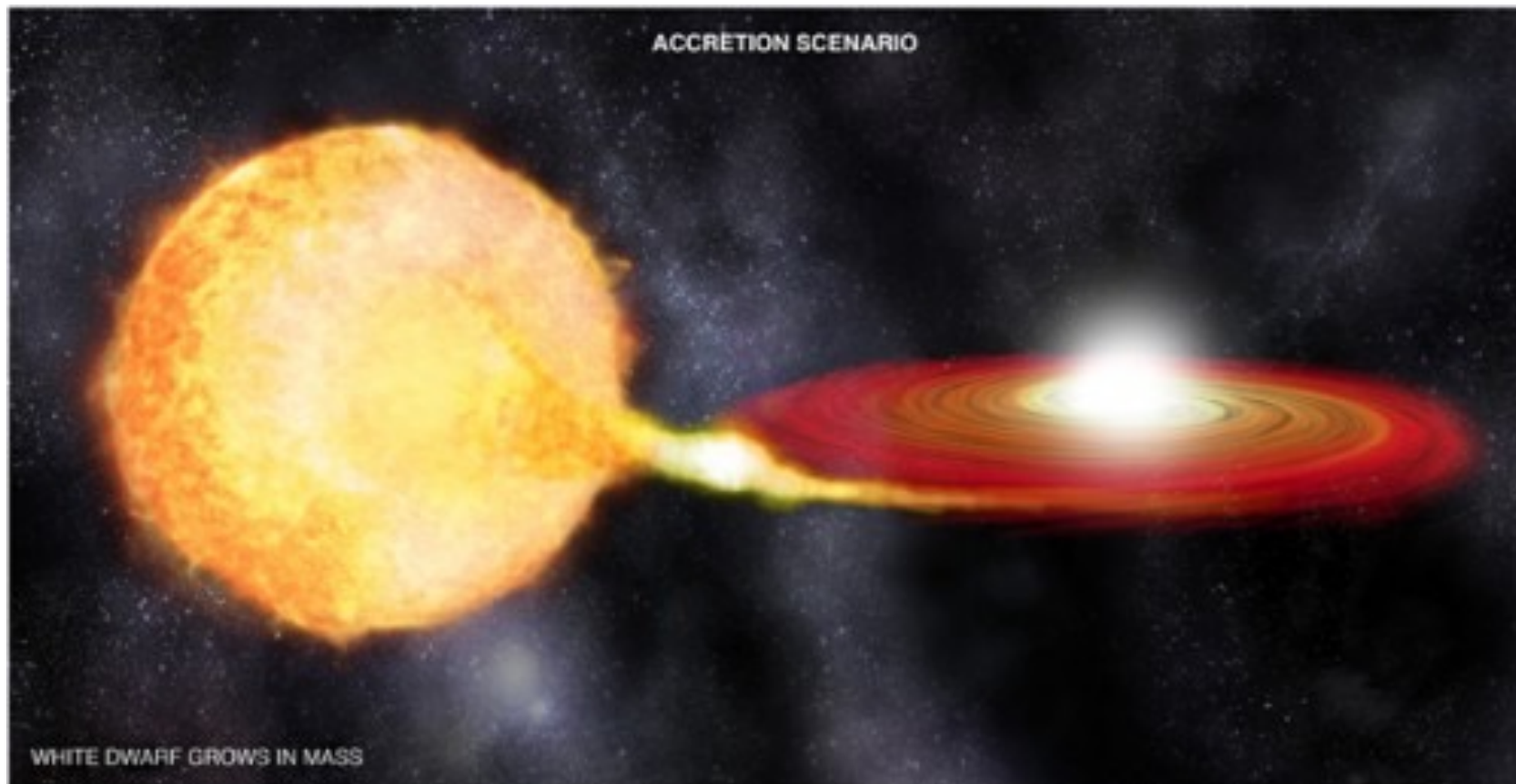
Chelsea Harris

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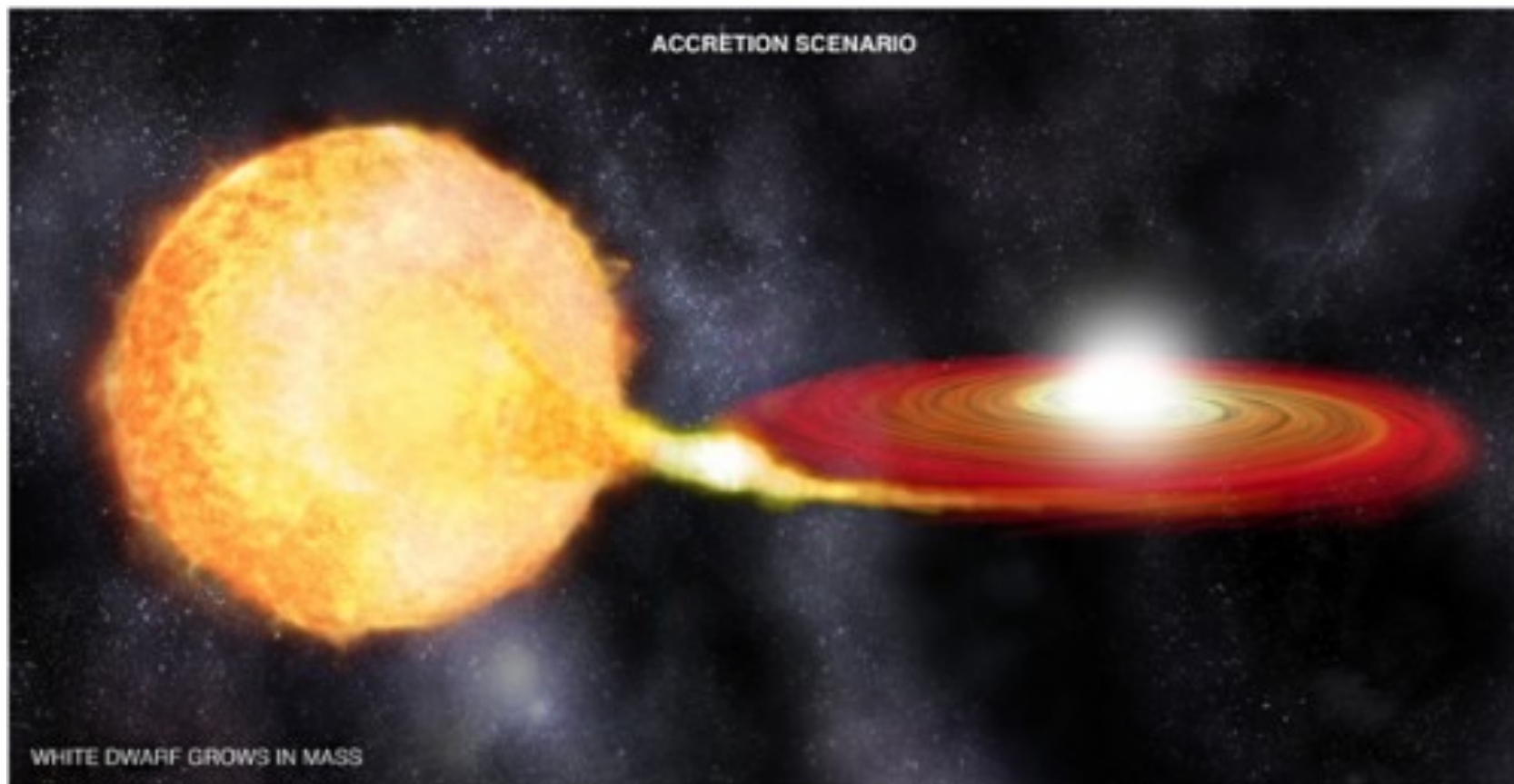
**exploring the SD channel through
delayed-interaction SNe Ia**

exploring the SD channel through delayed-interaction SNe Ia



only 91T-like SNe Ia have
H-rich CSM of the SD
channel

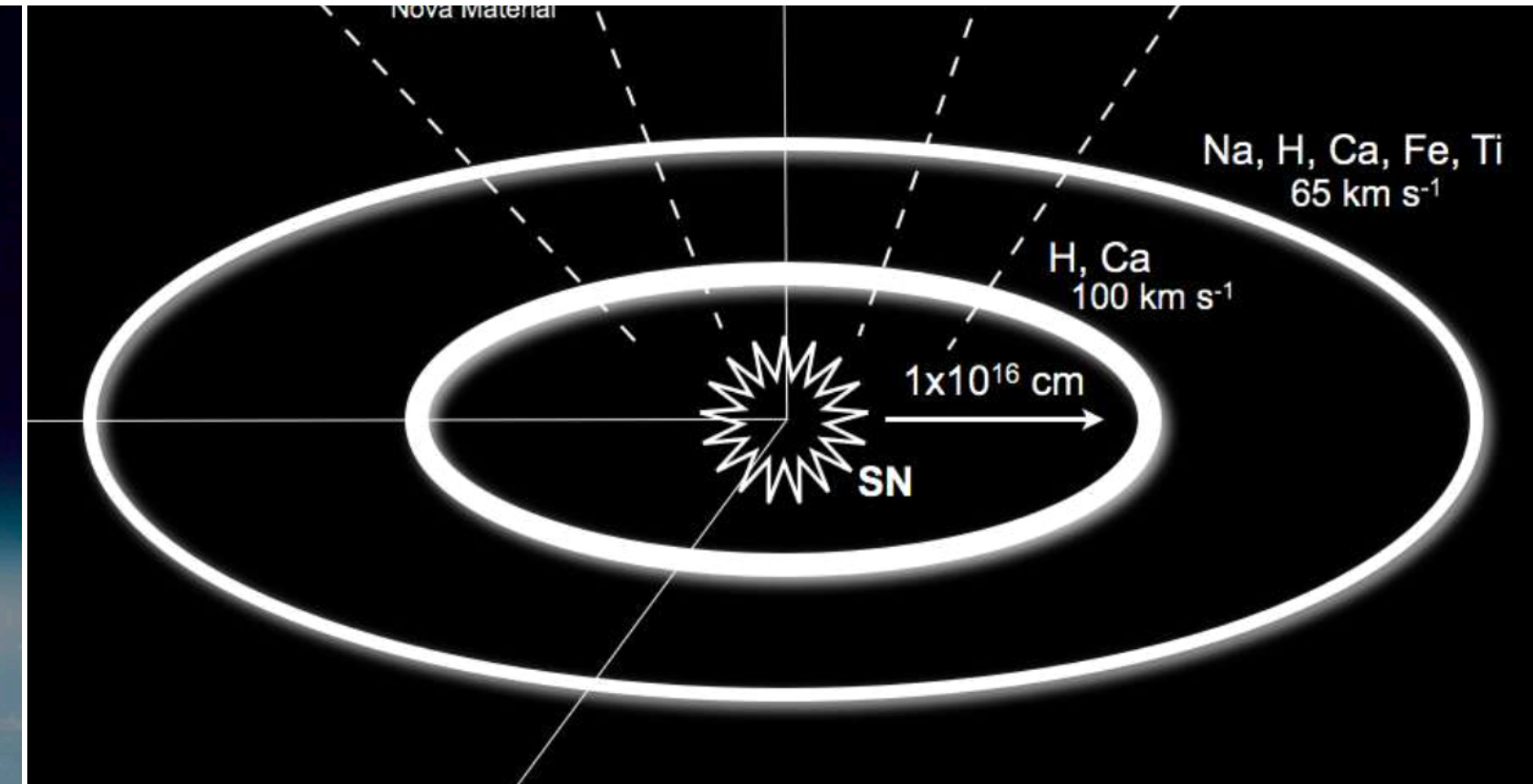
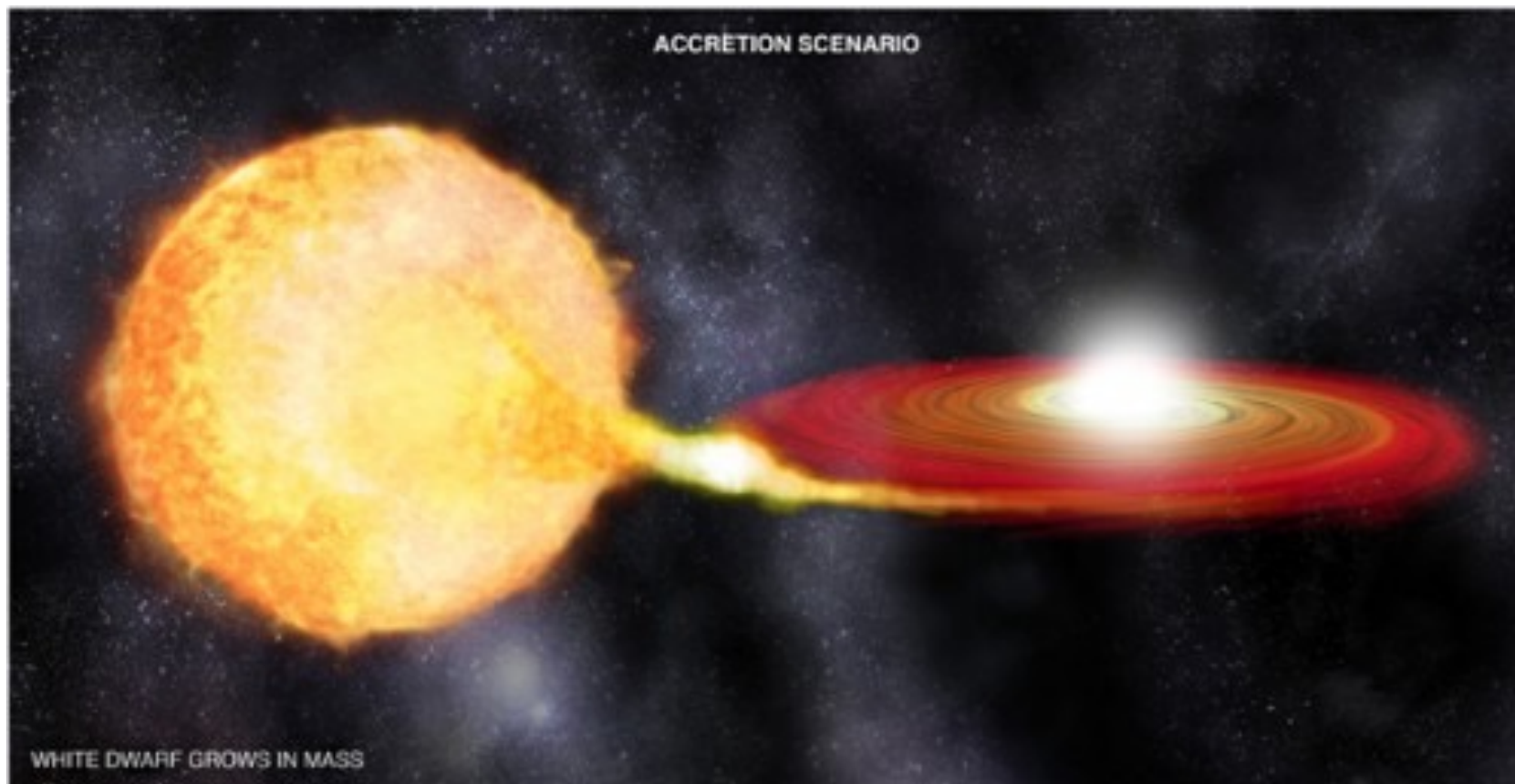
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we built a program to
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SNe Ia, and it worked!

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models suggest the new
find is a PTF11kx analog

Graham+ 2019 (arXiv:1812.02757)

Harris+ 2018 (arXiv:1812.02756)

single- vs. double-degenerate: CSM



single- vs. double-degenerate: CSM

single-degenerate channel:

long period of accretion from RG or MS companion



double-degenerate channel:

violent merger with CO WD



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H-rich CSM

double-degenerate channel:

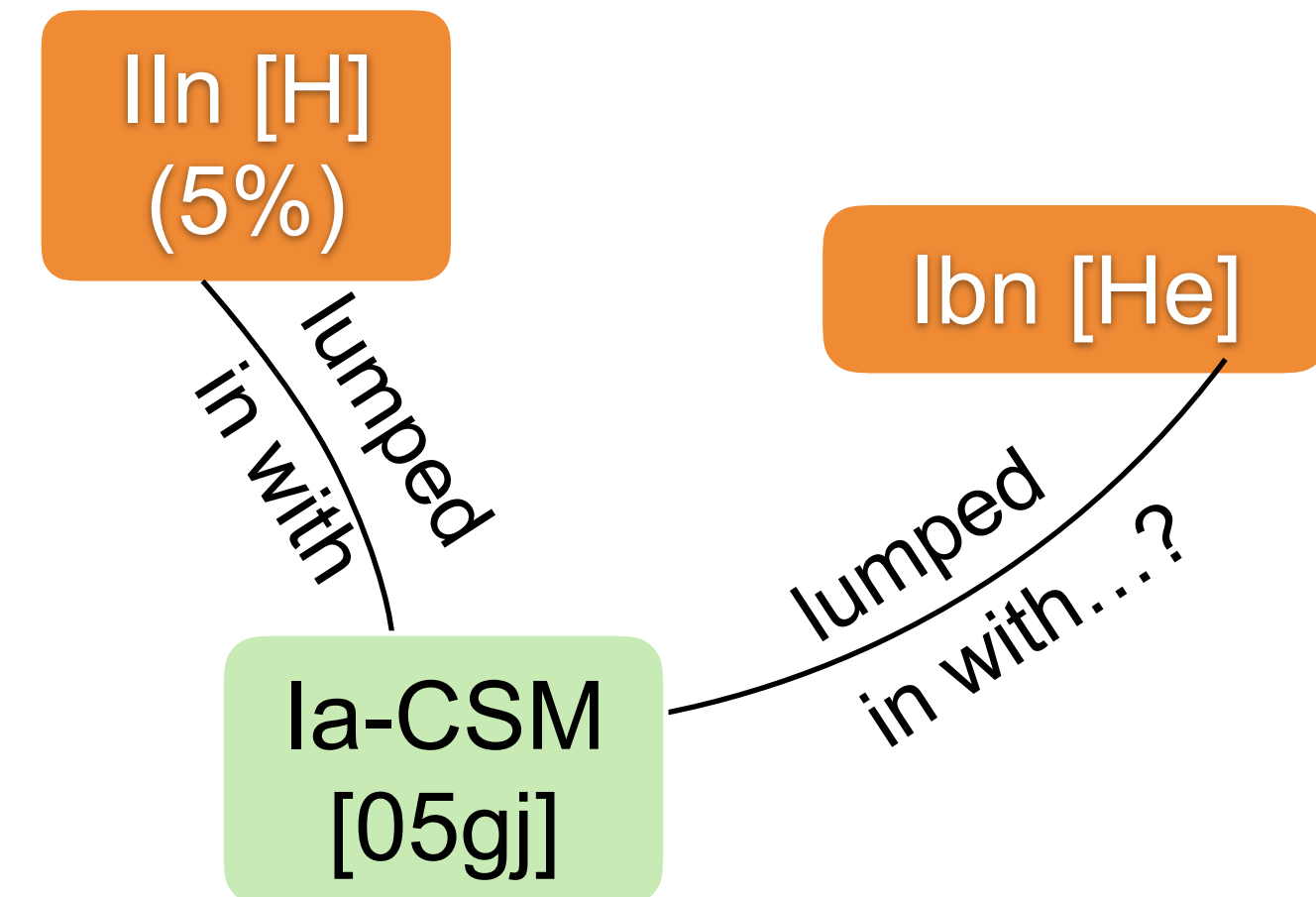
violent merger with CO WD



no H-rich CSM

SNe Ia can have H-rich CSM

SNe IIn (5% of all SNe)



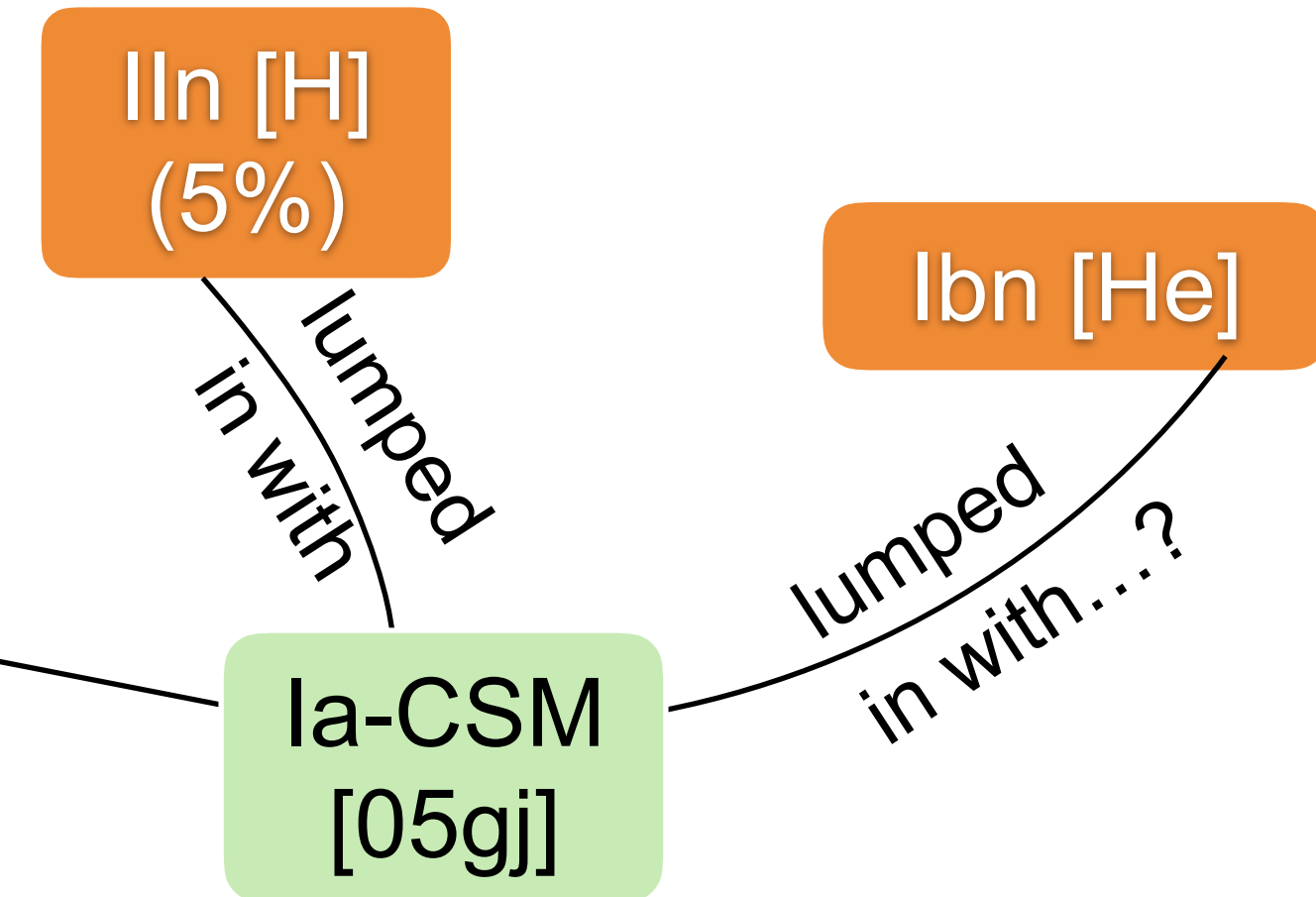
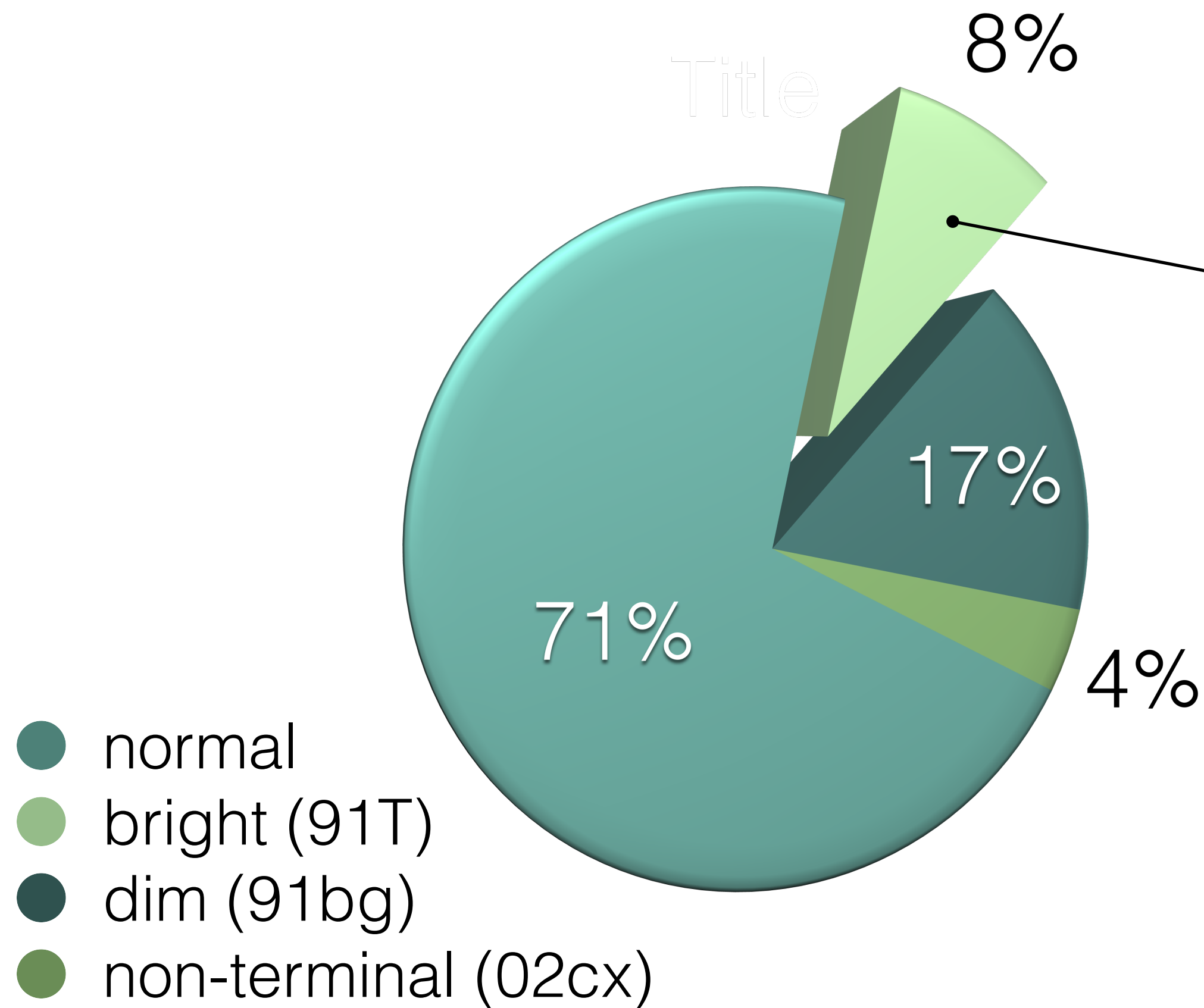
% is rate in a volume-limited sample (Li et al., 2011)

91T-like SNe Ia can have H-rich CSM

Leloudas+ (2015); Dilday+ (2012); Graham+ (2018; inc. CEH)

SNe Ia (24% of all SNe)

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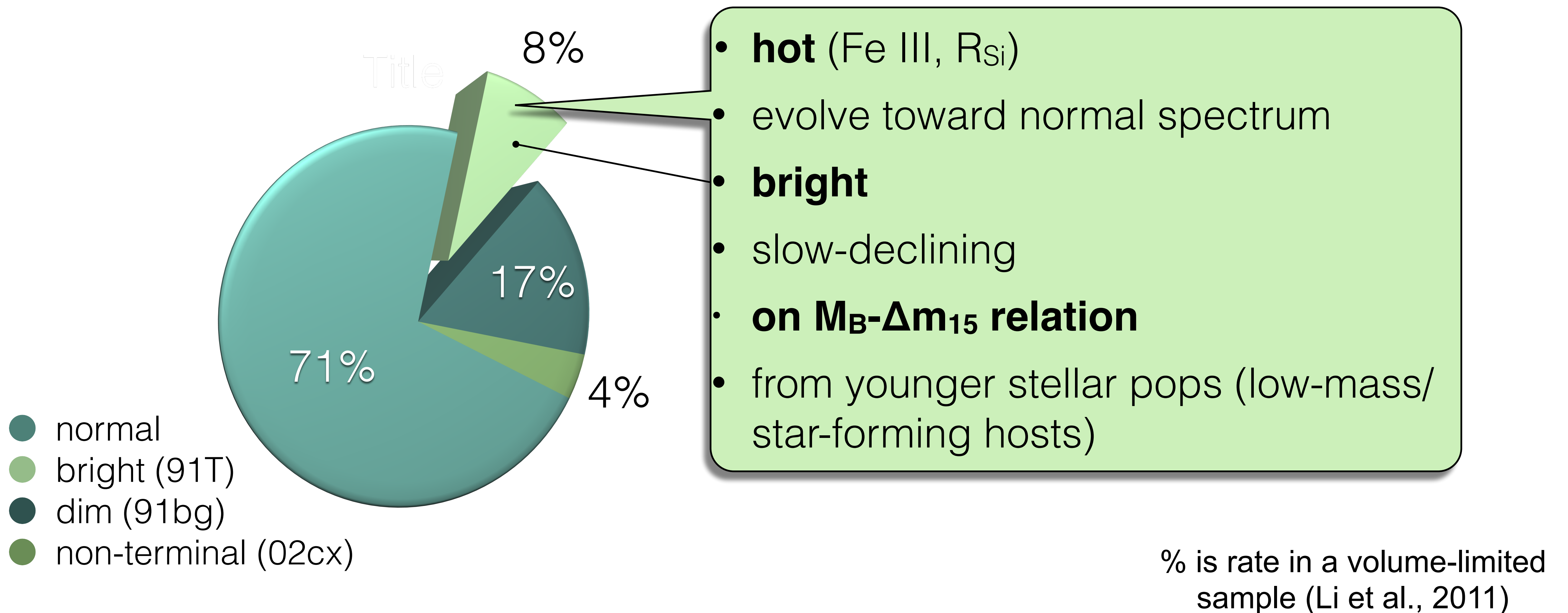
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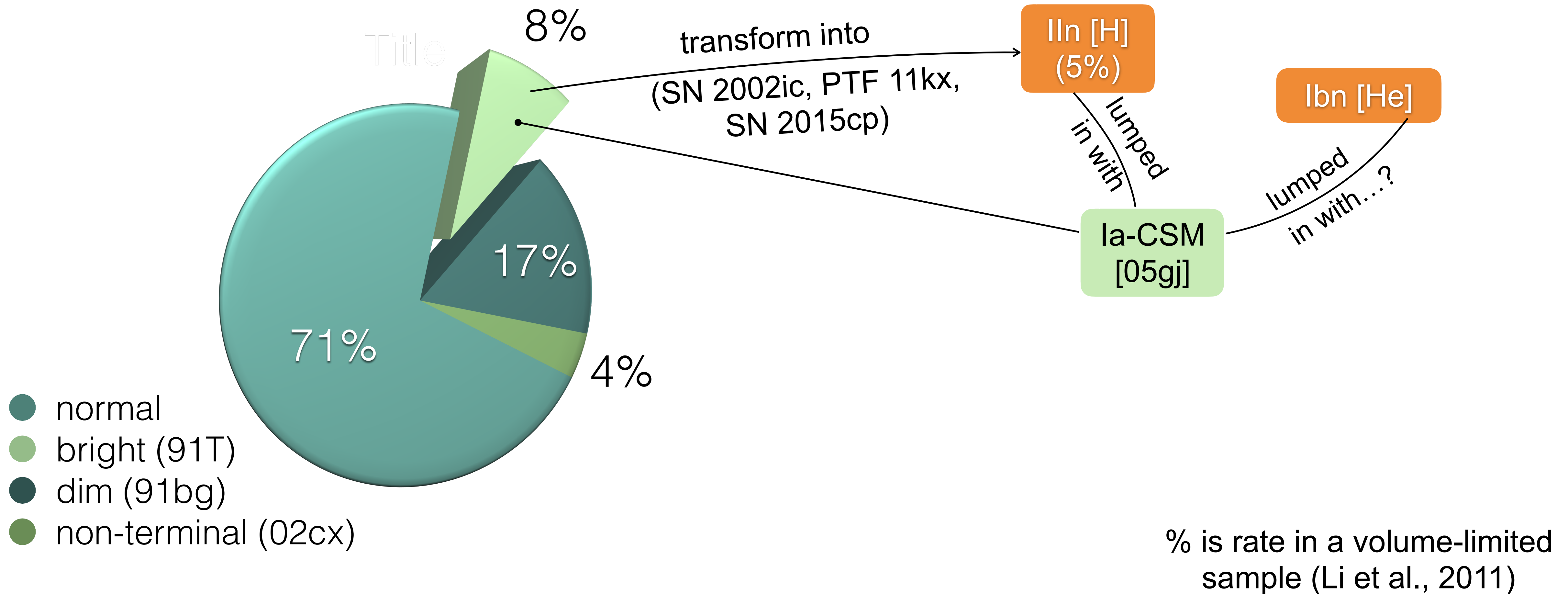


delayed interaction unveils the SN

Leloudas+ (2015); Dilday+ (2012); Graham+ (2018; inc. CEH)

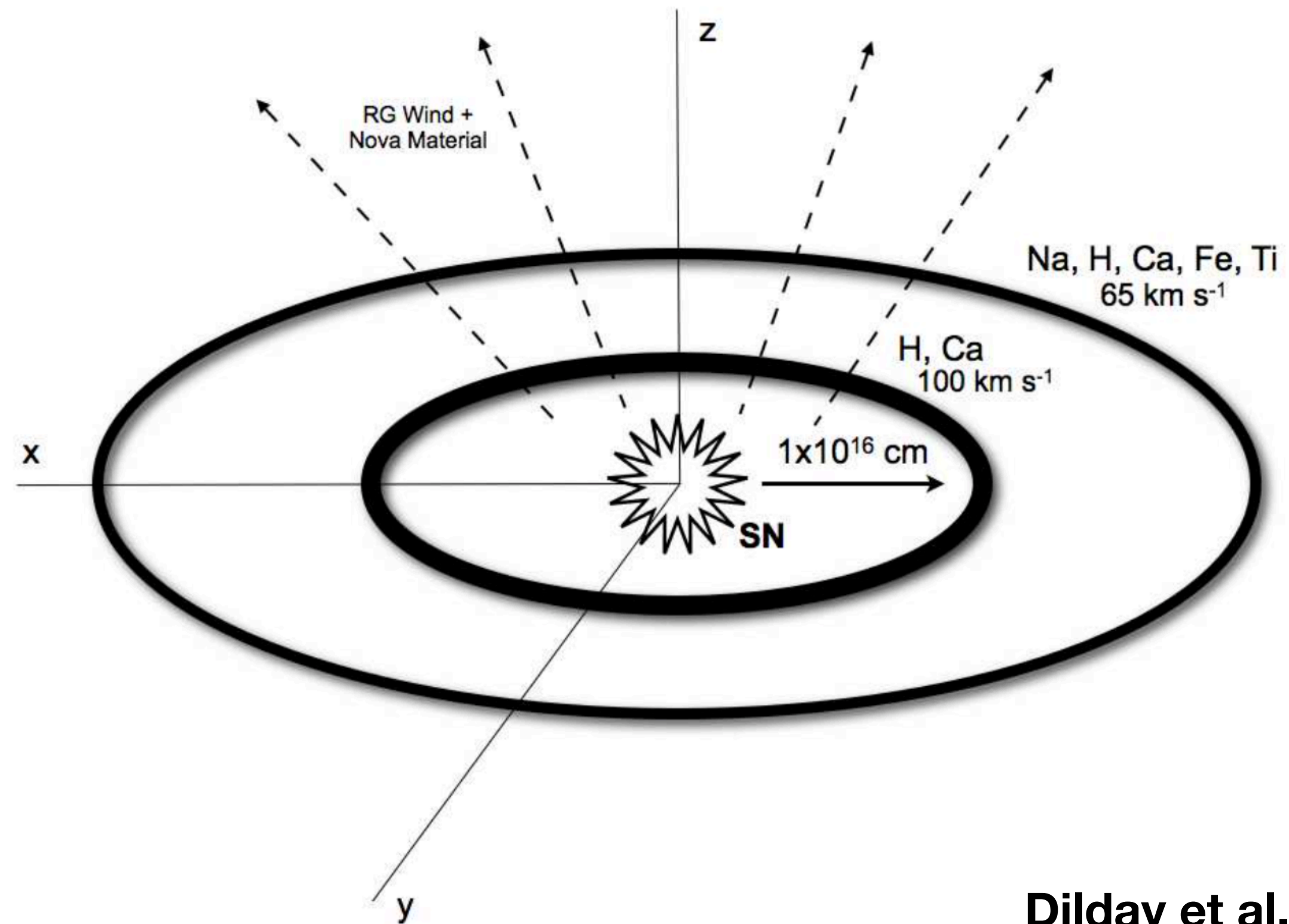
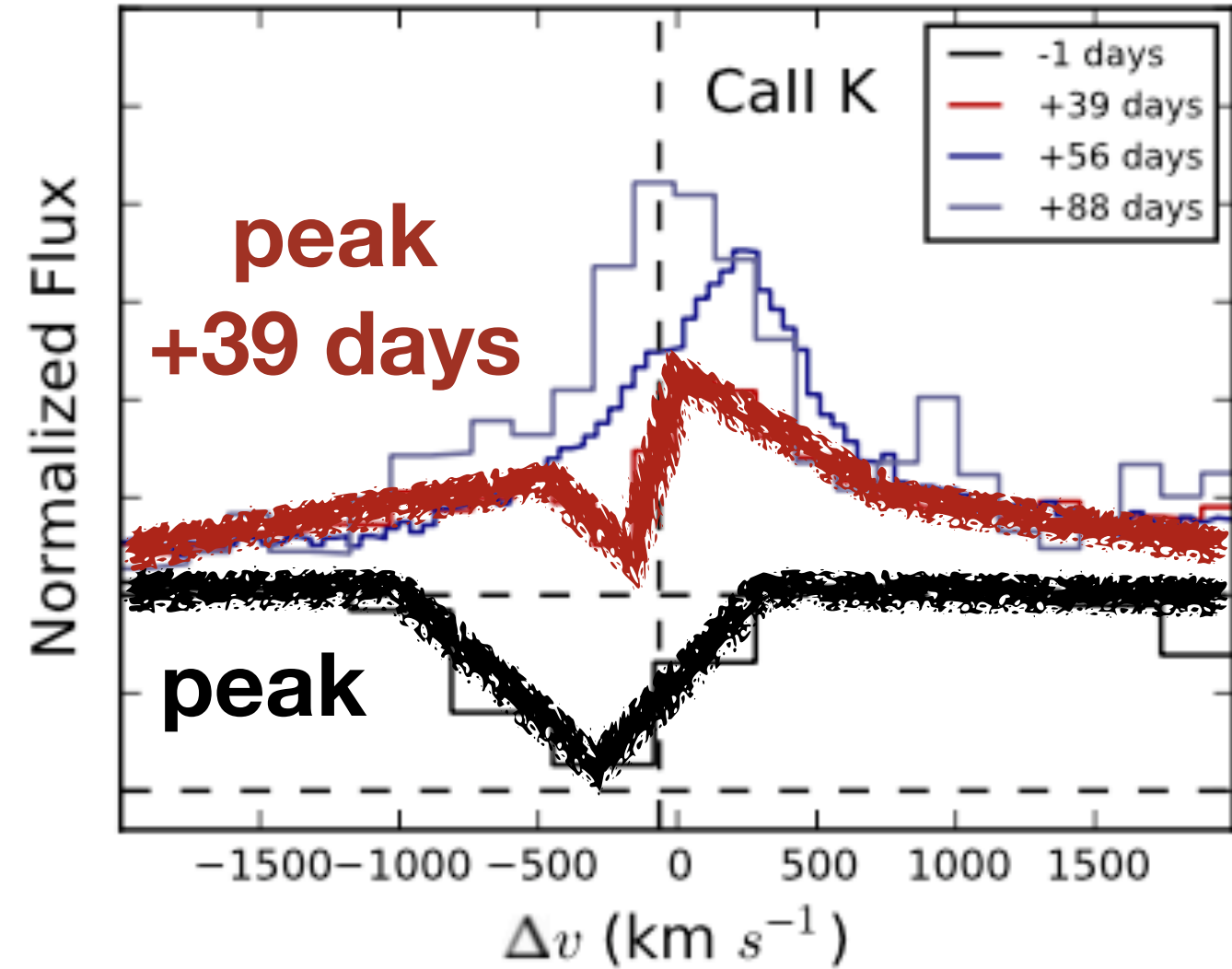
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PTF11kx:

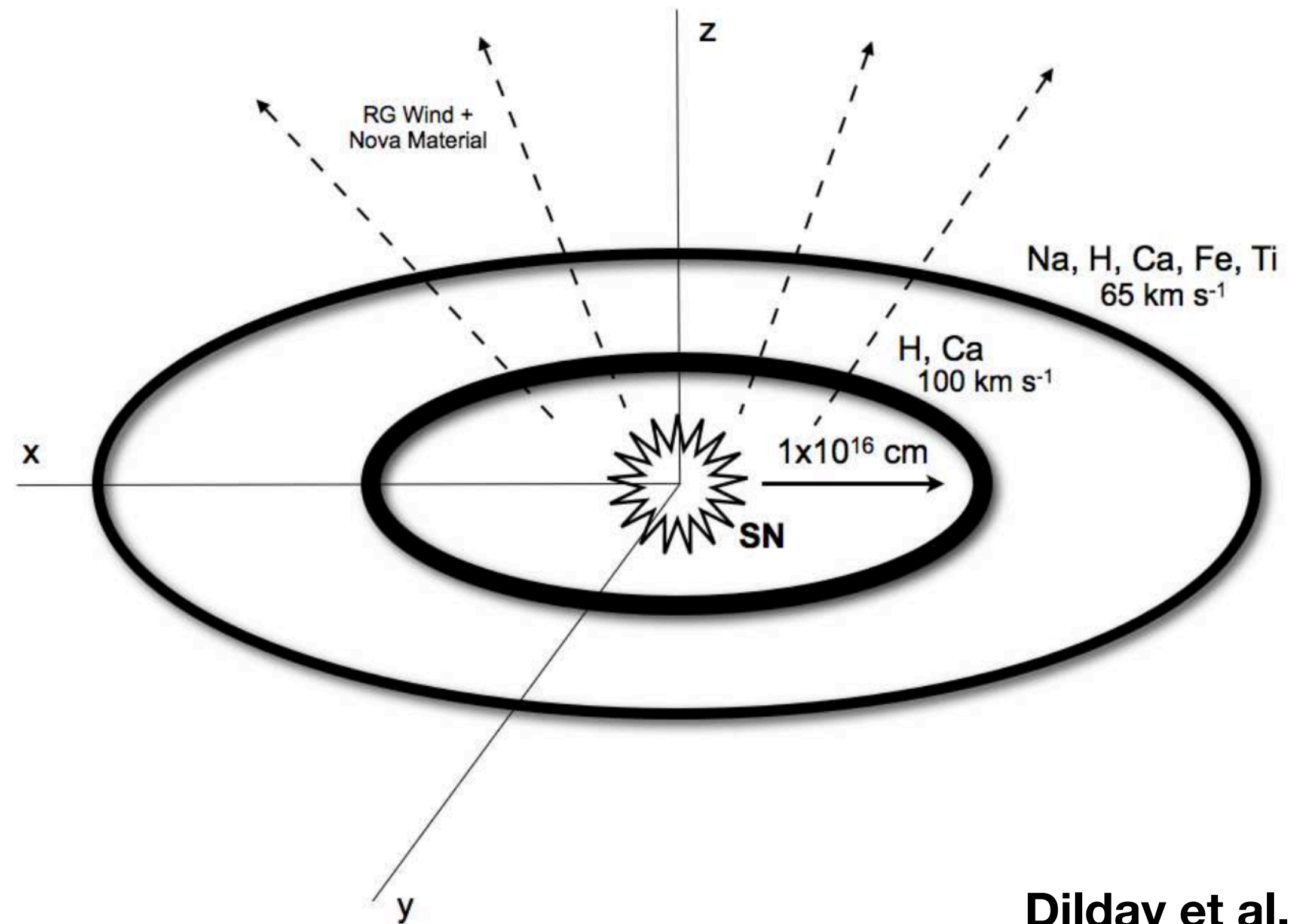
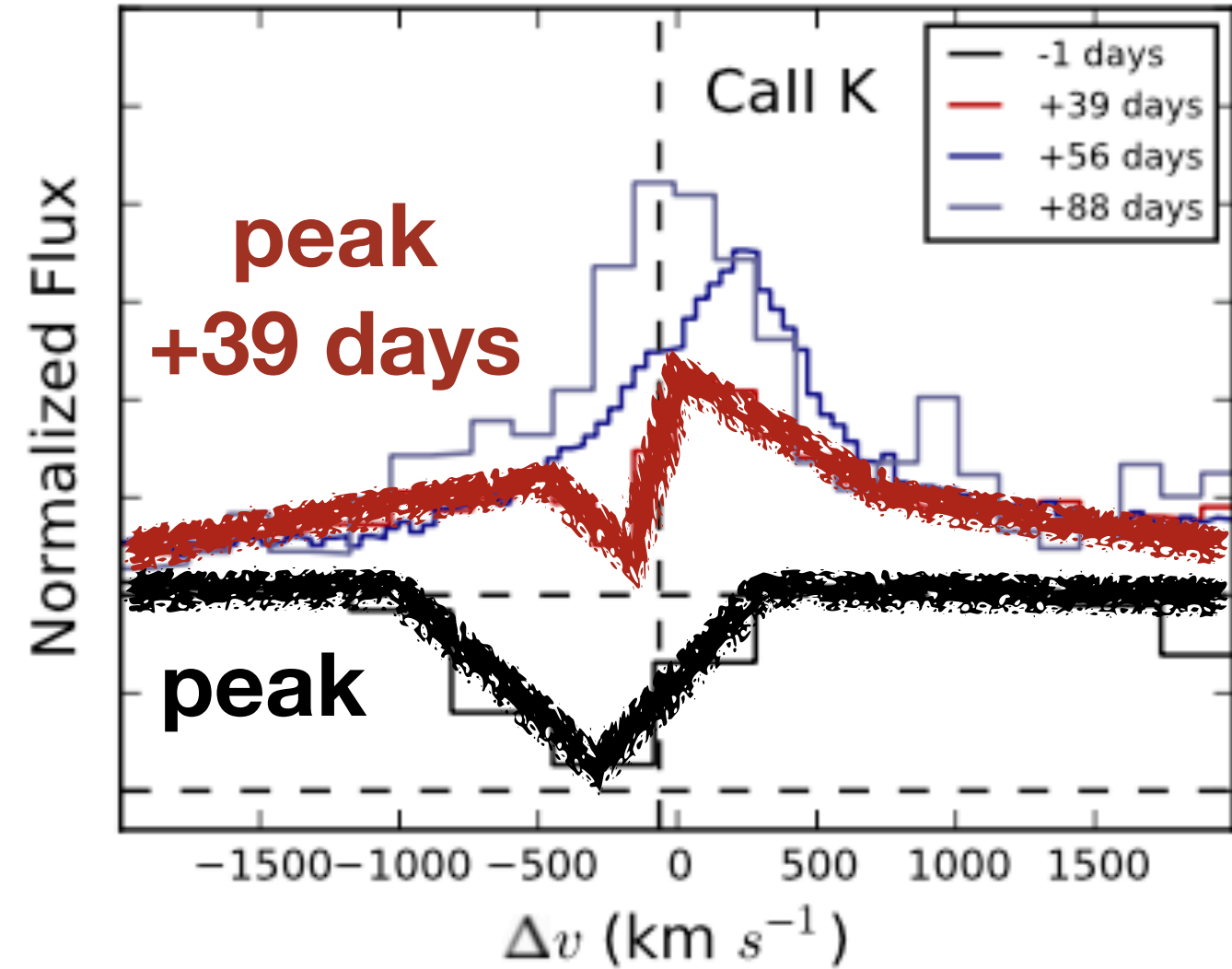
interaction can start well after peak brightness



Dilday et al. (2012)

PTF11kx:

interaction can start well after peak brightness



Dilday et al. (2012)

→ have we been missing it by not following 91T-like long enough?

HST NUV snapshot program

PI M. Graham

- 1-3 years old as of Oct 1 2016
- distance ≤ 300 Mpc



HST NUV snapshot program

PI M. Graham



- 1-3 years old as of Oct 1 2016
- distance ≤ 300 Mpc
- prefer targets
 - bright, Na D, high velocity, “91T” spectrum
 - good early-time data coverage

HST NUV snapshot program

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- control: SNe IIn and Ia-CSM, < 100 Mpc
normal SNe Ia

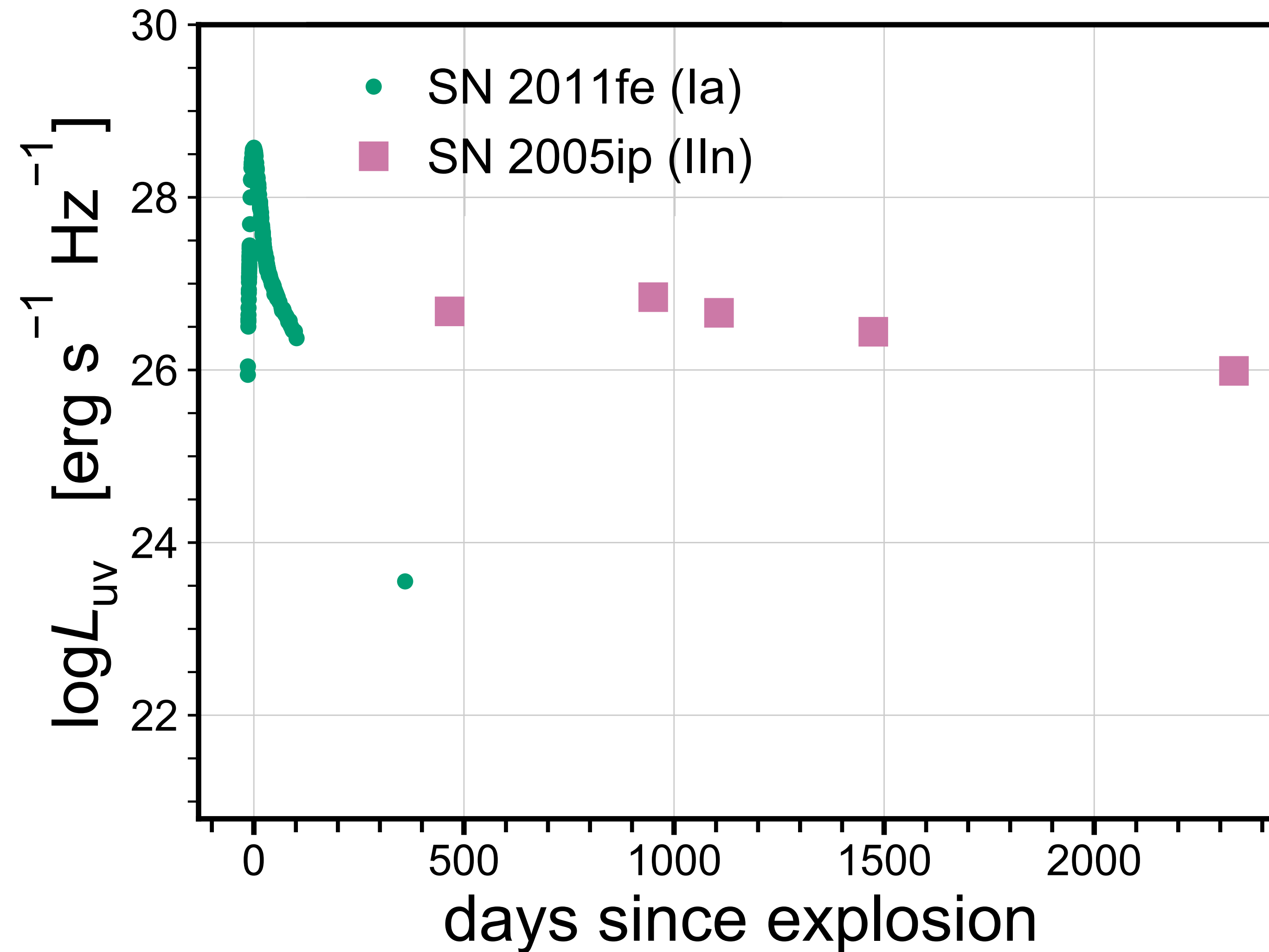
HST NUV snapshot program

PI M. Graham

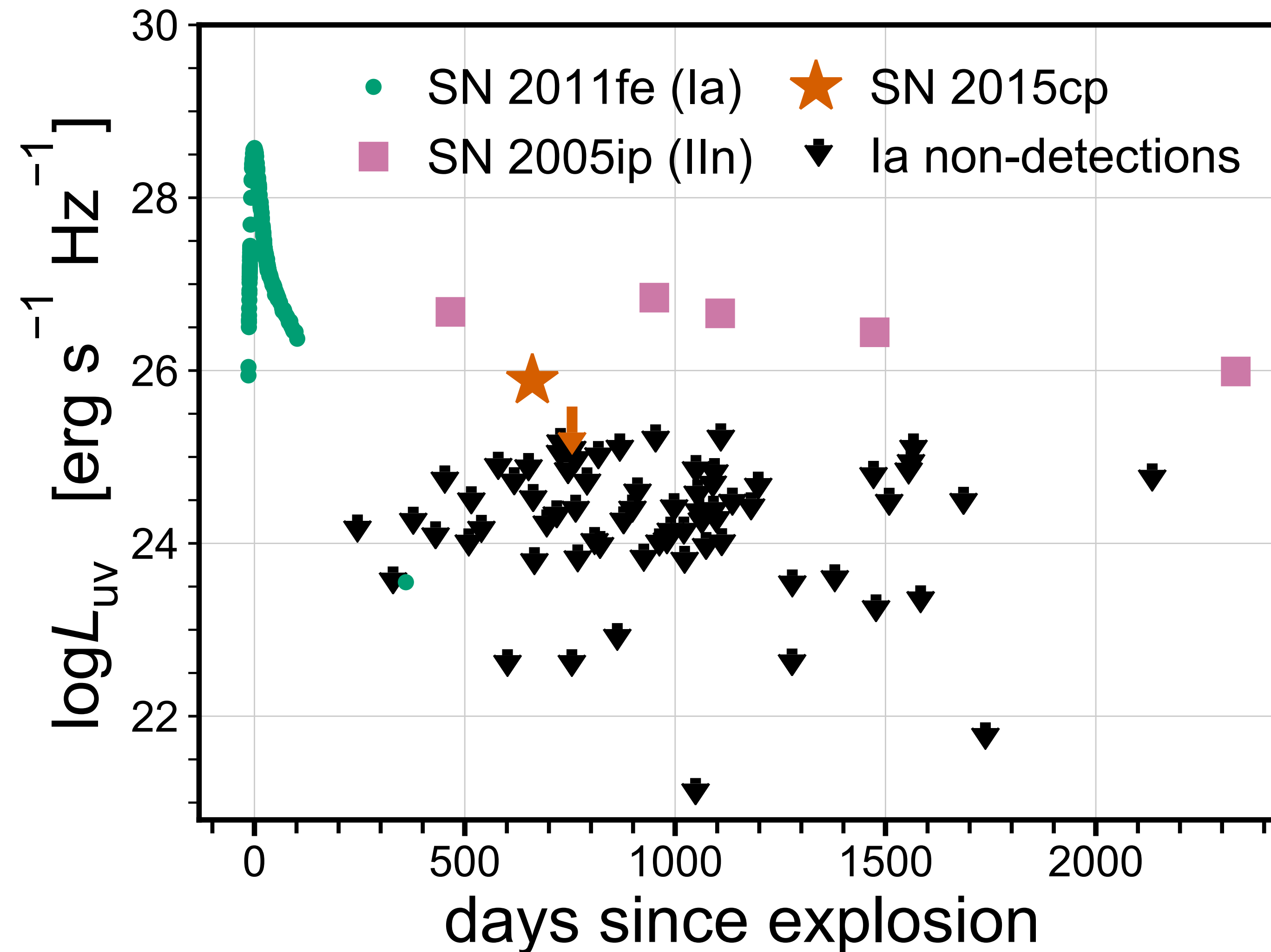


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- control: SNe IIn and Ia-CSM, < 100 Mpc
normal SNe Ia
- **result: 80 targets, of which 71 were observed!**

discovered interaction of SN 2015cp



discovered interaction of SN 2015cp

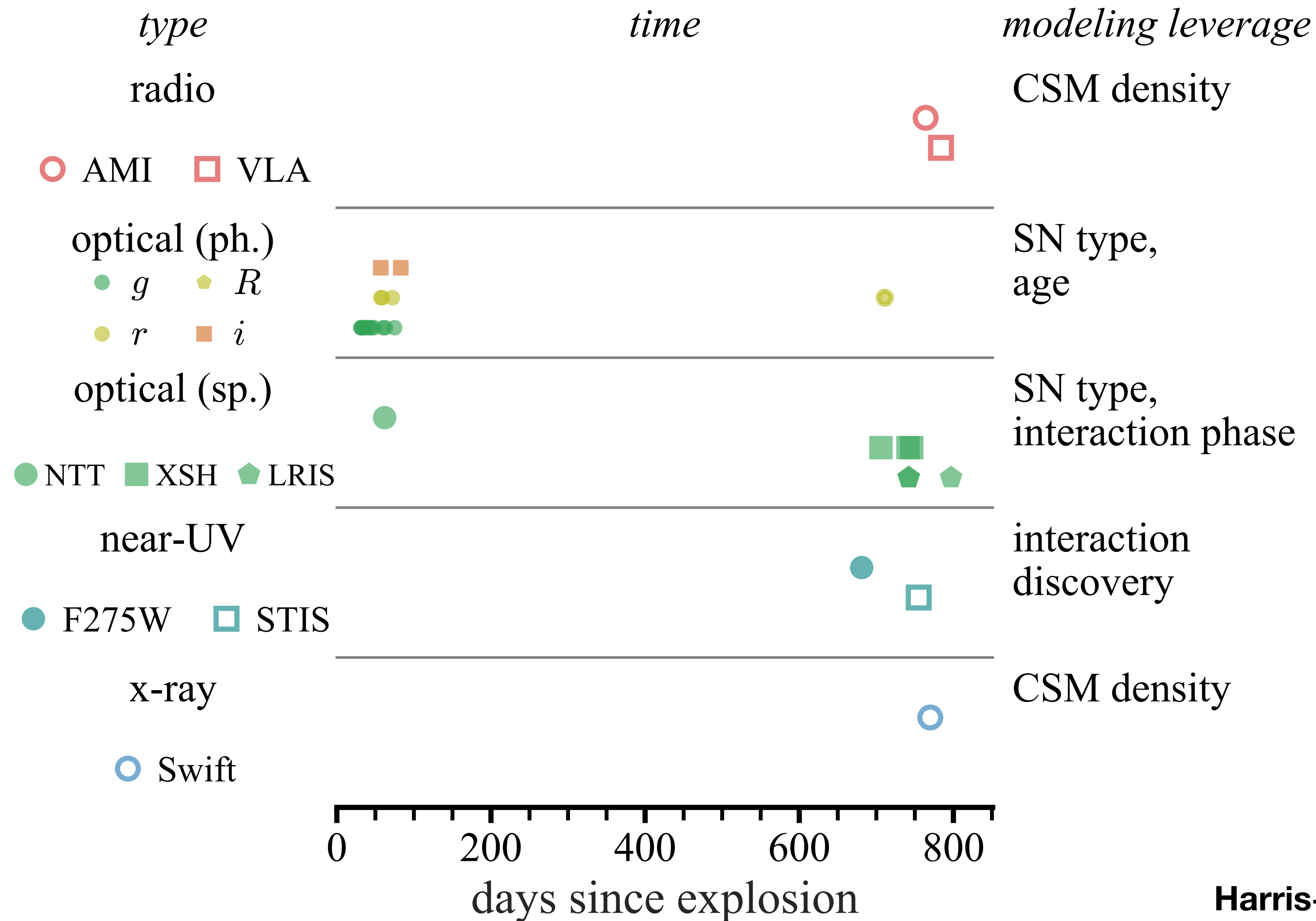


$d_L \sim 170$ Mpc

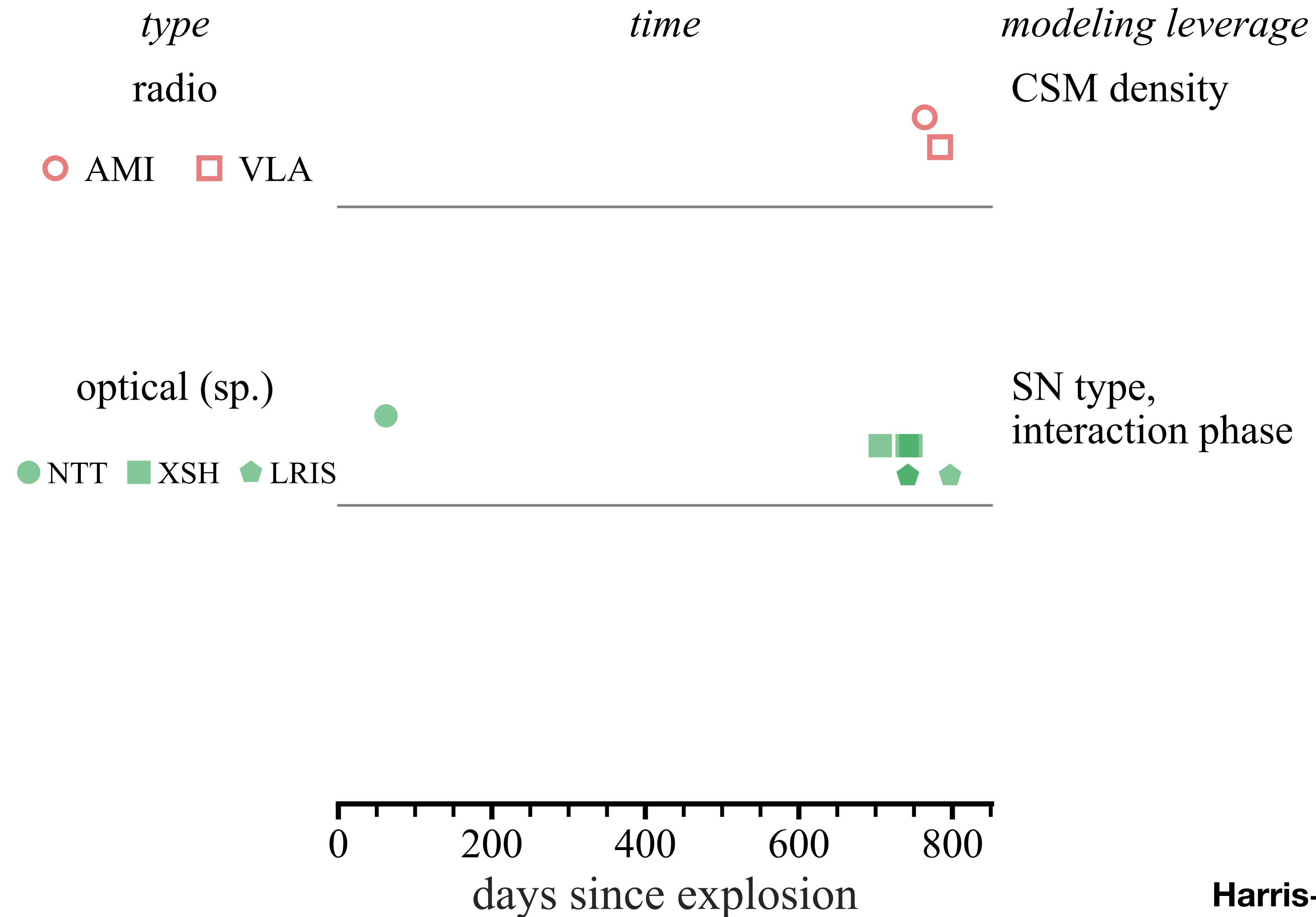
91T-like

**detection rate consistent
with ~ 10 - 25% occurrence**

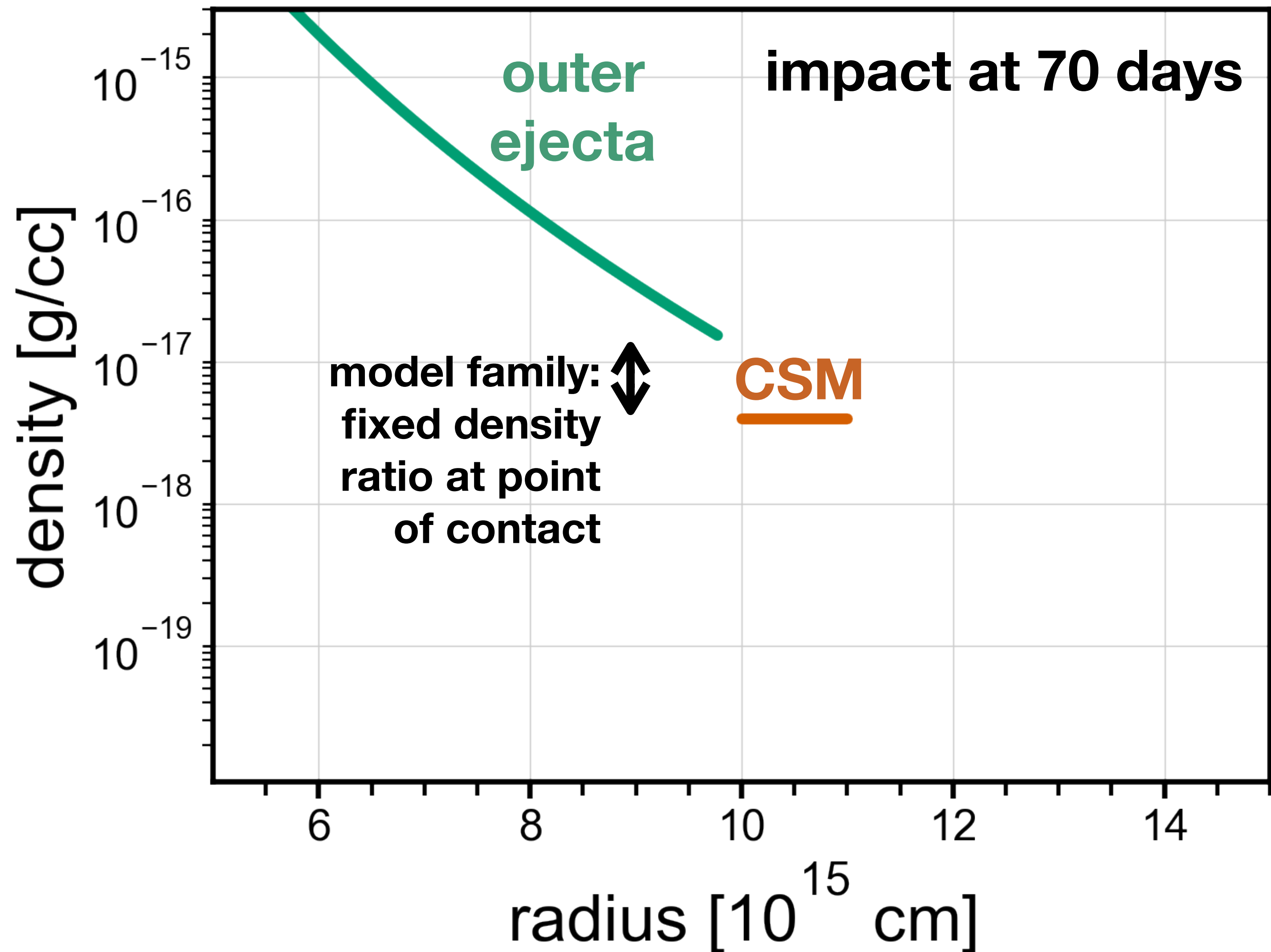
pursued panchromatic follow-up



pursued panchromatic follow-up



interaction of an SN Ia with detached shell



models in this family are specified by

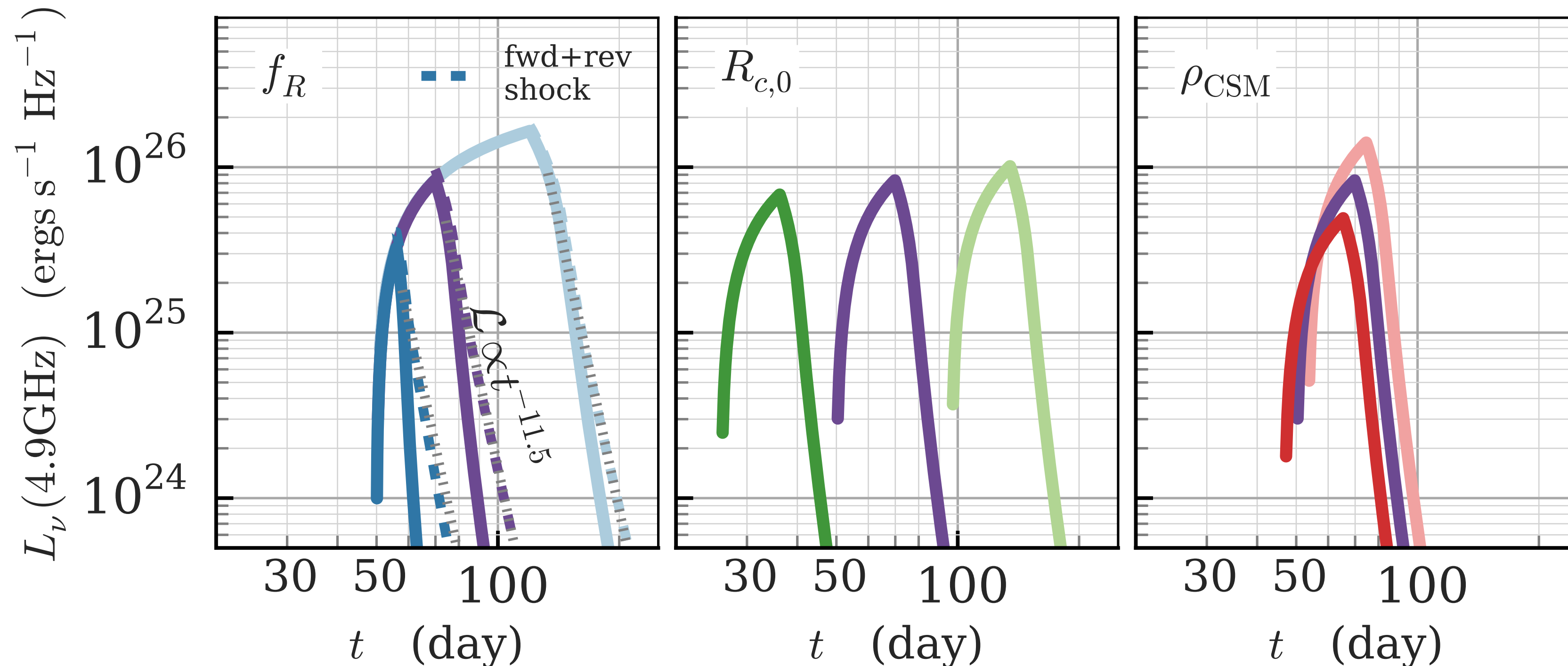
1. shell thickness
2. shell inner radius
3. shell density

radio light curves determined by 3 parameters

thickness

distance

density



optically thin synchrotron light curves with $\epsilon_B = \epsilon_e = 0.1$, $n_e \propto \gamma^{-3}$

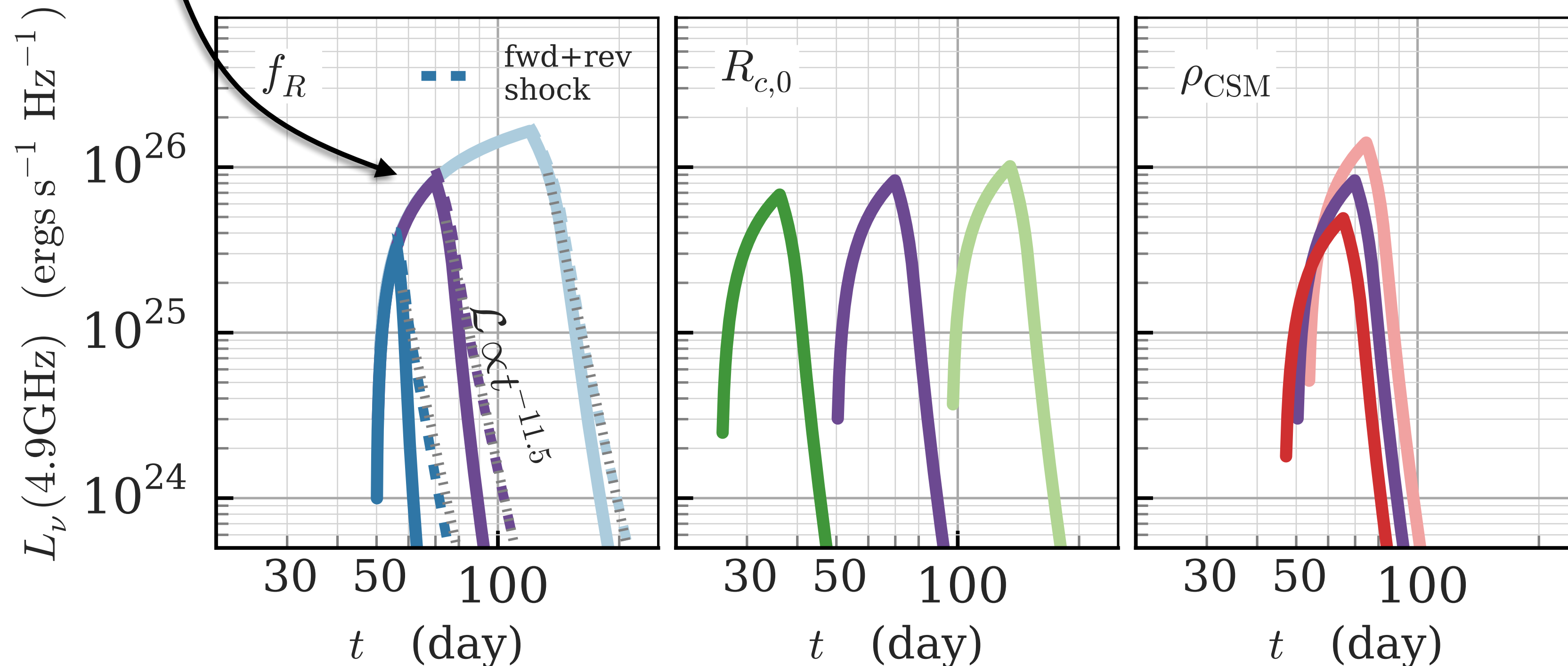
radio light curves determined by 3 parameters

peak = shock swept over CSM

thickness

distance

density



optically thin synchrotron light curves with $\epsilon_B = \epsilon_e = 0.1$, $n_e \propto \gamma^{-3}$

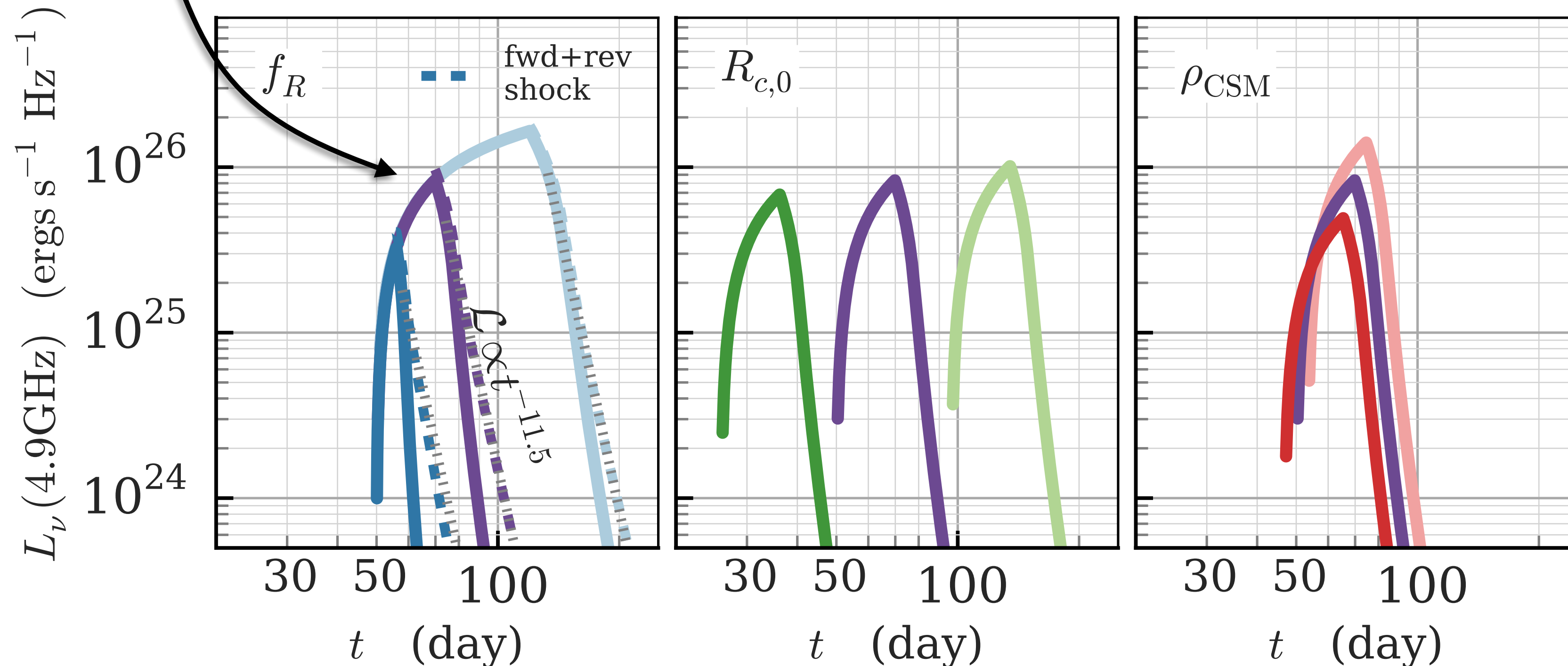
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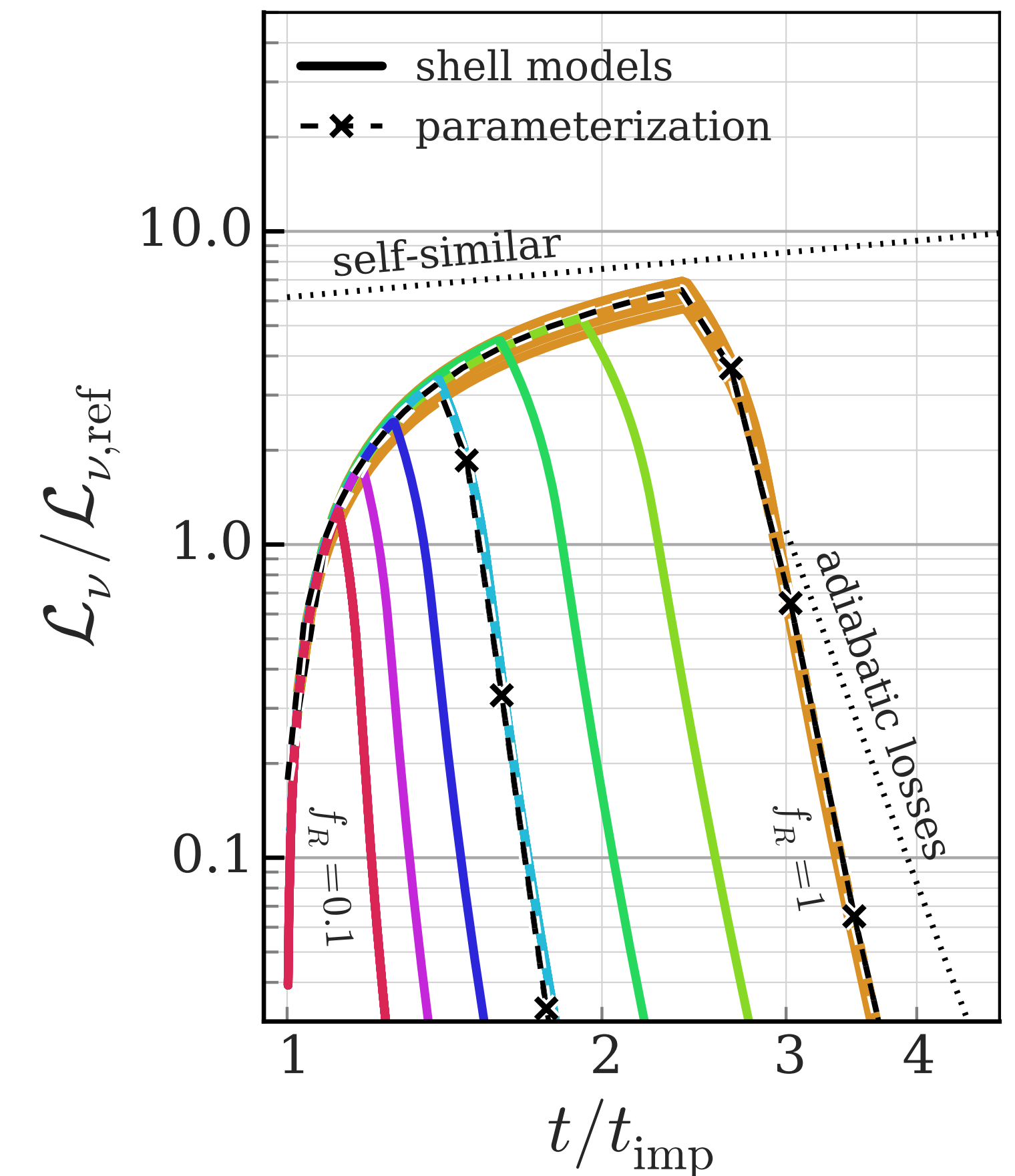
thickness

distance

density

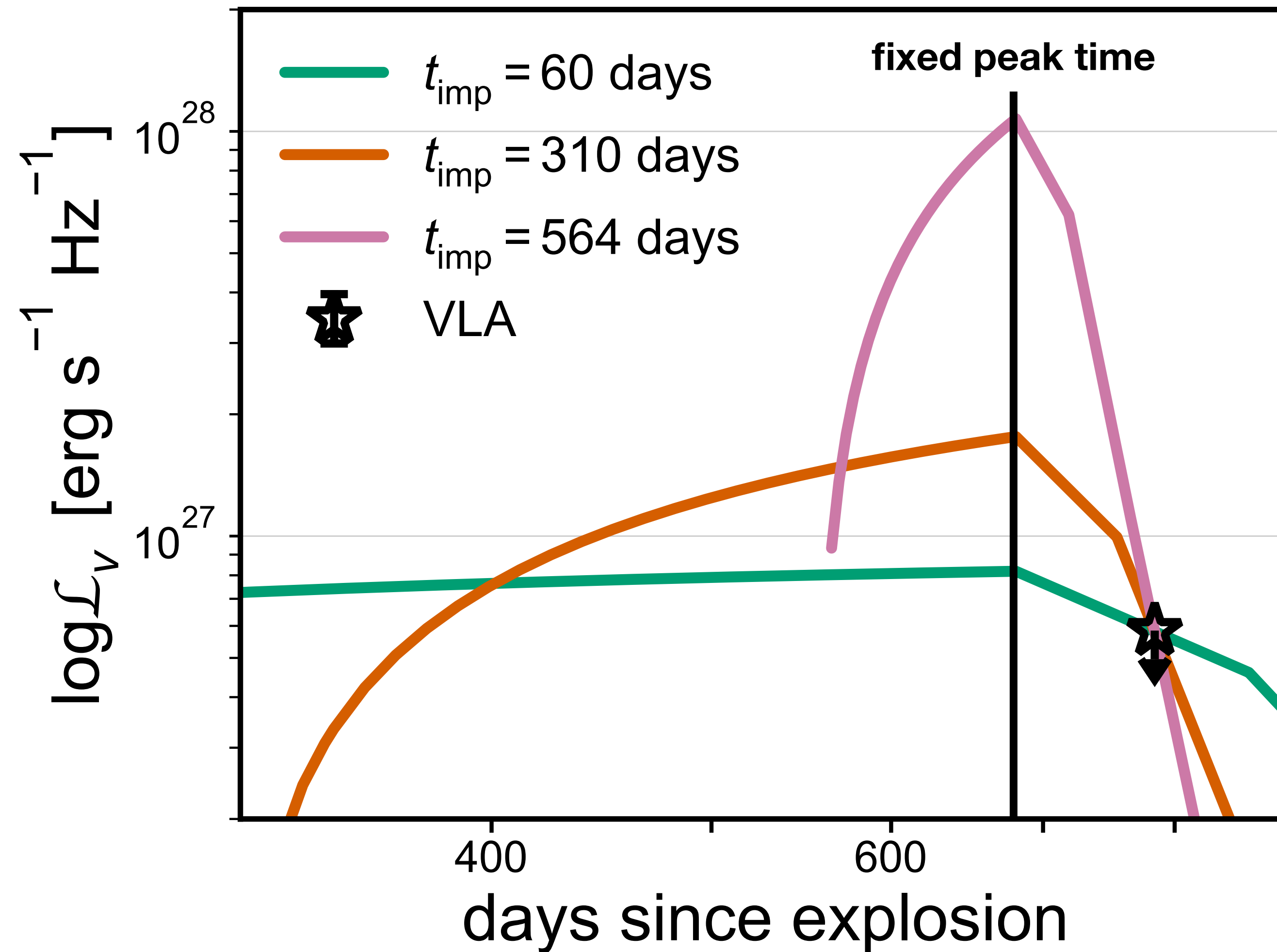
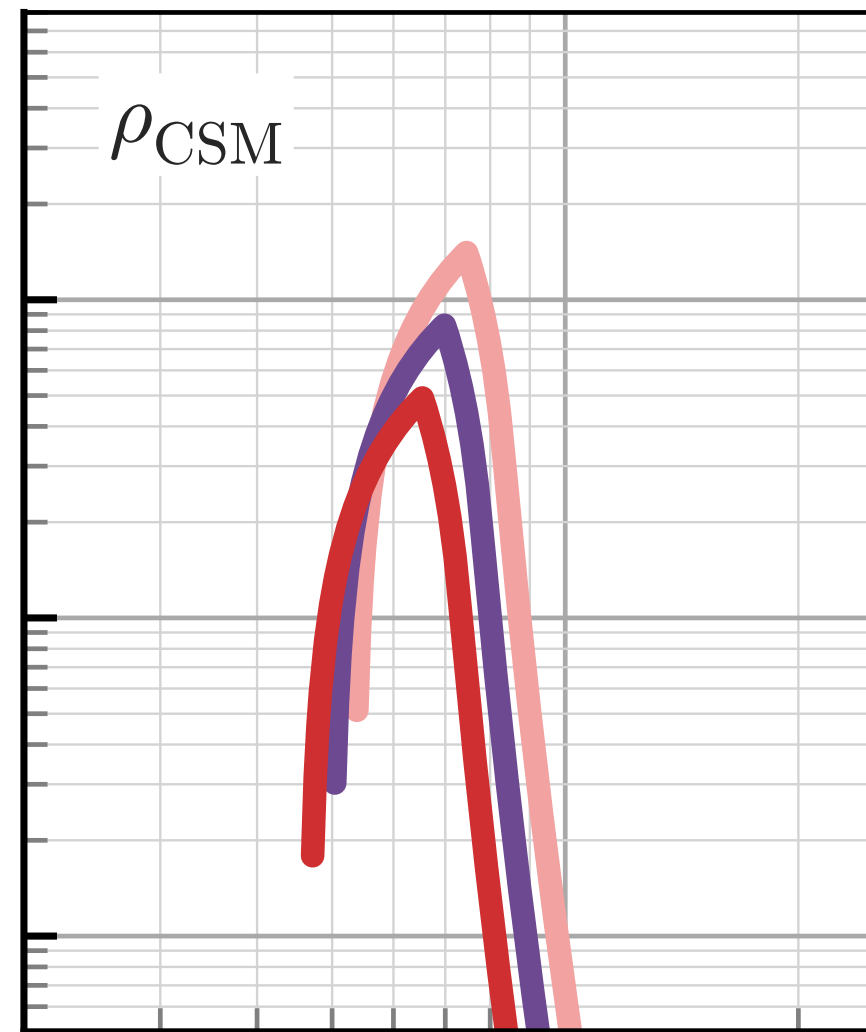


easy to reconstruct:



optically thin synchrotron light curves with $\epsilon_B = \epsilon_e = 0.1$, $n_e \propto \gamma^{-3}$

peak time + impact time + VLA limit \rightarrow density limit

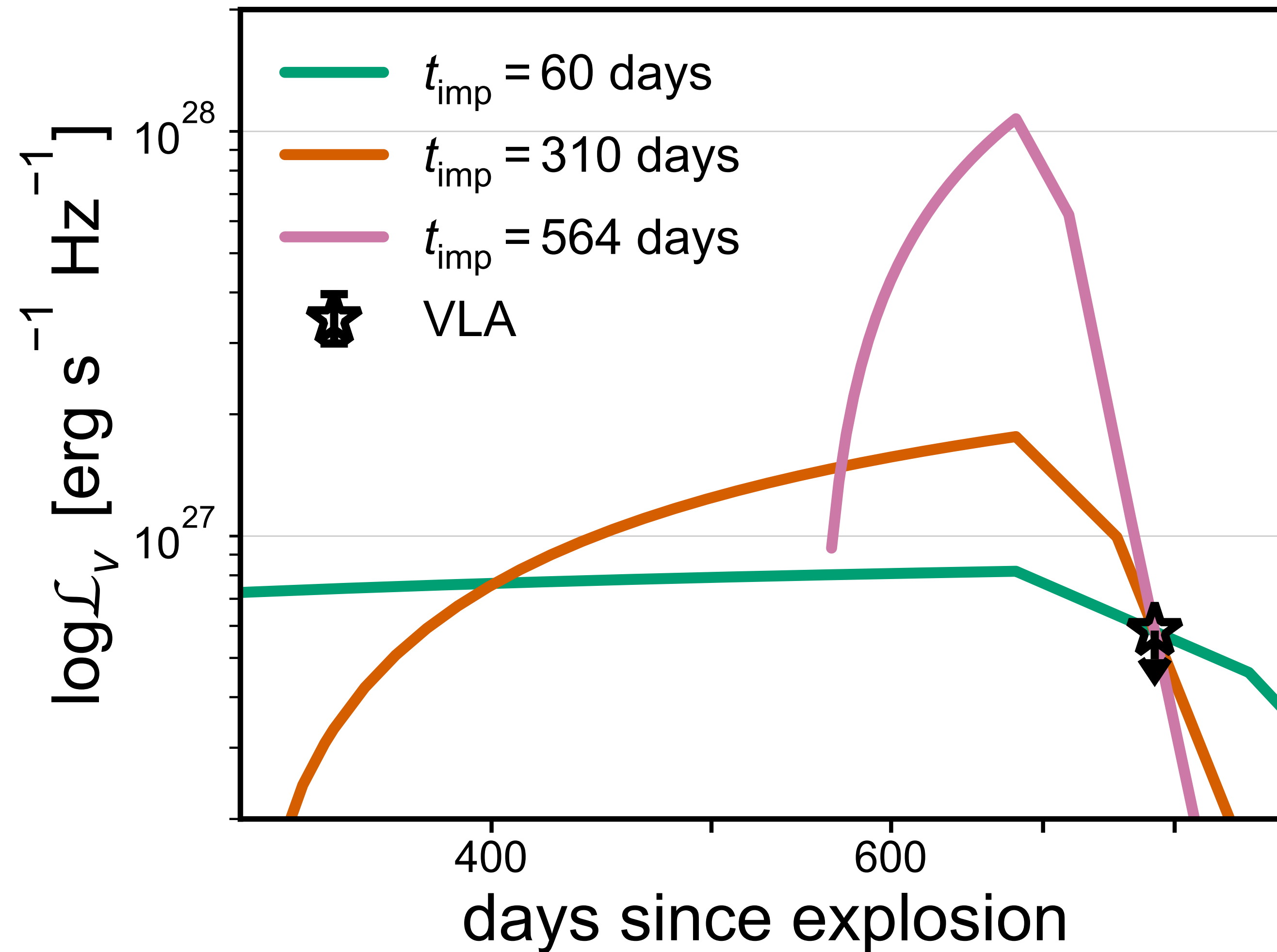


**times give CSM
physical extent,
so can convert
to mass limit**

peak time + impact time + VLA limit → density limit

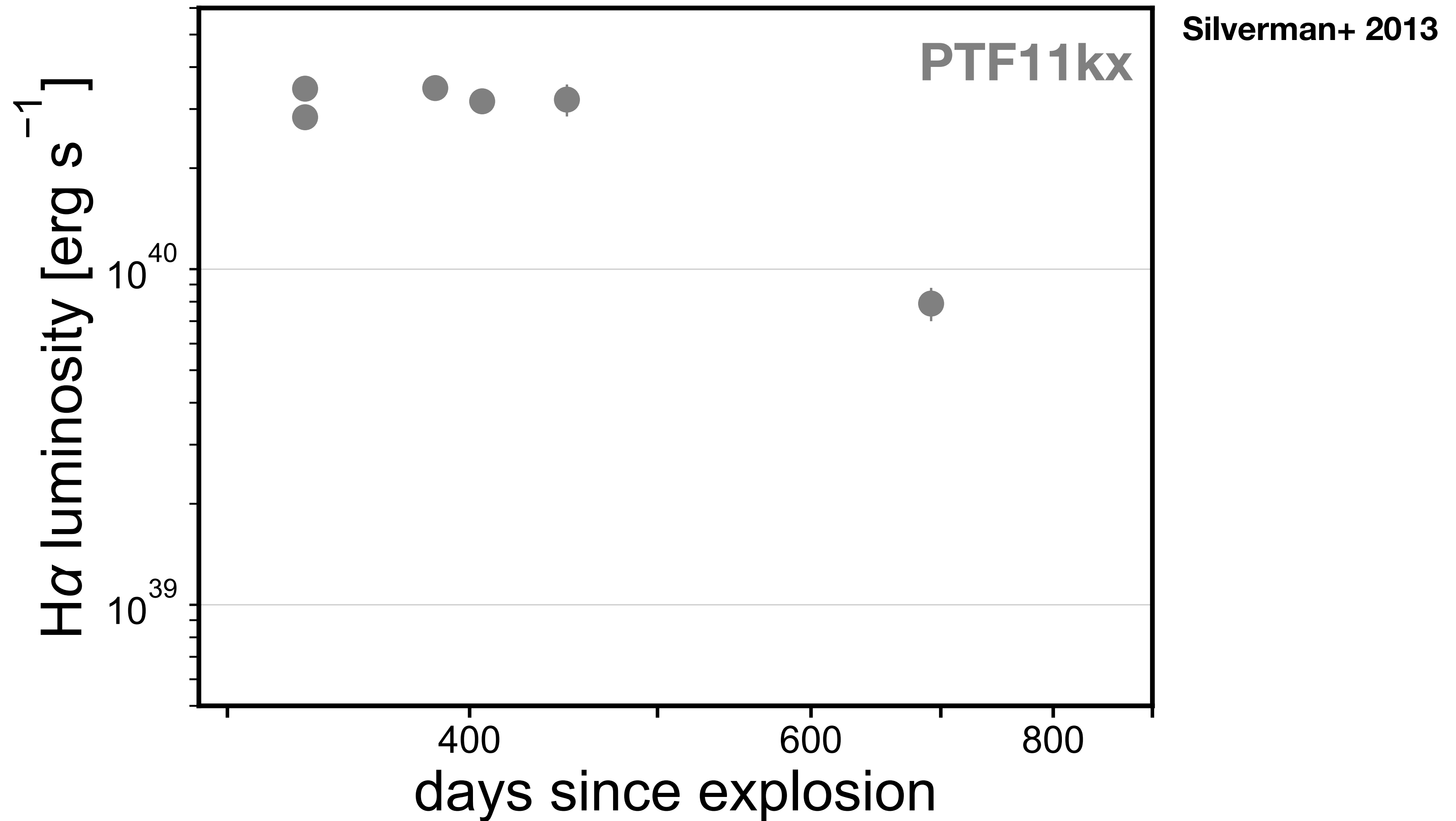
???

???

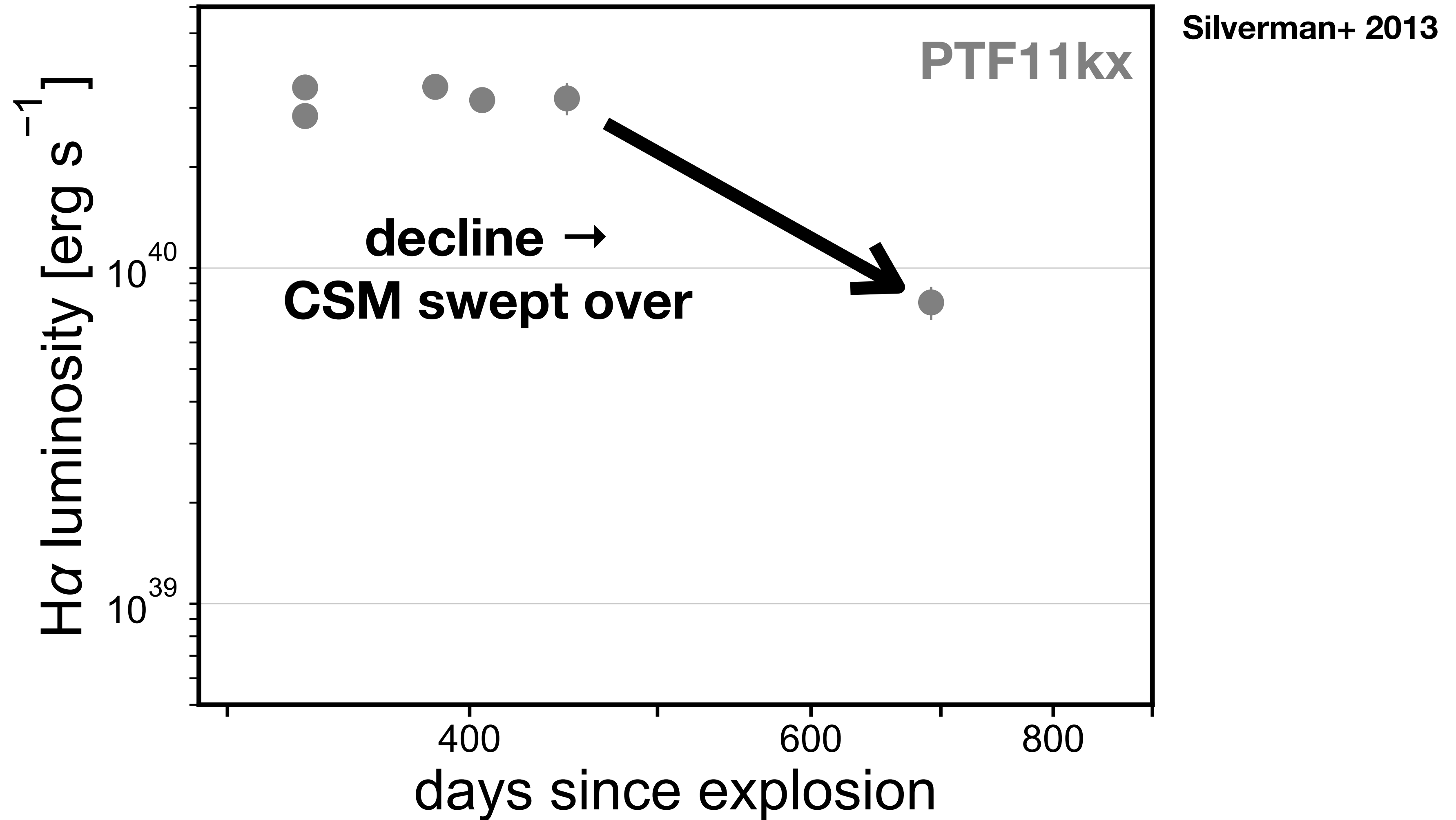


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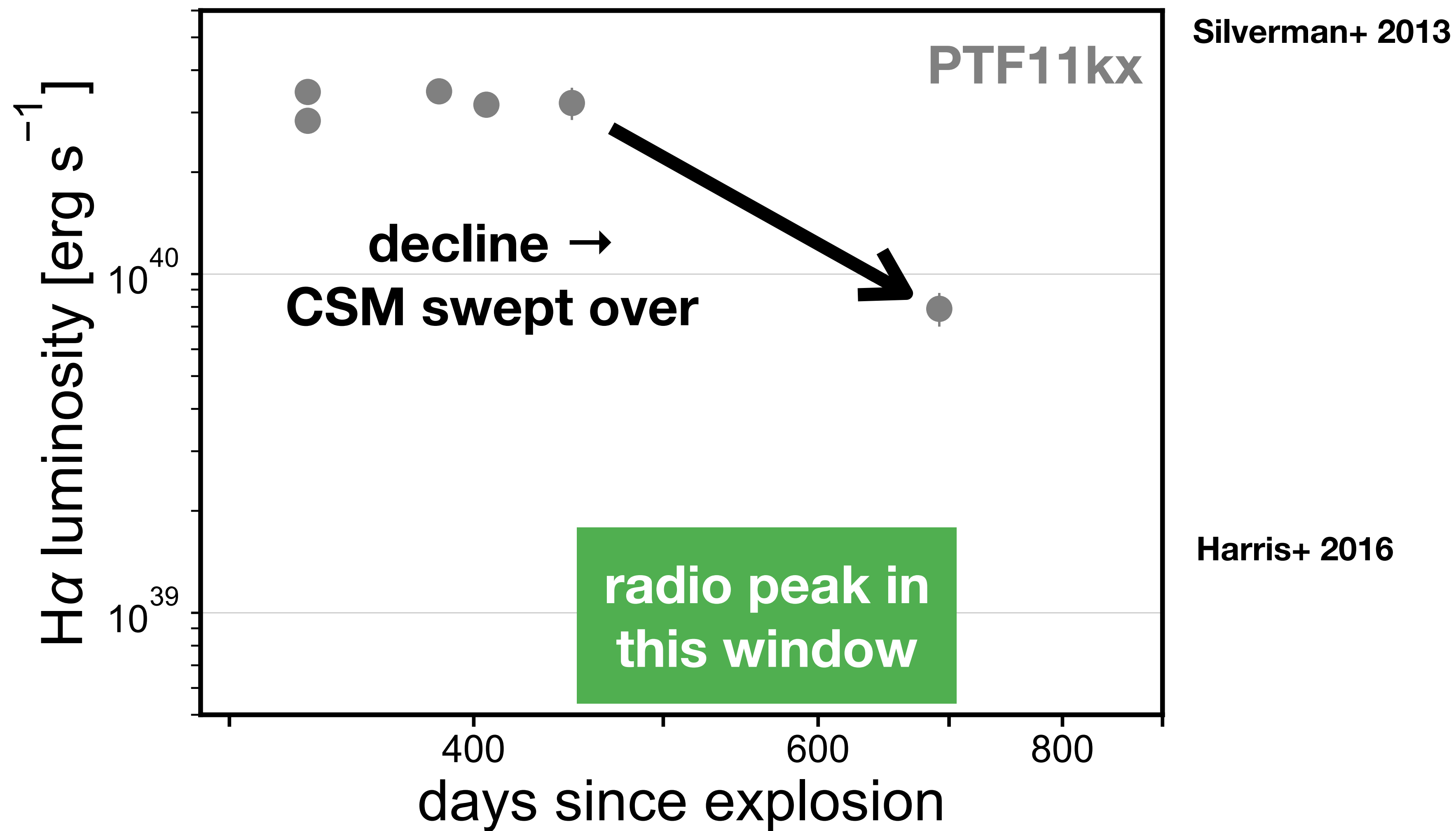
H α \rightarrow sweep-over time (radio peak)



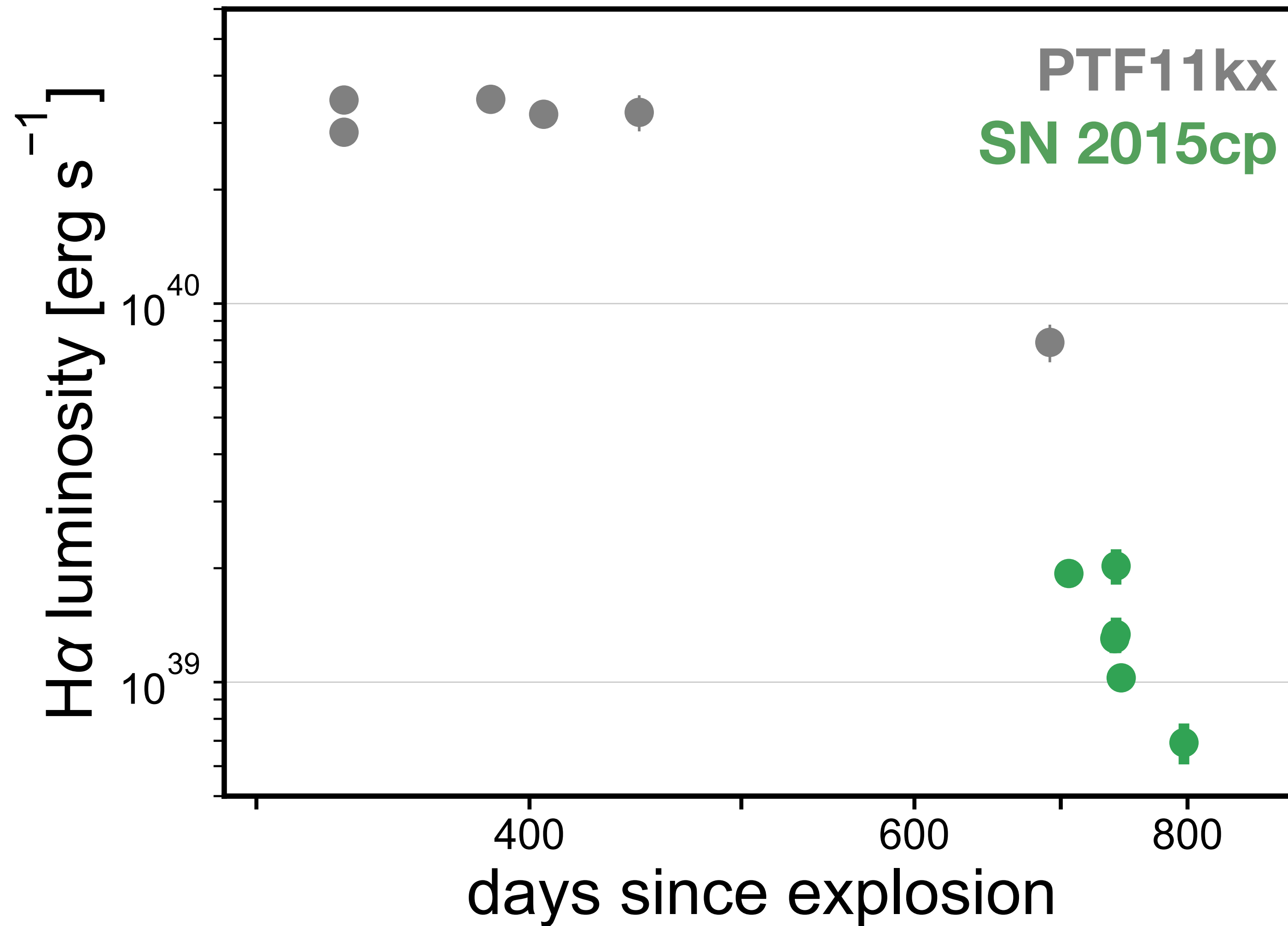
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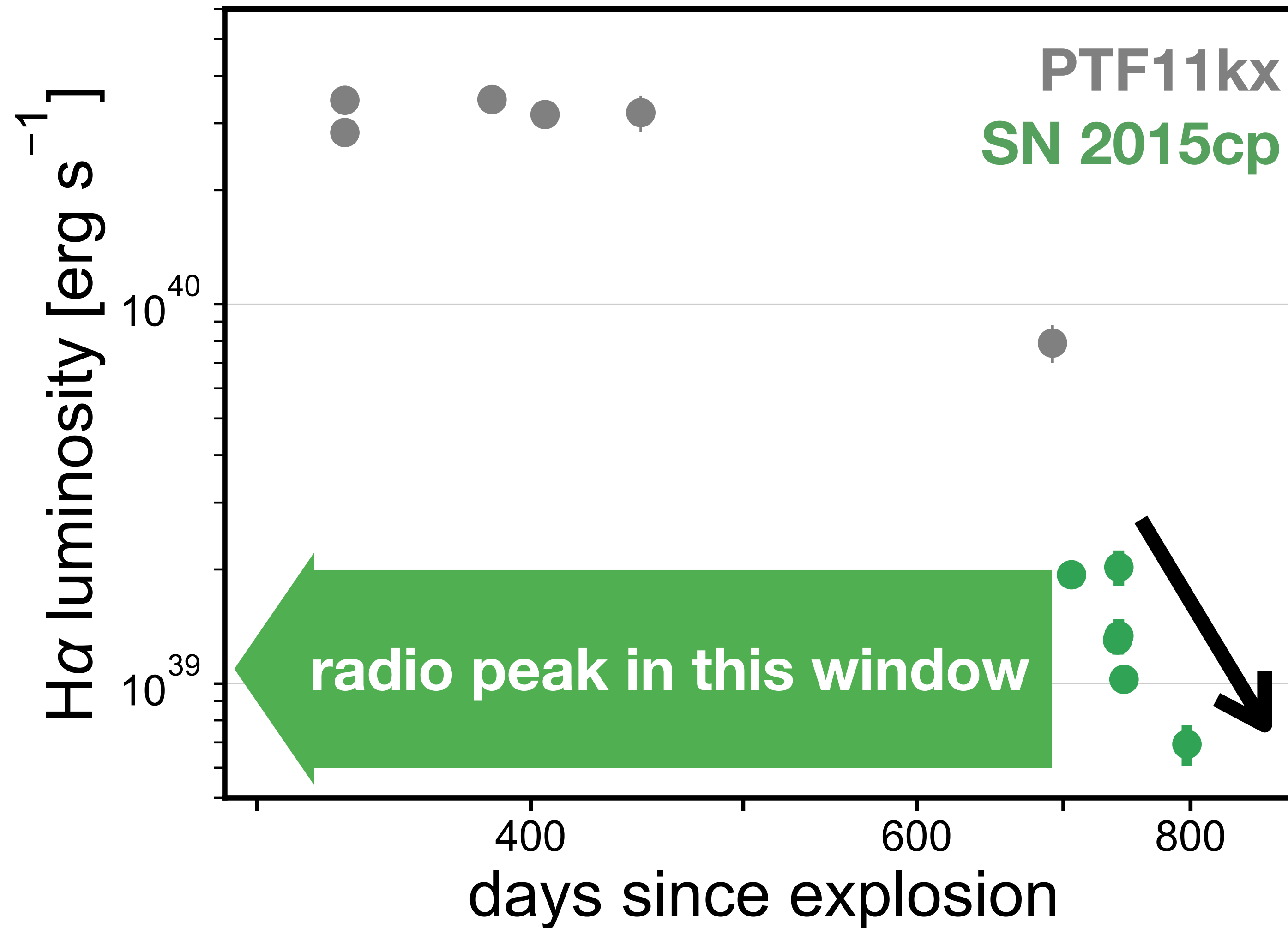
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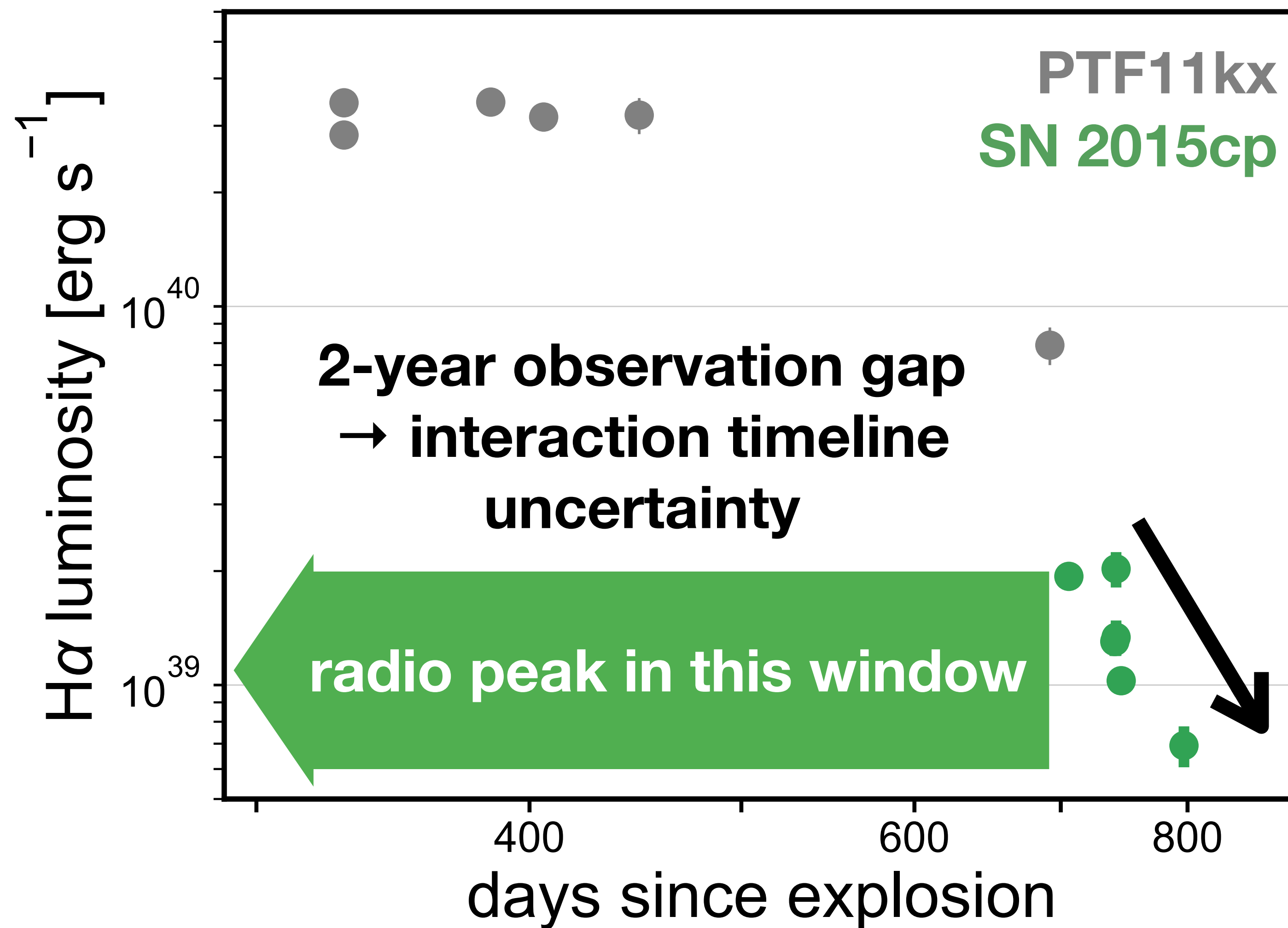
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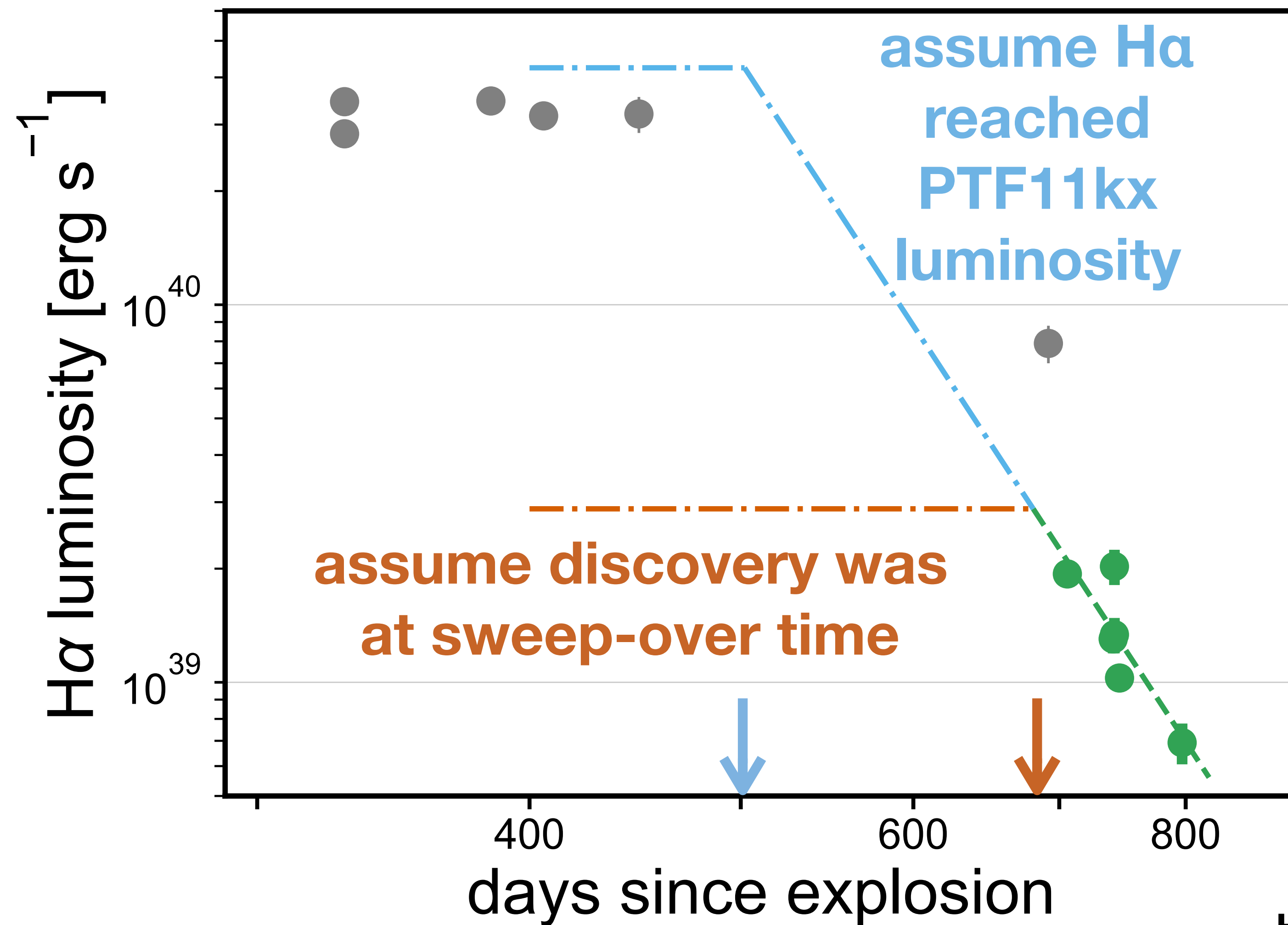
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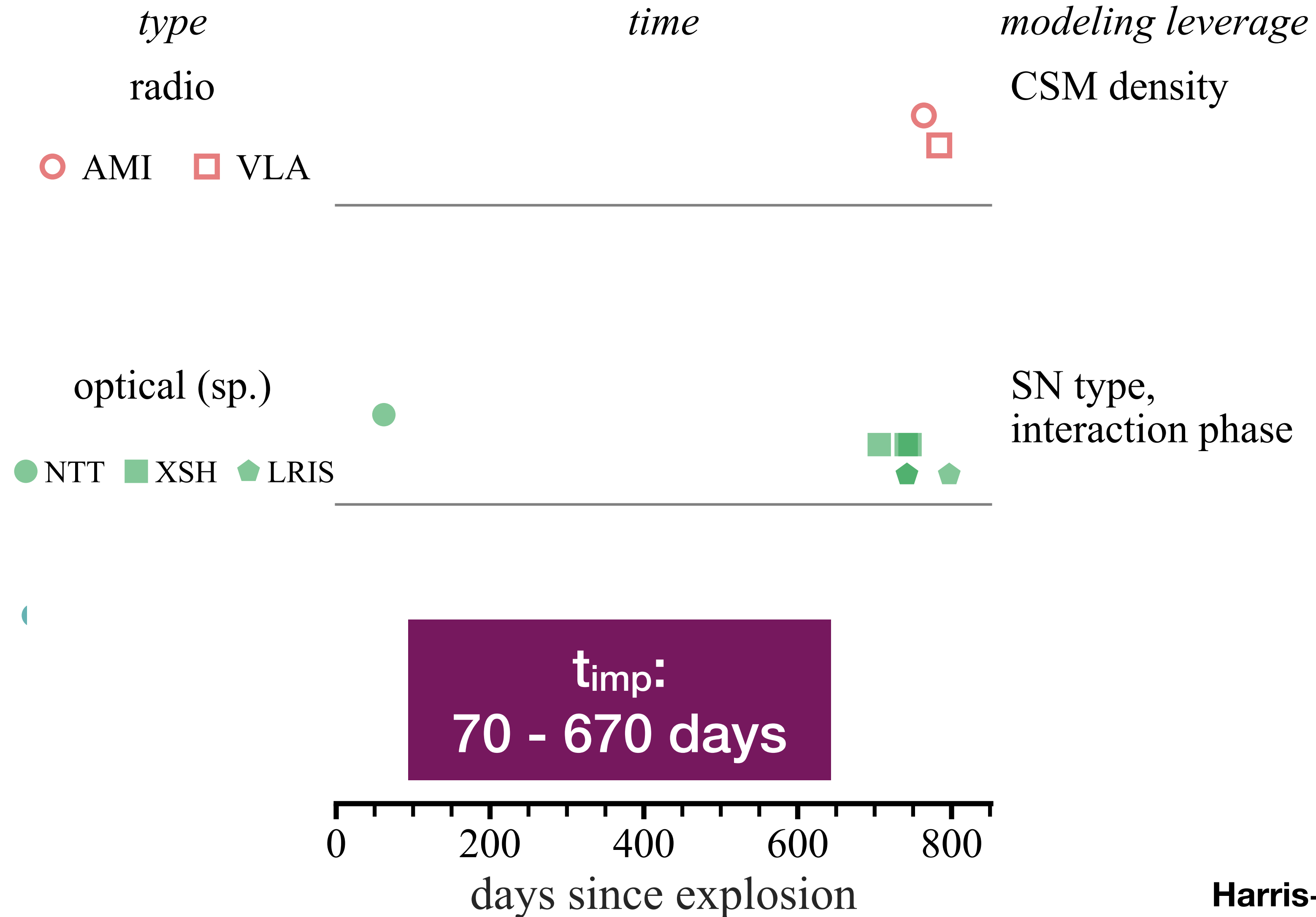
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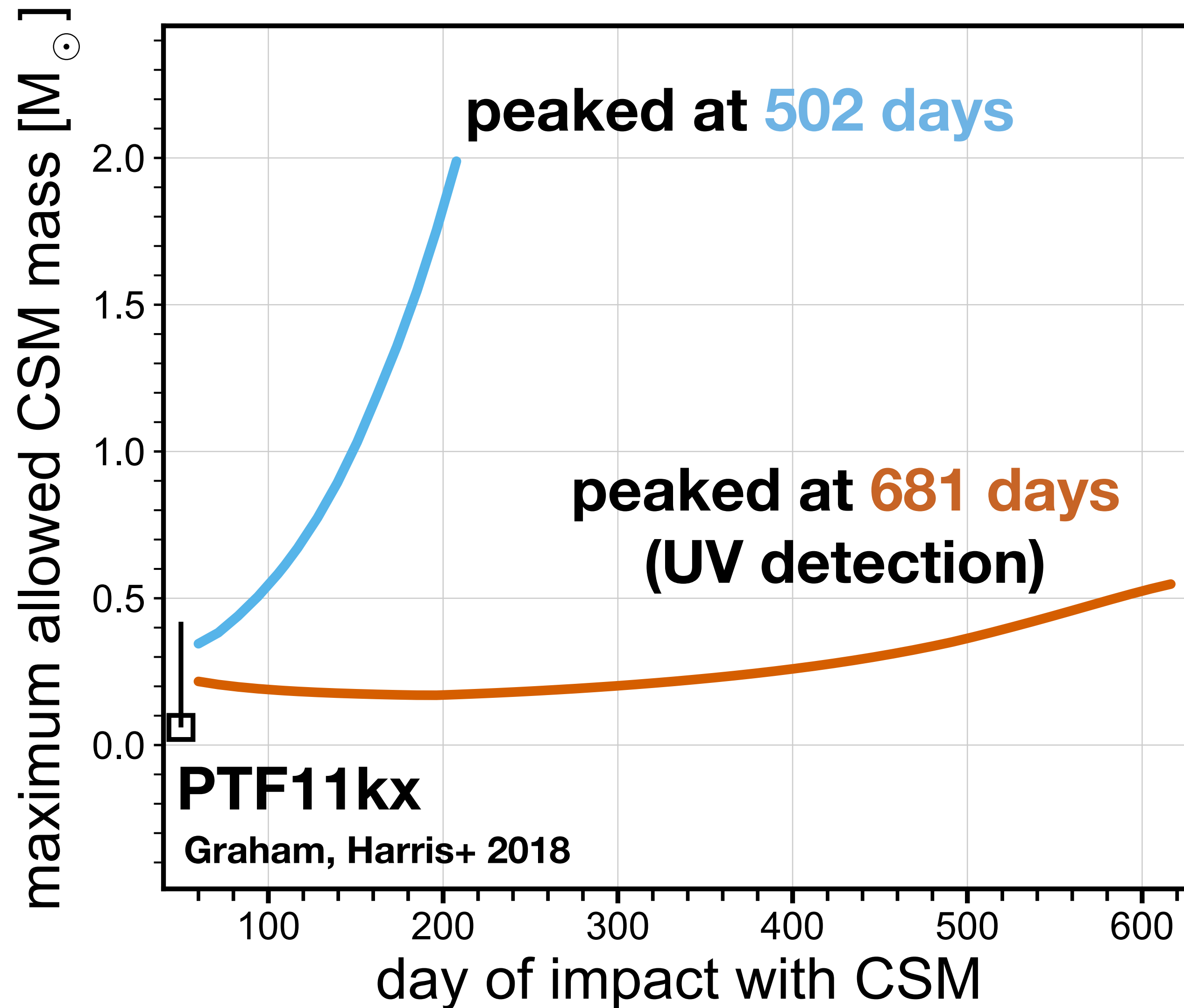
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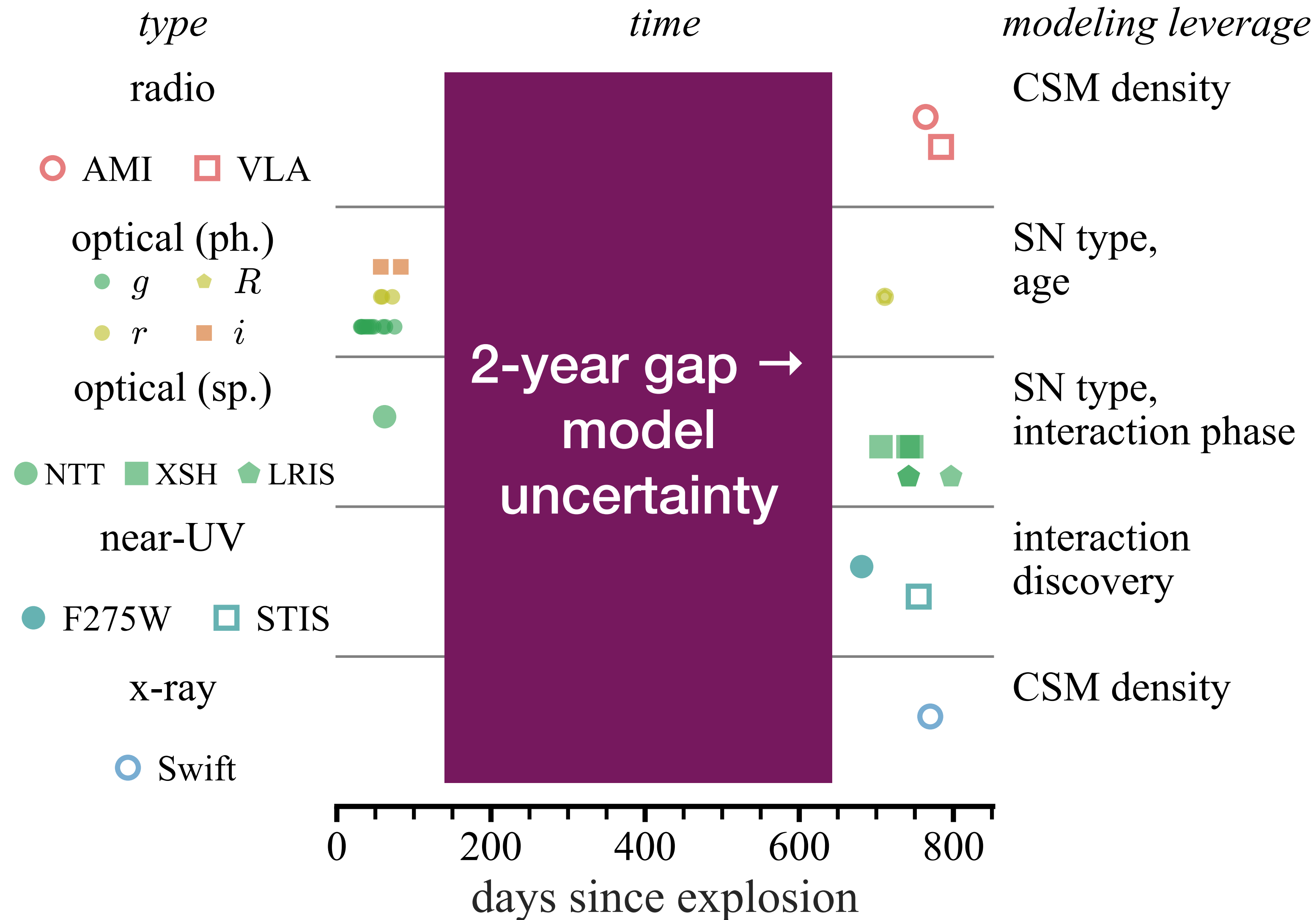
interaction started during observation gap



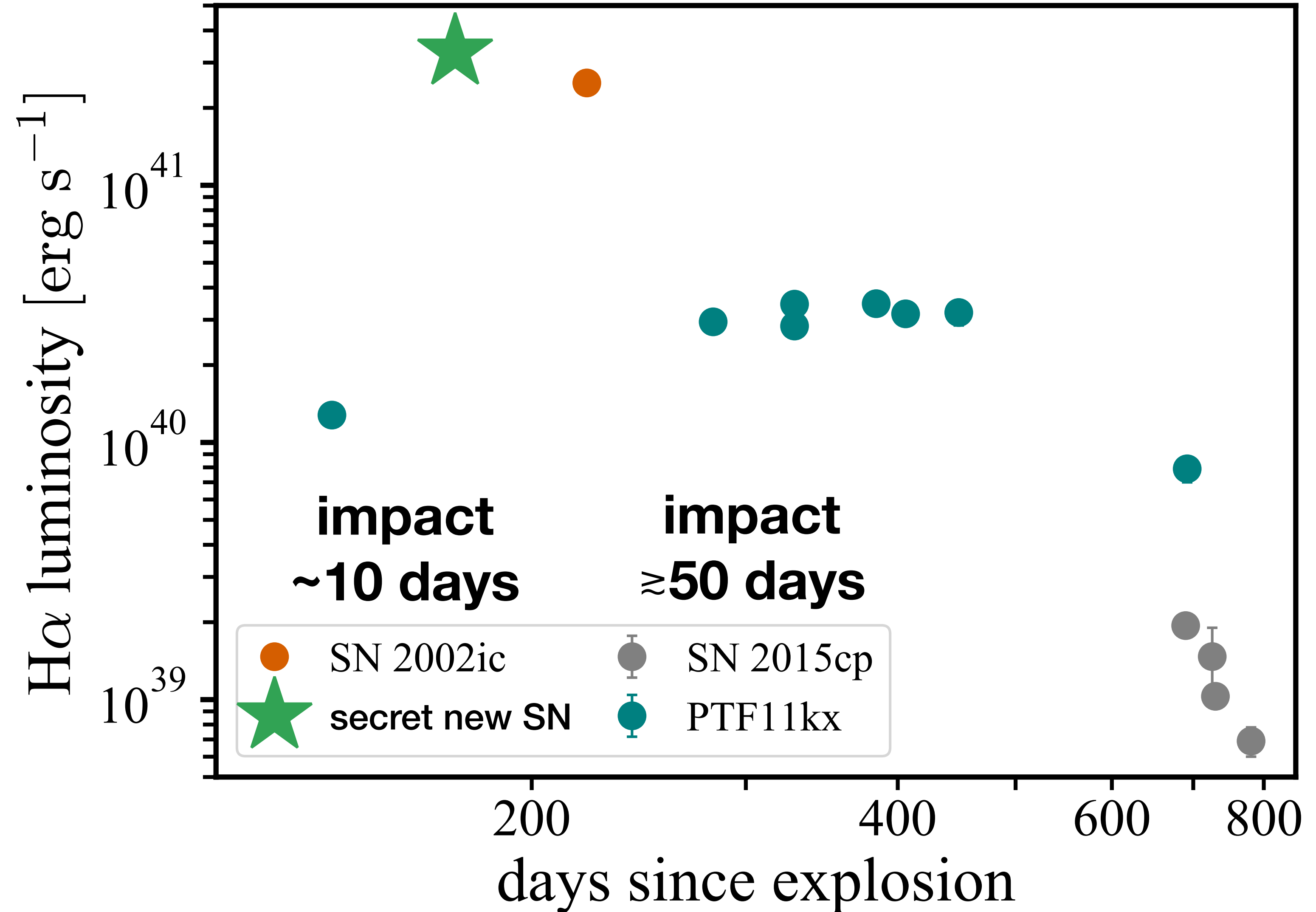
if caught near peak, $M_{\text{CSM}} \leq 0.5 M_{\odot}$



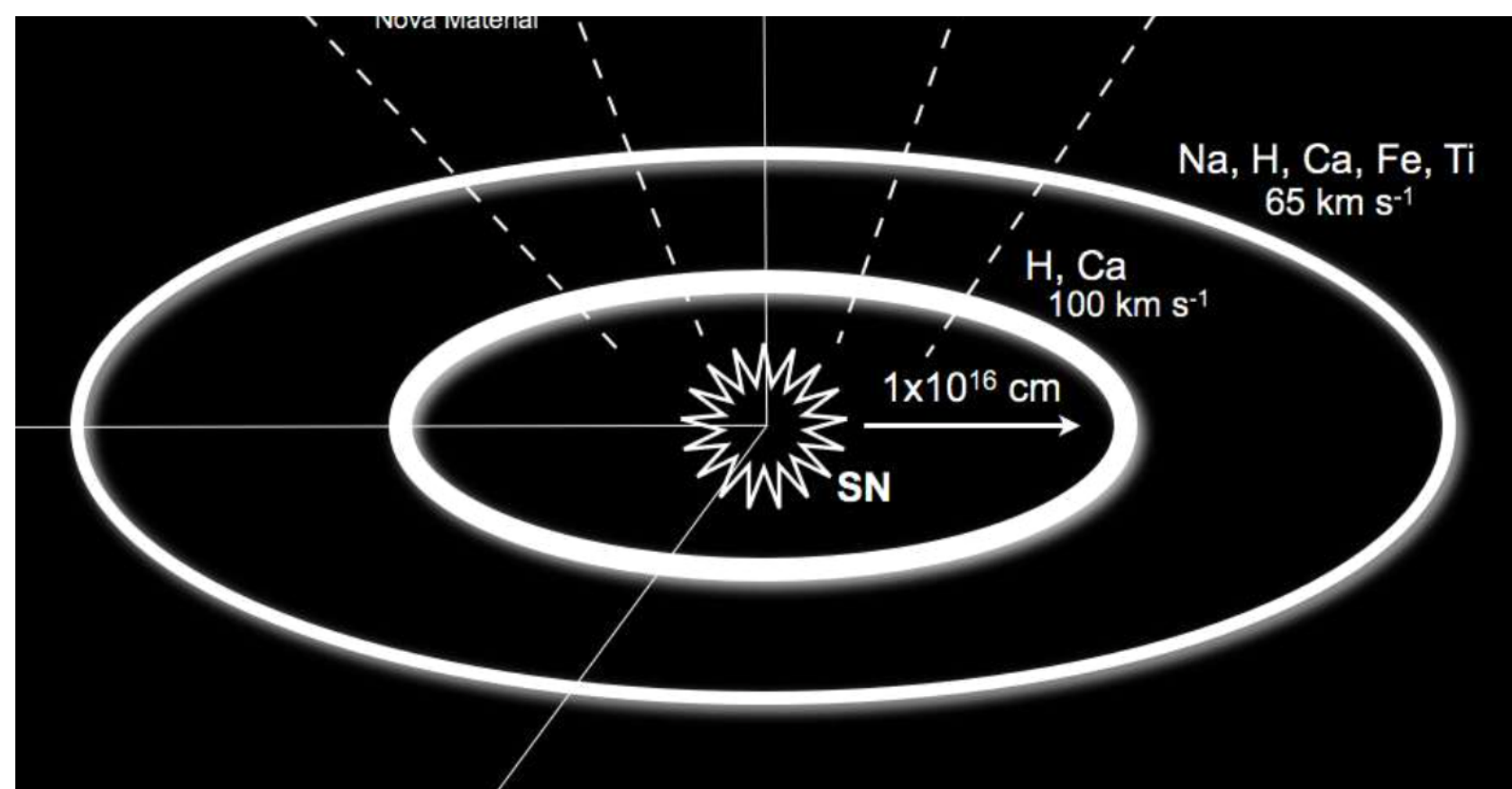
future efforts: mind the gap!



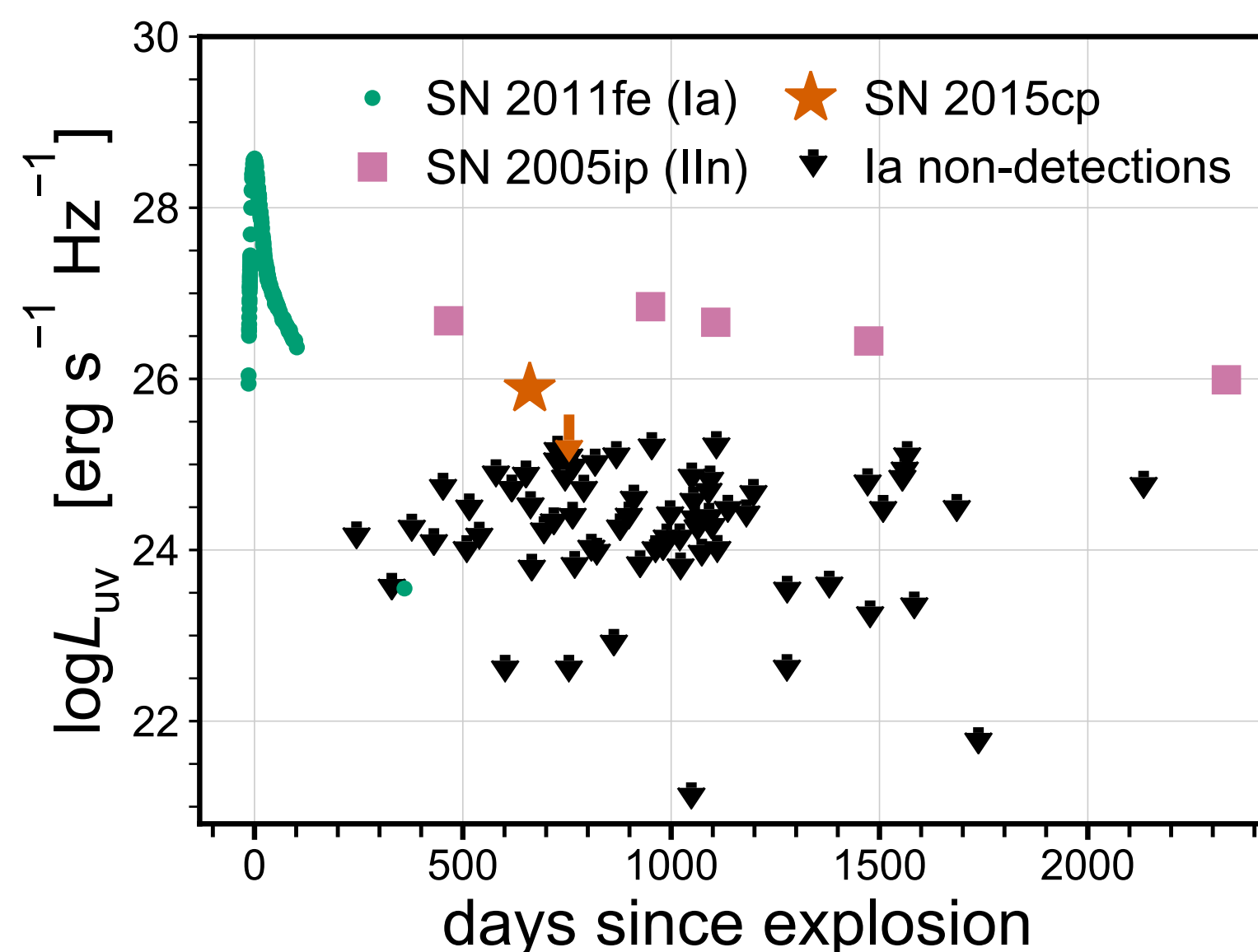
future goal: bridge SN 2002ic and PTF11kx



exploring the SD channel through delayed-interaction SNe Ia

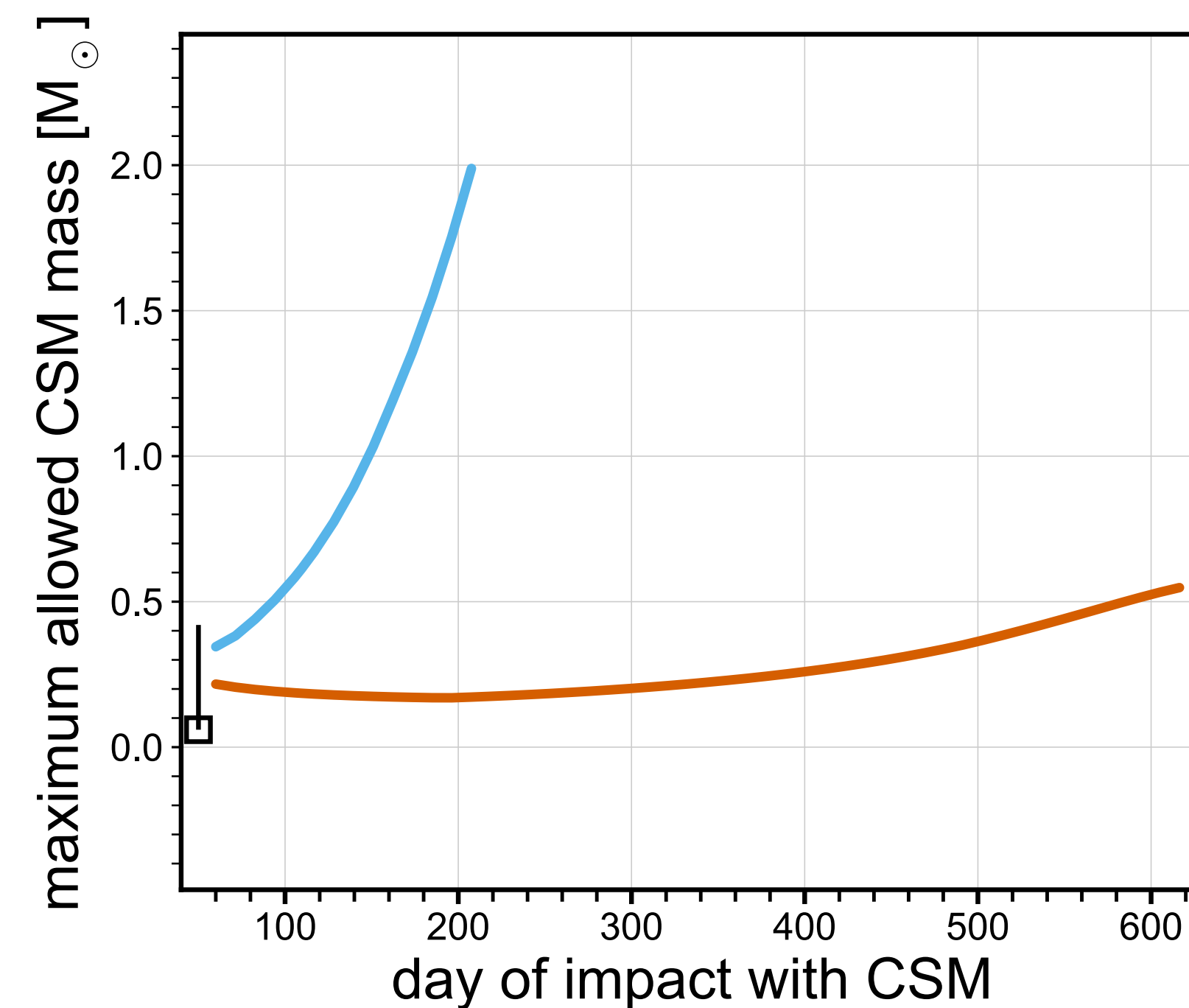


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