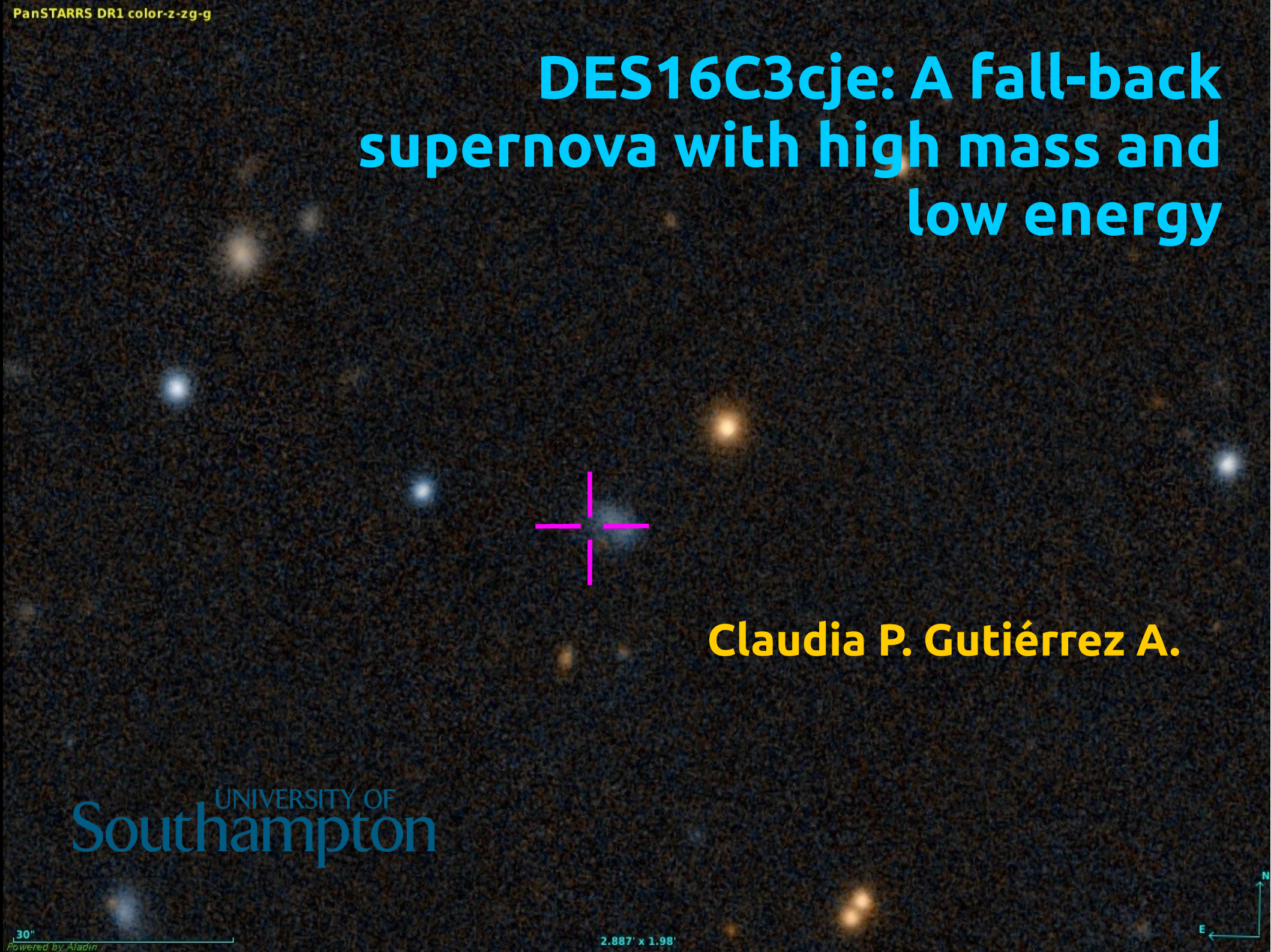
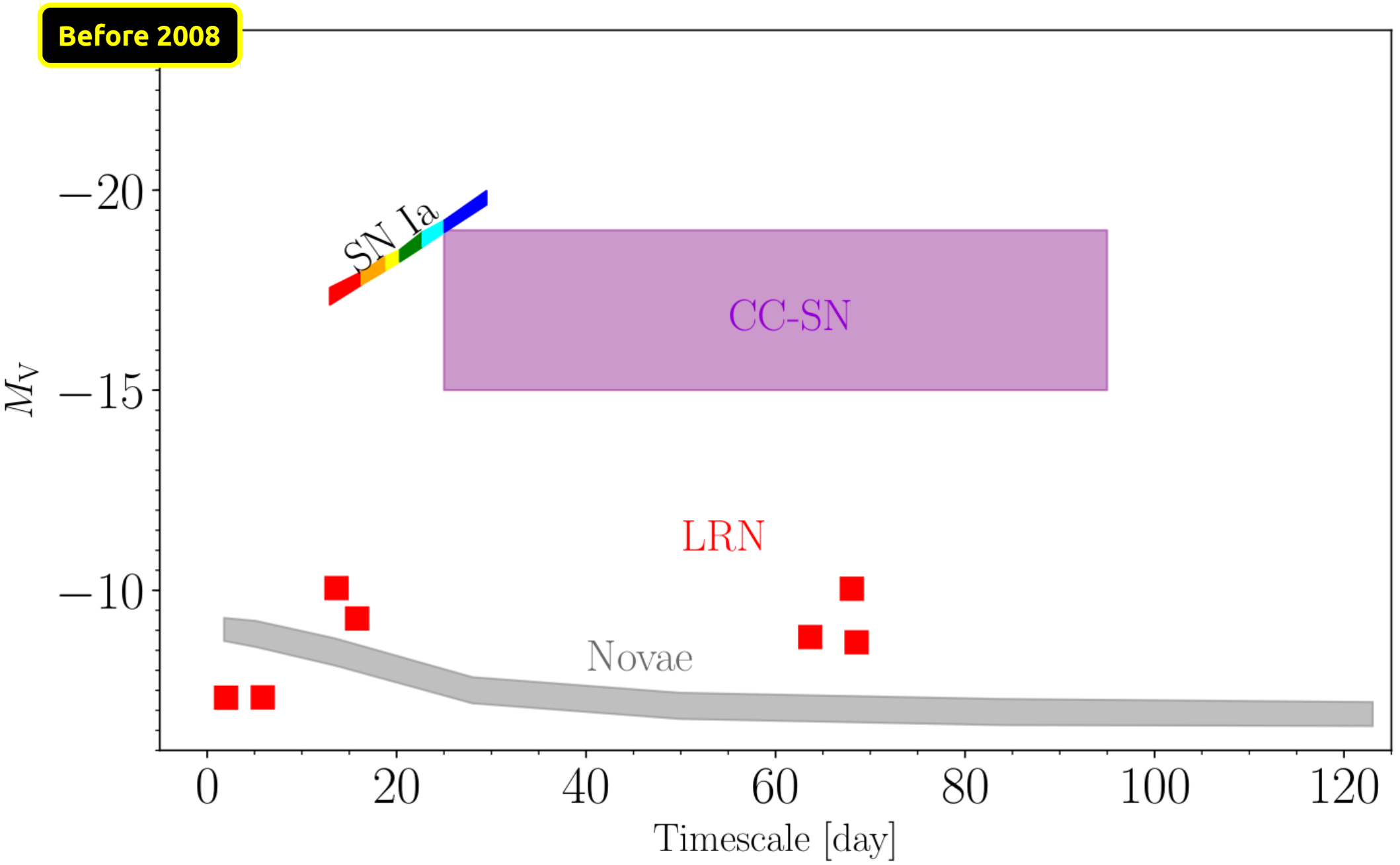


DES16C3cje: A fall-back supernova with high mass and low energy

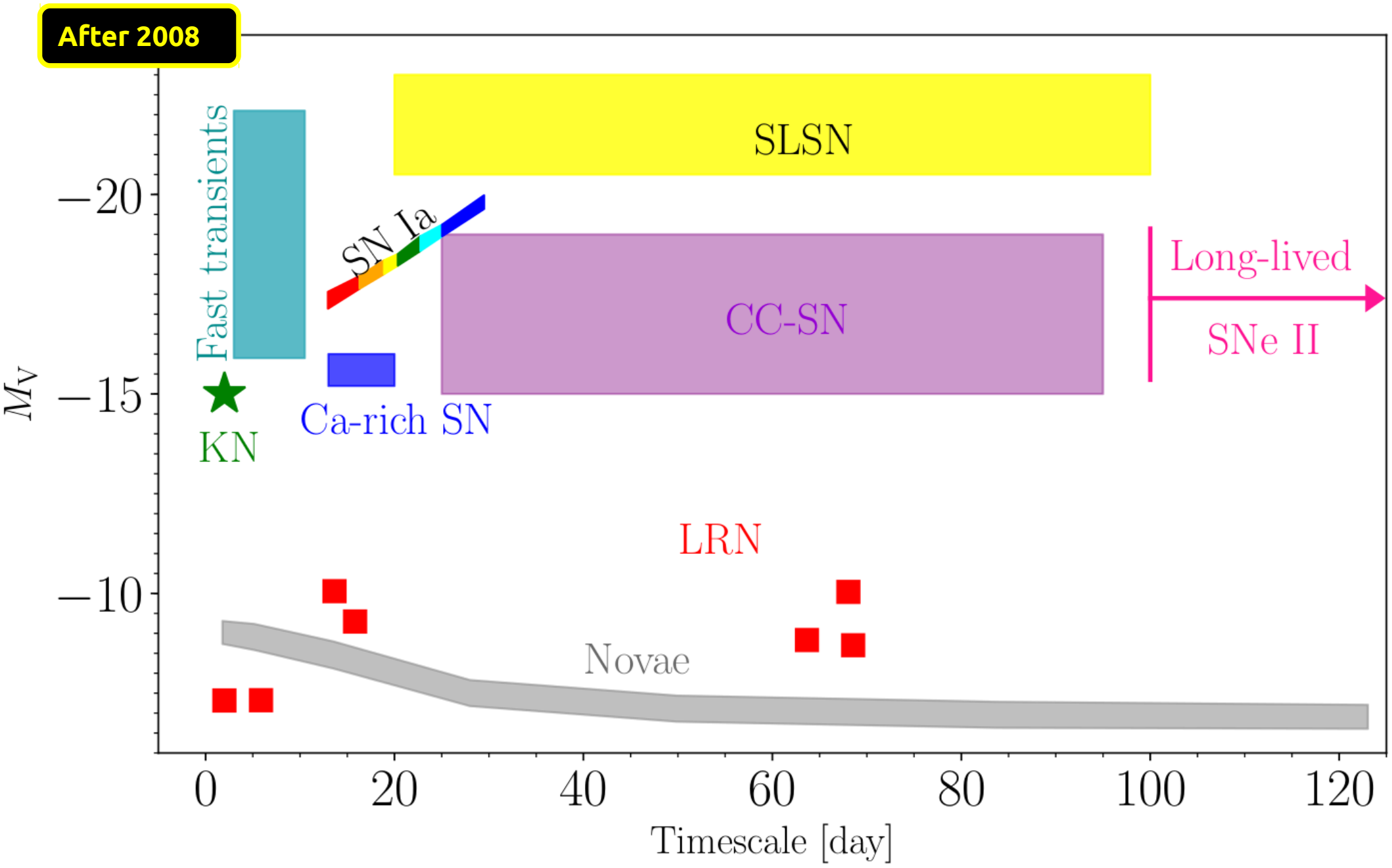
Claudia P. Gutiérrez A.

UNIVERSITY OF Southampton

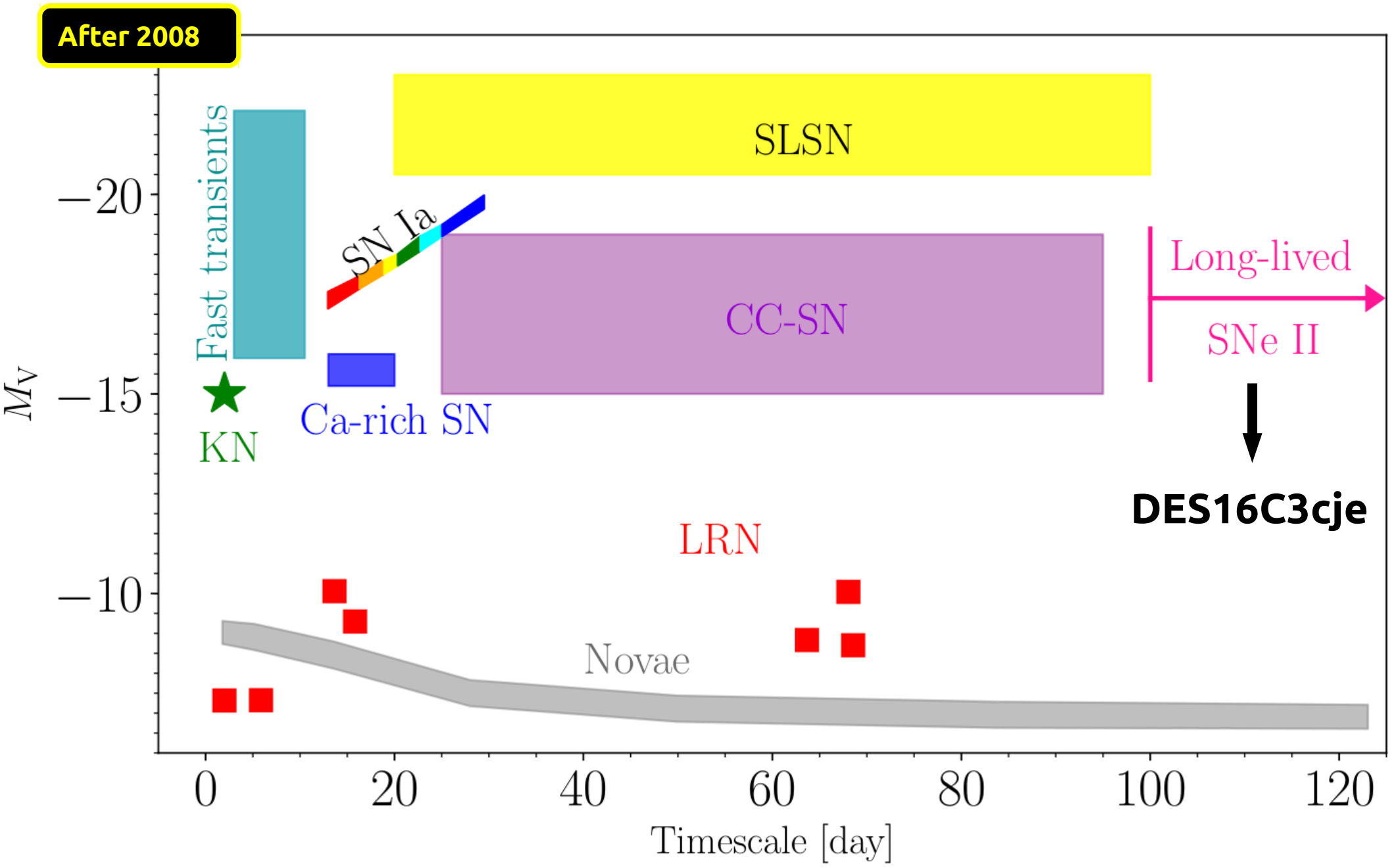
The diversity observed in the SN properties have increased in the last years



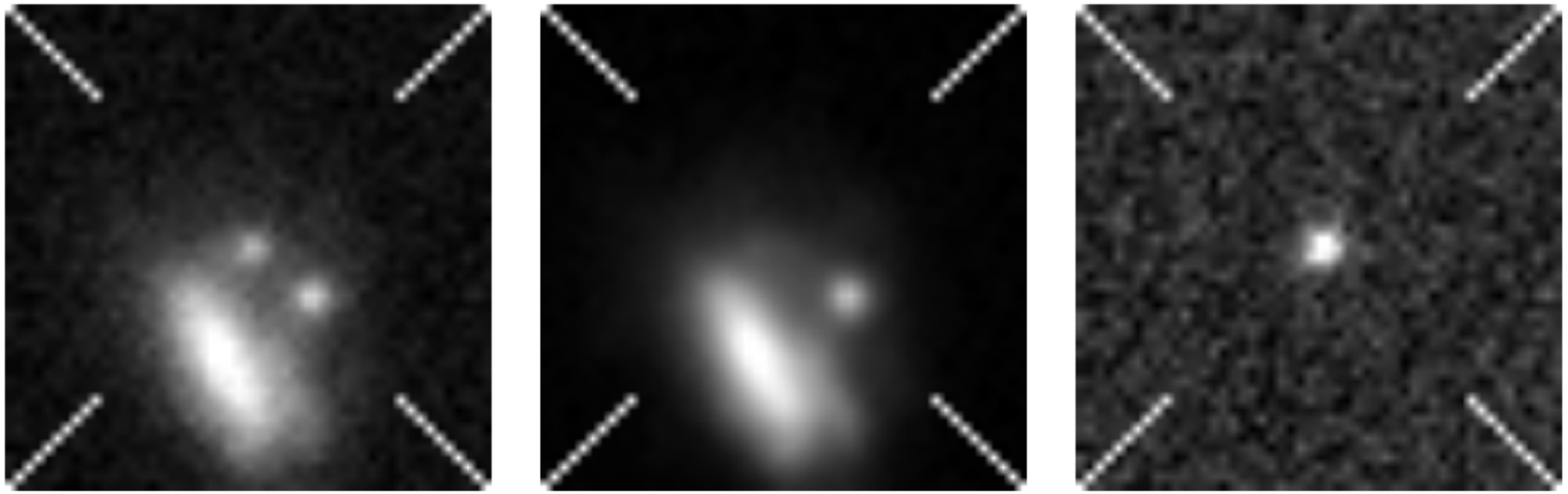
Recent wide-field surveys have revealed a large diversity in the observed properties SNe



Recent wide-field surveys have revealed a large diversity in the observed properties SNe



DES16C3cje was discovery by the Dark Energy Survey (DES) in October 11, 2016



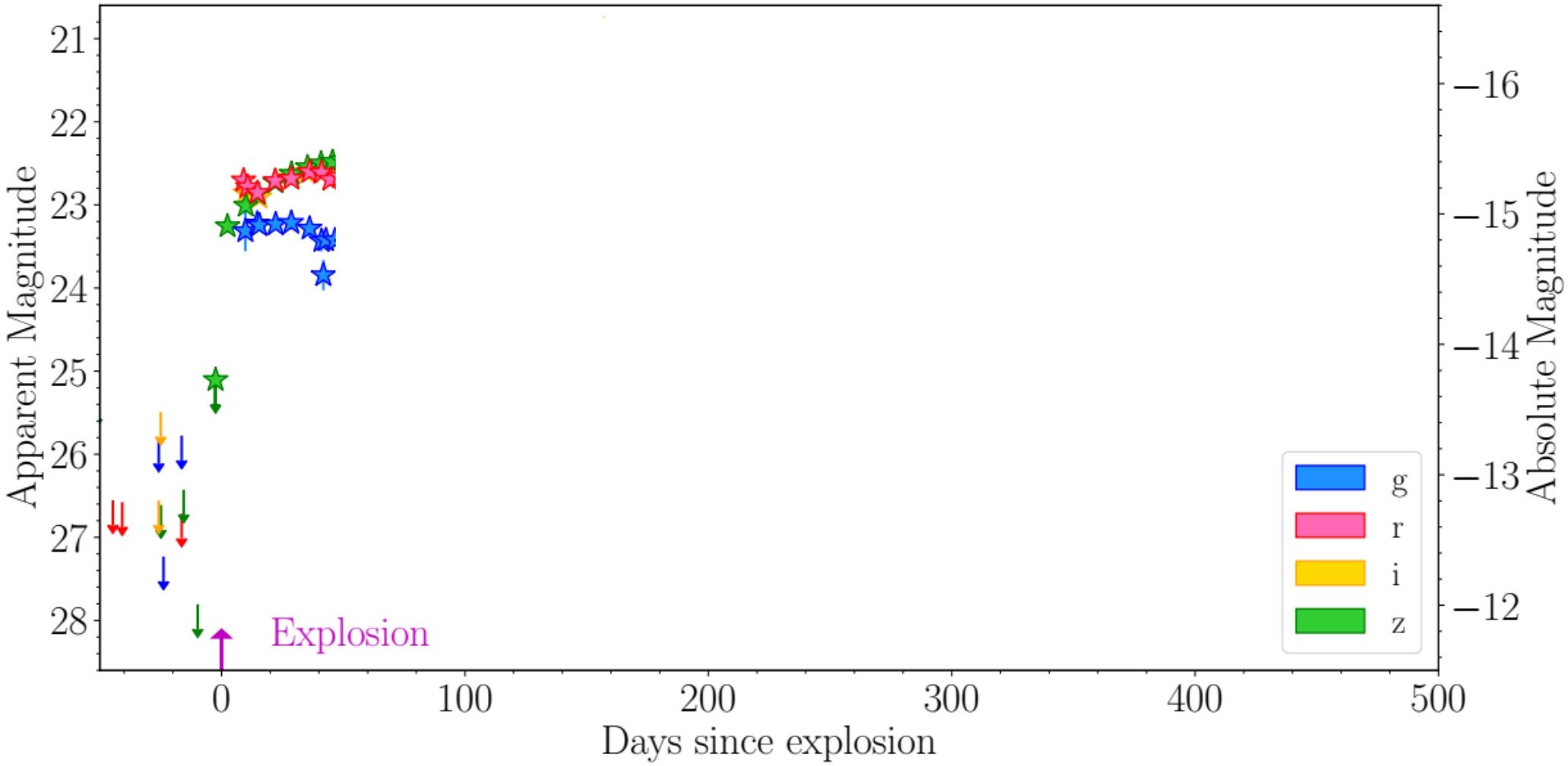
Magnitude (discovery): **23.26** (Mr ~ –14).

Last non-detection: October 07 (in z) → **Explosion**: October 9±2

Galaxy: Low luminosity (Mr = –16.34).

Redshift: 0.0615.

DES16C3cje was classified as a typical SN II based on the light curve (a visible “plateau” for two months)



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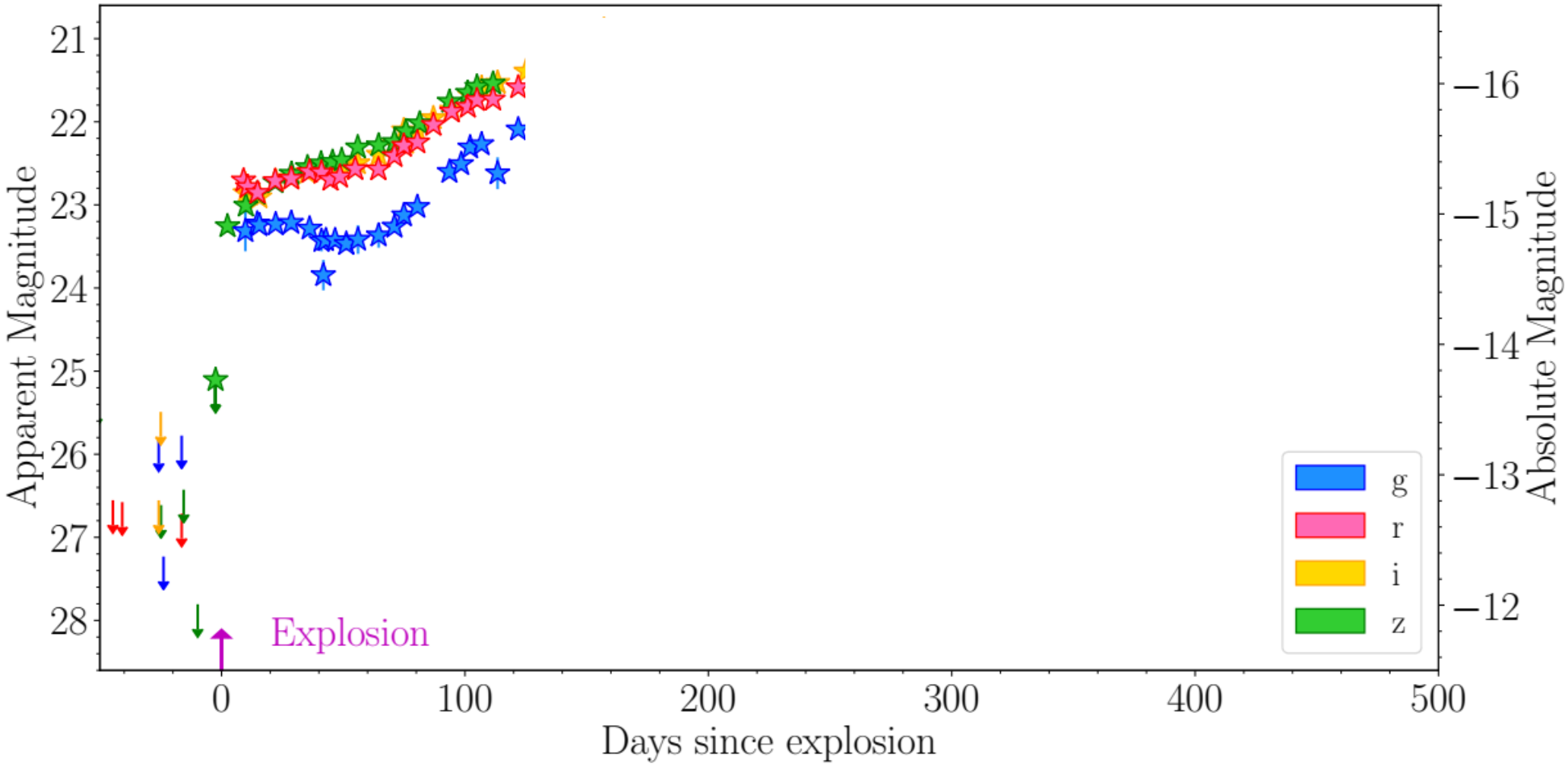

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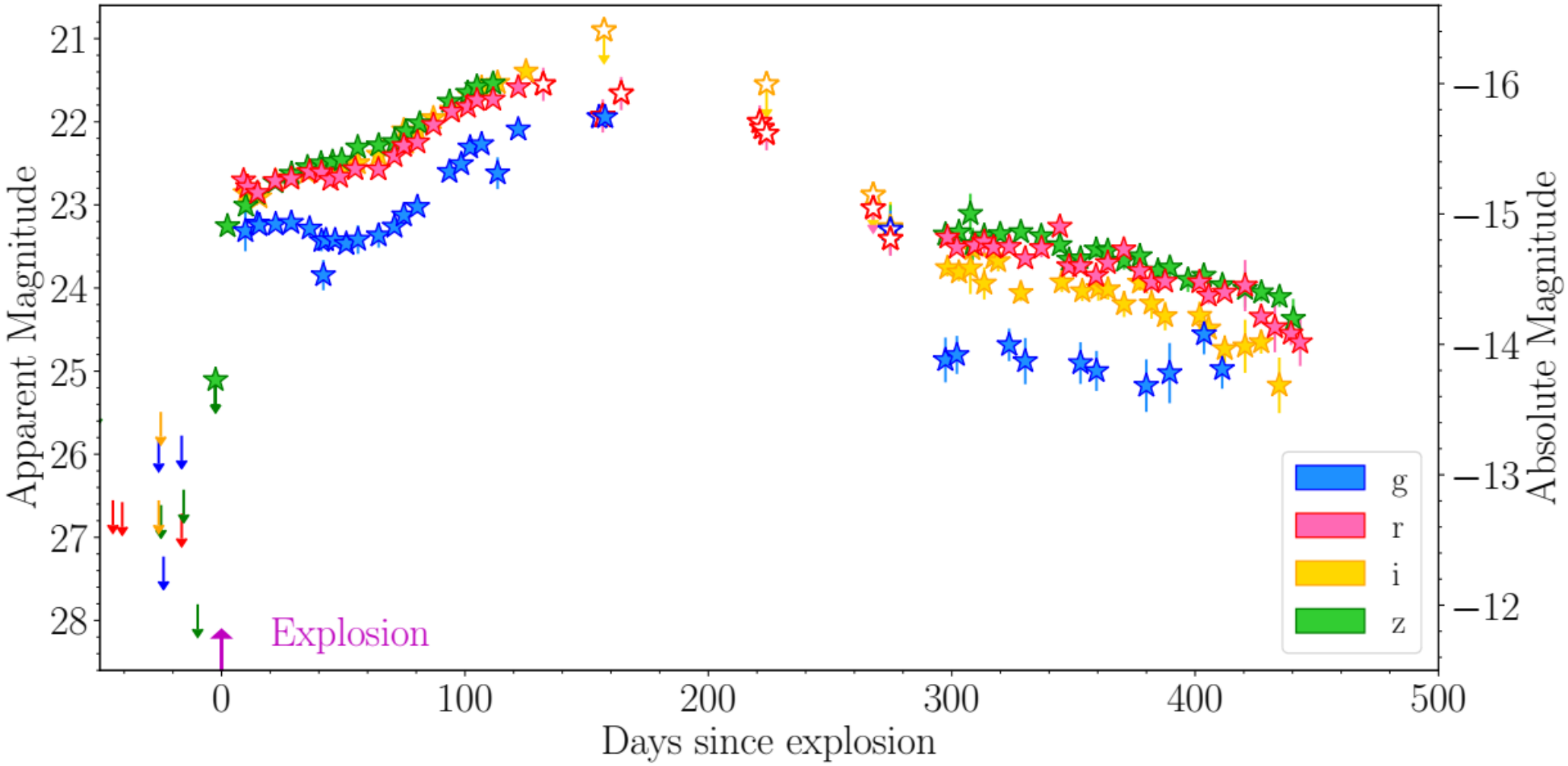
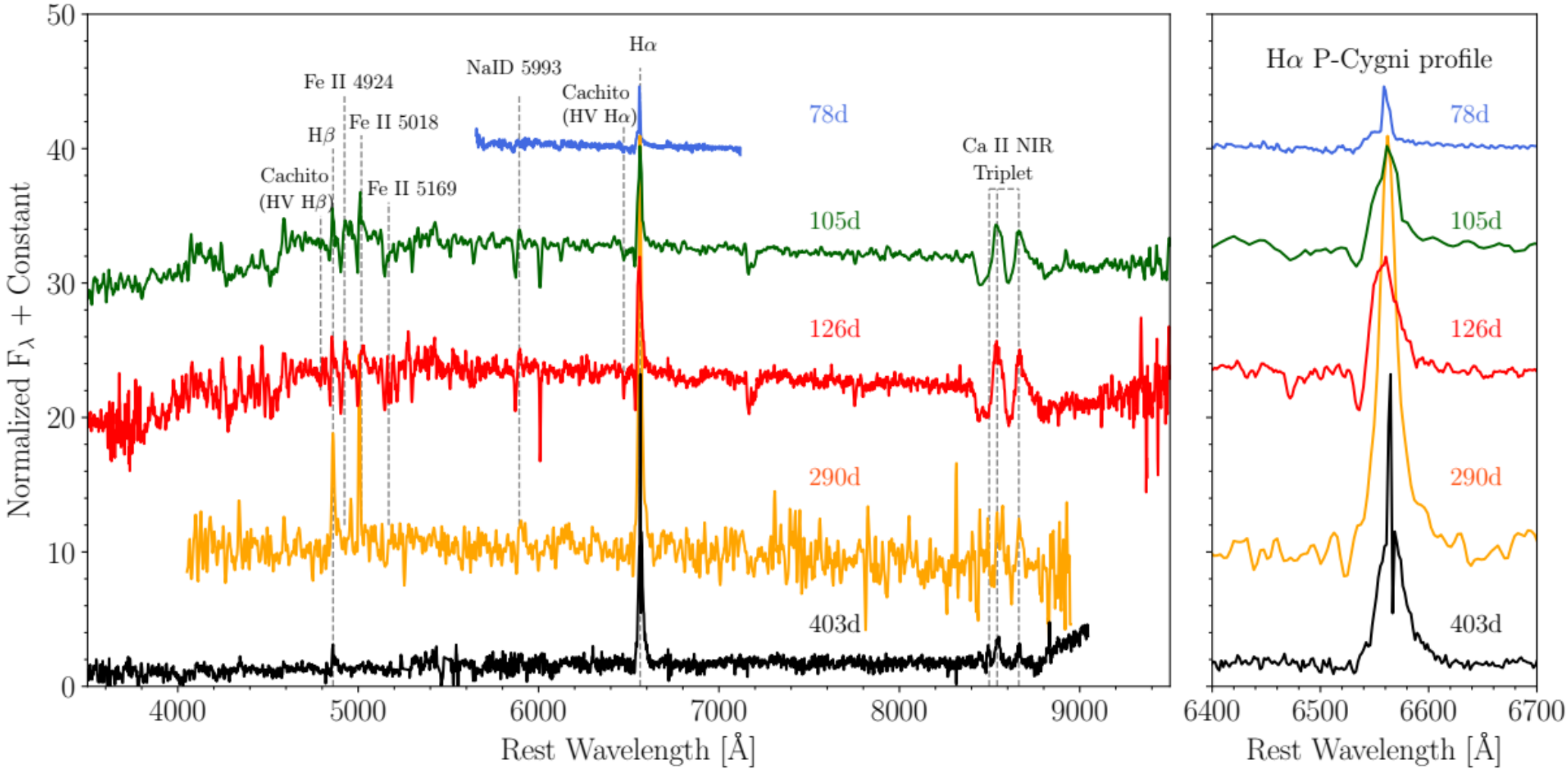
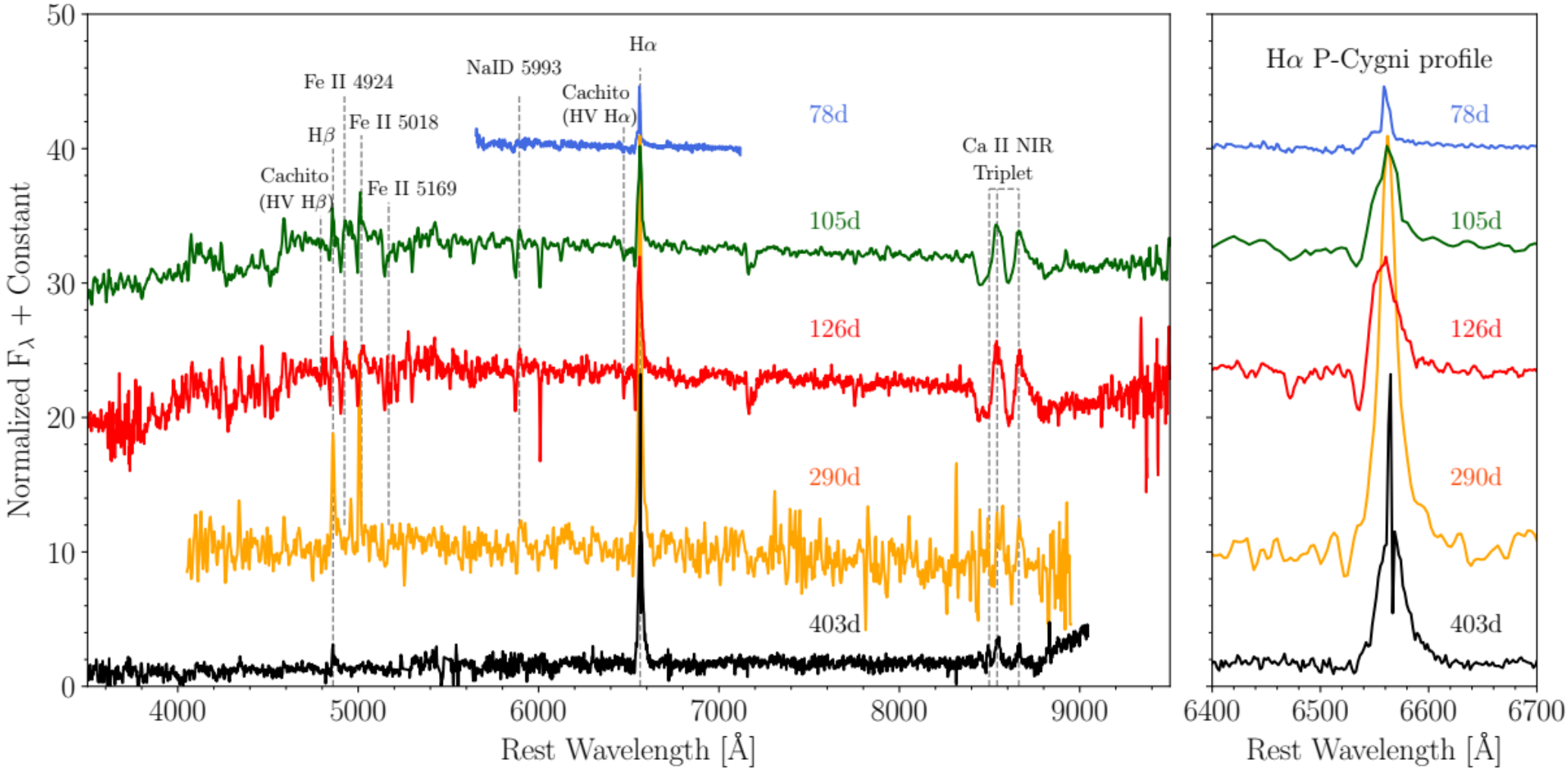


DES16C3cje was spectroscopically classified as a SN II at ~80 days from explosion



DES16C3cje was spectroscopically classified as a SN II at ~80 days from explosion



SN Impostor or SN explosion?

DES16C3cje: looking for a scenario that explain its peculiar evolution

SN Impostor **SN explosion**

LIGHT CURVE

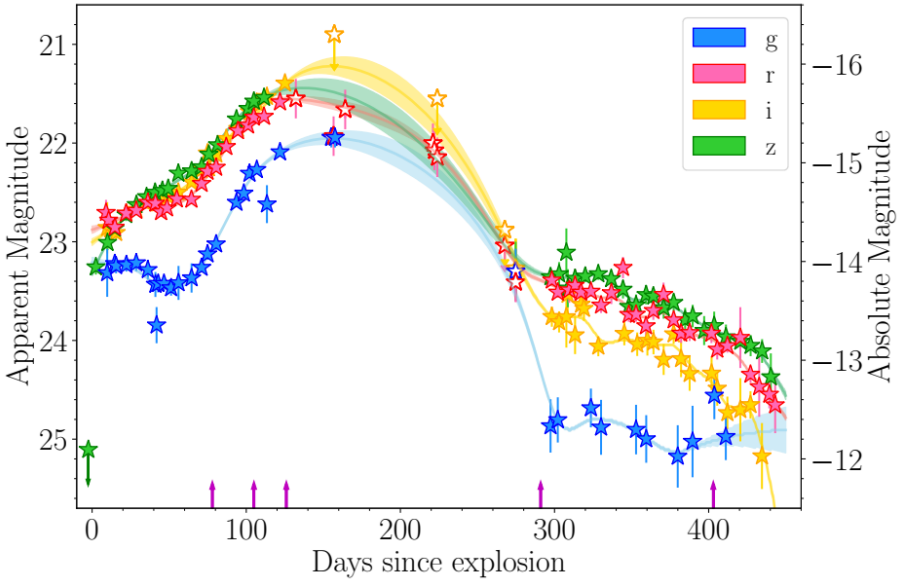
* Peculiar evolution
* Very slow rise
* Peak luminosity
* Variability over time
* Decline in the tail

SPECTRA

* Very narrow lines
* No evolution over time
* Lorentzian profile at late-times
* Lack of emission lines at late-times

DES16C3cje: looking for a scenario that explain its peculiar evolution

SN Impostor **SN explosion**



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* Peculiar evolution
* Very slow rise
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SPECTRA

* Very narrow lines
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DES16C3cje: looking for a scenario that explain its peculiar evolution

	SN Impostor	SN explosion
LIGHT CURVE		
* Peculiar evolution	✓	
* Very slow rise		
* Peak luminosity		
* Variability over time		
* Decline in the tail		
SPECTRA		
* Very narrow lines		
* No evolution over time		
* Lorentzian profile at late-times		
* Lack of emission lines at late-times		

DES16C3cje: looking for a scenario that explain its peculiar evolution

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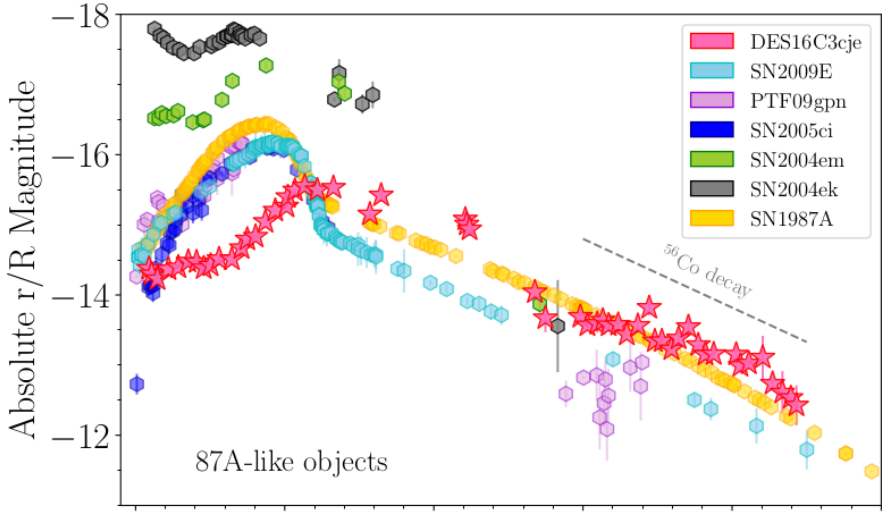

DES16C3cje: looking for a scenario that explain its peculiar evolution

	SN Impostor	SN explosion
LIGHT CURVE		
* Peculiar evolution	✓	✓
* Very slow rise		
* Peak luminosity		
* Variability over time		
* Decline in the tail		
SPECTRA		
* Very narrow lines		
* No evolution over time		
* Lorentzian profile at late-times		
* Lack of emission lines at late-times		

DES16C3cje: looking for a scenario that explain its peculiar evolution

	SN Impostor	SN explosion
LIGHT CURVE		
* Peculiar evolution	✓	✓
* Very slow rise	✗	
* Peak luminosity		
* Variability over time		
* Decline in the tail		
SPECTRA		
* Very narrow lines		
* No evolution over time		
* Lorentzian profile at late-times		
* Lack of emission lines at late-times		

DES16C3cje: looking for a scenario that explain its peculiar evolution

	SN Impostor	SN explosion
LIGHT CURVE		
* Peculiar evolution	✓	✓
* Very slow rise	✗	✓
* Peak luminosity		
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DES16C3cje: looking for a scenario that explain its peculiar evolution

	SN Impostor	SN explosion
LIGHT CURVE		
* Peculiar evolution	✓	✓
* Very slow rise	✗	✓
* Peak luminosity	✗	
* Variability over time		
* Decline in the tail		
SPECTRA		
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DES16C3cje: looking for a scenario that explain its peculiar evolution

	SN Impostor	SN explosion
LIGHT CURVE		
* Peculiar evolution	✓	✓
* Very slow rise	✗	✓
* Peak luminosity	✗	✓
* Variability over time		
* Decline in the tail		
SPECTRA		
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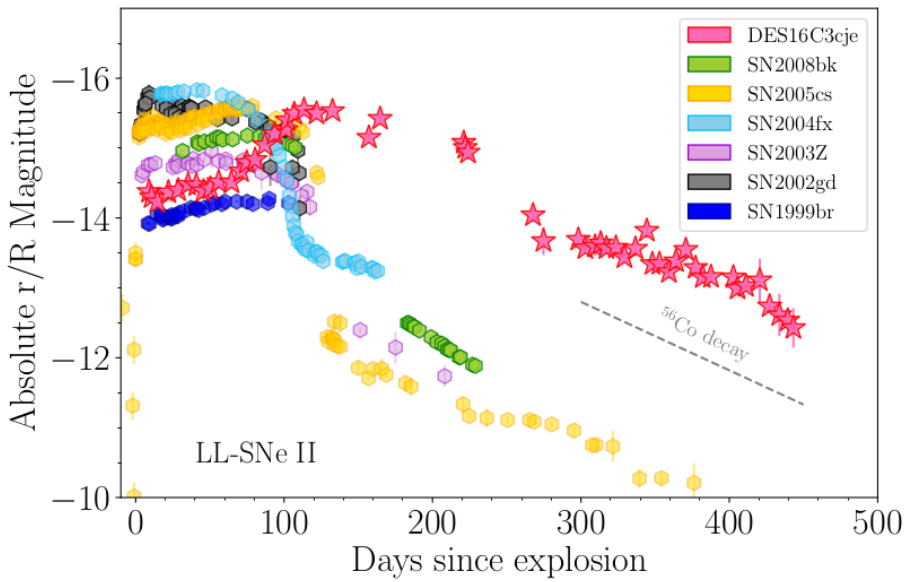

DES16C3cje: looking for a scenario that explain its peculiar evolution

	SN Impostor	SN explosion
LIGHT CURVE		
* Peculiar evolution	✓	✓
* Very slow rise	✗	✓
* Peak luminosity	✗	✓
* Variability over time	?	
* Decline in the tail		
SPECTRA		
* Very narrow lines		
* No evolution over time		
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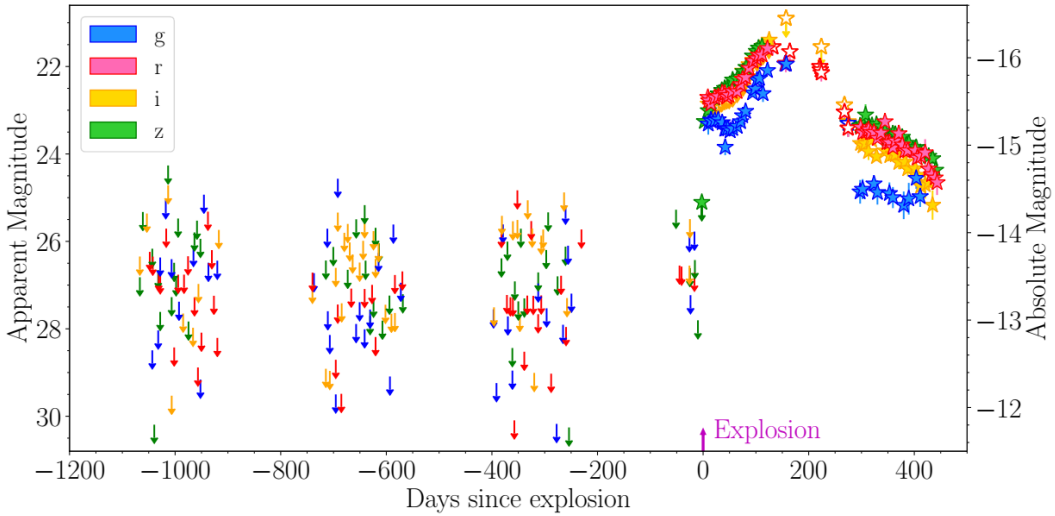

DES16C3cje: looking for a scenario that explain its peculiar evolution

	SN Impostor	SN explosion
LIGHT CURVE		
* Peculiar evolution	✓	✓
* Very slow rise	✗	✓
* Peak luminosity	✗	✓
* Variability over time	?	✓
* Decline in the tail		
SPECTRA		
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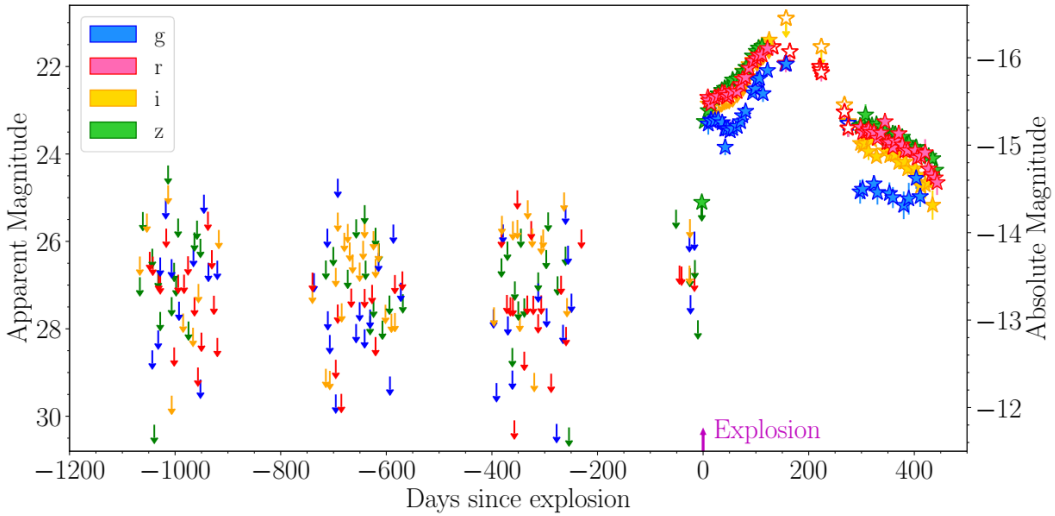

DES16C3cje: looking for a scenario that explain its peculiar evolution

	SN Impostor	SN explosion
LIGHT CURVE		
* Peculiar evolution	✓	✓
* Very slow rise	✗	✓
* Peak luminosity	✗	✓
* Variability over time	?	✓
* Decline in the tail		
SPECTRA		
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	SN Impostor	SN explosion
LIGHT CURVE		
* Peculiar evolution	✓	✓
* Very slow rise	✗	✓
* Peak luminosity	✗	✓
* Variability over time	?	✓
* Decline in the tail	✓	
SPECTRA		
* Very narrow lines		
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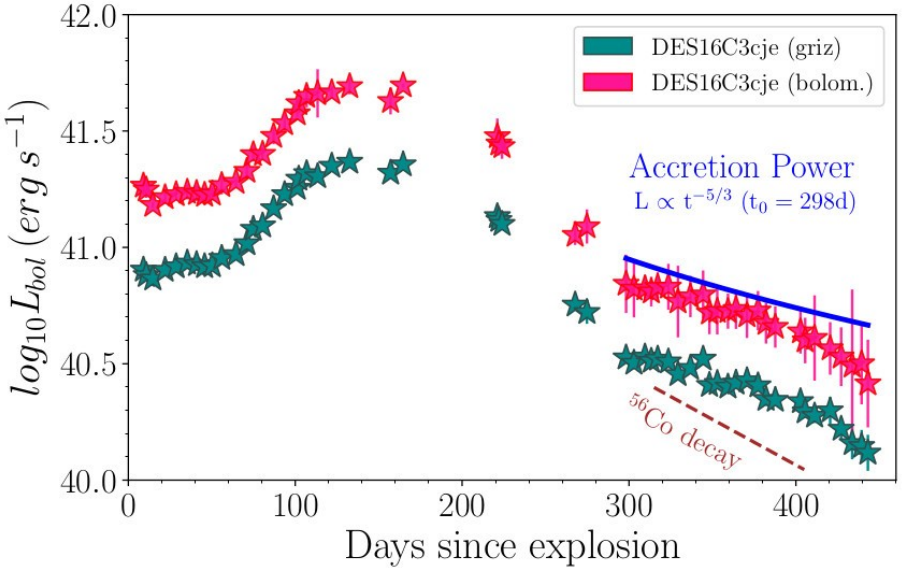

DES16C3cje: looking for a scenario that explain its peculiar evolution

	SN Impostor	SN explosion
LIGHT CURVE		
* Peculiar evolution	✓	✓
* Very slow rise	✗	✓
* Peak luminosity	✗	✓
* Variability over time	?	✓
* Decline in the tail	✓	?
SPECTRA		
* Very narrow lines		
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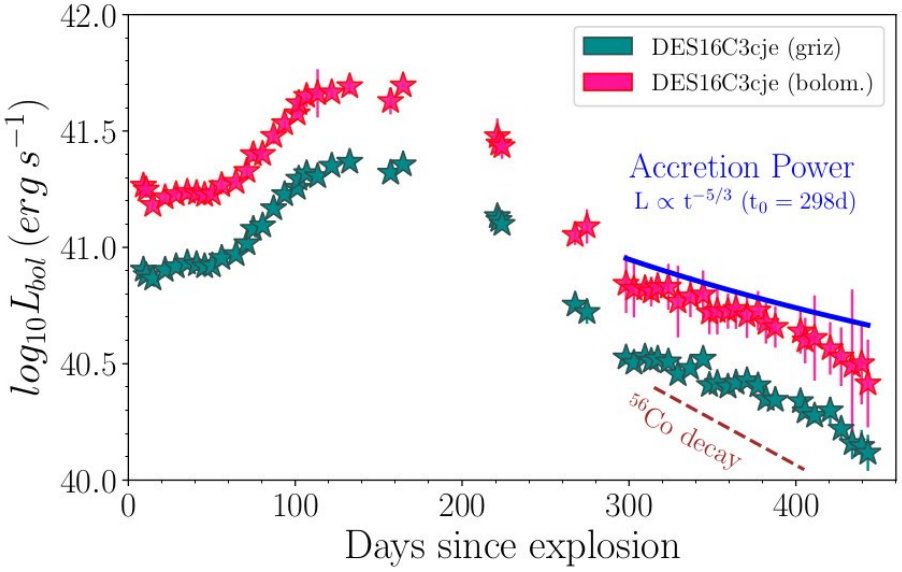

DES16C3cje: looking for a scenario that explain its peculiar evolution

	SN Impostor	SN explosion
LIGHT CURVE		
* Peculiar evolution	✓	✓
* Very slow rise	✗	✓
* Peak luminosity	✗	✓
* Variability over time	?	✓
* Decline in the tail	✓	? ✓
SPECTRA		
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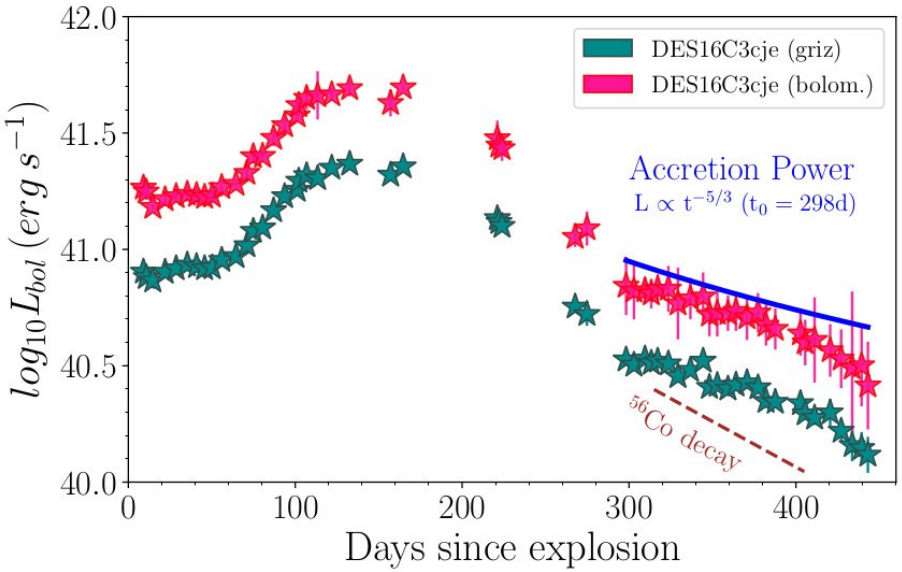

DES16C3cje: looking for a scenario that explain its peculiar evolution

	SN Impostor	SN explosion
LIGHT CURVE		
* Peculiar evolution	✓	✓
* Very slow rise	✗	✓
* Peak luminosity	✗	✓
* Variability over time	?	✓
* Decline in the tail	✓	? ✓

SPECTRA

* Very narrow lines
* No evolution over time
* Lorentzian profile at late-times
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DES16C3cje: looking for a scenario that explain its peculiar evolution

SN Impostor **SN explosion**

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* Peak luminosity
* Variability over time
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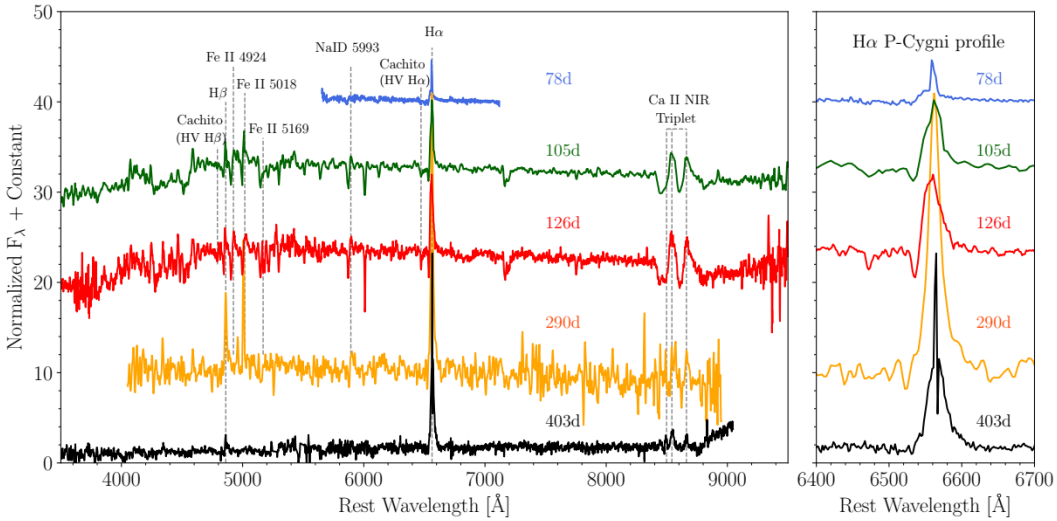

SPECTRA

* Very narrow lines
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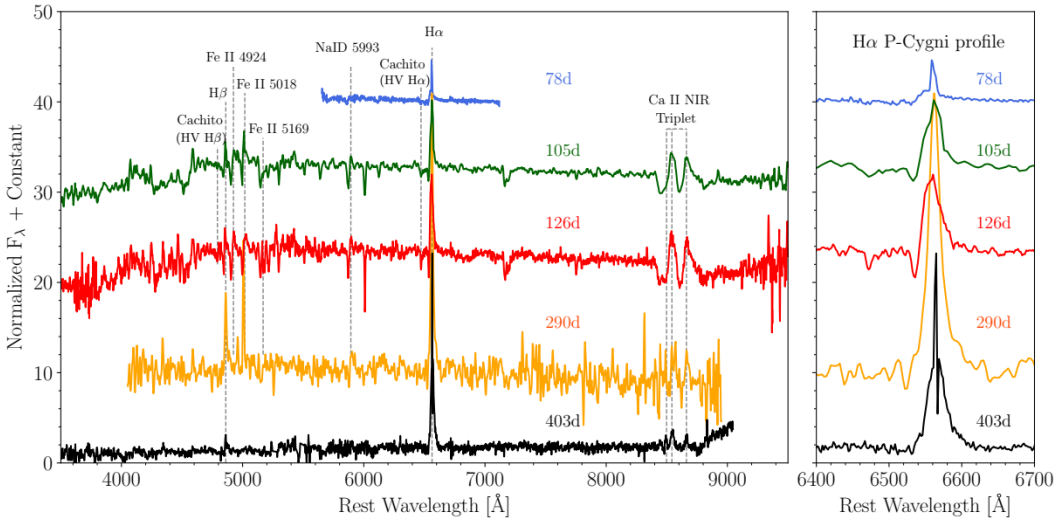

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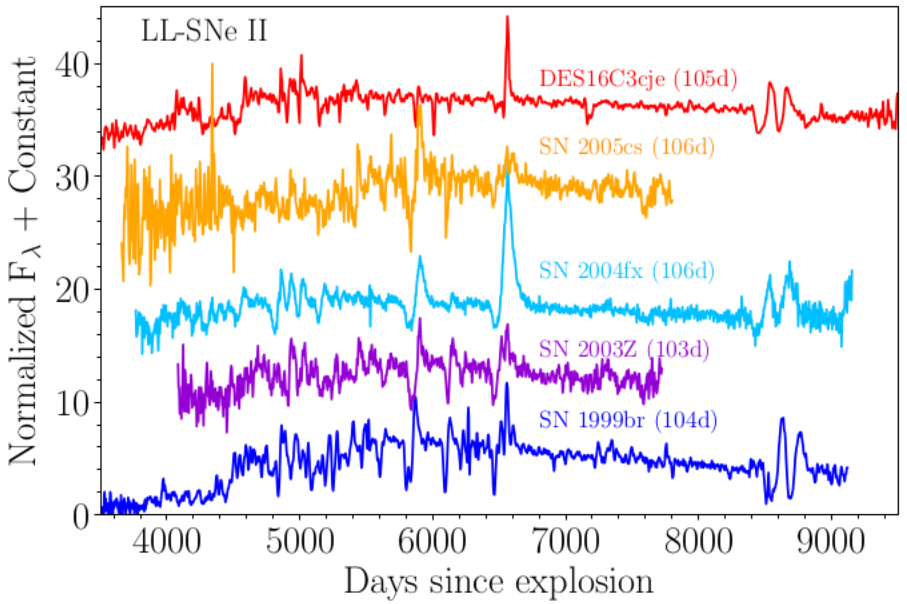

SPECTRA

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DES16C3cje: looking for a scenario that explain its peculiar evolution

	SN Impostor	SN explosion
LIGHT CURVE		
* Peculiar evolution	✓	✓
* Very slow rise	✗	✓
* Peak luminosity	✗	✓
* Variability over time	?	✓
* Decline in the tail	✓	? ✓
SPECTRA		
* Very narrow lines	✓	✓
* No evolution over time		
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DES16C3cje: looking for a scenario that explain its peculiar evolution

	SN Impostor	SN explosion
LIGHT CURVE		
* Peculiar evolution	✓	✓
* Very slow rise	✗	✓
* Peak luminosity	✗	✓
* Variability over time	?	✓
* Decline in the tail	✓	? ✓
SPECTRA		
* Very narrow lines	✓	✓
* No evolution over time	✓	
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DES16C3cje: looking for a scenario that explain its peculiar evolution

LIGHT CURVE

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* Peak luminosity
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* Decline in the tail

SPECTRA

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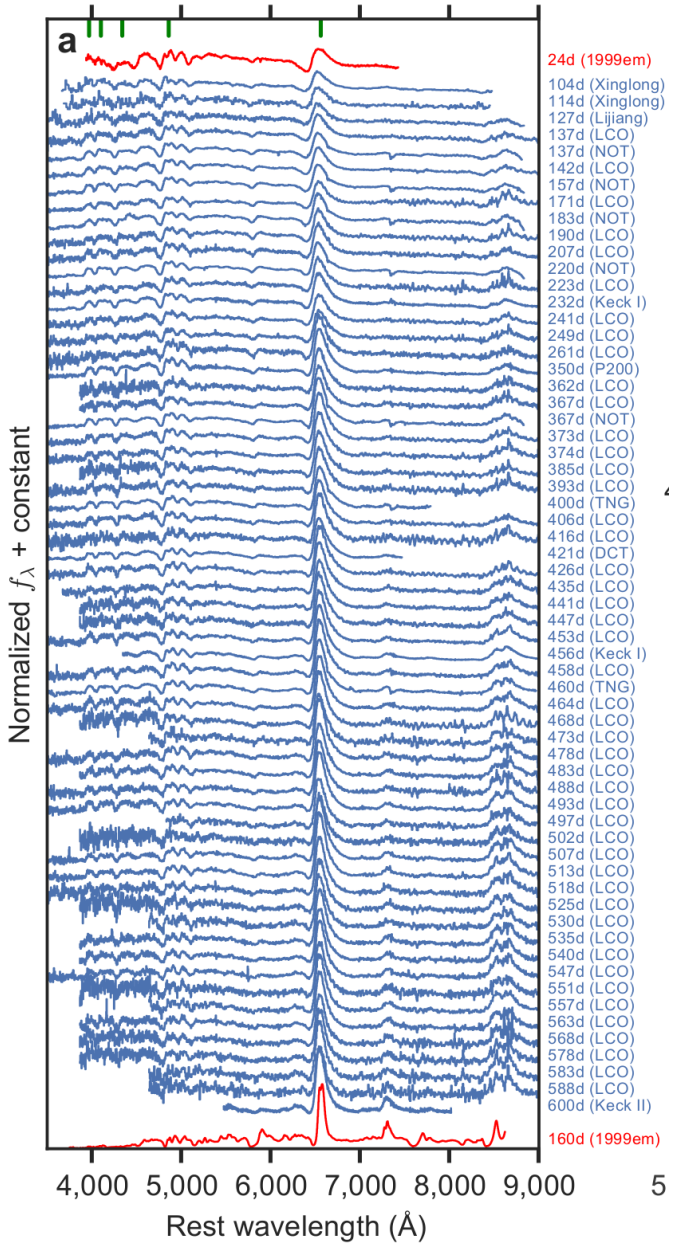
* Lack of emission lines at late-time

SN Impostor **SN explosion**



Arcavi + 2017

DES16C3cje: looking for a scenario that explain its peculiar evolution

	SN Impostor	SN explosion
LIGHT CURVE		
* Peculiar evolution	✓	✓
* Very slow rise	✗	✓
* Peak luminosity	✗	✓
* Variability over time	?	✓
* Decline in the tail	✓	? ✓
SPECTRA		
* Very narrow lines	✓	✓
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DES16C3cje: looking for a scenario that explain its peculiar evolution

SN Impostor **SN explosion**

LIGHT CURVE

* Peculiar evolution
* Very slow rise
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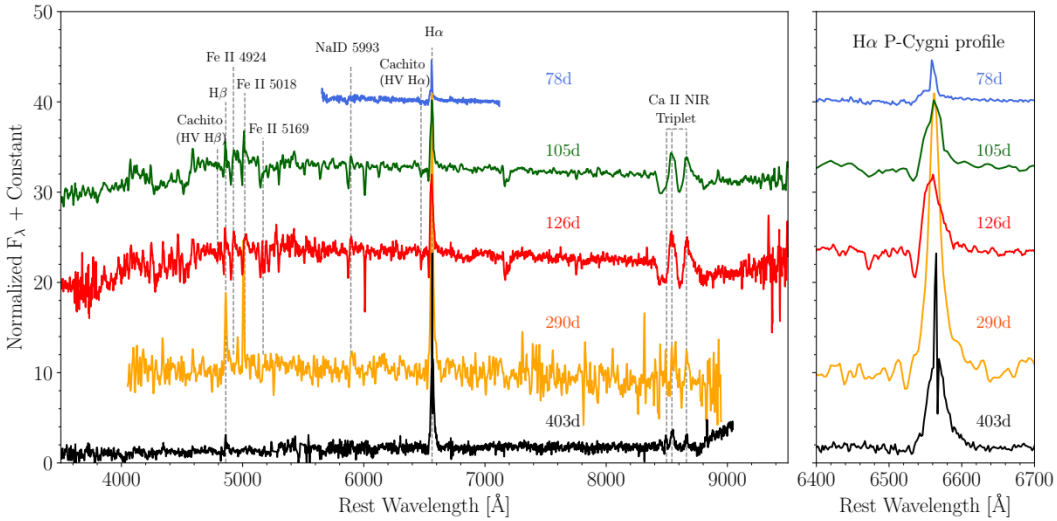

SPECTRA

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* No evolution over time ✓ ✓
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DES16C3cje: looking for a scenario that explain its peculiar evolution

SN Impostor **SN explosion**

LIGHT CURVE

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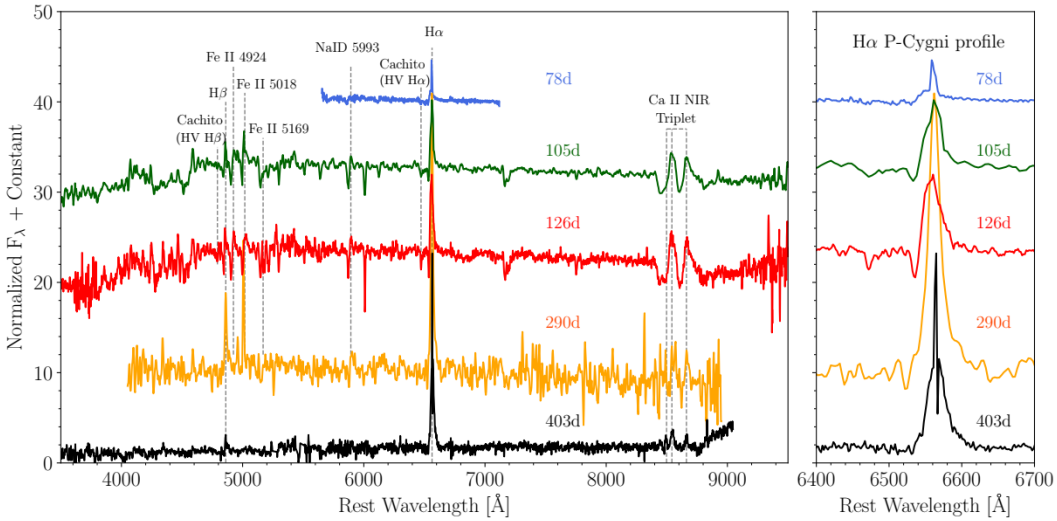

SPECTRA

* Very narrow lines ✓ ✓
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DES16C3cje: looking for a scenario that explain its peculiar evolution

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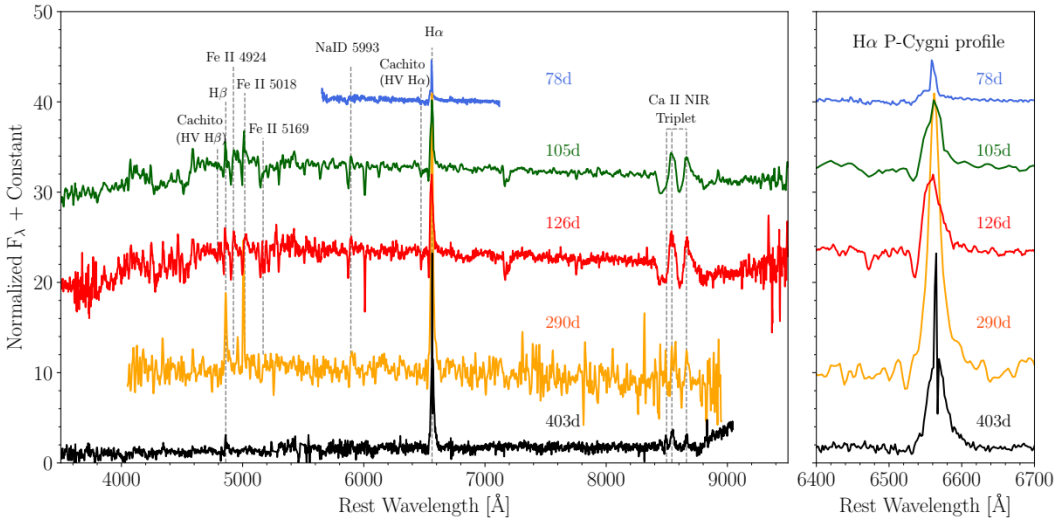

SPECTRA

* Very narrow lines ✓ ✓
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DES16C3cje: looking for a scenario that explain its peculiar evolution

SN Impostor **SN explosion**

LIGHT CURVE

* Peculiar evolution
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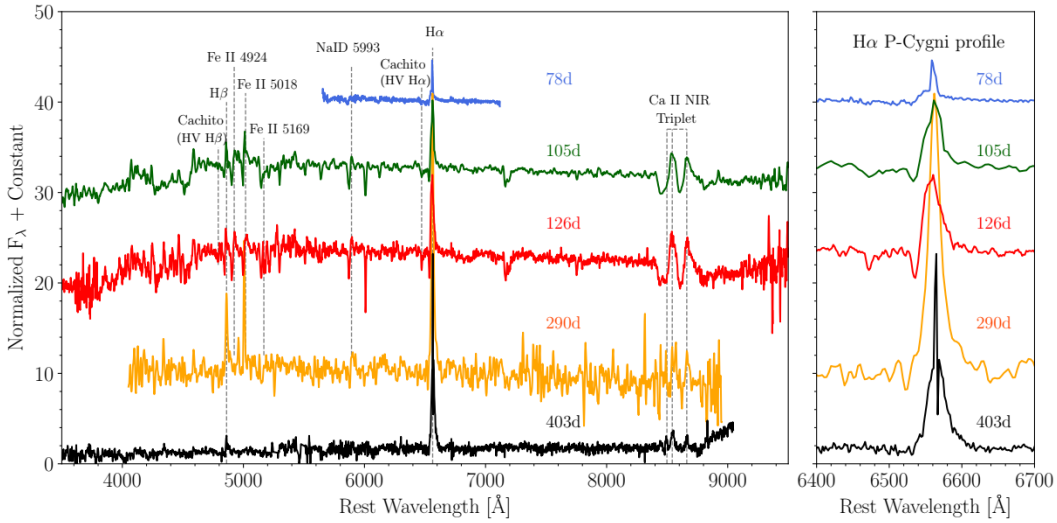

SPECTRA

* Very narrow lines ✓ ✓
* No evolution over time ✓ ✓
* Lorentzian profile at late-times ✓ ✓
* Lack of emission lines at late-times

DES16C3cje: looking for a scenario that explain its peculiar evolution

SN Impostor **SN explosion**

LIGHT CURVE

* Peculiar evolution
* Very slow rise
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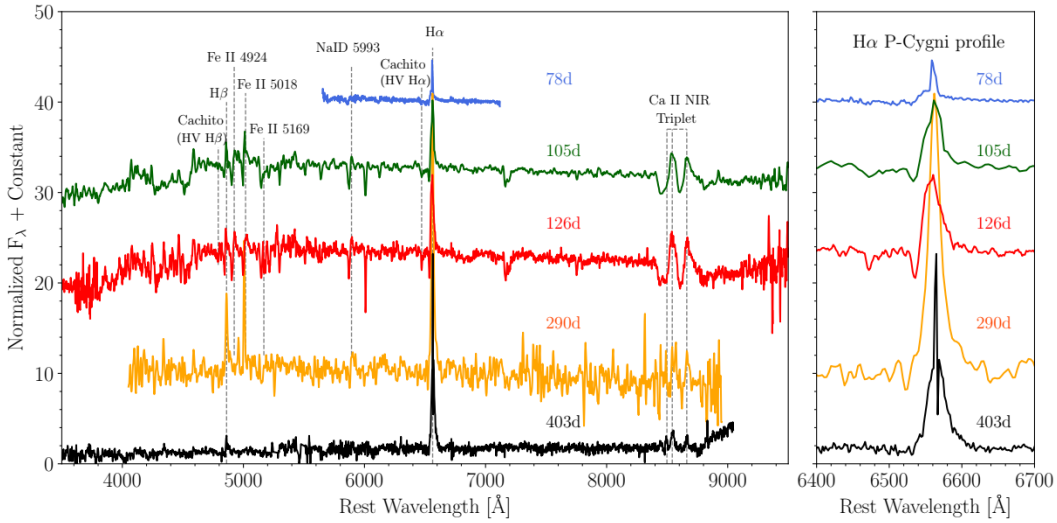


SPECTRA

* Very narrow lines ✓ ✓
* No evolution over time ✓ ✓
* Lorentzian profile at late-times ✓ ✓
* Lack of emission lines at late-times ✓

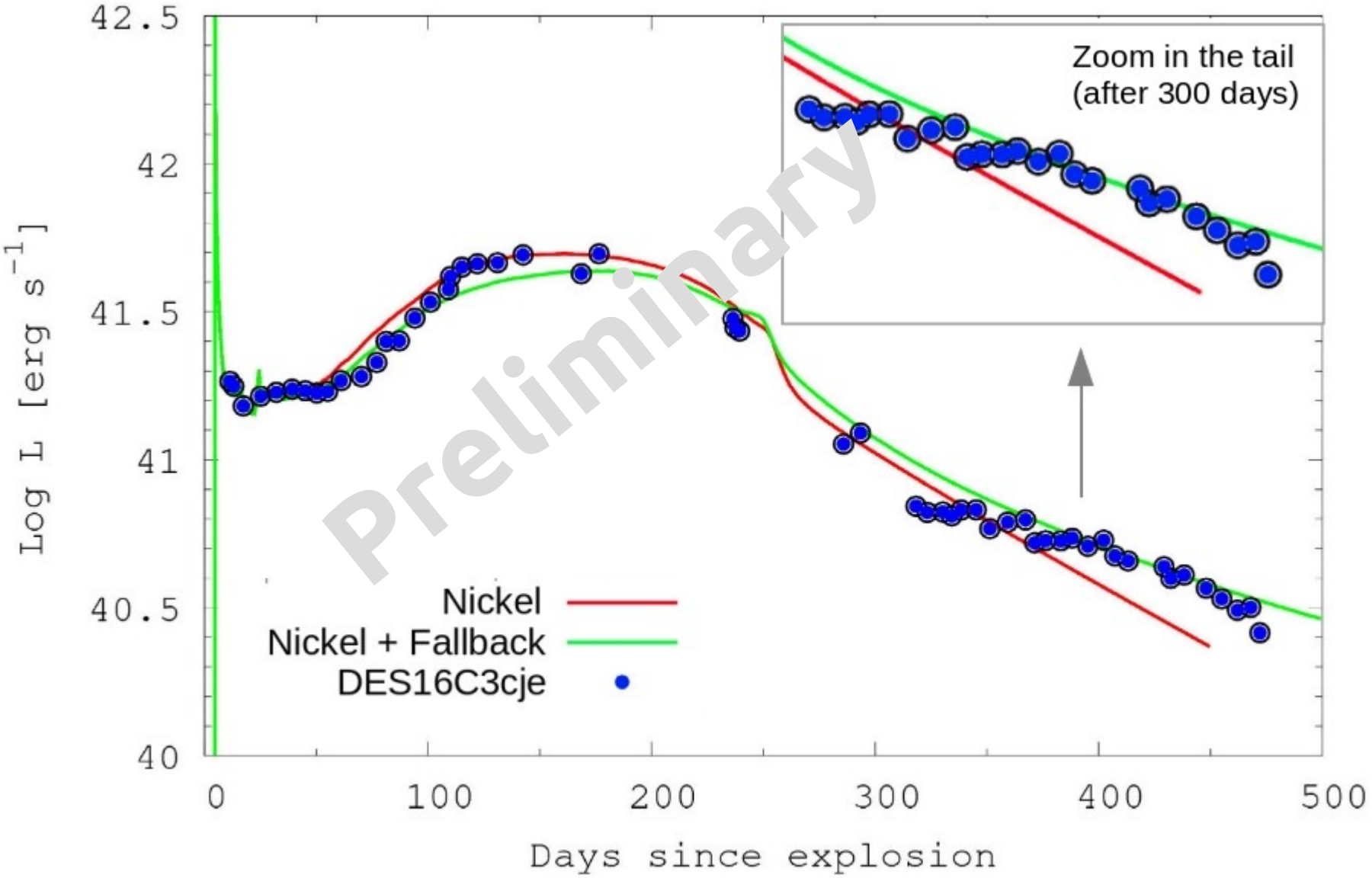
DES16C3cje: looking for a scenario that explain its peculiar evolution

	SN Impostor	SN explosion
LIGHT CURVE		
* Peculiar evolution	✓	✓
* Very slow rise	✗	✓
* Peak luminosity	✗	✓
* Variability over time	?	✓
* Decline in the tail	✓	? ✓
SPECTRA		
* Very narrow lines	✓	✓
* No evolution over time	✓	✓
* Lorentzian profile at late-times	✓	✓
* Lack of emission lines at late-times	✓	✓

DES16C3cje: looking for a scenario that explain its peculiar evolution

	SN Impostor	SN explosion
LIGHT CURVE		
* Peculiar evolution	✓	✓
* Very slow rise	✗	✓
* Peak luminosity	✗	✓
* Variability over time	?	✓
* Decline in the tail	✓	? ✓
SPECTRA		
* Very narrow lines	✓	✓
* No evolution over time	✓	✓
* Lorentzian profile at late-times	✓	✓
* Lack of emission lines at late-times	✓	✓

Exploring the alternatives to explain the evolution of DES16C3cje, the fall-back SN scenario fits with the parameters



Parameters: M ~ 15M_{sun}; R ~ 700R_{sun}; E = 0.1Foe

Summarising

DES16C3cje:

* Peculiar type II supernovae

* Very faint object (Mr ~ -15.6 mag at maximum) exploding in a low-luminosity host galaxy (Mr = –16.34).

* The decline rate at late-time does not follow the decay of ^{56}Co

* The spectra display very narrow lines → very low velocities!

* Lack of emission lines in the late-time spectra

We explored the **fall-back** scenario to explain the uncommon evolution of DES16C3cje obtaining:

$$M \sim 15 M_{sun}; R \sim 700 R_{sun}; E = 0.1 Foe$$