The Curious Case of iPTF14hls

Iair ("ya-eer") Arcavi
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Quintuple-Peaked Light Curve

At least 5 peaks

Last non-det is 140d before discovery

Arcavi et al. 2017
SN 1999em (typical IIP)
iPTF14hls

Leonard et al. 2002
Arcavi et al. 2017
How can a Velocity Gradient be Constant in Time?

SN 1999em

iPTF14hls

Time since discovery (rest-frame days)

Expansion velocity (km s⁻¹)

Hα
Hβ
Fe

Arcavi et al. 2017
Photosphere Radius Estimates Diverge

Arcavi et al. 2017
Quintuple-Peaked Light Curve

At least 5 peaks

Last non-det is 140d before discovery

Arcavi et al. 2017
Adapted from Waldman 2008

- "Normal" core collapse evolutionary path
- Pulsational pair instability
- Pair instability
- Fe disintegration

More Massive
Is 14hls a Pulsational Pair Instability Supernova?

Woosley 2017
Evidence for a Historic Eruption

1954

1993

Arcavi et al. 2017
Late Spectra Show Line Structure = Interaction?
<table>
<thead>
<tr>
<th></th>
<th>LC Energetics</th>
<th>LC bumps</th>
<th>Velocity Evolution</th>
<th>1954 eruption</th>
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</thead>
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<tr>
<td><strong>Soker &amp; Gilkis</strong> (common env. jets)</td>
<td>✔️ ?</td>
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<td><strong>Andrews &amp; Smith</strong> (CSM)</td>
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<td><strong>Dessart</strong> (Magnetar)</td>
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<td>✗</td>
<td>✔️</td>
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<td><strong>Wang et al.</strong> (Fallback accretion)</td>
<td>✔️ ✔️</td>
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<td><strong>Woosley</strong> (CSM, PPISN, Magnetar)</td>
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<td>?</td>
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</tr>
</tbody>
</table>

Different models

وردية: ✗
الأخضر: ✔️
الأسود: ❓
Late Sudden Drop in Light Curve

![Graph showing the late sudden drop in light curve with data points from different telescopes.](image)

- **Rest-frame days since discovery**
- **Apparent magnitude**
- **Absolute r/R-band magnitude**

Legend:
- P48
- P60-GRBCam
- P60-SEDM
- LCO-1m
- LCO-2m
- NOT
- TNG
- HST

Arcavi+17 This work

Sollerman et al. accepted
Don’t Know What it is But Here’s Another One?

SN 2018aad Might be Another iPTF14hls at z=0.025

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Credential Certification: Iair Arcavi (arcavi@gmail.com)

Subjects: Optical, Supernovae, Transient

Tweet

SN 2018aad (ASASSN-18eo; Nicholls et al. 2018, ATel #11391) was classified as a Type II supernova at z=0.01 (Hosseinzadeh et al. 2018, TNSCR 1784) based on a broad H-alpha P-Cygni profile. Here we report the observed 8000 km/s recession velocity at 250d post-discovery.
What is iPTF14hls?

- $E_{\text{rad}} \sim \text{few } \times 10^{50} \text{ erg}$
- $T \sim 5000-6000 \text{ K}$
- $R_{\text{ph}} \sim 2 \times 10^{15} \text{ cm}$
- $L_{\text{bol}} \sim \text{few } \times 10^{42} - 10^{43} \text{ erg/s}$
- $[M_H \sim \text{few tens of solar masses}$
- $E_{\text{kin}} \sim 10^{52} \text{ erg}$

1954