**Fast and Furious: Analysis of the Luminous and Rapidly-Evolving Type Ic-BL Supernova iPTF16asu**

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### Assessing the Scene: Data and context of iPTF16asu

**Context**

- **PTF16asu Light Curve**
  - Rest-frame rise time ($t_r$): 4.0 days!
  - Peak luminosity ($M_L$): -20.4 mag

**Photometry**

- **g Band Light Curve**
  - More luminous and rapidly-evolving than other similar transients.

**Spectroscopy**

- **Superluminous**
  - Featureless, blue continuum, similar to [3].
  - From host galaxy narrow emission lines: $z = 0.1874$

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### Investigating the Explosion: Analysis of physical properties

#### Bolometric Light Curve & Radiated Energy

- **Total Radiated Energy:** $4.0 \times 10^{50} \pm 6.3 \times 10^{50}$ ergs
- **Peak Bolometric Luminosity:** $3.4 \times 10^{50} \pm 2.8 \times 10^{50}$ ergs/s

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#### Temperature & Radius

- **Peak Parameters:**
  - $T = 10820 \pm 520$ K
  - $R = 2.6 \times 10^{15} \pm 1.9 \times 10^{14}$ cm

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#### Velocity

- **Magnetar**
  - Rapidly-spinning neutron star generates extreme magnetic fields.
  - Energy is released to the supernova as magnetar spins down.

- **Magnetar Energy**:
  - $1/P^2$

- **Spin-down Time**:
  - $\propto P / B^2$

- **Magnetic Field**:
  - $6.5 \times 10^{14}$ G

- **Ejecta Mass**:
  - $0.13 M_\odot$

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### Unraveling the Mystery: Testing various explosion models

#### Nickel-56 Decay?

- Normal Type Ic supernovae powered by radioactive decay of $^{56}$Ni:
  - $^{56}$Ni $\rightarrow$ $^{56}$Co $+$ γ
  - $^{56}$Co $\rightarrow$ $^{56}$Fe $+$ γ

- **Ni Decay Powered Light Curve**
  - **Not feasible**

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#### Magnetar?

- Rapidly-spinning neutron star generates extreme magnetic fields.
  - Energy is released to the supernova as magnetar spins down.

- **Magnetar Powered Light Curve**
  - **Possible**

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#### Off-Axis GRB?

- Velocities comparable to other SN Ic-BL + GRB.
- Featureless blue spectra at early times.
- No reported GRB consistent with location and explosion time.
- No radio detection with VLA.
- No X-ray detection with Swift/XRT.

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#### Shock Cooling?

- Early blue spectra, luminous, and short-lived.
- Peak radius of $4 \times 10^4 R_\odot$ is larger than any star, requiring circumstellar material.

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### References