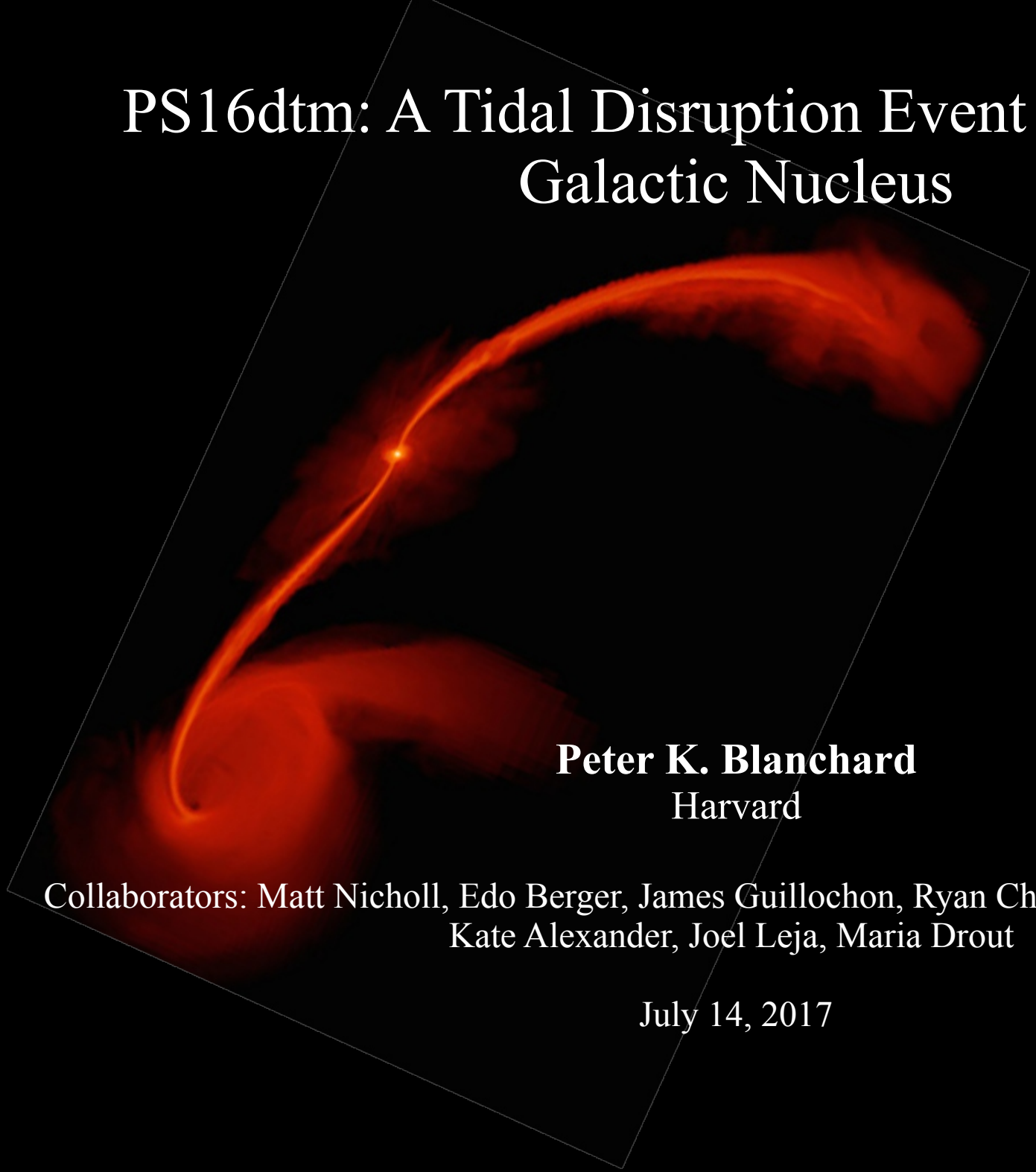
PS16dtm: A Tidal Disruption Event in an Active Galactic Nucleus



Peter K. Blanchard
Harvard

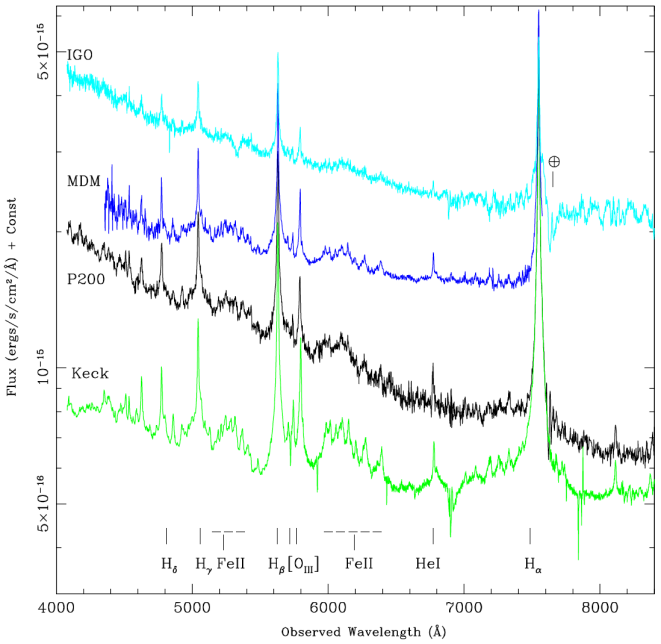
Collaborators: Matt Nicholl, Edo Berger, James Guillochon, Ryan Chornock, Raffaella Margutti, Kate Alexander, Joel Leja, Maria Drout

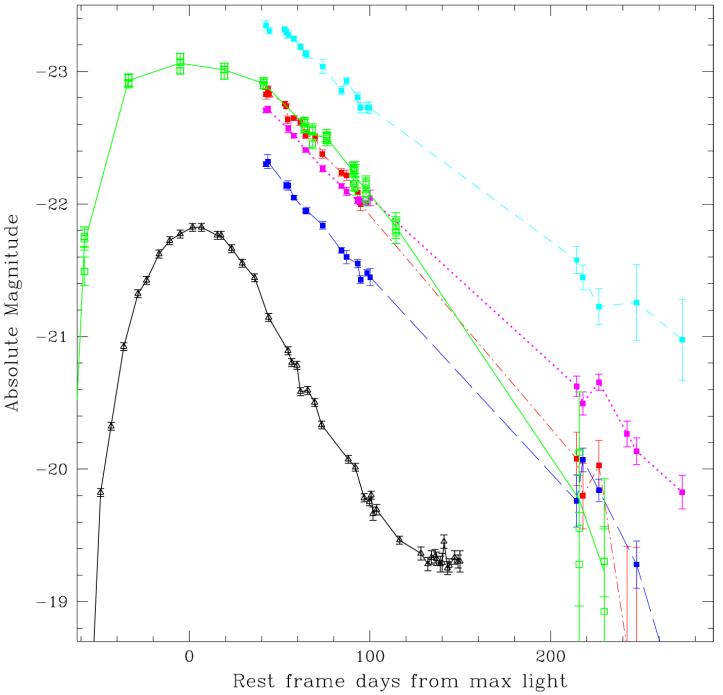
July 14, 2017

Image credit: J. Guillochon and E. Ramirez-Ruiz

TDEs in Active Galaxies

- Though no physical process specifically forbids TDEs from occurring in AGN, identification of TDEs in AGN galaxies is complicated by the possibility such an event is due to AGN variability
    - Finding and studying TDEs in AGN is crucial if we want to understand the full range of disruption scenarios
- Wide-field untargeted surveys have led to the discovery of several luminous nuclear transients that are not easily classified and which could be due to TDEs, AGN activity, or supernovae

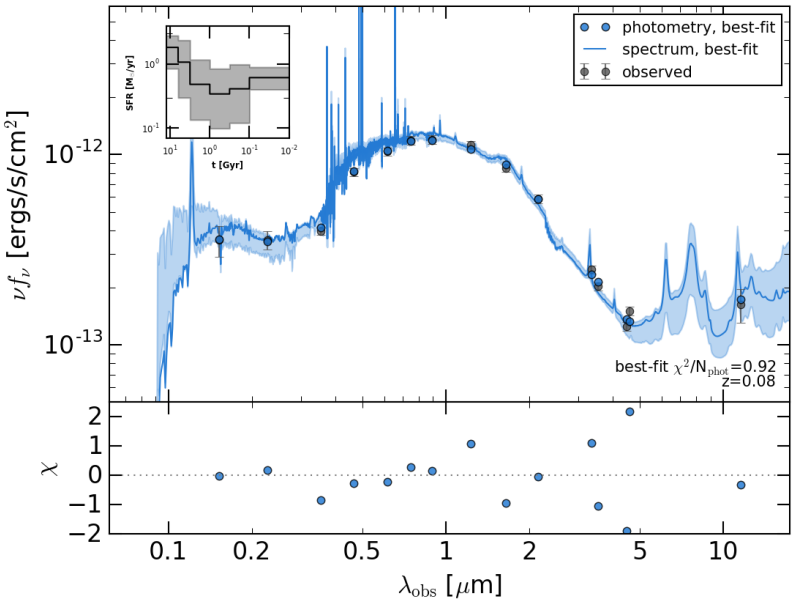


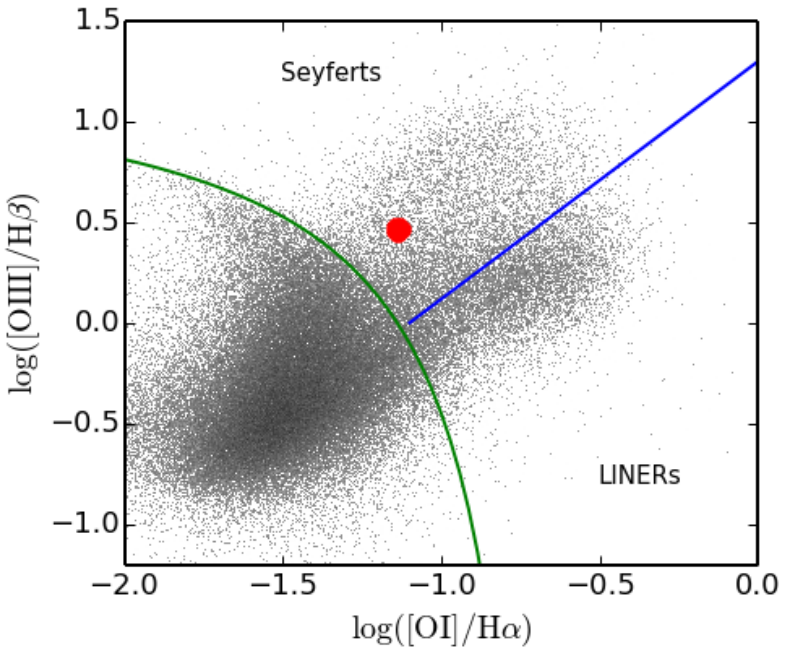


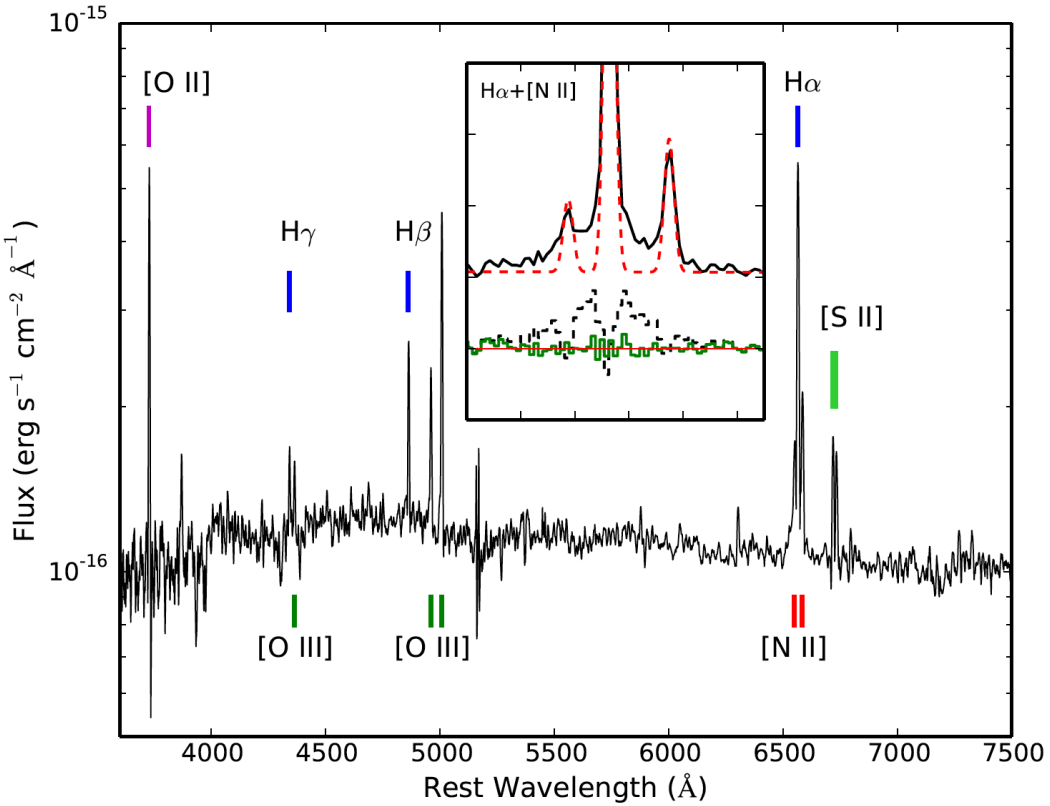
Drake et al. 2011

The Narrow-line Seyfert 1 (NLS1) Host Galaxy of PS16dtm

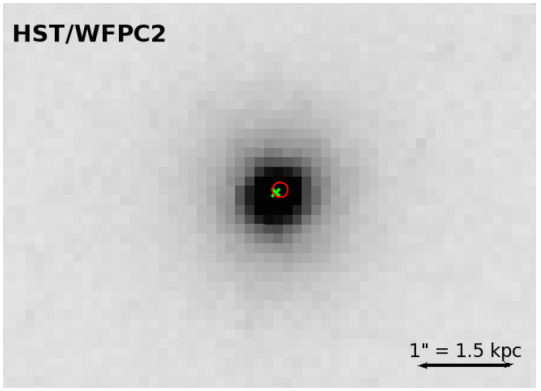
- Pre-transient galaxy SED modeling and emission line properties indicate the host of PS16dtm is a NLS1 at $z = 0.0804$
- Key properties:
  - Broad Hα width ~ 1200 km/s
  - Black hole mass $\sim 10^6\ M_\odot$
  - X-ray emission detected by *XMM/Newton* yielding $L_{\rm opt}/L_{\rm X} \sim 0.5$





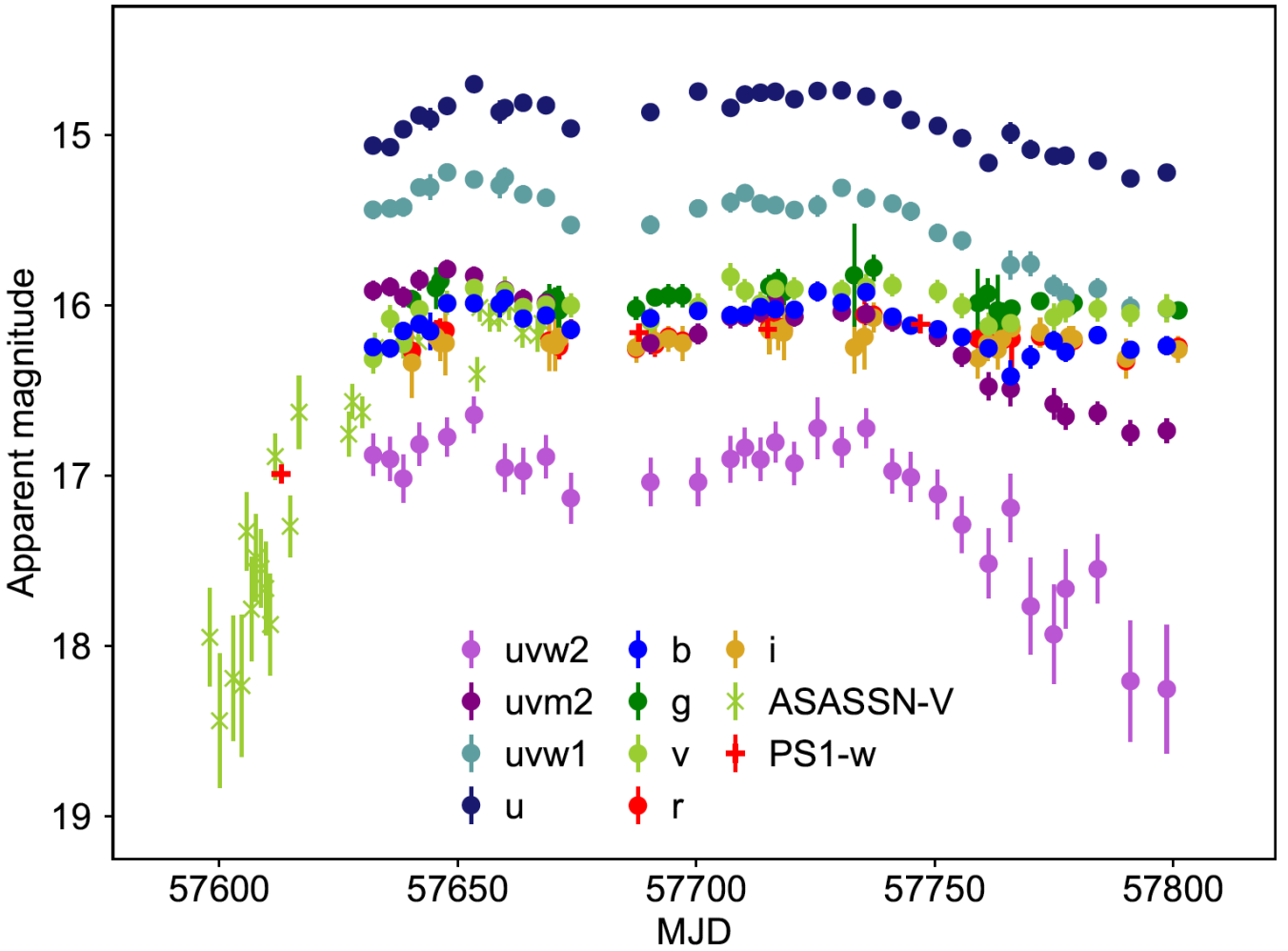


PS16dtm: An Unusual Luminous Transient



Key Light Curve Properties

- ~50 day rise of two orders of magnitude above the archival AGN luminosity
- ~100 day plateau
  - No color evolution
  - **Bolometric Luminosity equal to L_{Edd}**



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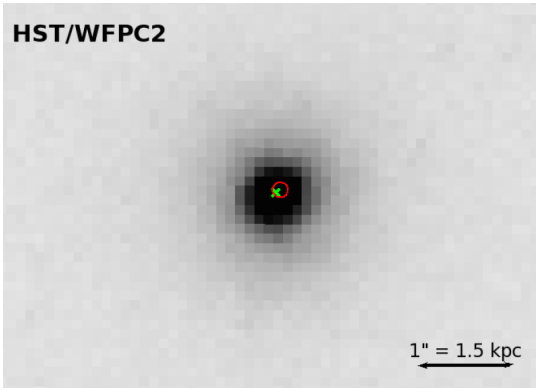

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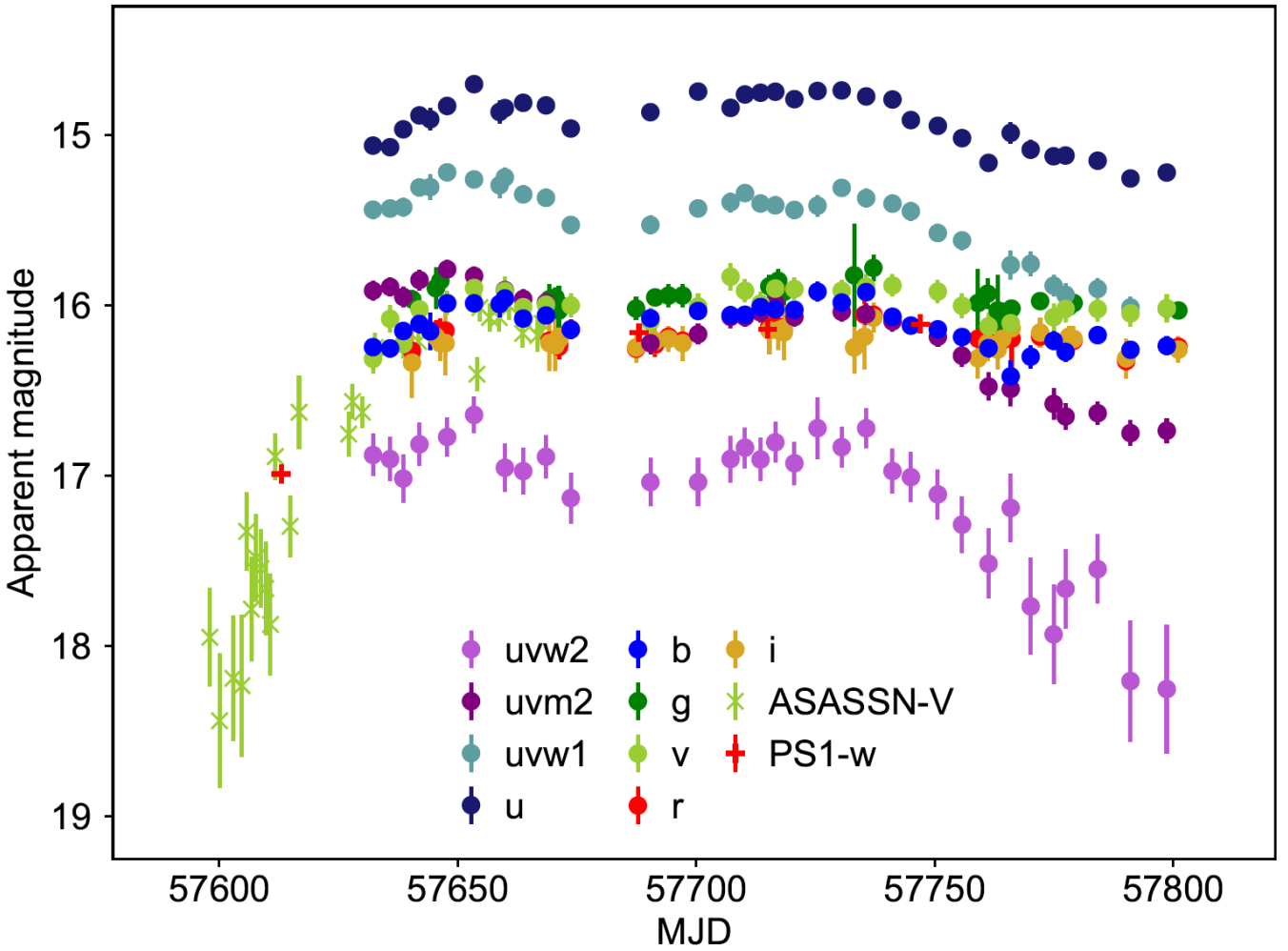

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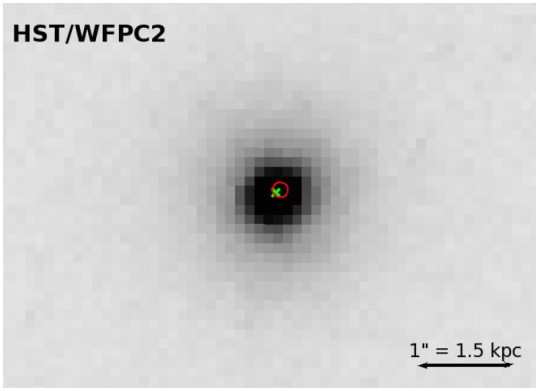

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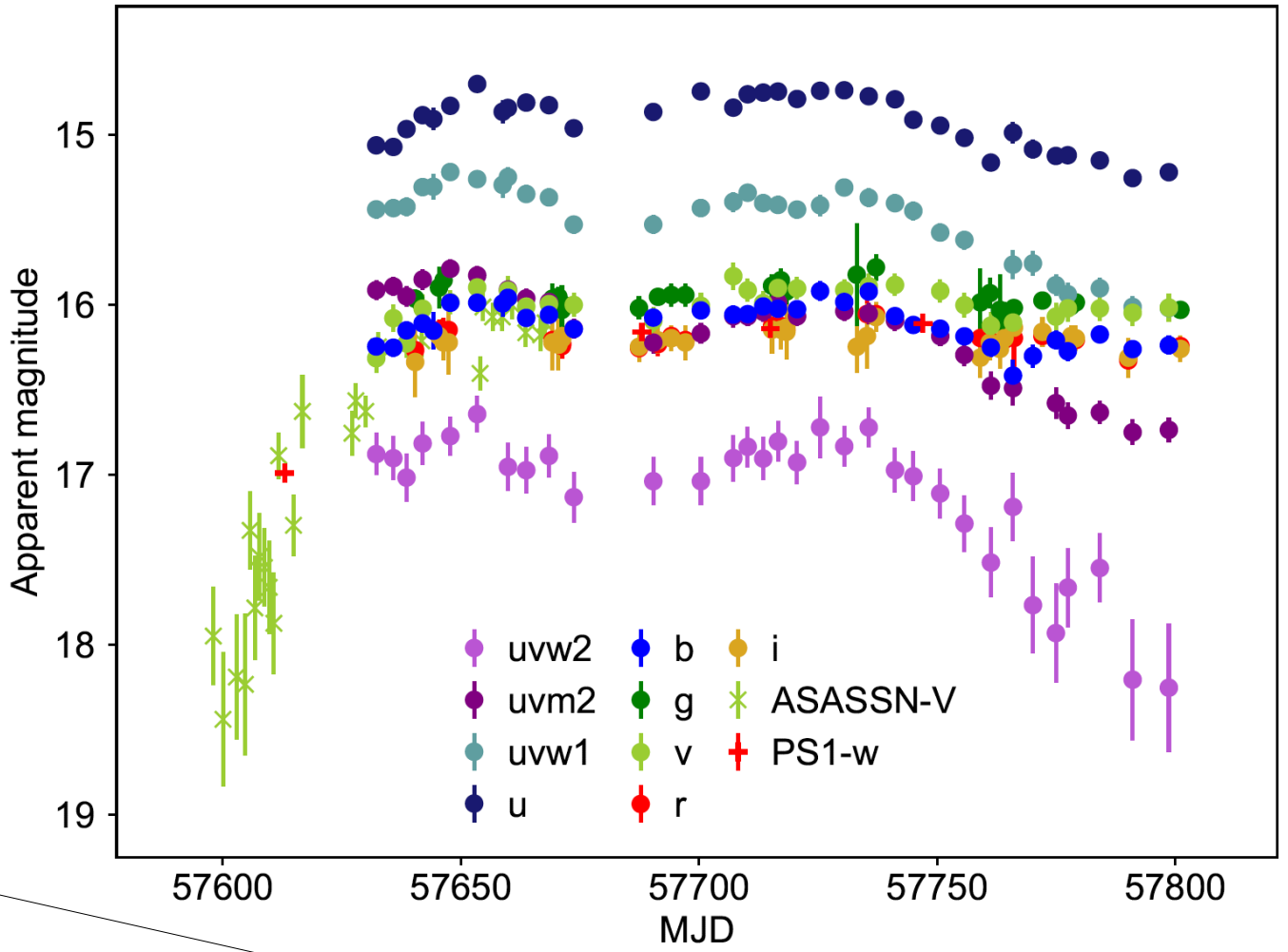

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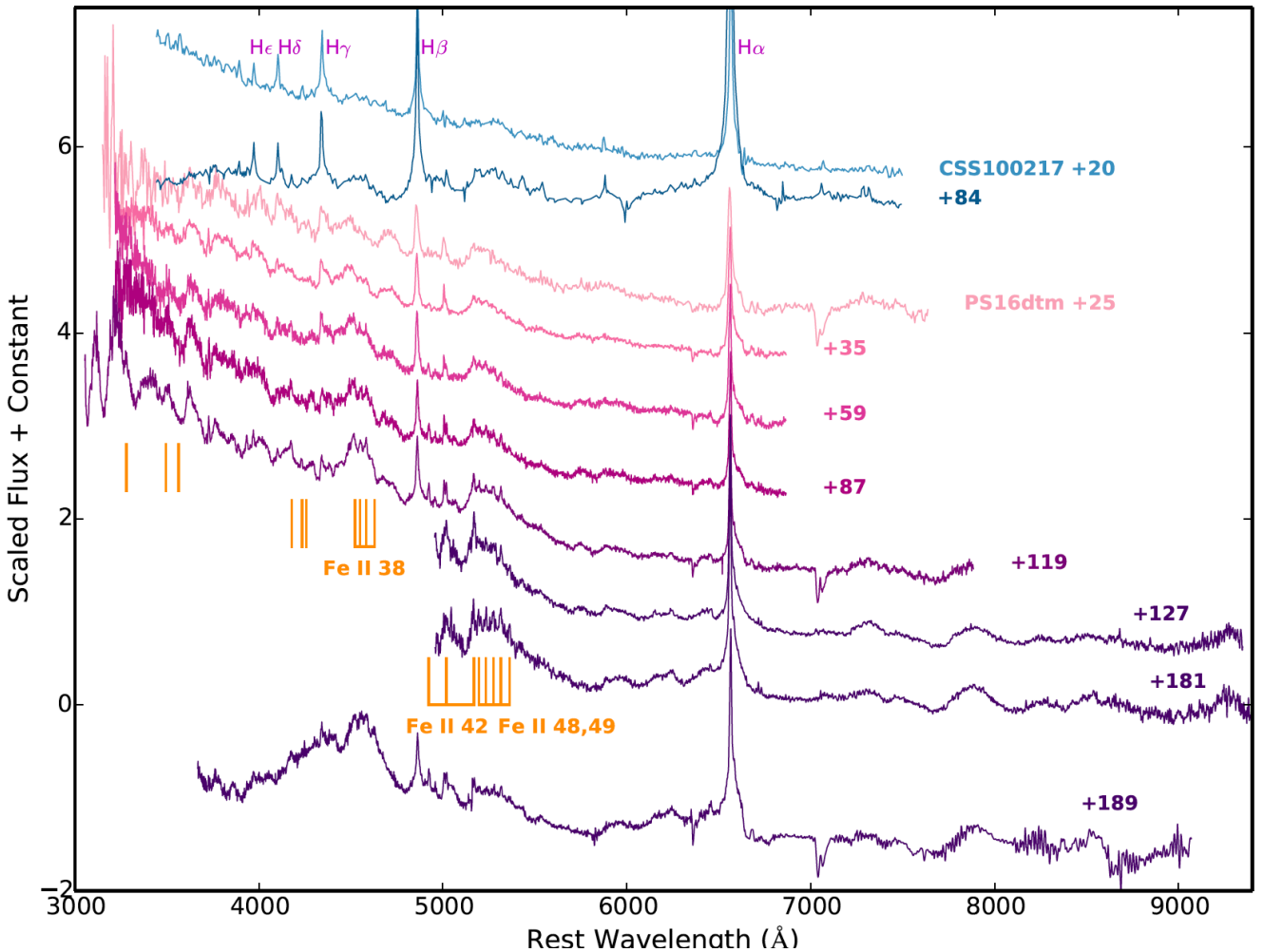
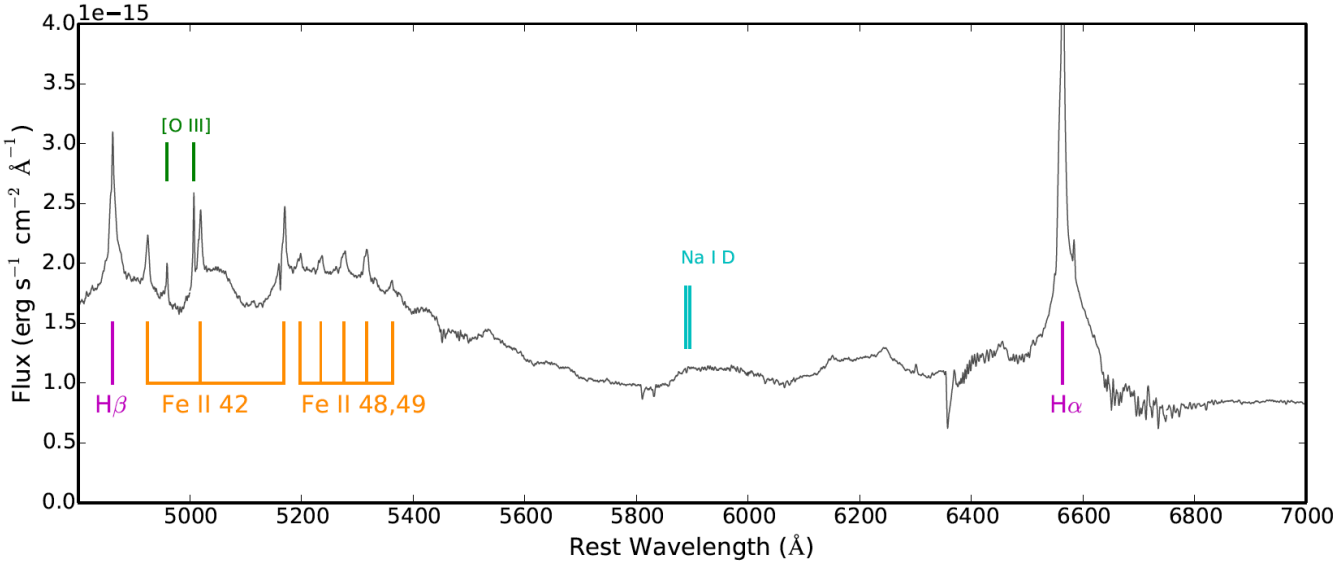
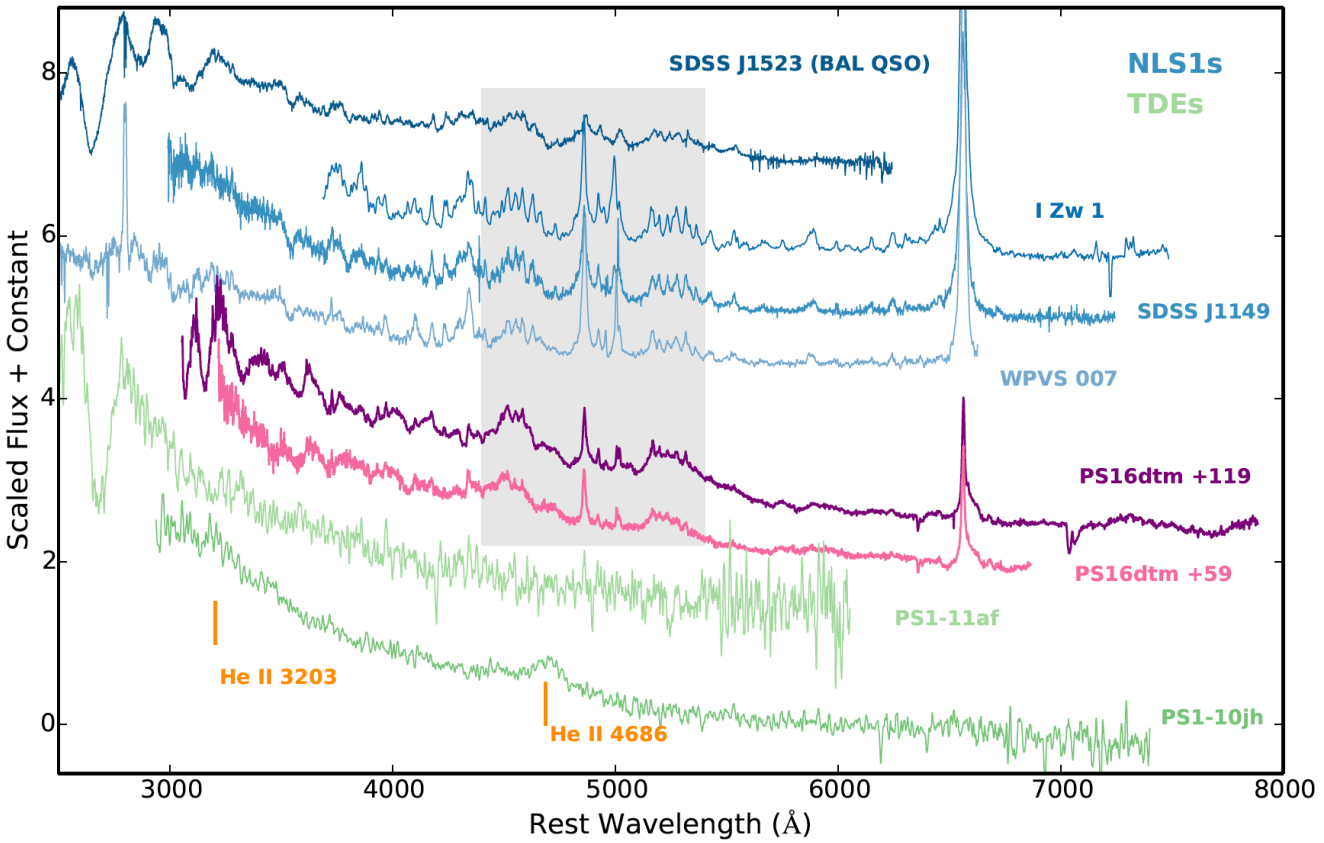
These properties are not easily explained by supernovae or known forms of AGN variability

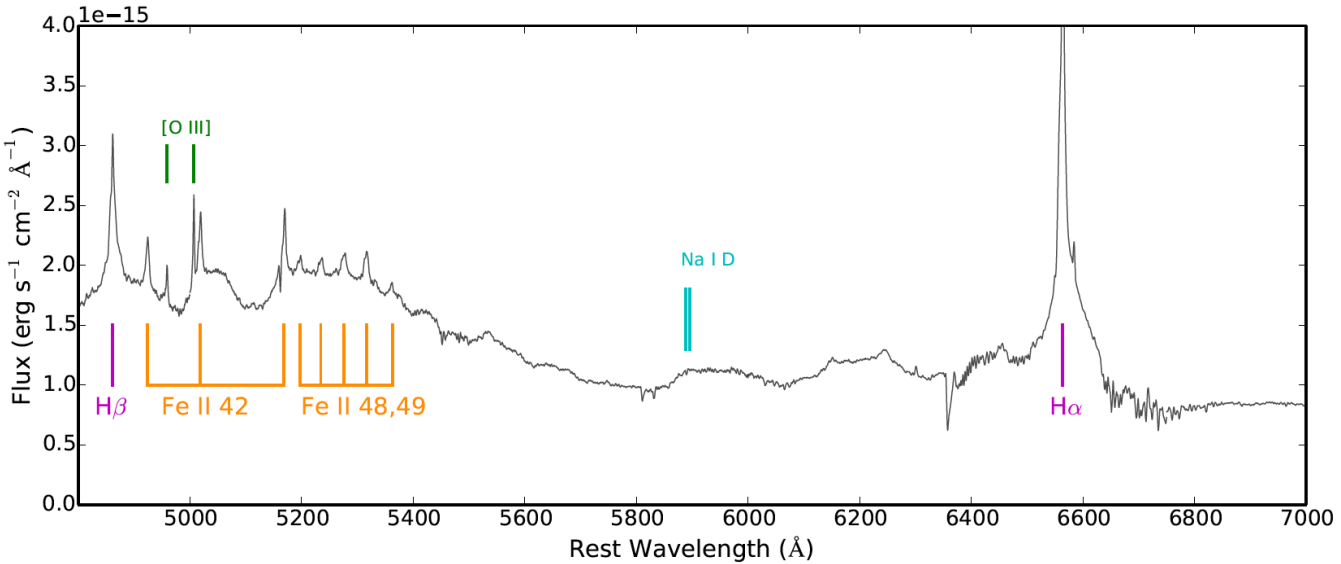




Key Spectral Properties

- 3-component (narrow, intermediate, and broad width) hydrogen Balmer lines
- Strong Fe II emission complexes
- No significant evolution with time
- Spectra closely resemble NLS1 galaxies while being distinct from Type IIn SNe
- In the NUV, we see broad (~10,000 km/s) blueshifted Mg II absorption indicative of an outflow





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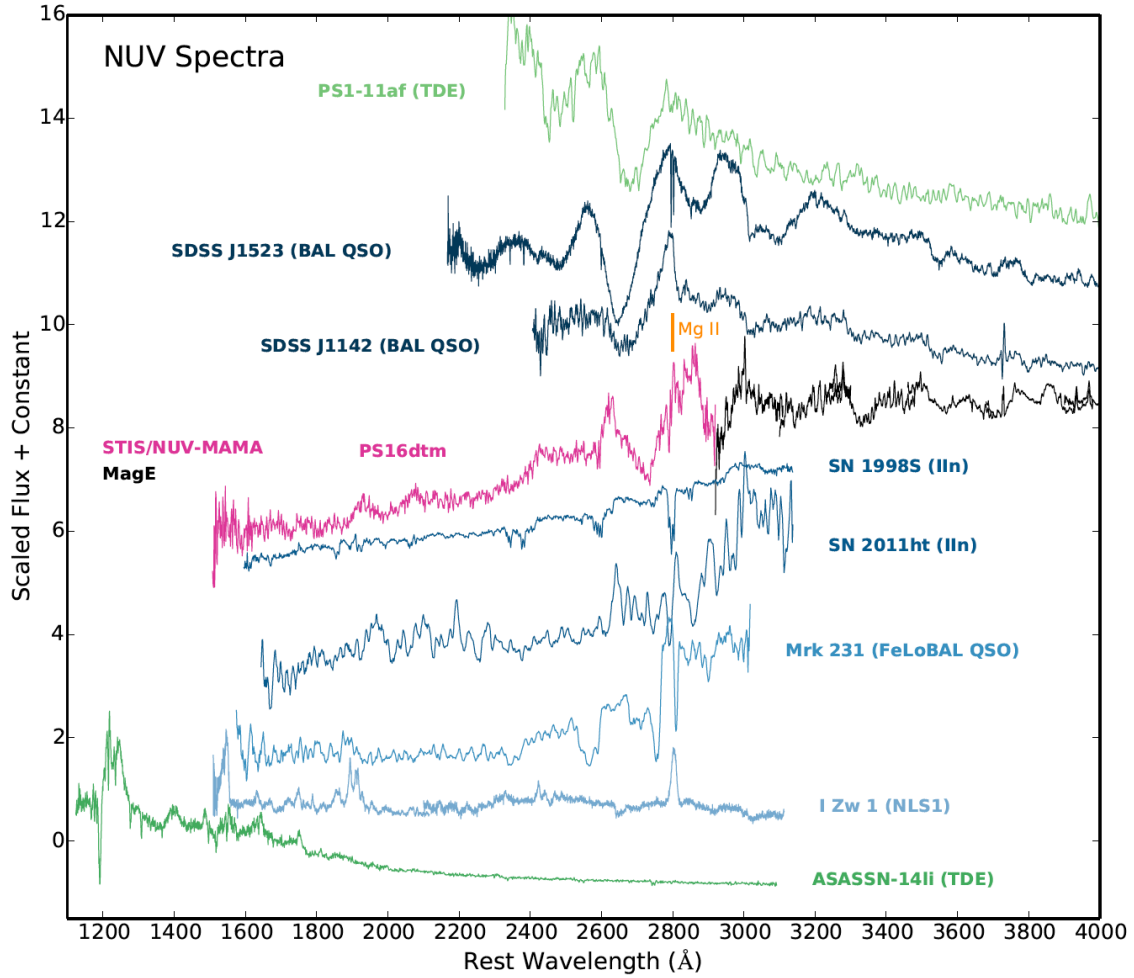

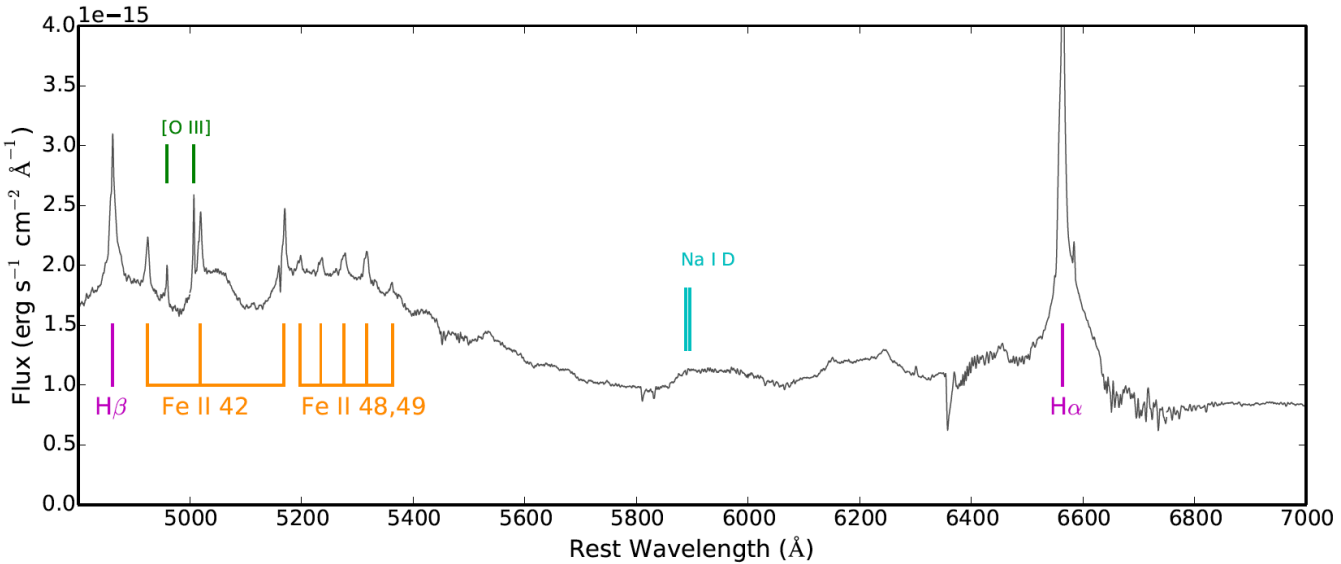

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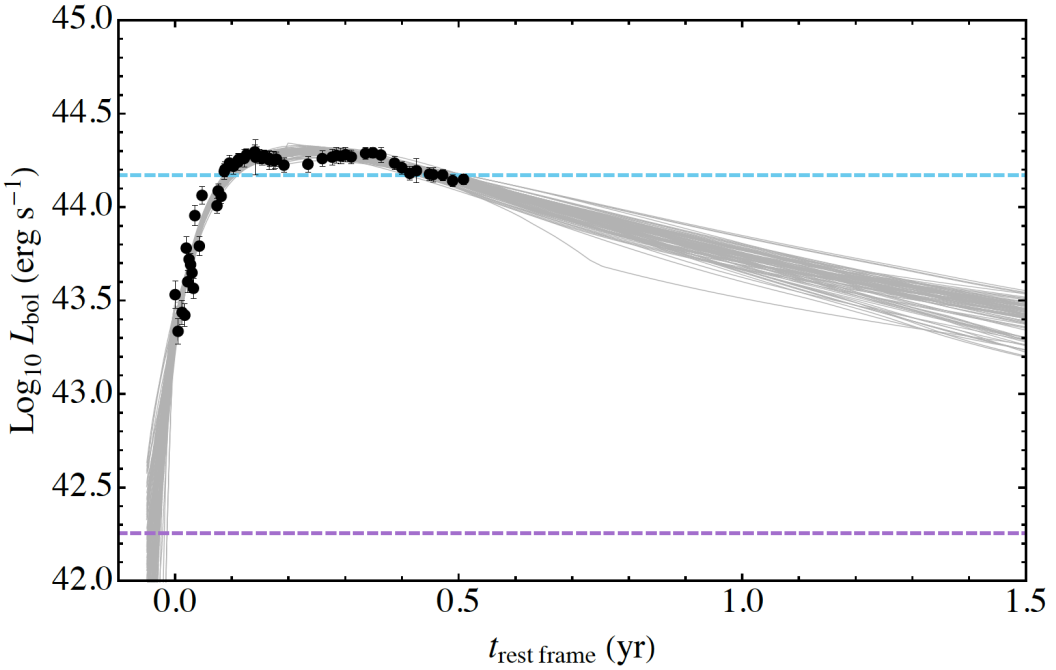
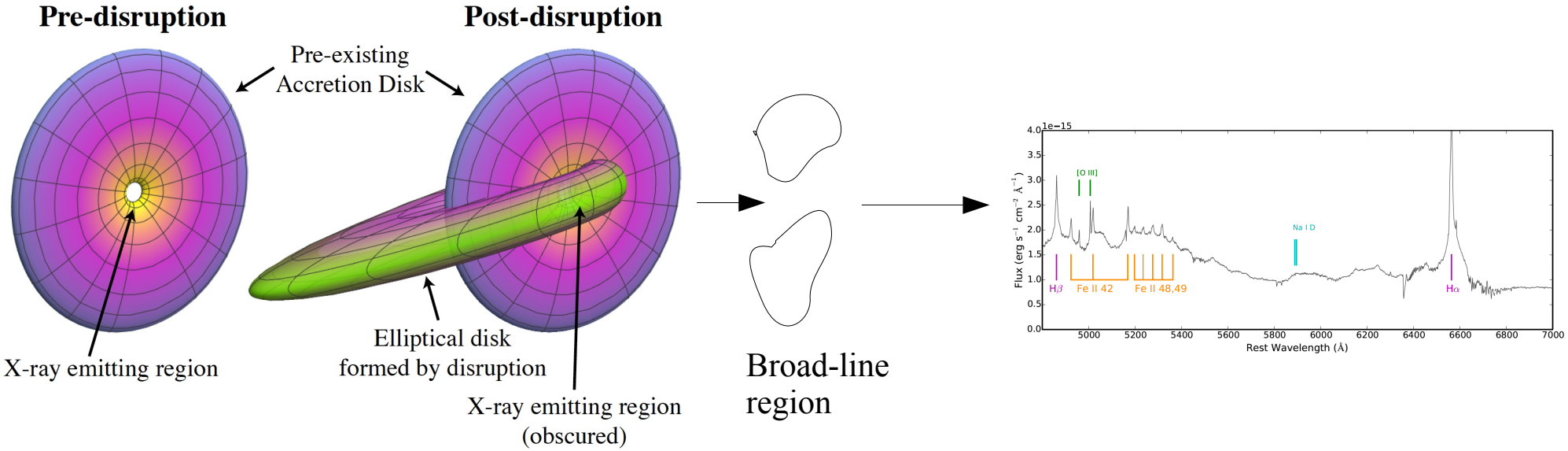
PS16dtm as a TDE

The accretion of the stellar debris provides a luminous flare which excites the broad line region,

and at the same time,

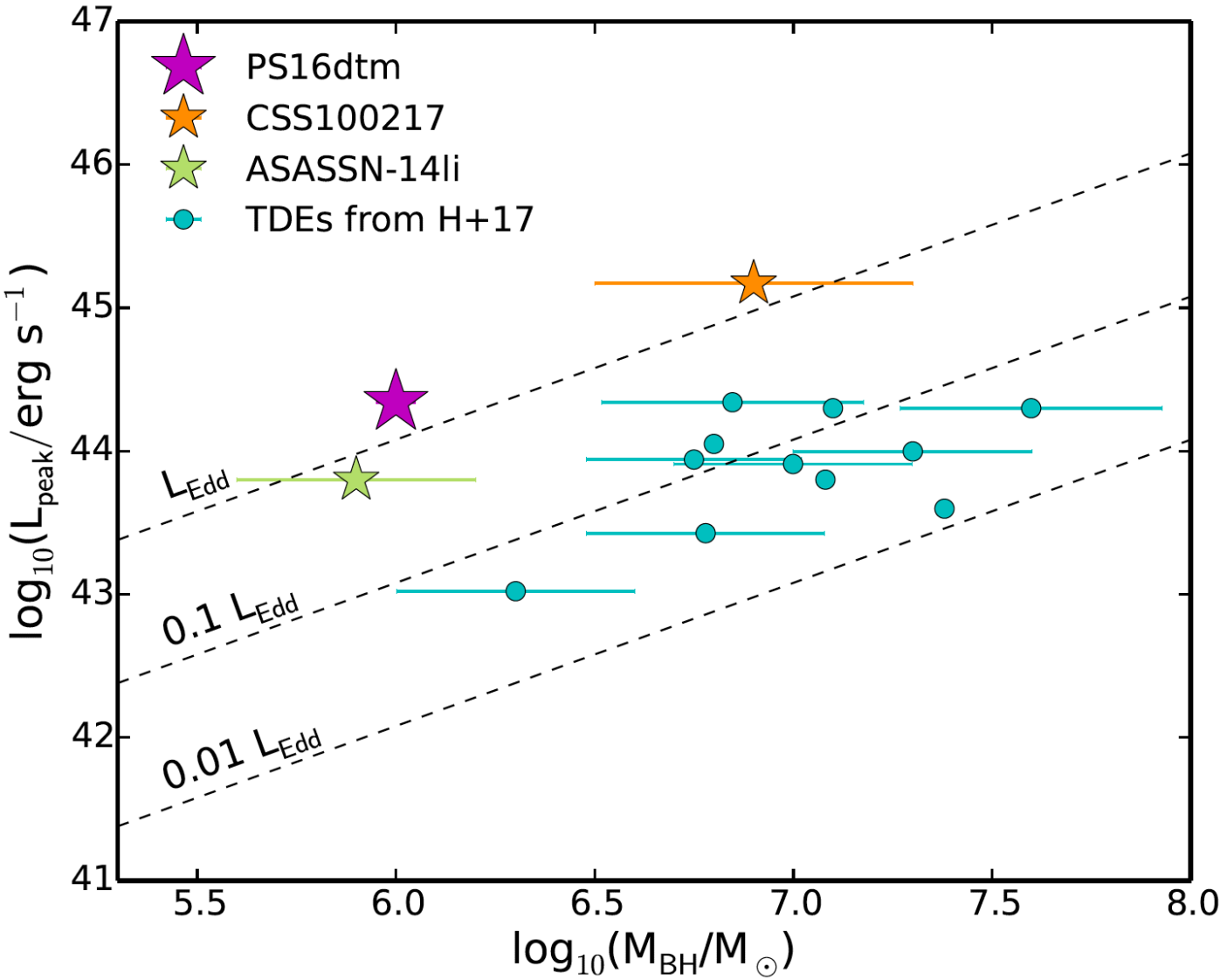
provides material that obscures the X-ray emitting region of the pre-existing disk





Prediction: X-rays will reappear as the accretion rate decreases

PS16dtm in a Broader Context



- TDEs in AGN galaxies may exhibit more efficient accretion due to interaction with the pre-existing disk

Conclusions

- PS16dtm is a new member of a very small class of luminous nuclear transients that occurred in AGN
- During the ~100 day plateau in the light curve, PS16dtm radiated at the Eddington luminosity of the SMBH
- PS16dtm was not detected in the X-rays to a limit an order of magnitude below an archival detection

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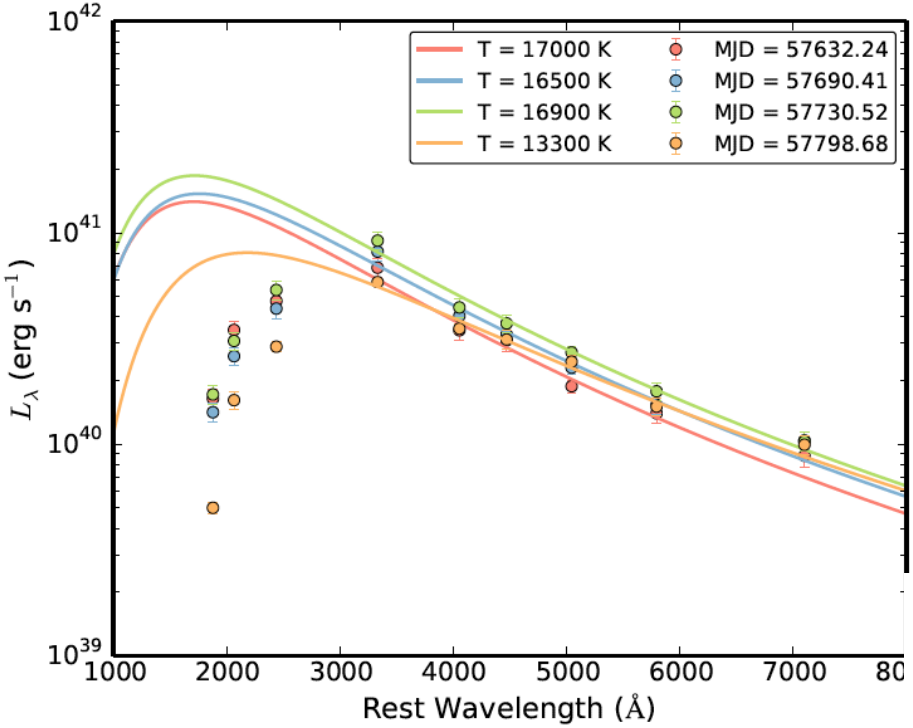
  → The UV/optical light curve behavior coupled with the disappearance of the X-rays is not easily explained by supernovae or AGN variability
- Its spectra closely resemble NLS1 galaxies and show evidence for outflowing material
- These properties strongly suggest that PS16dtm is a TDE in which the accretion of the stellar debris excites the broad line region and provides material that obscures the pre-existing X-ray emission
- There is a hint that TDEs which occur in AGN may exhibit more efficient accretion than TDEs which occur in inactive galaxies.

For more details, see Blanchard et al. 2017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10^{42}
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L_λ (erg s^{-1})
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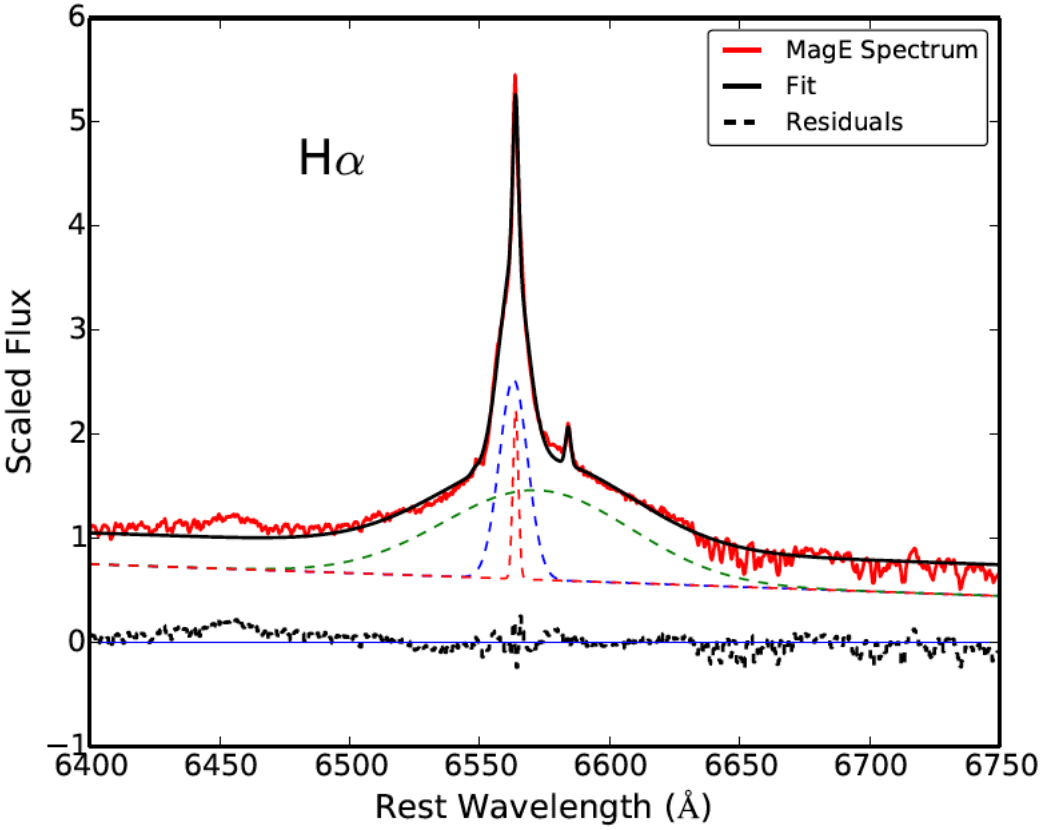
Rest Wavelength (Å)


MagE Spectrum
Fit
Residuals
Hα
Scaled Flux
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5
4
3
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1
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6400
6450
6500
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6600
6650
6700
6750
Rest Wavelength (Å)