A Changing Look Seyfert Observed by K2 SN Team
OR
One Wild and Crazy Galaxy

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- K2 Supernova Team and K2 Project Team.
Observational Background

- The K2 Extragalactic Survey (KEGS) team monitored galaxies searched for Supernova and AGN.
- 2000-3000 galaxies in campaigns 3, 5, 6, 8, 10, 12, 14
- Campaign 16 and 17 were forward facing:
  - The K2 field were well positioned for night time observing
  - To provide for additional ground based follow ups, the K2 SN Team was formed
  - Encouraged by the interest, we went for ~9,000 galaxy targets.
- Campaign 18 was back facing.
DECam discovers a change at the nucleus of 2MASX J08565098+2107380 (z=0.082)
Changing Look Seyfert
Strong Broad H (blueshifted) lines and a continuum are new.
K2 Data of AT2018qb (raw, fit, and final)
3891 measurements, 80.5 days
No discernable sawtooth pattern

TDE2018qb = EPIC 212051579

Normalized Flux vs. Day
Photometry: K2, DECam and PS1
After subtracting galaxy light

A slow linear rise, then a $t^{-5/3}$ falloff.
Typical TDE light curve except not blue.
Delay between bands <1 day.
t(peak) = 39 days
Instantaneous (5day) LC slope of K2 data.

- Logarithmic slope hits $-5/3$ at 65 days when $t = t - 60$
- Fits hydrodynamic models: $\beta = r_{\text{tidal}} / b = 2 - 3$
- The star is totally disrupted.

Figure 5. Upper panel: Fallback rates onto the SMBH as a function of time for the different orbits modelled. As indicated in the legend, the penetration parameter increases from darker to lighter lines. The black dashed line shows the rate computed assuming that the energy distribution is frozen in at the tidal radius, while the dotted horizontal line corresponds to the Eddington mass accretion rate for a $10^6 M_{\odot}$ SMBH. Lower panel: Time evolution of the logarithmic derivative of each fallback rate presented in the upper panel. The dashed horizontal line indicates the theoretical value of $-5/3$. 
Theory of Seyferts

- Seyfert 2 is Seyfert 1 but accretion disk blocks central region where continuum and broad lines come from.

- Or, Seyfert 2 is Seyfert 1 but the power law continuum has shut off temporarily. Since narrow lines come from much further from center and are bigger than broad lines, they stay on longer.

- For 2018qb, the continuum and broad lines have turned on.
Conclusions

- AGN at z=0.082 had peak luminosity increase of $6.8 \times 10^{11}$ (BC/150) $L_\odot$ and $\dot{M}_{\text{peak}} = 0.46 \left(\frac{0.1}{\eta}\right) (\text{BC}/150) M_\odot/\text{yr}$.

- Went from Seyfert 1.9 (small broad lines) to Seyfert1, i.e. suddenly strong broad H$\alpha$, i.e. a Changing-Look AGN.

- Spectra and light curve do not support either a SN or accretion disk instability.

- K2 optical light abruptly started to rise on Dec 24, 2017 (mjd 58111.1 ± 0.2), smoothly for ~39 days, then a $t^{-5/3}$ slow decline.
  
  - Typical of tidal disruption event. But, colors are redder and no X-ray, but H$\alpha$/H$\beta$ ratio tells us $A_v > 5$ (So, optical actually 100 x brighter!).

- Broad lines blueshifted: Seeing front side of expanding gas at few % c?
  
  - Seyfert 1.9 so expect accretion disk to block light from near BH.

- $\nu^{1.7}$ power law continuum gone by 5 months. But, broad (FWHM 5500 km/s) lines continue to grow.

- Mass of BH from broad lines (Reines et al., 2013) and TDE fit $\sim 5 \times 10^7 M_\odot$. 
- Broad ~5500 km/s Hα, blueshifted 1-2000 km/s, rising.
- Even broader Hα base, Jumps up from 0, then falls.
- Narrow Ha Flux dropped at first? Returned to normal.

![Graphs showing luminosity variations](image-url)
Narrow Line Diagnostics.
Baldwin, Phillips & Terlevich (1981)

Squares – narrow + broad, Circles – narrow only.

Narrow lines – Moves from (composite) Seyfert1.9 + Starformation galaxy to Low-Ionization Nuclear Emission Region.
But, broad lines indicate it is now A Seyfert 1 by convention.
[NII] lines appear a bit stronger.
[O\textsc{i}] and [O\textsc{iii}] relatively unchanged.
Model fit to K2 data.
Assume $t_{\text{viscous}} = 0.08$, efficiency = 0.01
Get $M_{bh} = 4.5 \times 10^6 \, M_{\sun}$