

Title:

The changing changing-look AGN 1ES 1927+654

Abstract:

We report on X-ray follow-up observations of the March 2018 nuclear transient event AT2018zf (ASASSN-18el) from an ongoing campaign that includes XMM-Newton, NuSTAR, Swift, and high cadence (daily-to-weekly) NICER observations. The event was associated with the Seyfert galaxy 1ES 1927+654, a "True Type-2" that, nevertheless, showed an X-ray spectrum typical of an unobscured Type 1 AGN. Optical monitoring revealed the emergence of broad Balmer emission lines following the outburst, suggesting a transition from a Type 2 to a Type 1 AGN on timescales consistent with the light-travel time between the central black hole and the broad line region. The optical outburst was followed by a dramatic shift in the X-ray spectrum as the hard X-ray luminosity of the corona plunged by  $>2$  orders of magnitude and the spectrum became dominated by a  $10^6$  K thermal component. The subsequent X-ray evolution of 1ES 1927+654 includes an additional two-order of magnitude decline in overall luminosity, followed by an extended period of quiescence, and re-brightening to levels that make it the brightest AGN currently in the X-ray sky. Throughout its evolution, the source has displayed X-ray flux variability of factors of several on timescales less than hour, and of  $\sim 100$  on timescales less than a day. The X-ray spectrum varies along a consistent luminosity-dependent track, wherein increases in flux are accompanied by a spectral hardening. We seem to be witnessing the onset of an instability in the pre-existing AGN disc and corona, followed by a still-continuing re-emergence of the corona. If the initial transient is identified as the tidal disruption of a star, it is possible that this was the instigator of this unique behavior.

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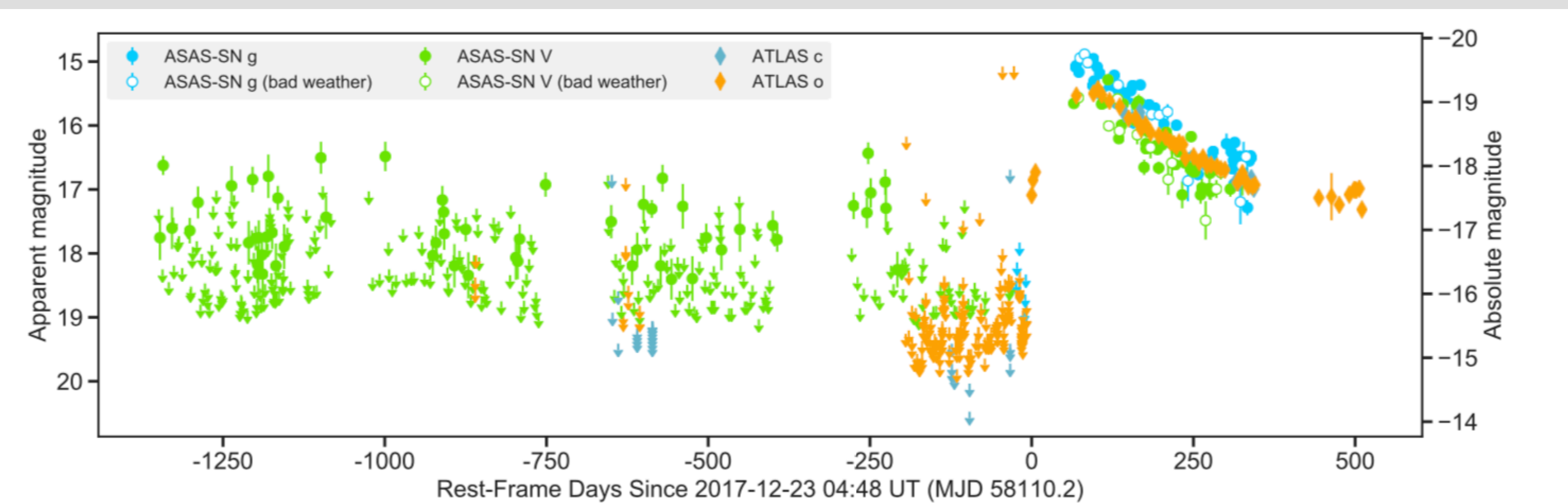
# The changing changing-look AGN 1ES 1927+654

M. Loewenstein, C. Ricci, E. Kara, R. Remillard, B. Trakhtenbrot, A. Fabian,  
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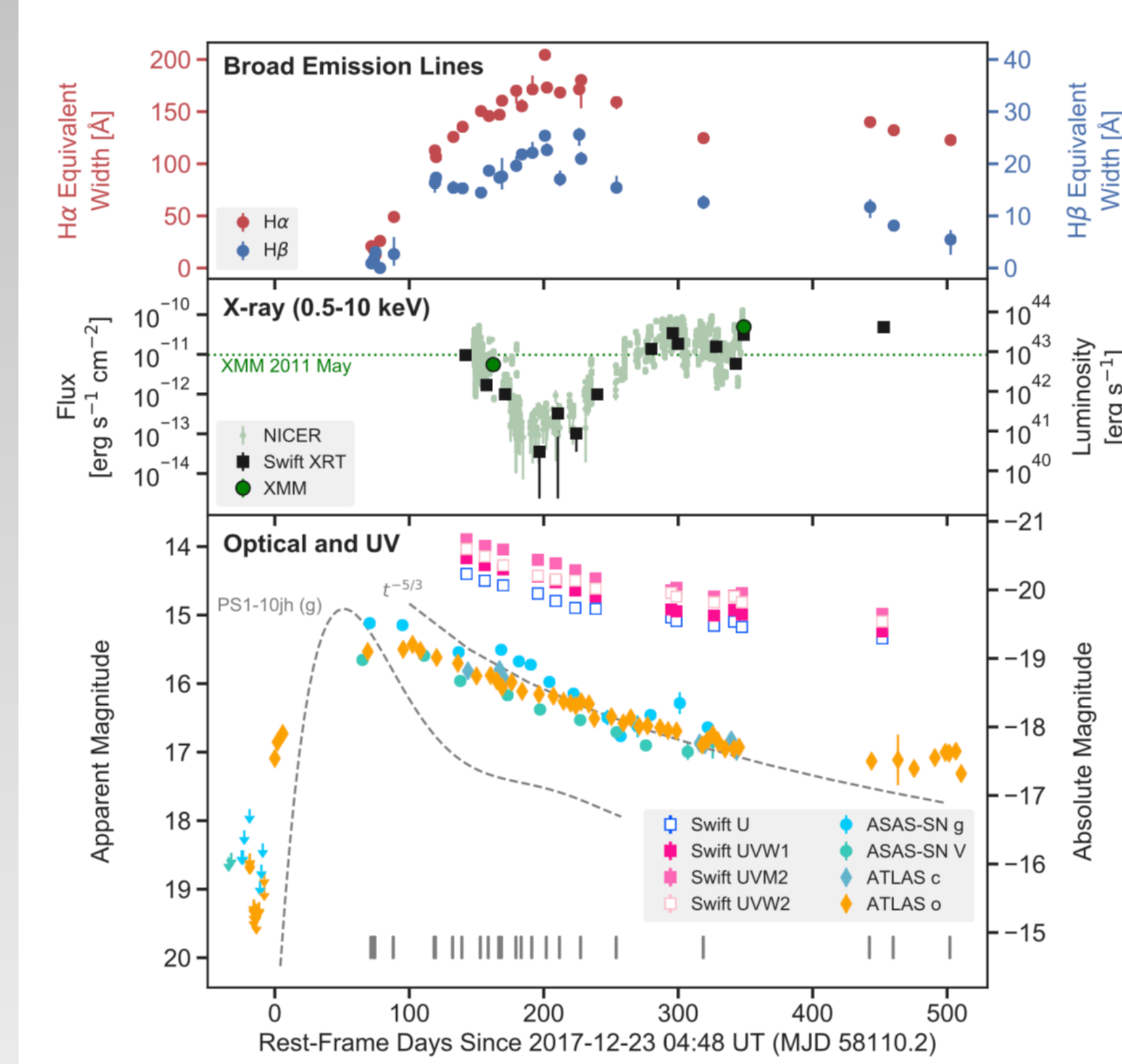
## Introduction

1ES 1927+654, previously characterized as a “true” Type-2 AGN lacking obscuration and broad emission lines, is the first “changing-look” AGN (CLAGN) caught in the act (Trakhtenbrot et al. 2019, ApJ, in press). A sudden  $>2$  magnitude optical flare was captured by the Automated Survey for Supernovae (as ASASSn-18el, aka AT2018zf). Follow-up optical monitoring (and re-examination of previous data) captured the appearance of a blue continuum followed by the appearance, delayed, by  $> 1$  month, of broad Balmer emission lines (the lag expected based on the predicted BLR size).

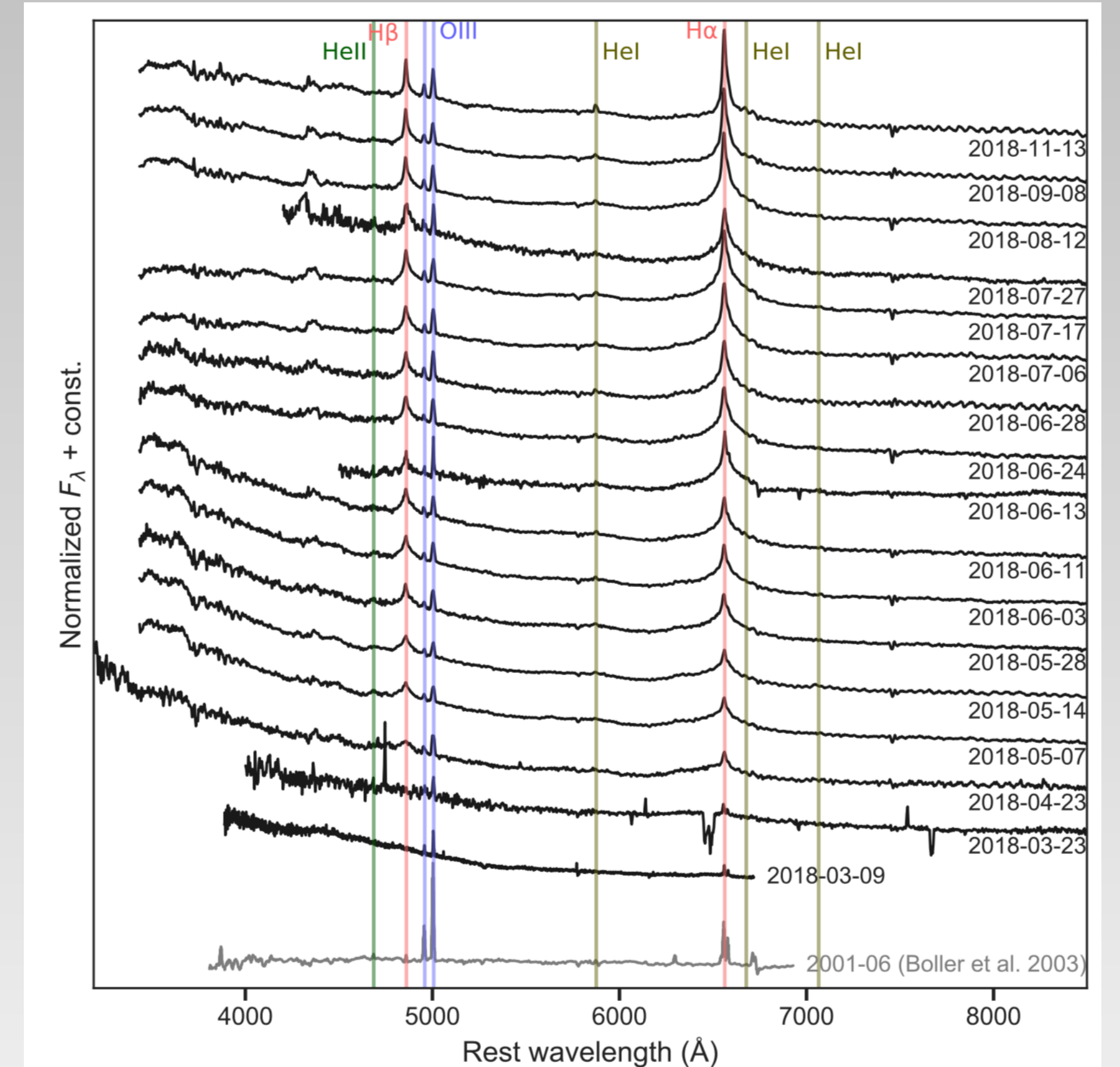
We report here on the multi-mission (Swift, XMM-Newton, NuSTAR, NICER) X-ray campaign that commenced soon after the appearance of the broad lines (Ricci et al., in preparation), emphasizing the NICER results.



## 1ES 1927+654 Caught Changing Look



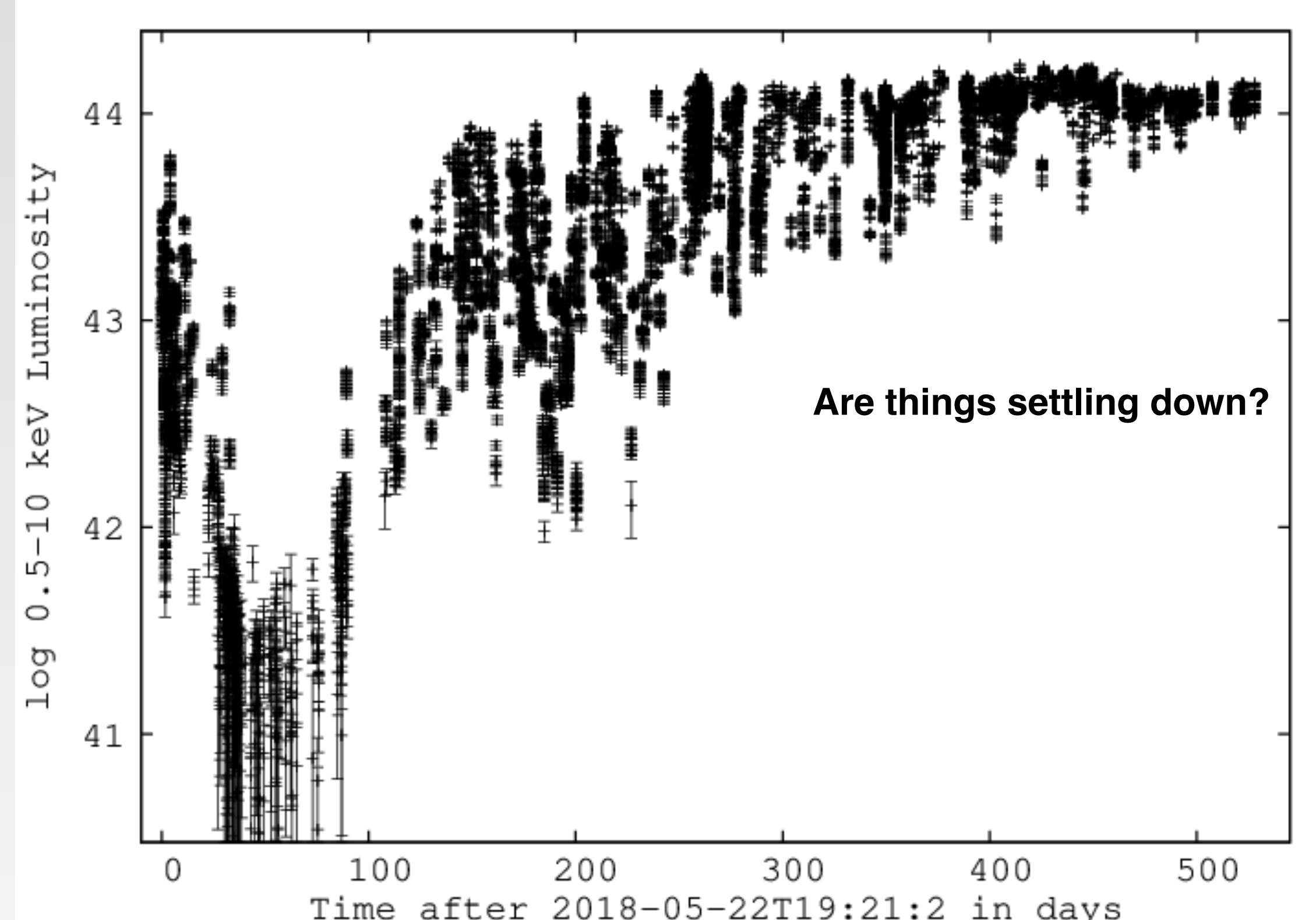
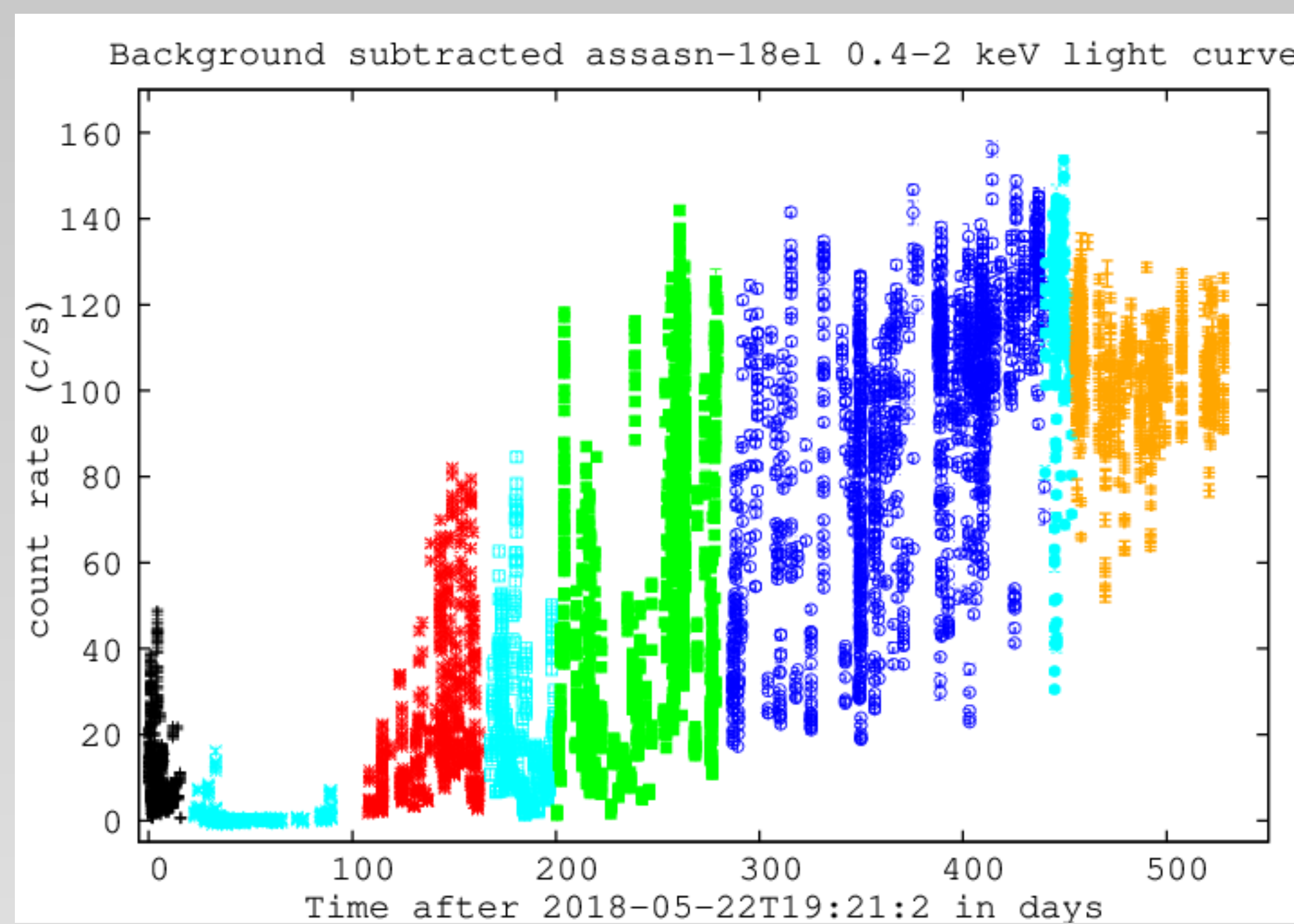
Light curve and equivalent-width evolution.



Optical spectra of 1ES1927+654 showing the Type-2 to Type-1 transition with an intermediate stage of a blue-continuum-dominated emission.

## The NICER Campaign

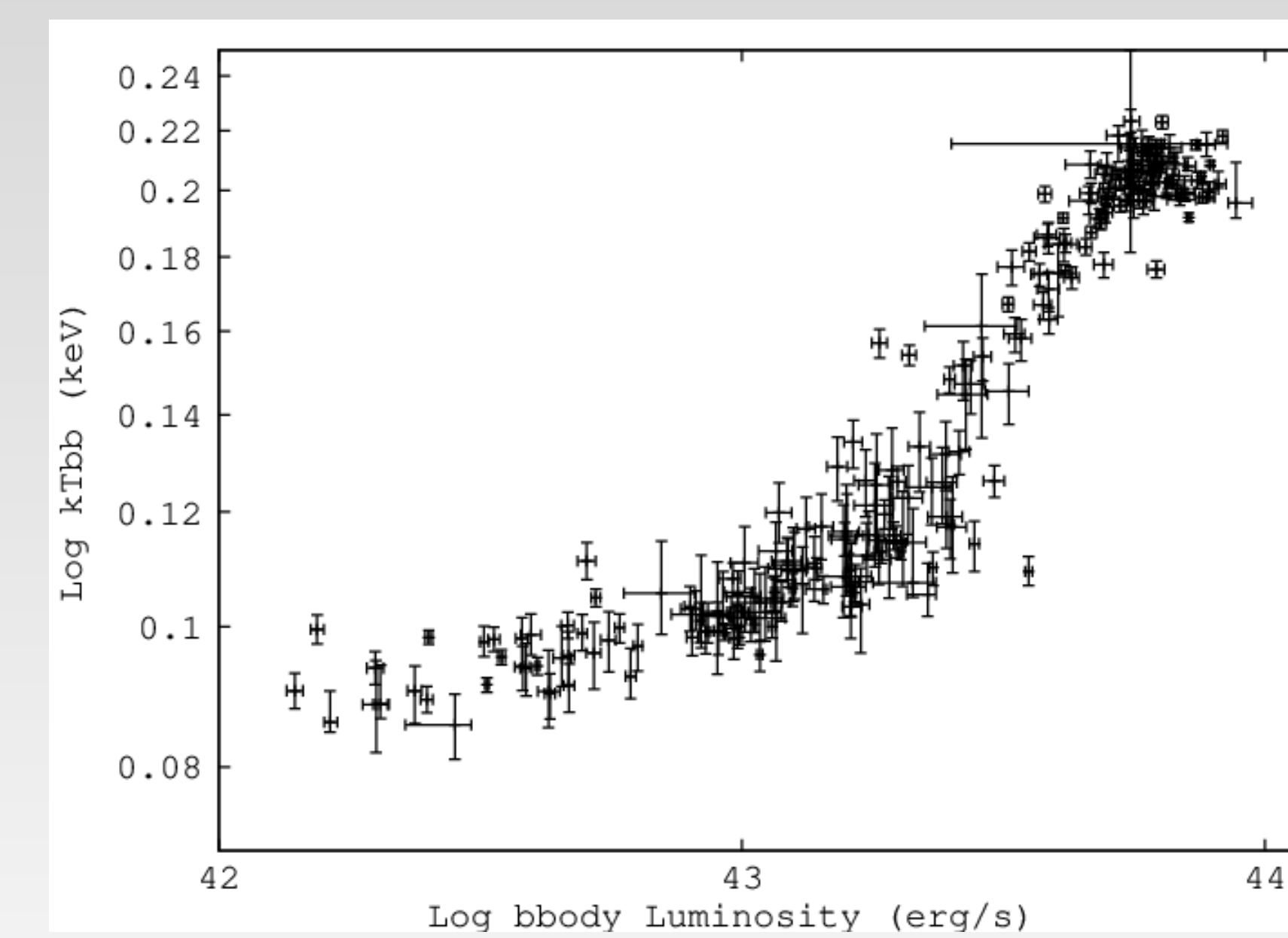
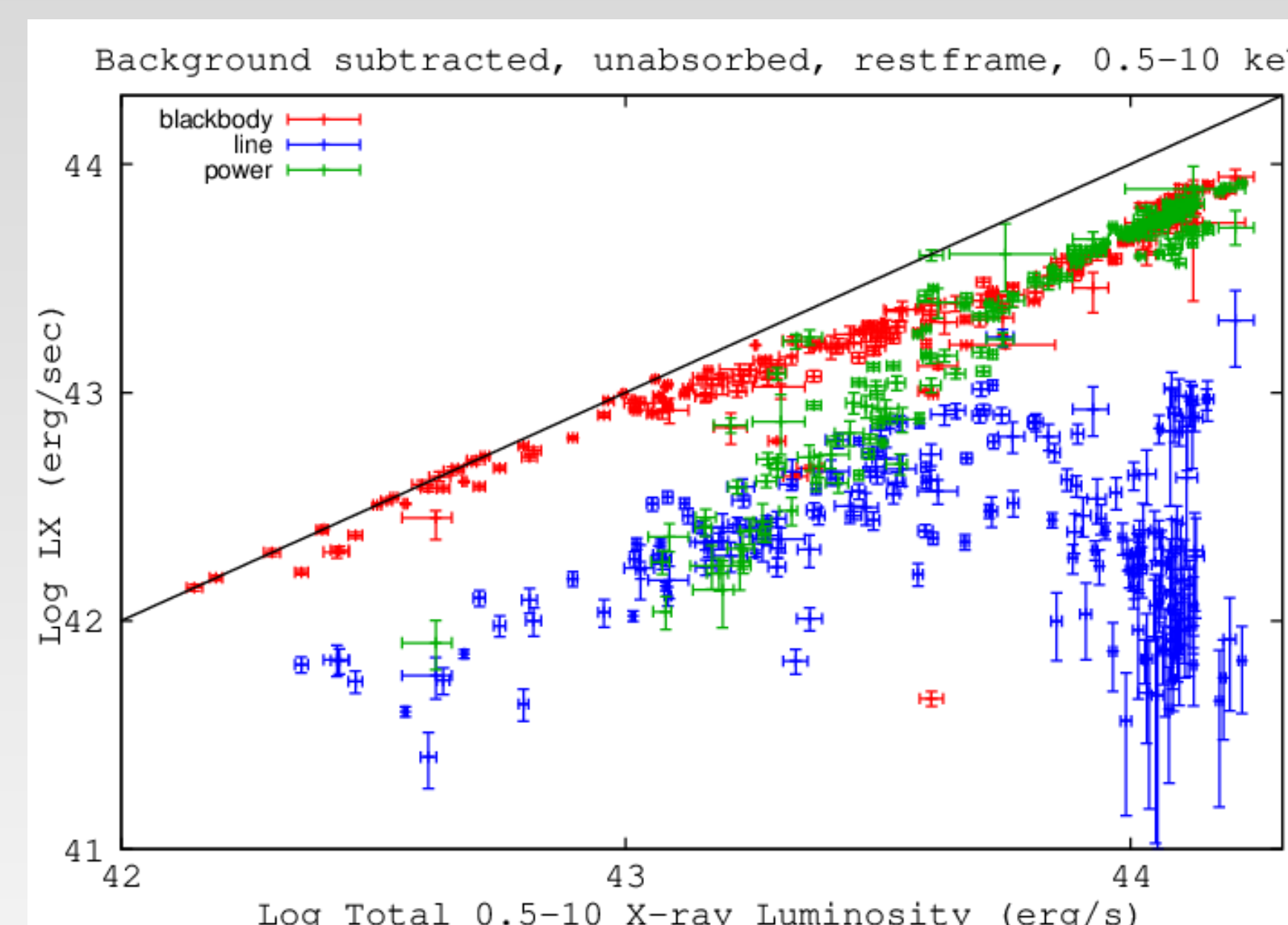
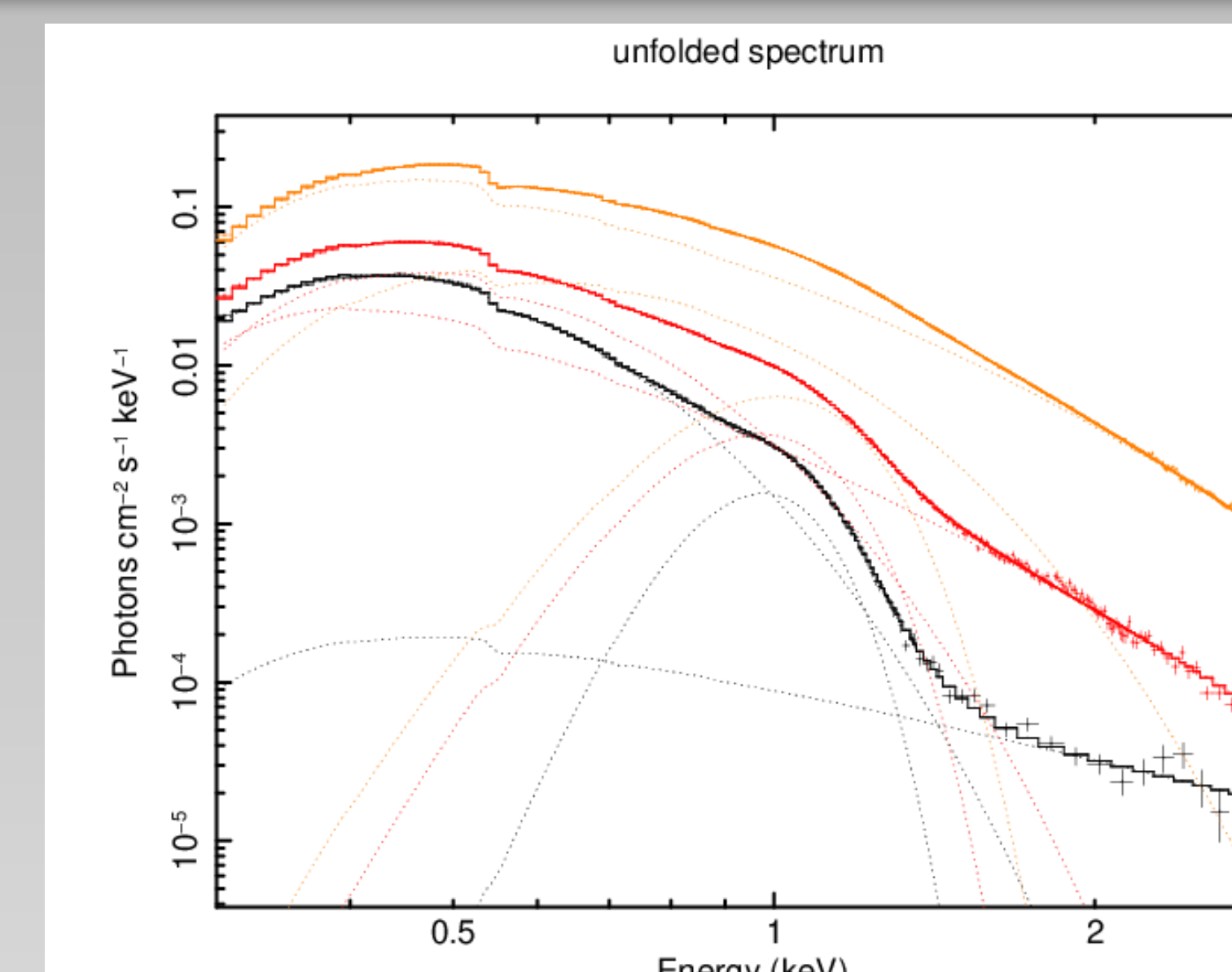
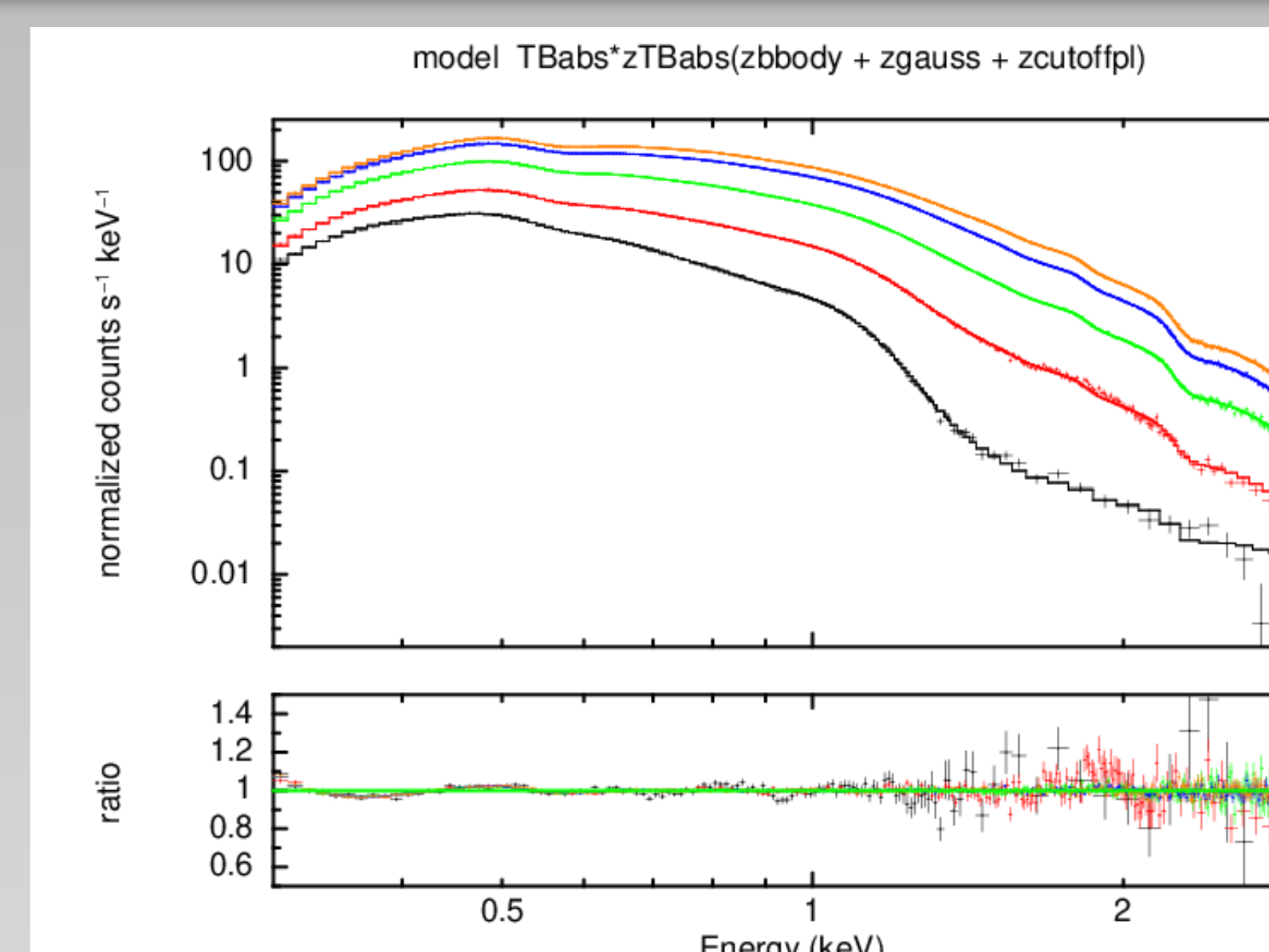
- 315 observations (as of 2019 Nov 01) starting 2018 May 22
- Total good (used for spectroscopy) exposure 788 (675) ks - mostly  $\sim 1$ -5 ks/obs ( $\sim 20$  ks max); mean (median)  $\sim 2.2$  (1.5) ks
- Cadence - typically  $\sim 1$  day (1.5 hrs to 18.7 days)



Part of a much broader campaign:

- 14 SWIFT/XRT
  - 3 simultaneous XMM-NEWTON/NuSTAR observations
- These data support the NICER results

## NICER Spectral Analysis



- Background spectra are computed using library spectra constructed by R. Remillard based on blank-sky background fields, categorized by two event-based background proxies (“unfocused” events identified as originating at the edges of the individual detectors, and events with off-band energies). A correction is applied to account for an additional low energy component associated with optical light.
- The NICER source spectra are characterized by a soft thermal (blackbody) “disk”, hard non-thermal (power-law with cutoff) “corona”, and  $\sim 1$  keV excess (gaussian) components.
- As the 1ES1927+654 X-ray luminosity increases, the X-ray spectrum hardens, with the coronal component becoming more prominent.

- As the 1ES1927+654 X-ray luminosity increases, the X-ray spectrum hardens, with the coronal component becoming more prominent even as the disk component continues to brighten - heating up as it does so.
- Note that the disk parameters scale with luminosity - not only as the average flux secularly increases, but as it varies on timescales of hours.

## Spectral Evolution Summary and Final Remarks

- (1) 1ES1927+654 was observed in transition from a Type 2 to a Type 1 AGN following an optical outburst, accompanied by the disappearance of the X-ray corona and the emergence of a million degree thermal component.
- (2) A subsequent decline in overall X-ray luminosity was followed by an extended period of quiescence, and then a steady re-brightening to  $>10^{44}$  erg/sec.
- (3) X-ray flux variability of factors of several on timescales less than hour, and of  $\sim 100$  on timescales less than a day are observed.
- (4) 1ES 1927+65 continues to brighten, on average, and harden spectrally.

We seem to be witnessing the onset of an instability in the pre-existing AGN disc and corona, followed by a still-continuing re-emergence of the corona. If the initial transient is identified as the tidal disruption of a star, it is possible that this was the instigator of this unique behavior.

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