Multiwavelength monitoring of the extraordinary changing-look AGN Mrk1018

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CLOSE AGN REFERENCE SURVEY

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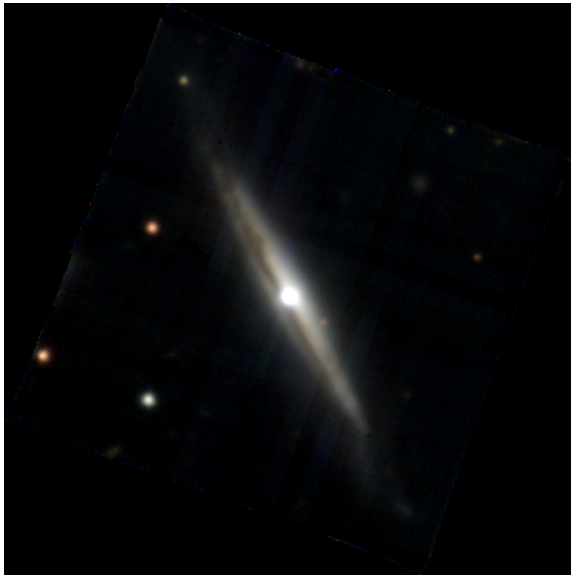
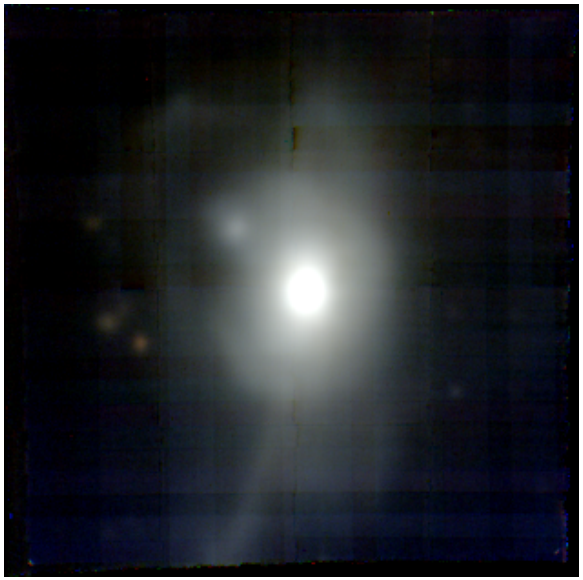
The Close AGN Reference Survey

- **40 unobscured AGN from HE survey with 0.01<z<0.06**
- **Follow-up multi-wavelength data (X-ray to radio)**
- **All targeted with VLT-MUSE IFU in 2015**

Primary aim of CARS is to study the AGN-host relation
see *www.cars-survey.org* for details

The Close AGN Reference Survey

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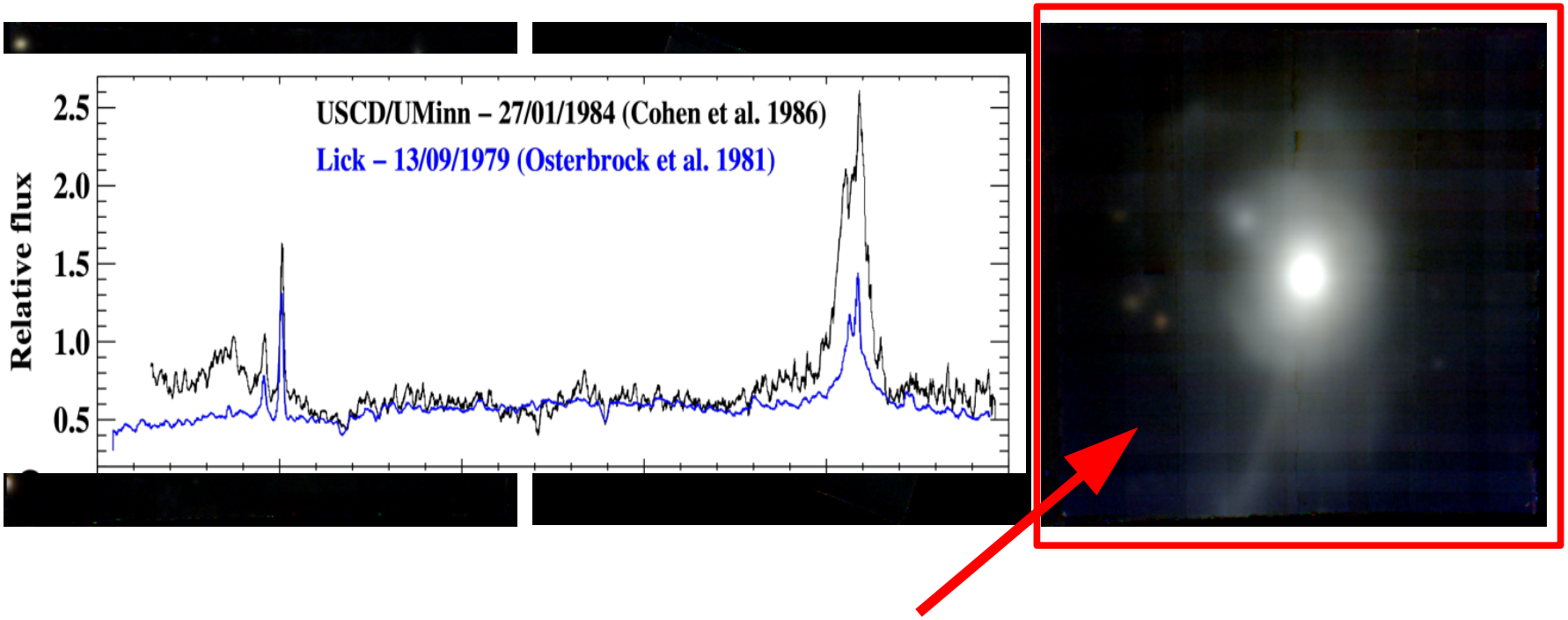
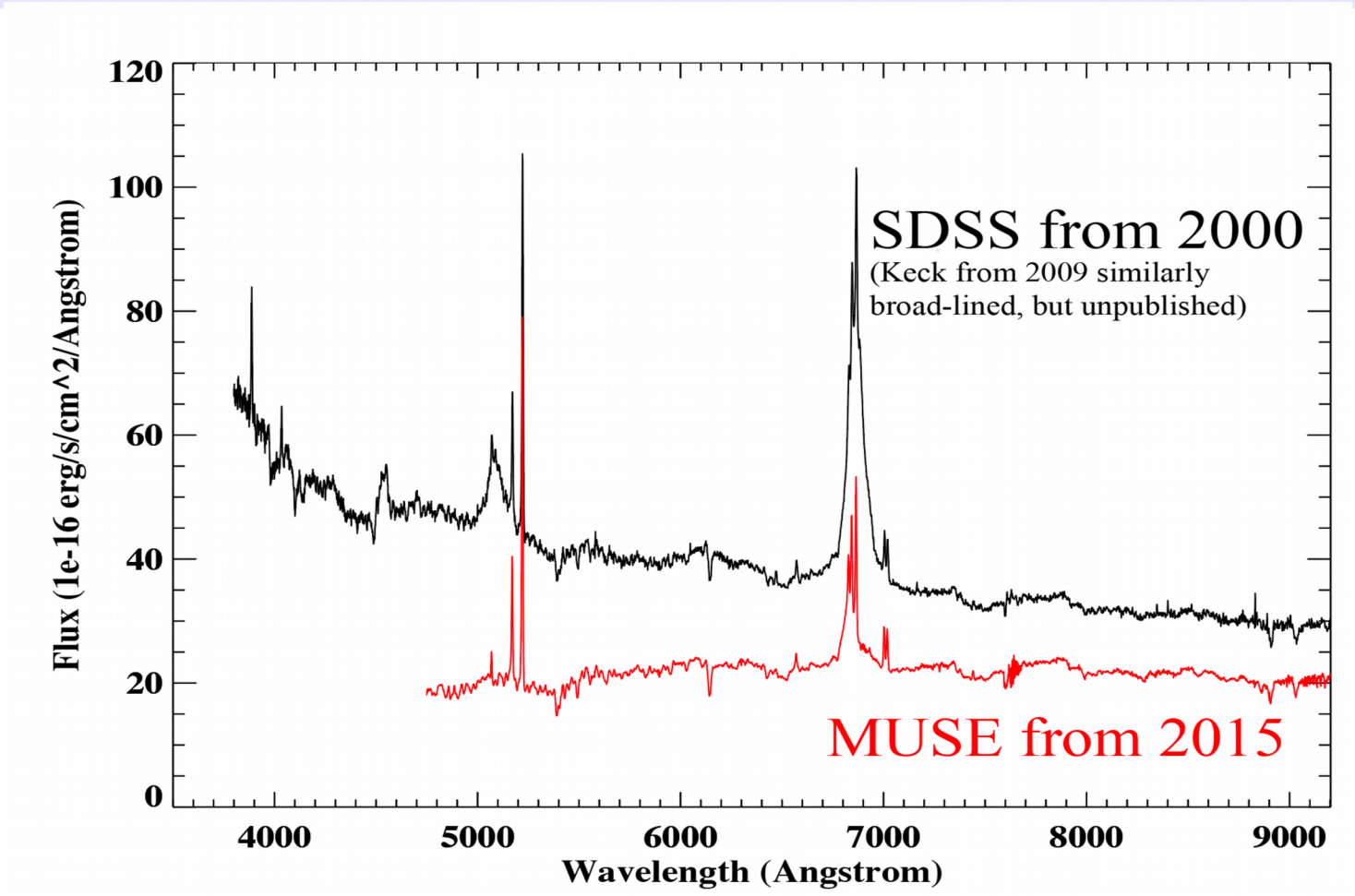


"changing-look" AGN Mrk1018 in 1980's: type 1.9 → type 1

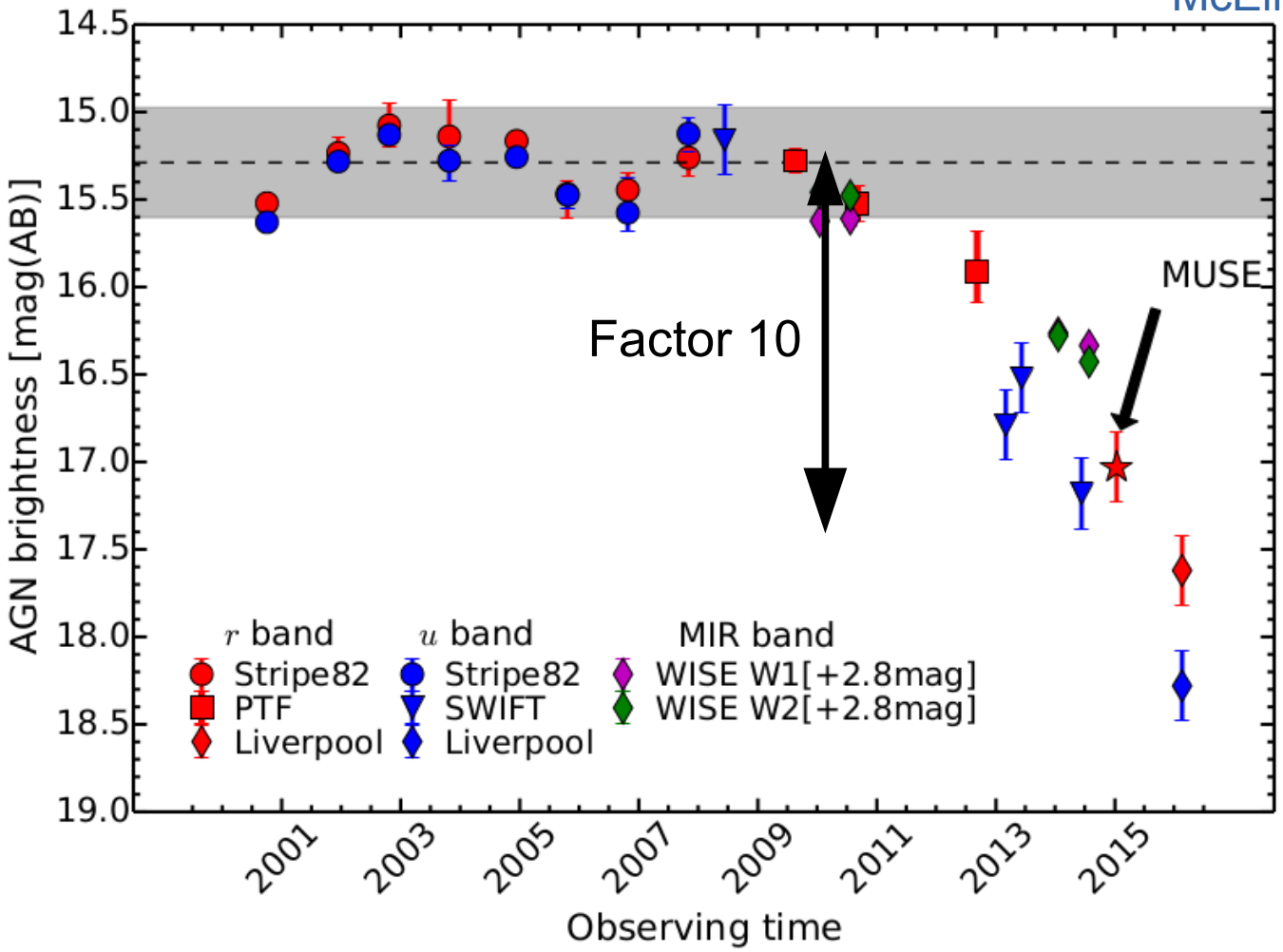
The change back again after 30yrs



It took us until Feb 2016 to notice this discovery...

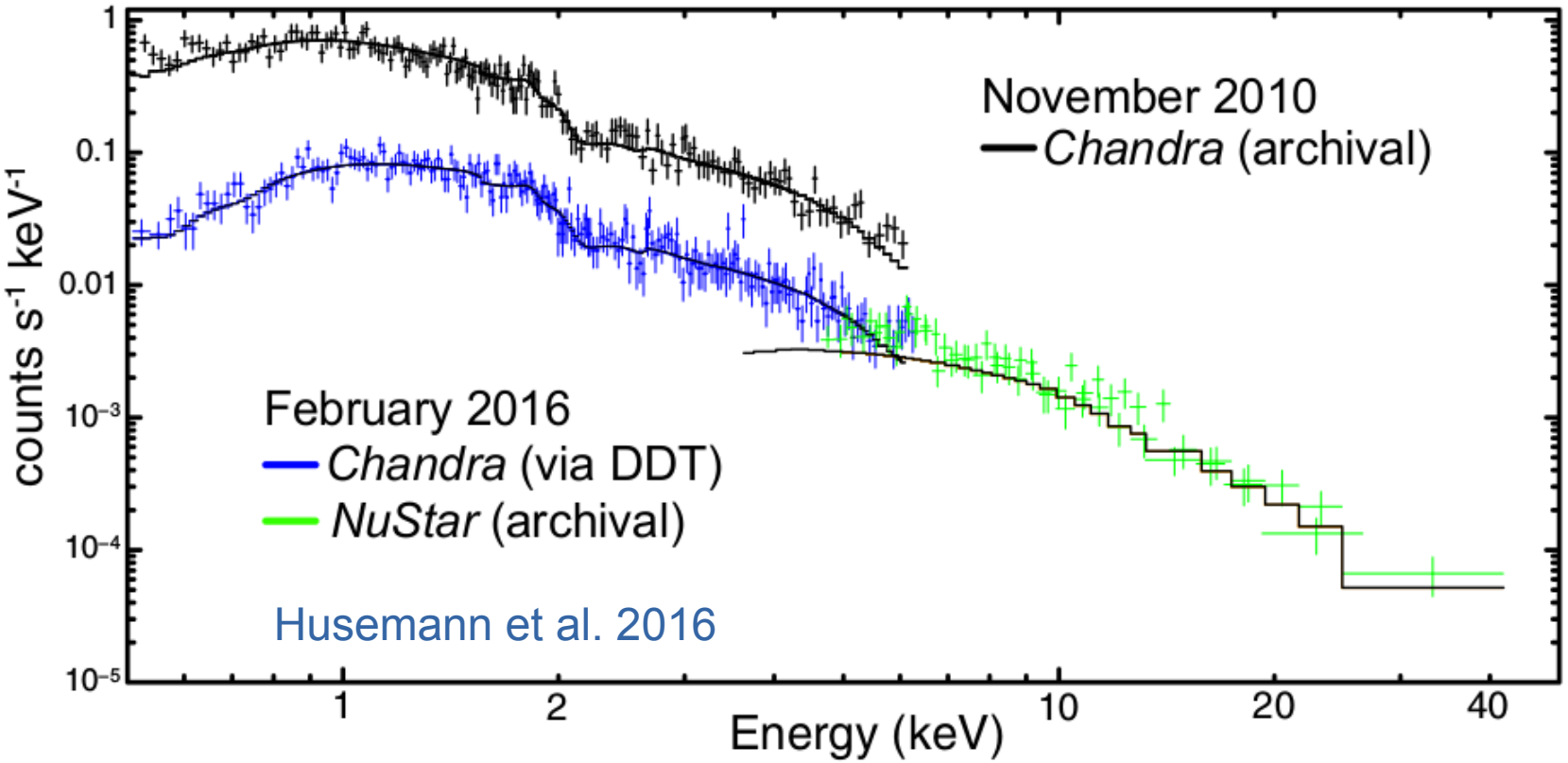
The light curve in the last 15 years

McElroy et al. 2016



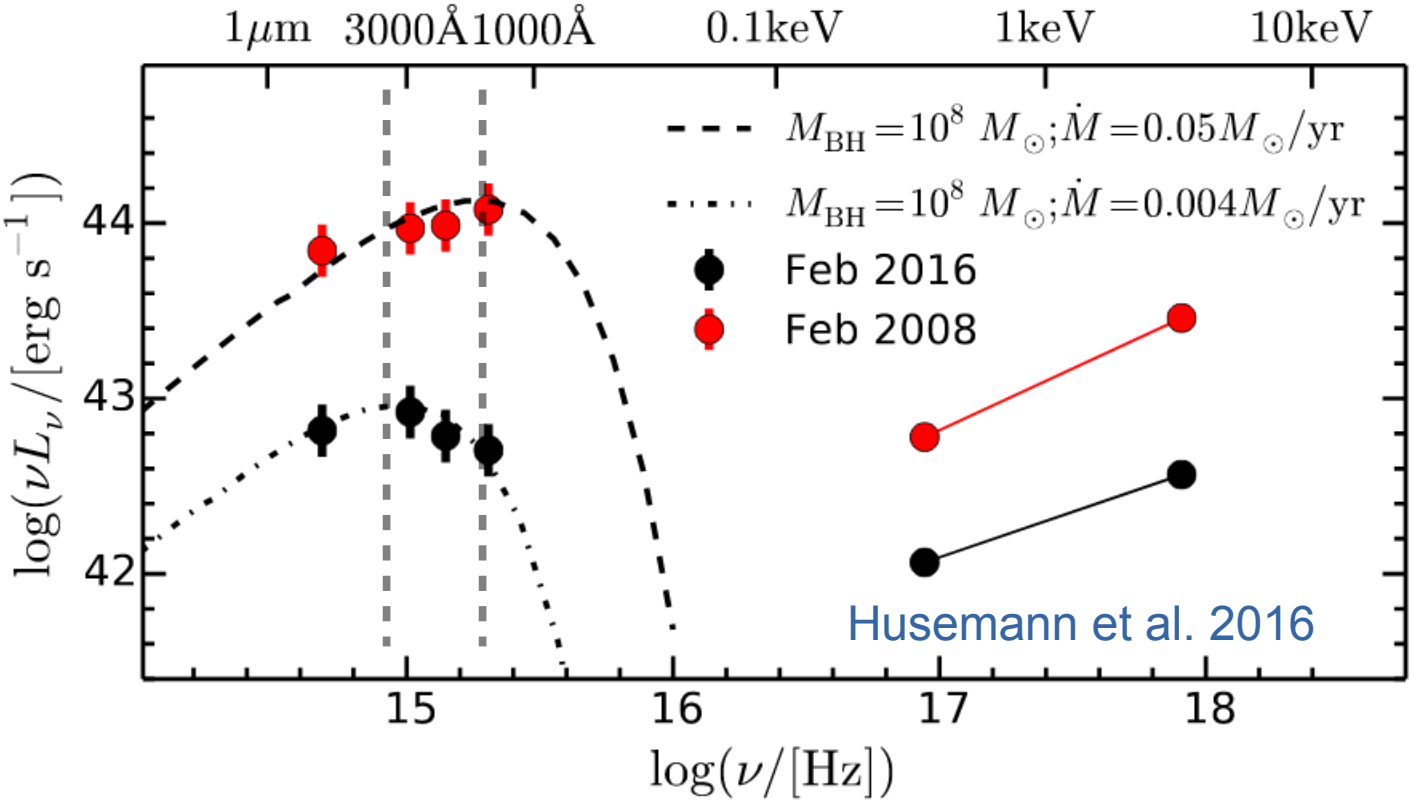
TDE is unlikely due to constant activity over 30yr

Chandra (DDT) + NuStar X-ray spectra



- X-ray spectra consistent with no absorption
- obscuration up to Compton-thick level ruled out
  ➔ accretion disc luminosity is declining

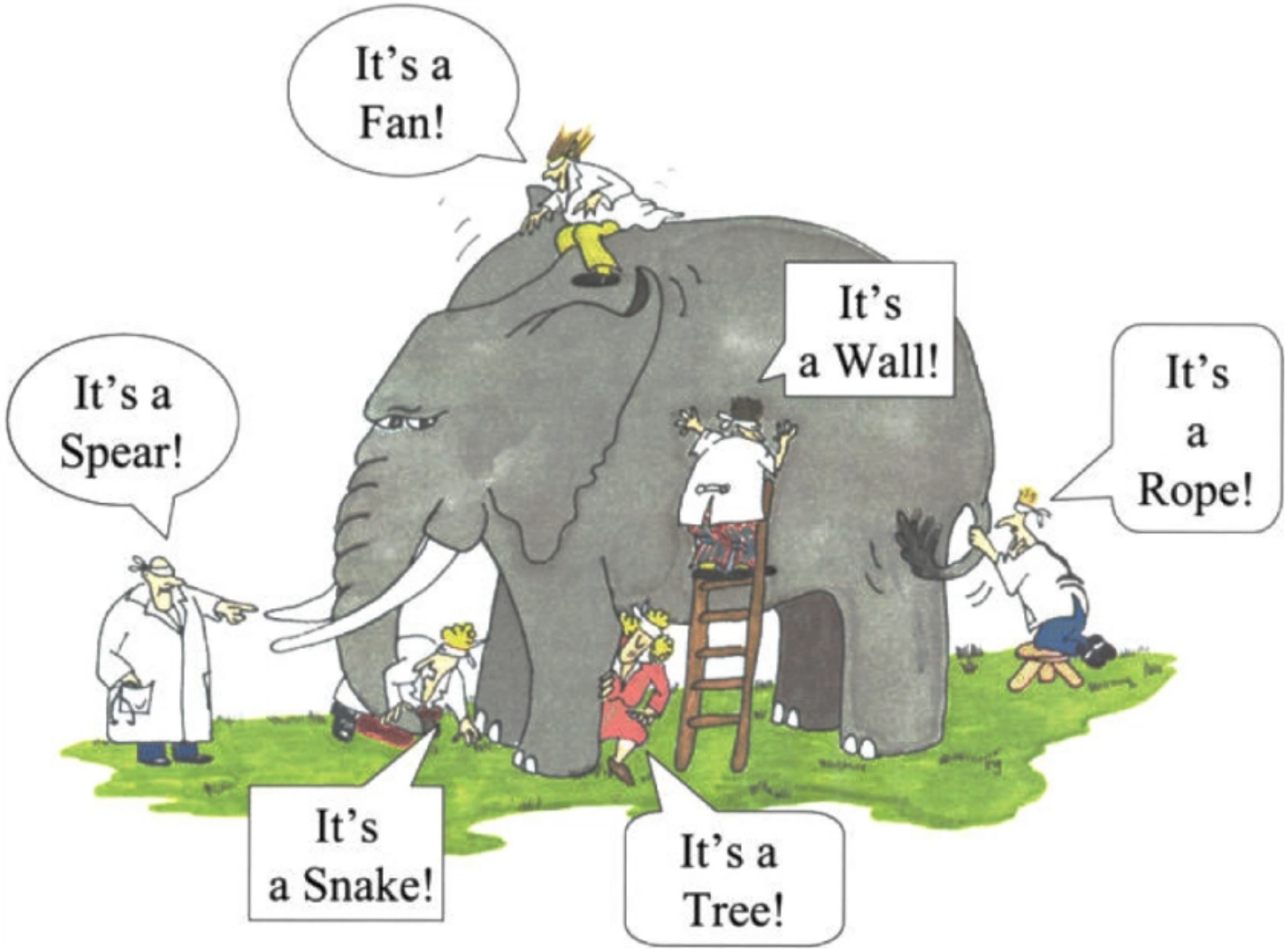
The optical to X-ray SED



- Peak luminosity shifts by a factor of ~2 in wavelength
- Roughly consistent with L~T^4 relation
  ➔ support for relativistic geometrically thin disc

CLOSE AGN REFERENCE SURVEY

How to make sense of Mrk1018?



Several ideas what could have happened

1) Physical explanation of change:

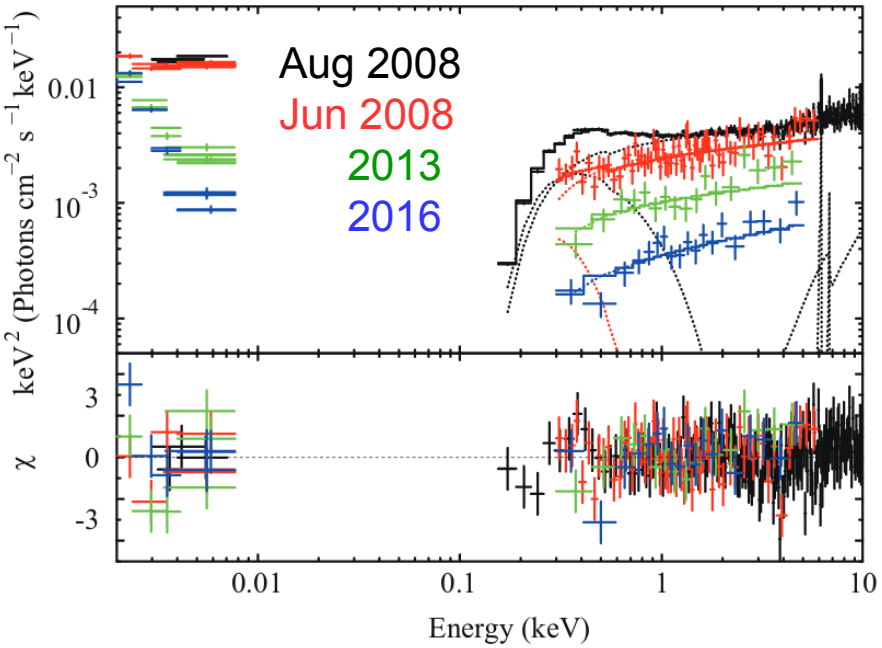
- **"state change" of AGN engine as in HMXB** (Noda & Done 2018)
- **Magnetically-elevated (thick) accretion disc** (Dexter et al. 2019)

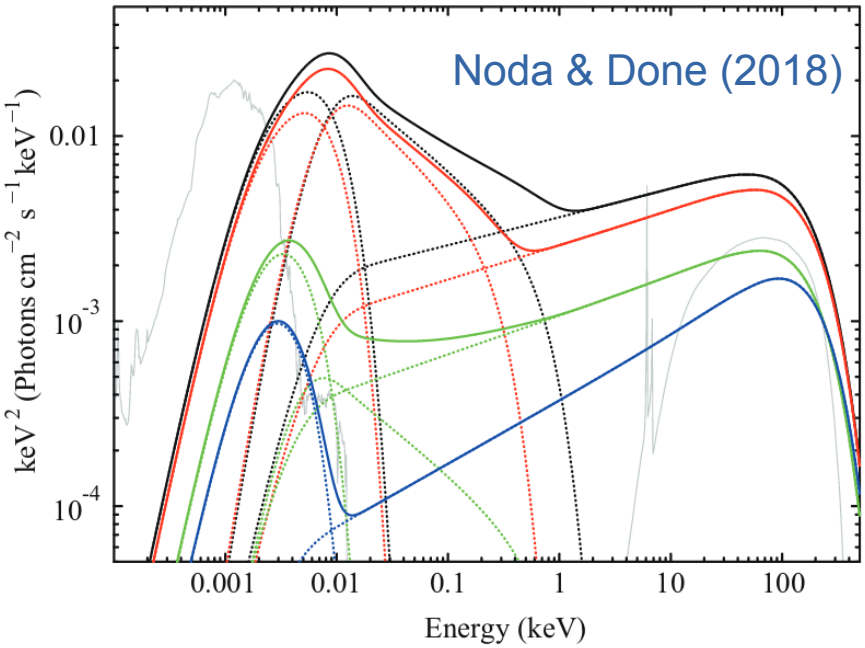
2) Triggering of the change:

- **Induced disruption of the accretion flow** (Husemann et al. 2016)
  - Binary BH interaction
  - Self-regulation via fast outflows
- **Recoiling BH after binary BH merger** (Kim et al. 2018)

→ **Long-term multi-wavelength monitoring necessary**

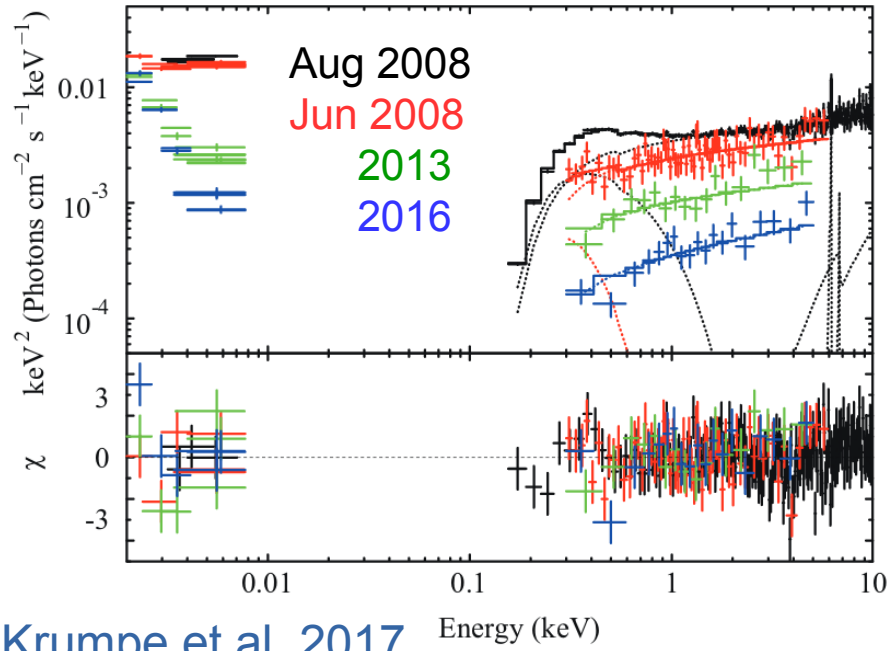
Changes in soft X-ray emission

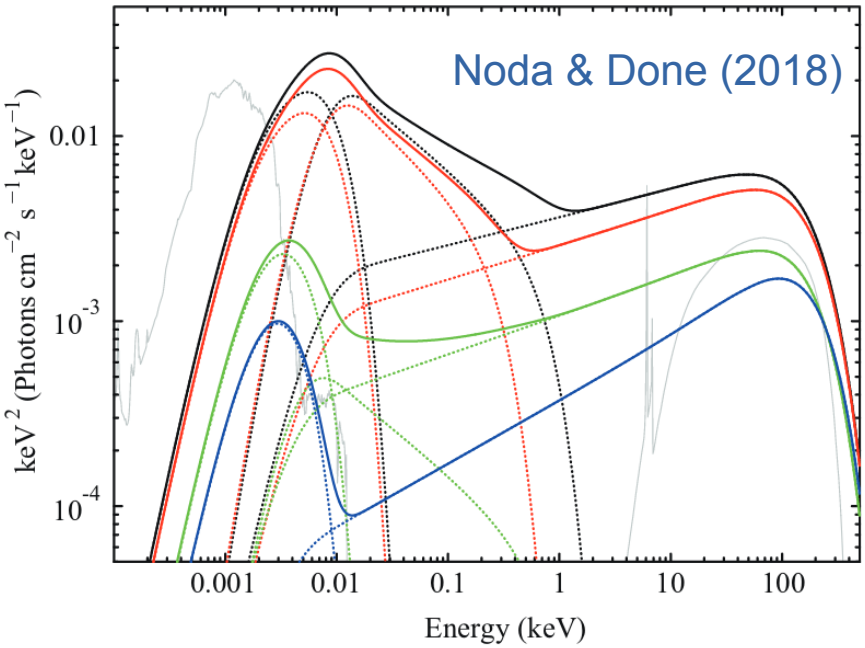




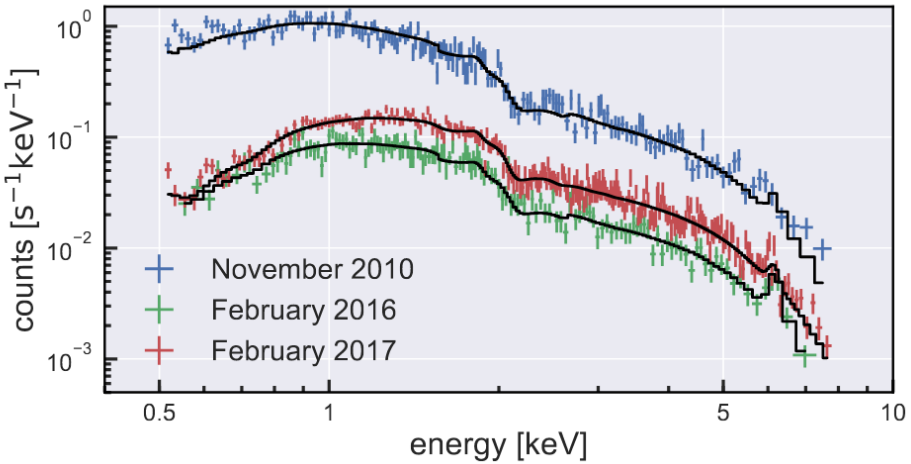
→ Soft excess emission disappeared after 2008

Changes in soft X-ray emission





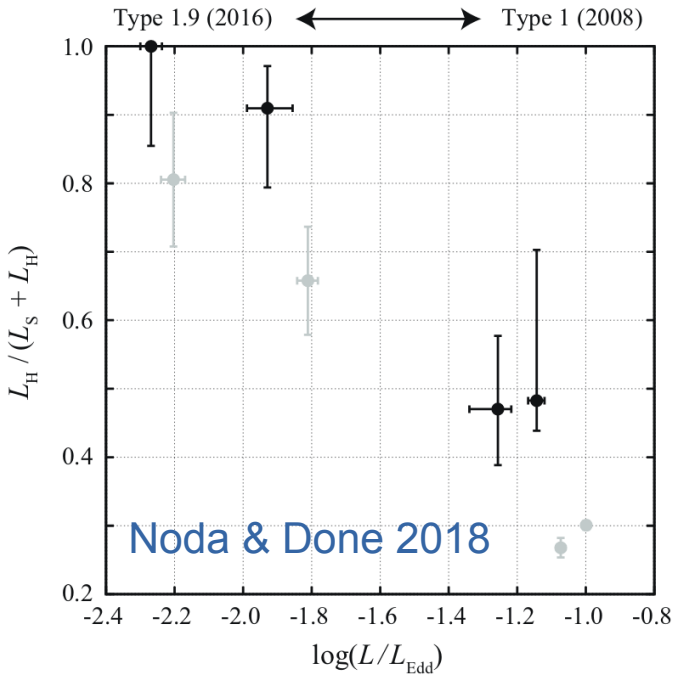
Krumpe et al. 2017

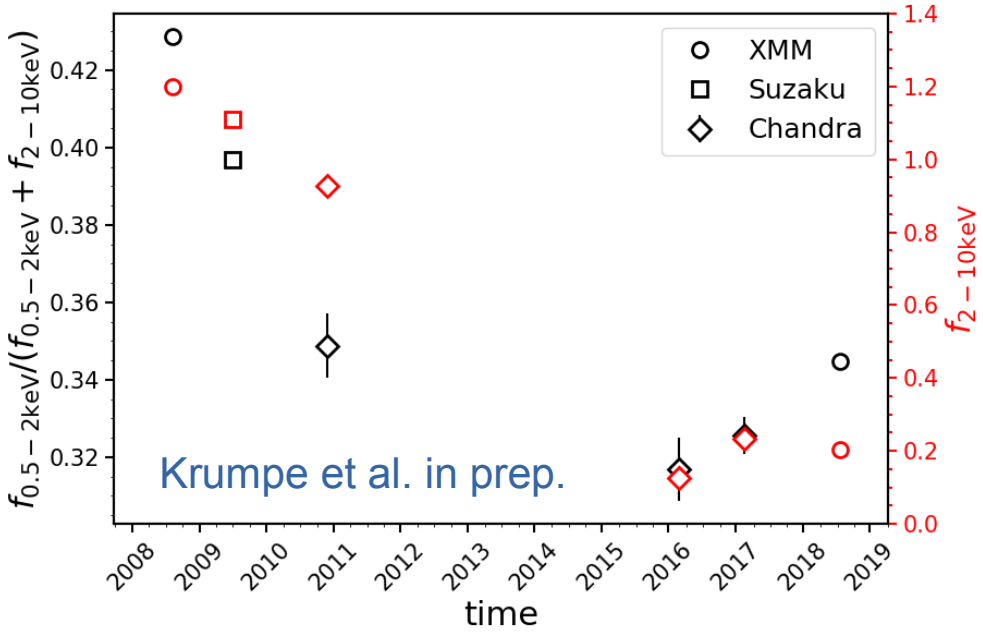


Chandra spectra fully consistent with single power-law

→ How fast did the soft-excess actually fade away?

Time evolution of X-ray soft-excess

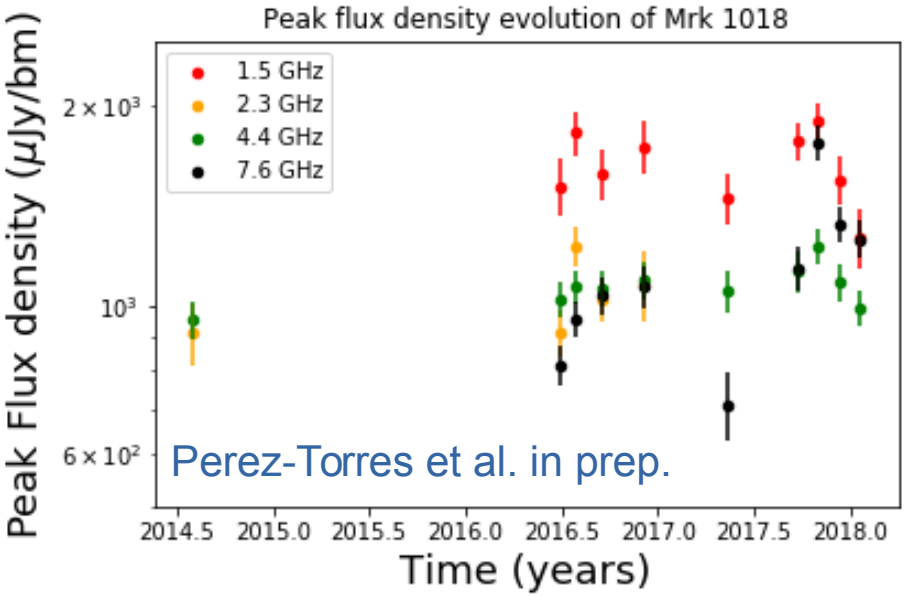


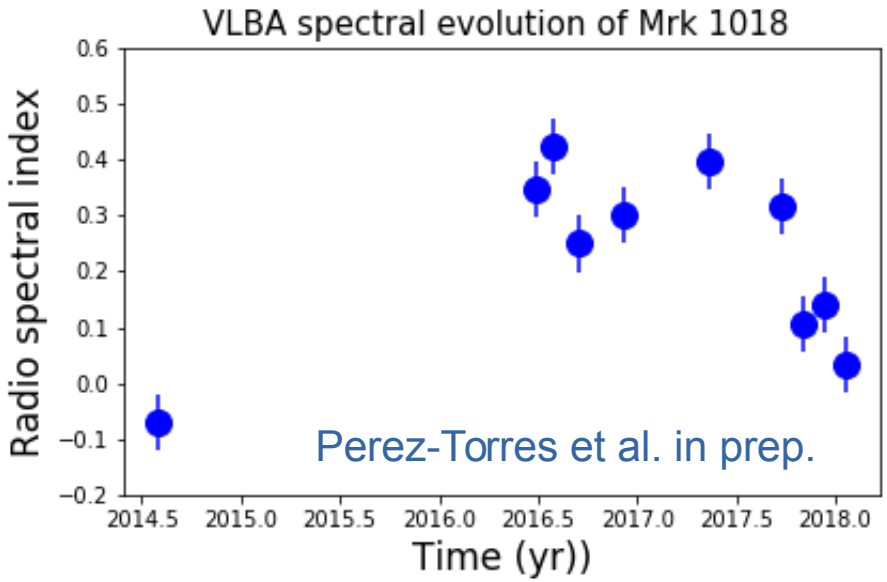


- Very fast evolution in the X-ray soft excess emission
- No significant soft-excess in the 0.5-2kev since 2011
- Decline of soft-excess emission faster than total dimming

→ **soft-excess variation unrelated or precedes dimming**

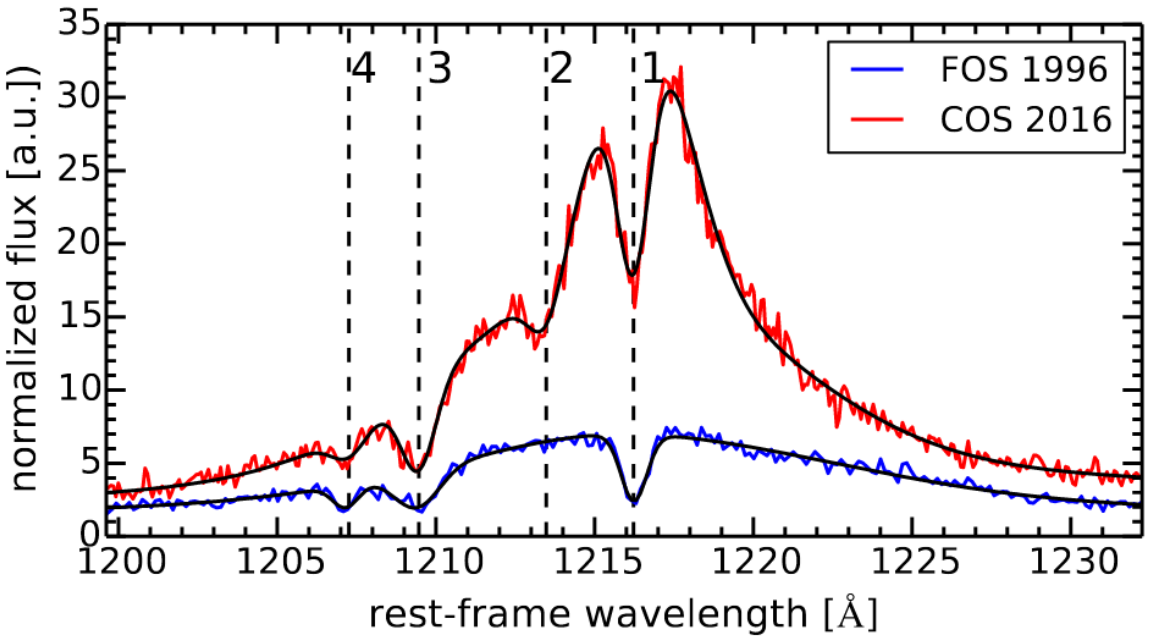
Radio variability from VLBA interferometry





- Almost constant radio flux during dimming phase
  - → Not exactly a “state” change as in X-ray binaries
  - → Drastic variation already happened before 2014
- Significant radio spectral index variations
  - → Origin of the variation is unknown at the moment

FUV HI absorber and outflows



Absorbers:

1 → host

2 → ????

3 → intervening

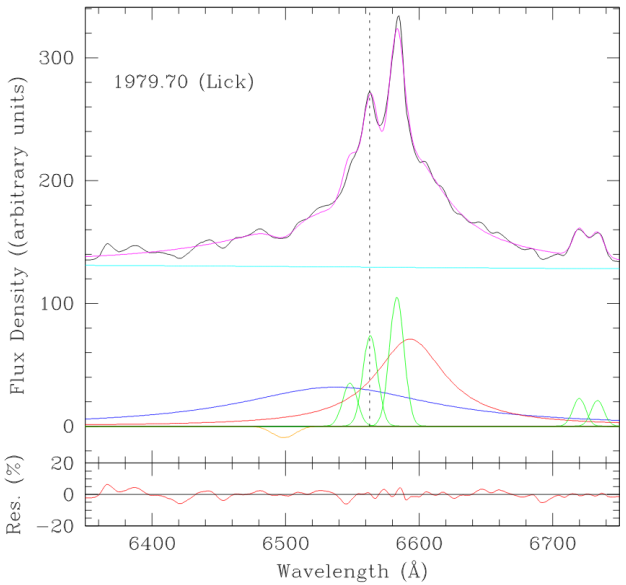
4 → intervening

Husemann et al. 2016

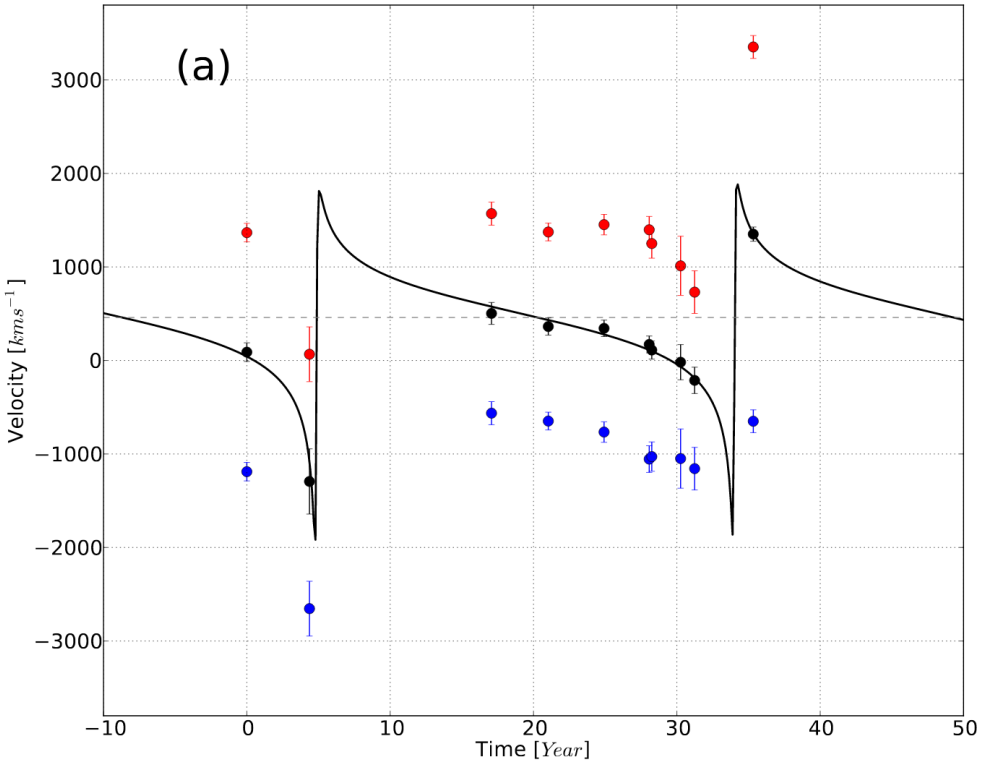
- New HI absorber present in LyA line in 2016
- blue shifted by 700km/s with systemic redshift of host
- Possibly connected to the development of a fast outflow

Big issue: No data to tell when absorber appeared

Mrk1018 - A recoiling black hole?

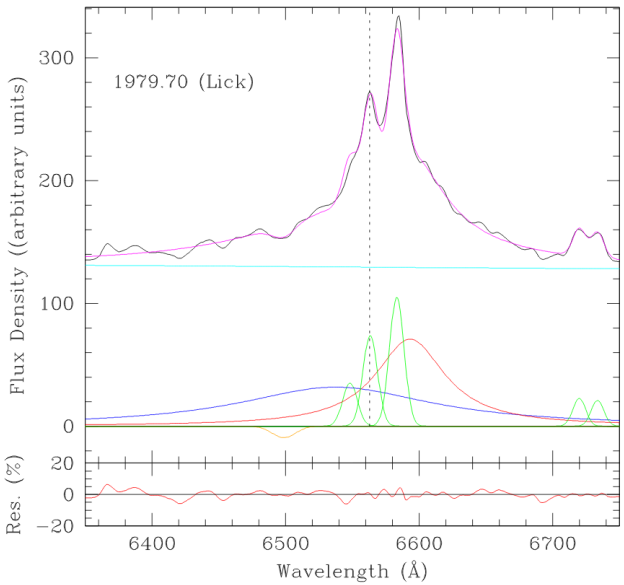


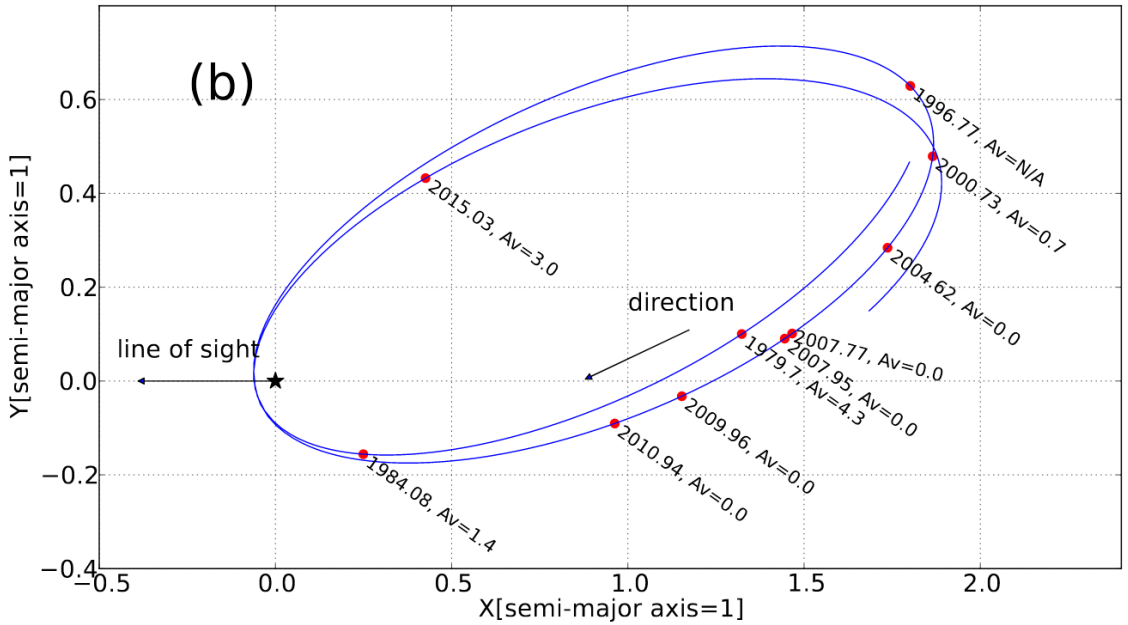
Kim et al. 2018



- Broad Hα line described by two Gaussian components
- Average of centroids → *interpreted as orbital motion*

Mrk1018 - A recoiling black hole?



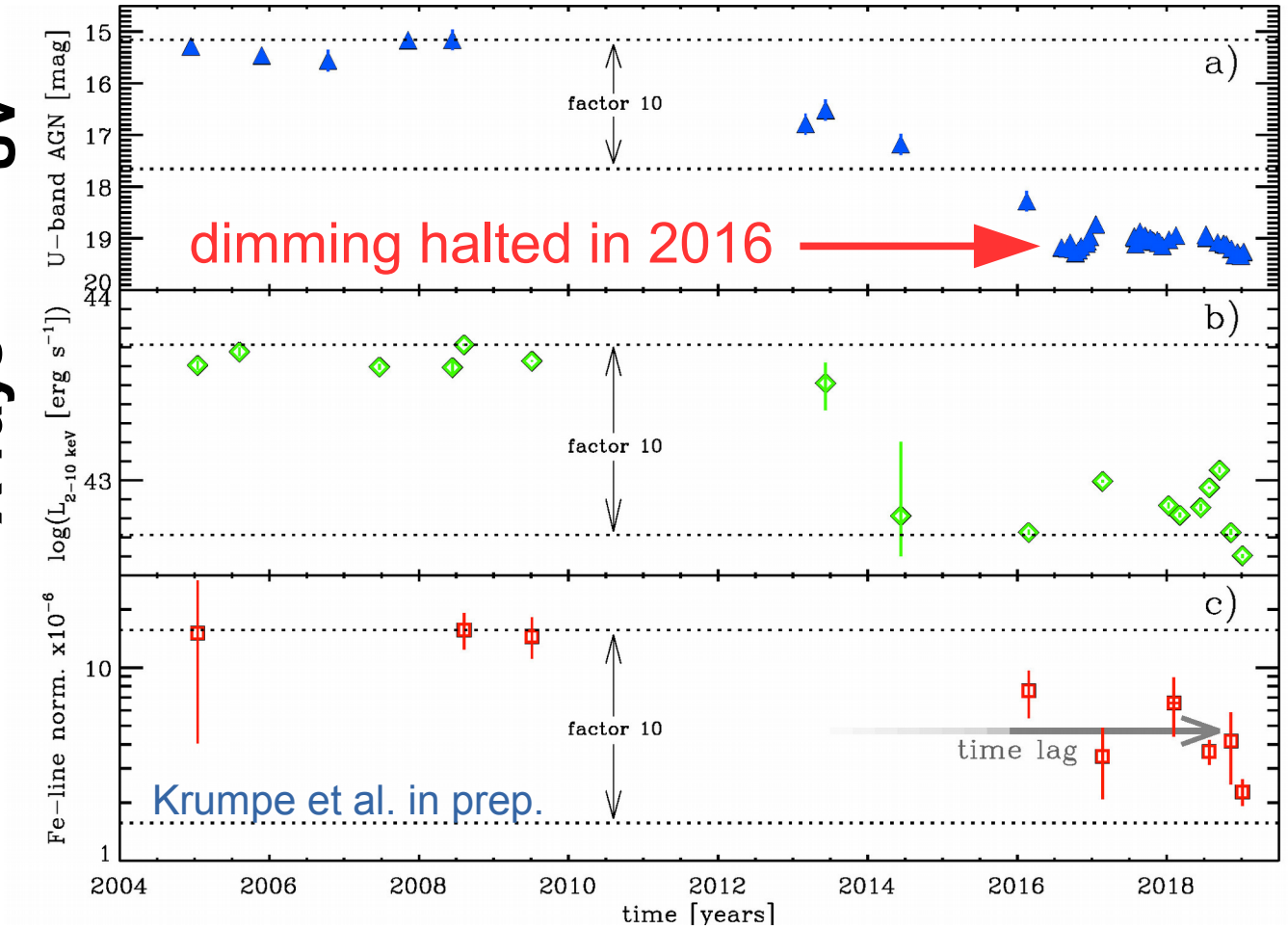


Kim et al. 2018

- Broad Hα line described by two Gaussian components
- Average of centroids → *interpreted as orbital motion*
  → Period of 30 years recovered with high excentricity

Issues: *Hα line asymmetric and affected by telluric absorption*

Some more multi-wavelength variability



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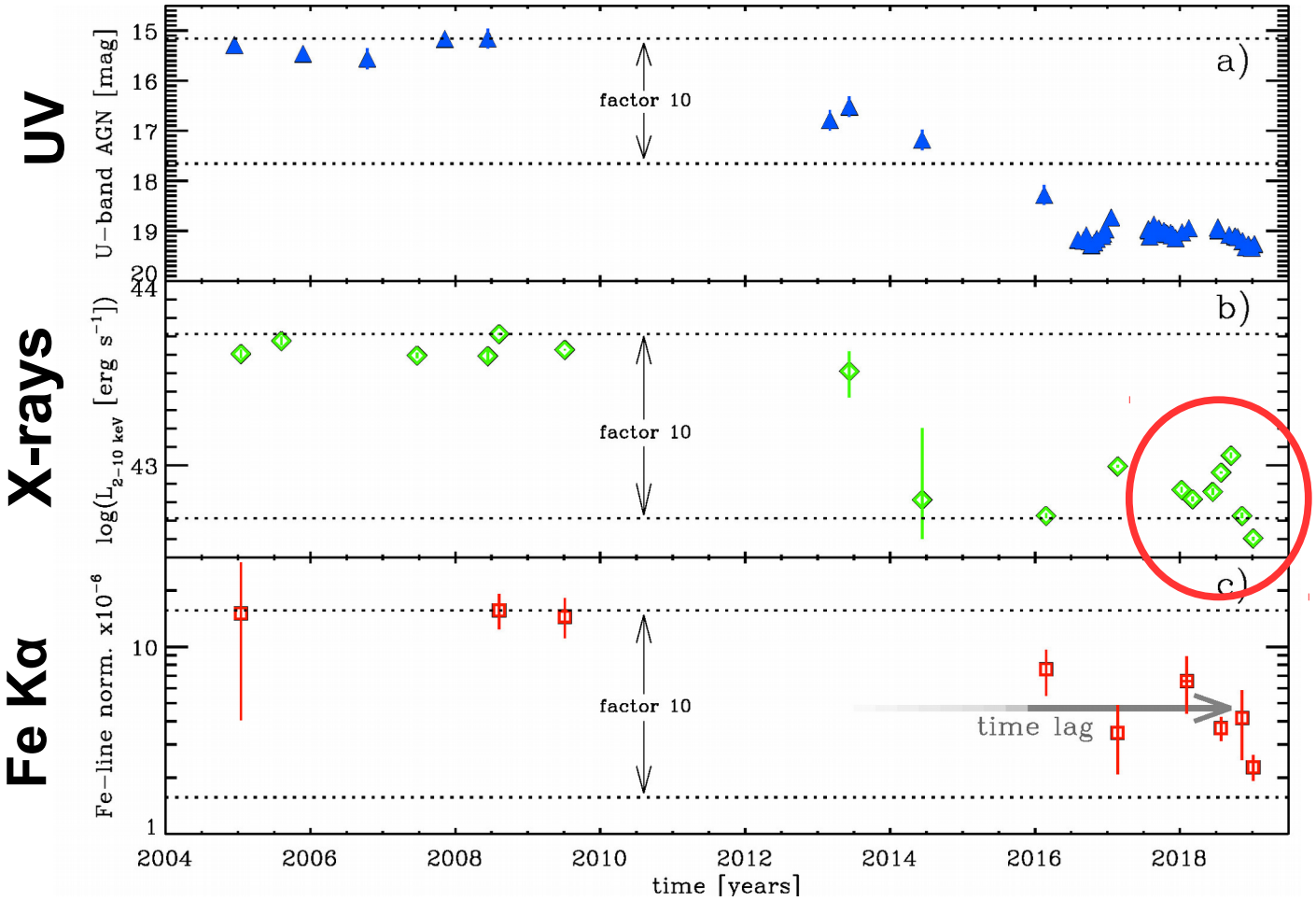

X-ray flux is not tracing UV variations

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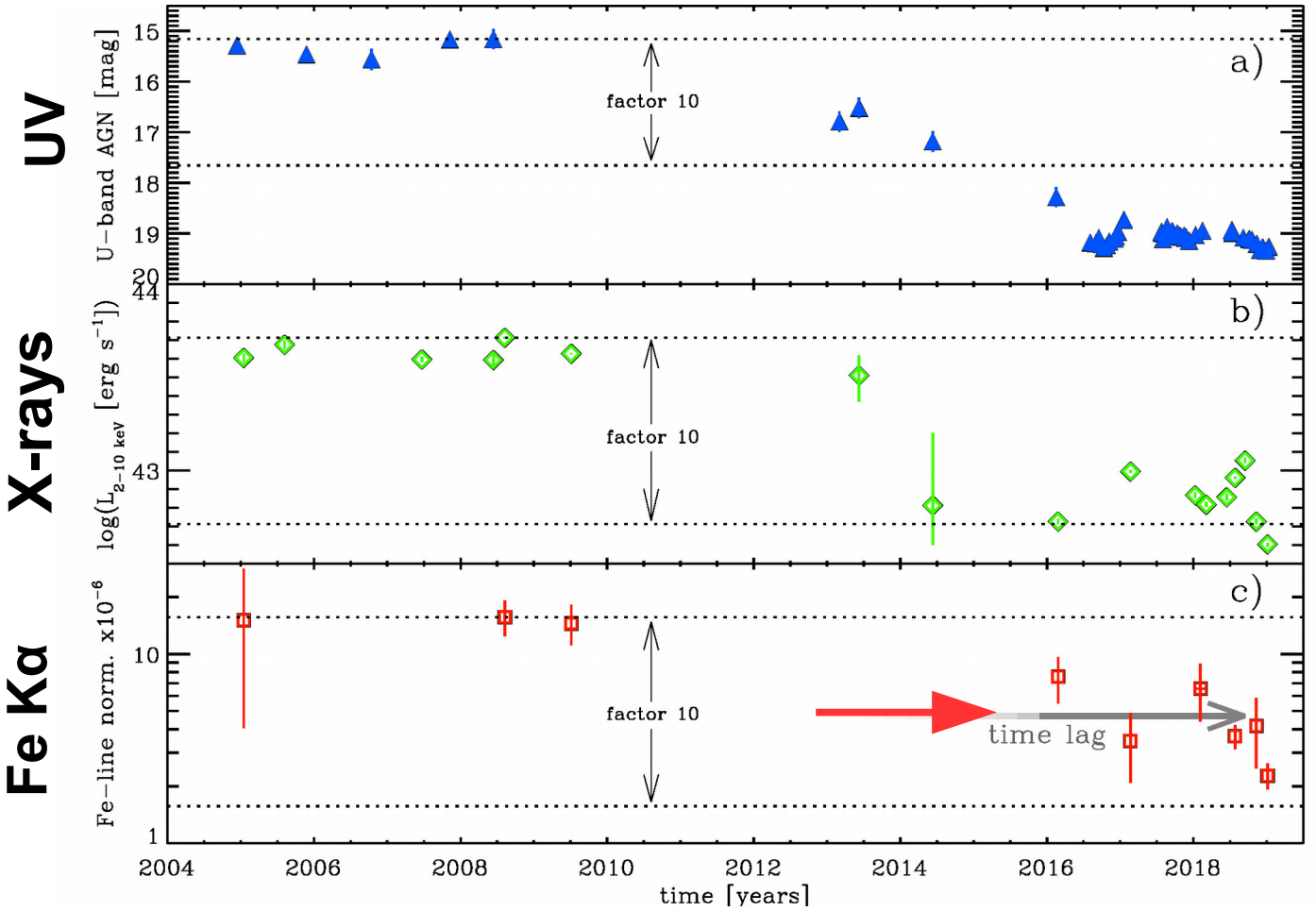
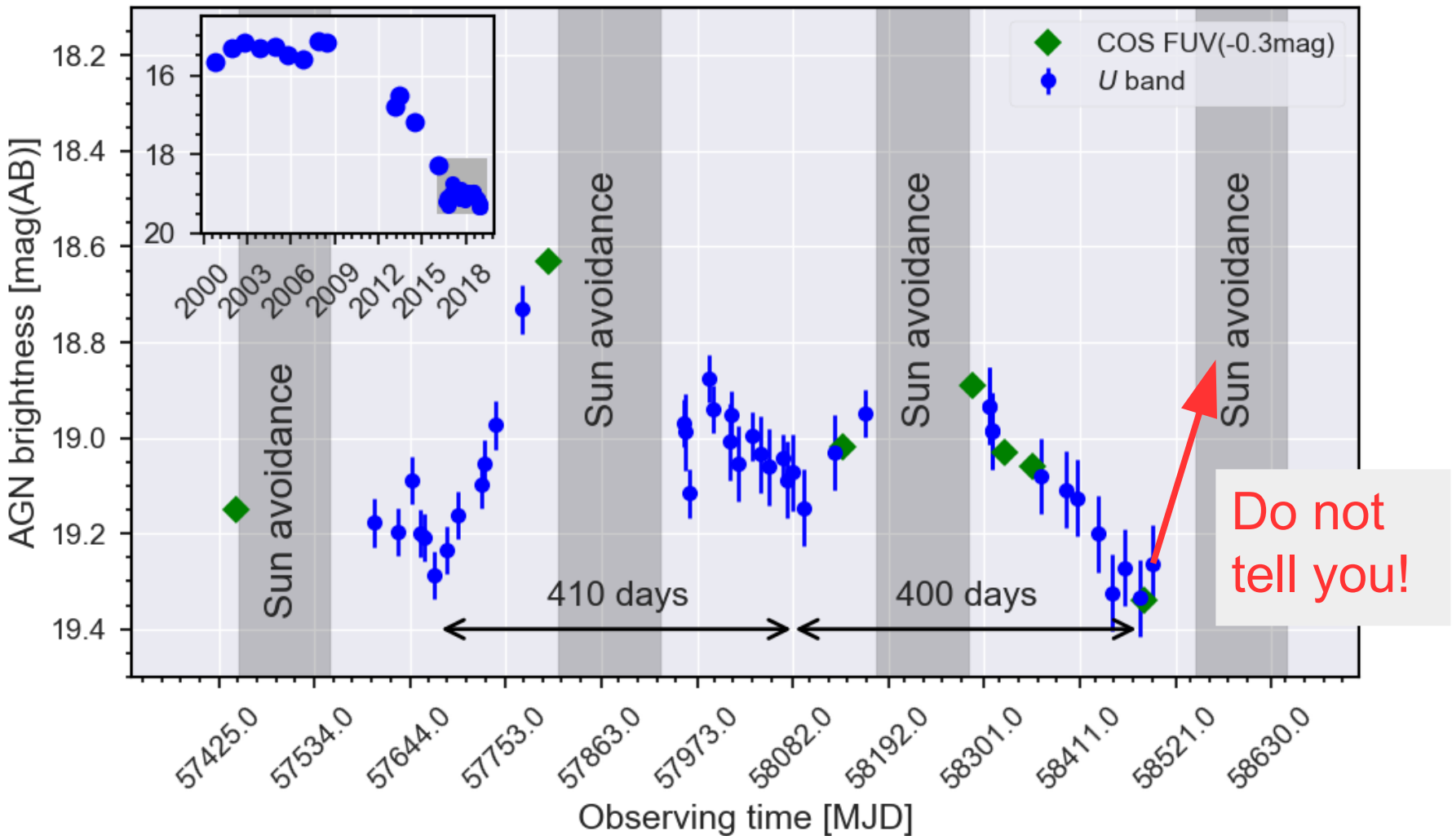


Fe Kα line flux:

1) short response
   or
2) long time lag

Unknown priors on expected variability → *cadance insufficient*

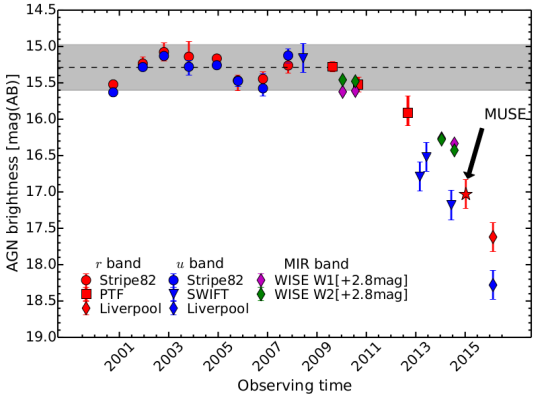
UV variability pattern during faint state

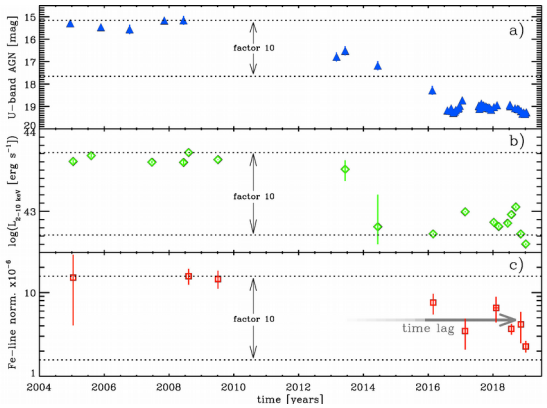


2yr monitoring-programme approved for ESO-VST telescope

Conclusions

1) Mrk1018 is a unique AGN to challange fundamental principles of AGN physics





2) Large multi-wavelength data available
→ do we know what to look for?

3) Mrk1018 is still full of surprises and we should expect the unexpected
→ models are judged by predictive power