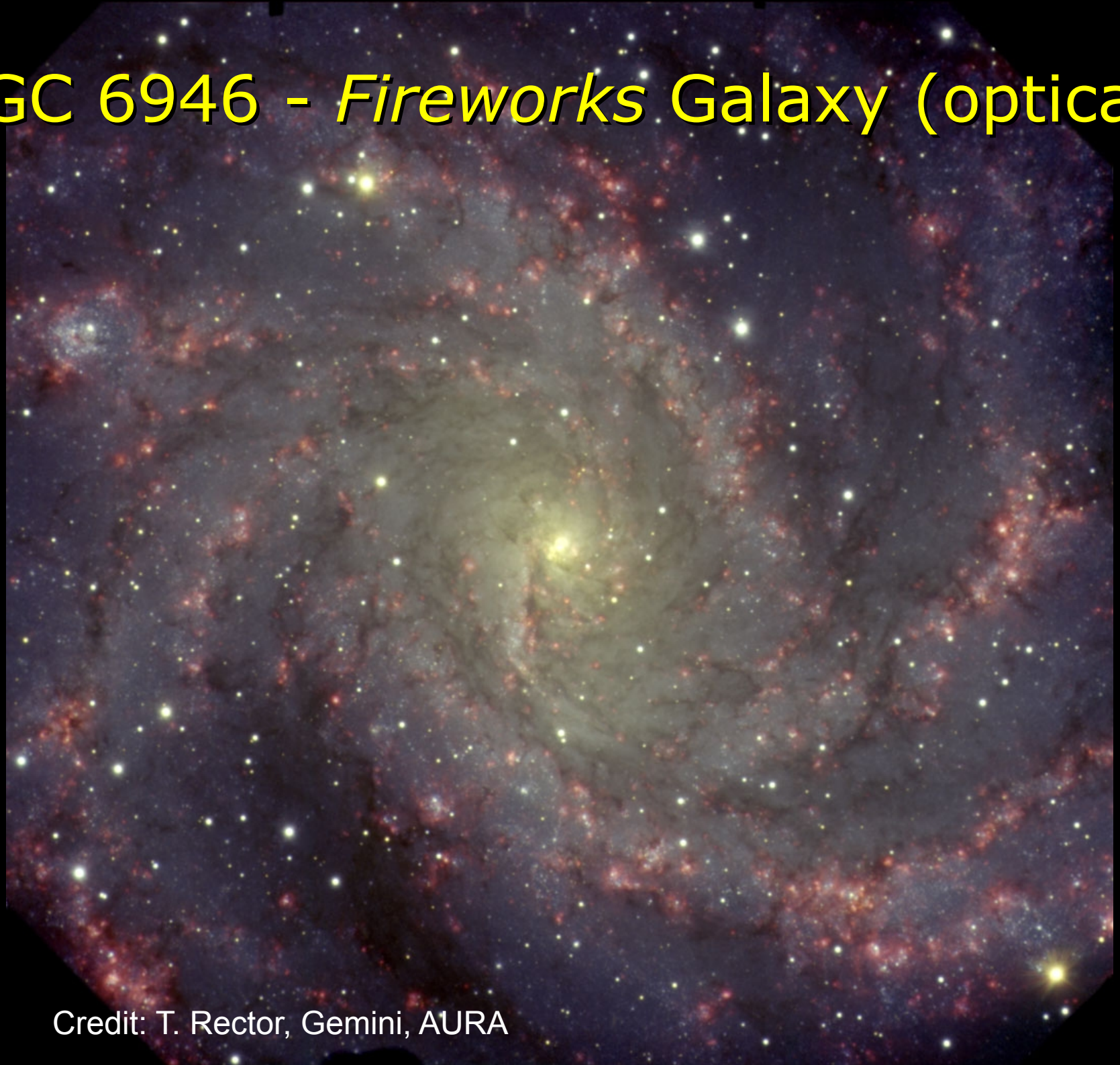


XMM-Newton reveals extreme winds in ultraluminous X-ray sources

Ciro Pinto

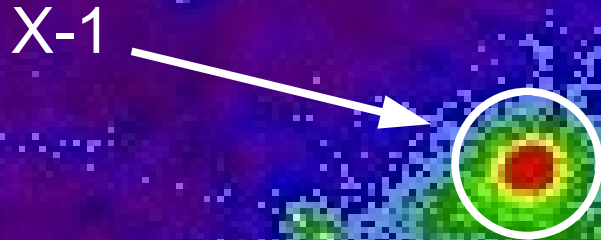
Matthew Middleton and Andrew Fabian

NGC 6946 - *Fireworks Galaxy* (optical)



Credit: T. Rector, Gemini, AURA

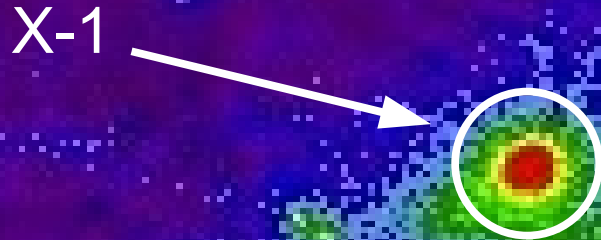
NGC 6946 - *Fireworks Galaxy* (X-rays)



Off-nuclear point sources
with $L_x > 10^{39}$ erg/s

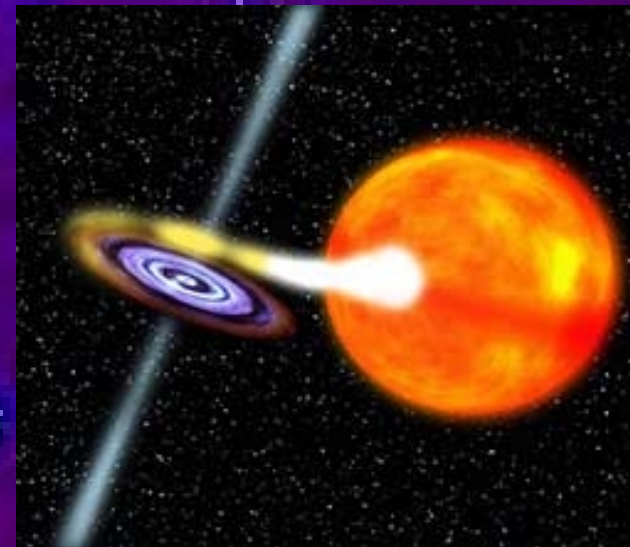


Ultraluminous X-ray source(s)



Accretion onto a compact object

Above the Eddington limit for
a standard $10M_{\odot}$ black hole



Mysterious compact objects

1) Up to \sim a few 10^{40} erg/s : **stellar-mass BH**

Radio jets, variability, and binary periods

(Middleton+2011, Motch+2014, Cseh+2015)

At least one is a **neutron star** (Bachetti+14)

$\rightarrow \rightarrow \rightarrow$ *supercritical accretion* (Poutanen+07)

powerful winds?

2) Above 10^{41} erg/s : **intermediate-mass BH** ($\sim 10^{3-4} M_{\odot}$) ?

(e.g. Colbert & Mushotzky 1999, Pasham+2014, **HLX X-1**)

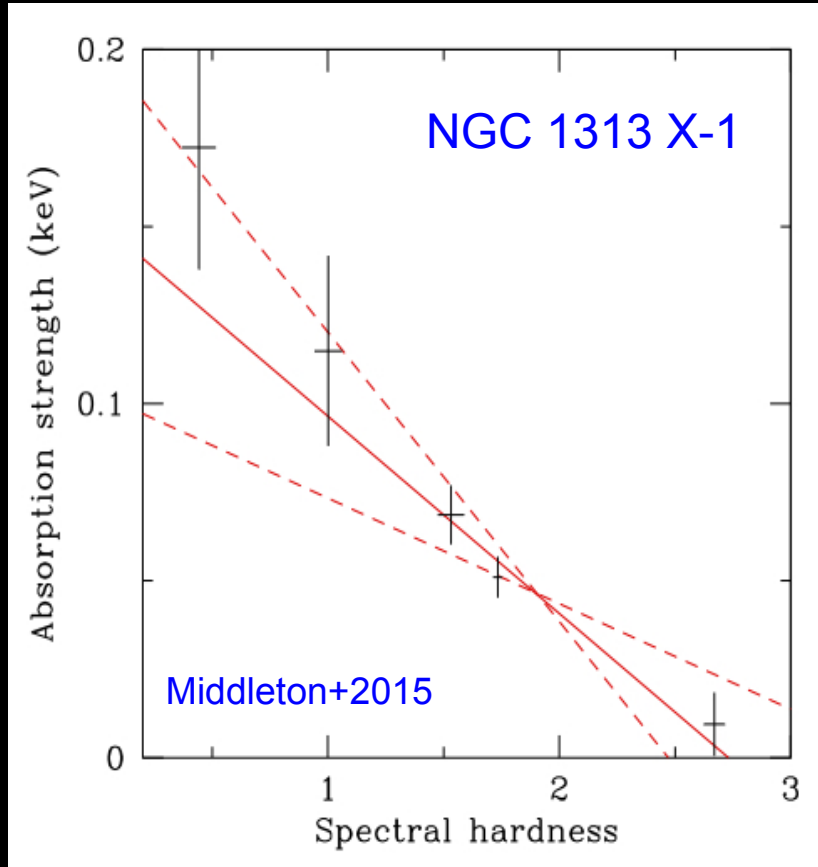
Limitations:

Difficult to detect the counter part (Heida+15)

The absence of X-ray spectral lines



Suspicious features in CCD spectra



1 keV emission / 0.1c absorber

No reflection, no diffuse emission, possibly L.O.S
(Chandra as well, e.g. Sutton+2015)

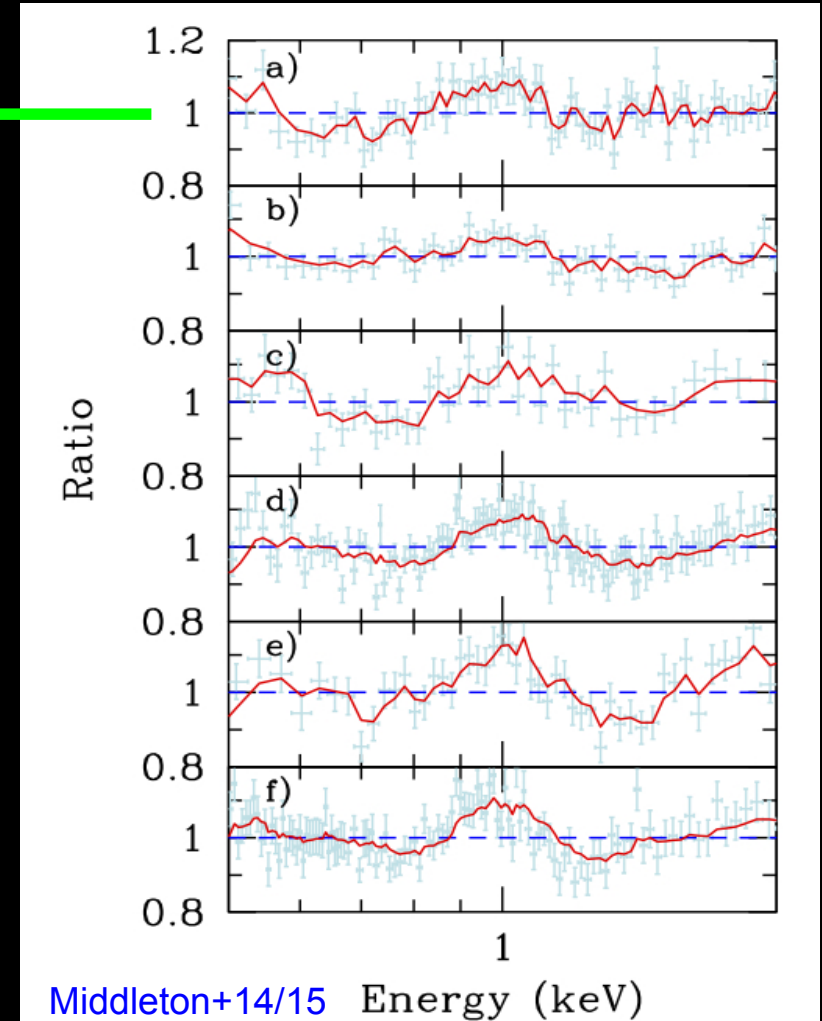


Figure 1. Plot showing the residuals to the best-fitting model of the continuum (TBABS*(DISKBB+NTHCOMP); see M15) for a) NGC 1313 X-1 (ObsID: 0405090101), b) Ho IX X-1 (ObsID: 0200980101), c) Ho II X-1 (ObsID: 0561580401), d) NGC 55 ULX-1 (ObsID: 0655050101), e) NGC 6946 X-1 (ObsID: 0691570101) and f) NGC 5408 X-1 (ObsID: 0302900101). The spectral data

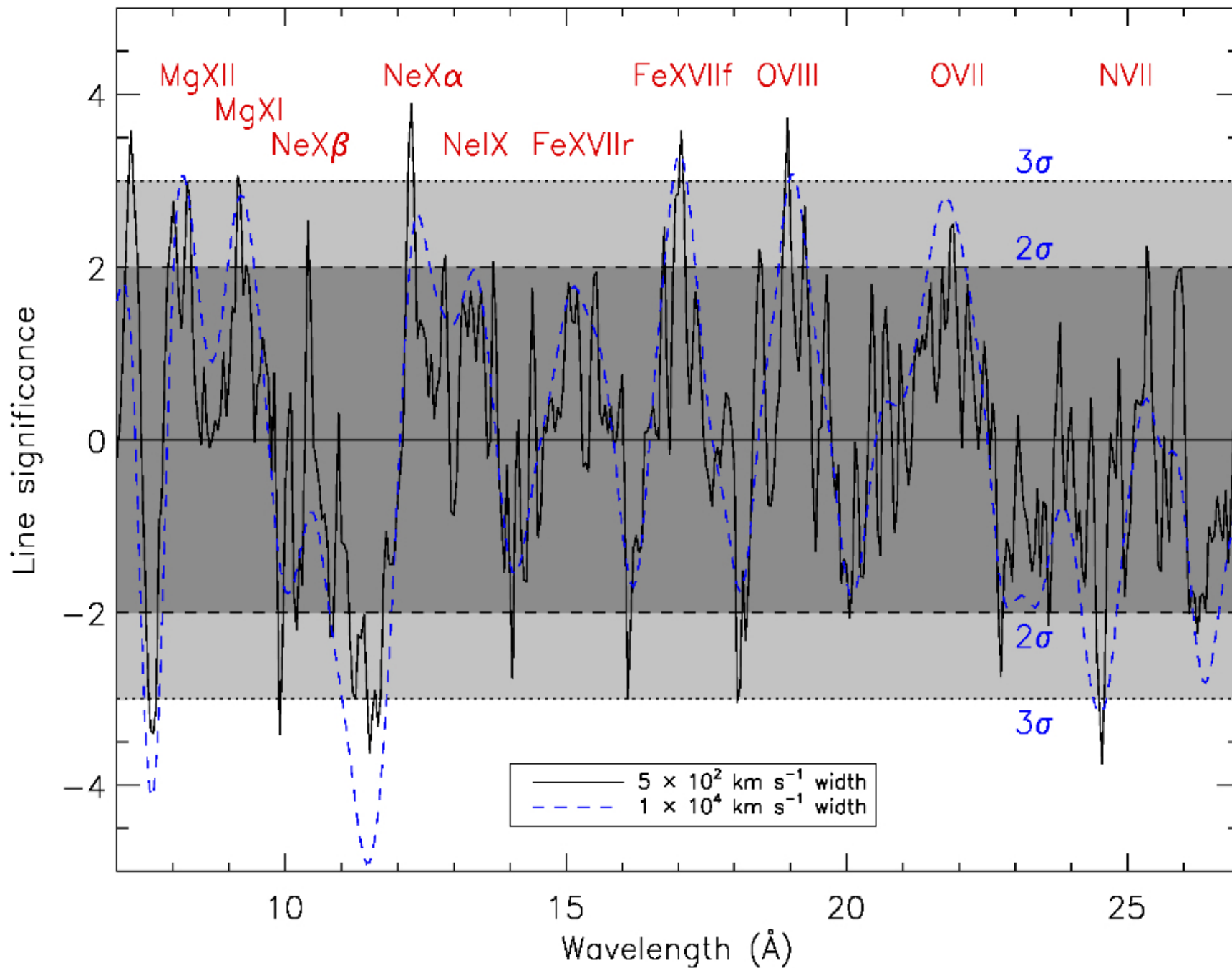
RGS "*magic*"

NGC 1313 X-1

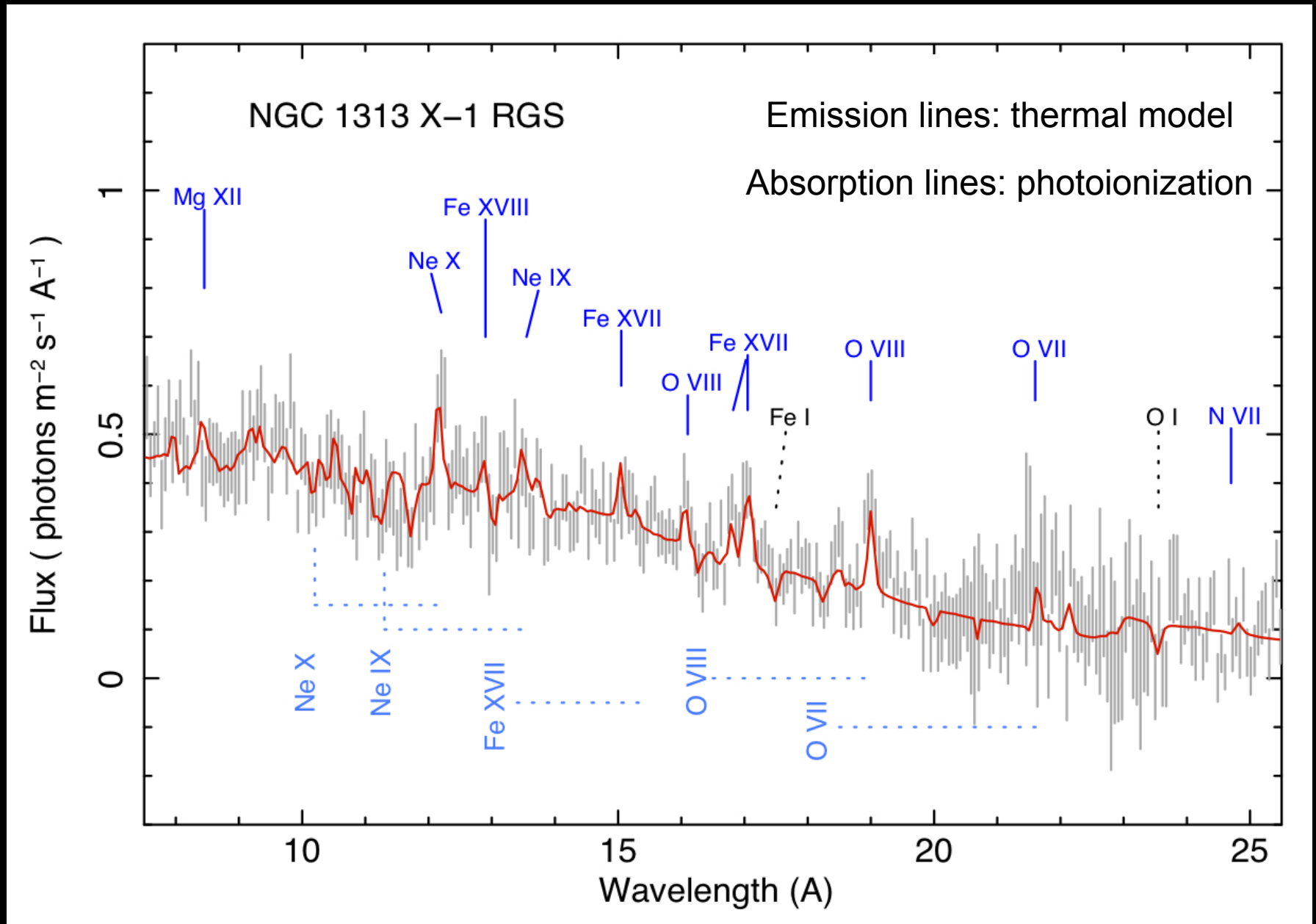
NGC 5408 X-1

- Longest (350 ks and 650ks) XMM exposures
- Bright, nearby, ULX "prototypes"
- Luminous soft states

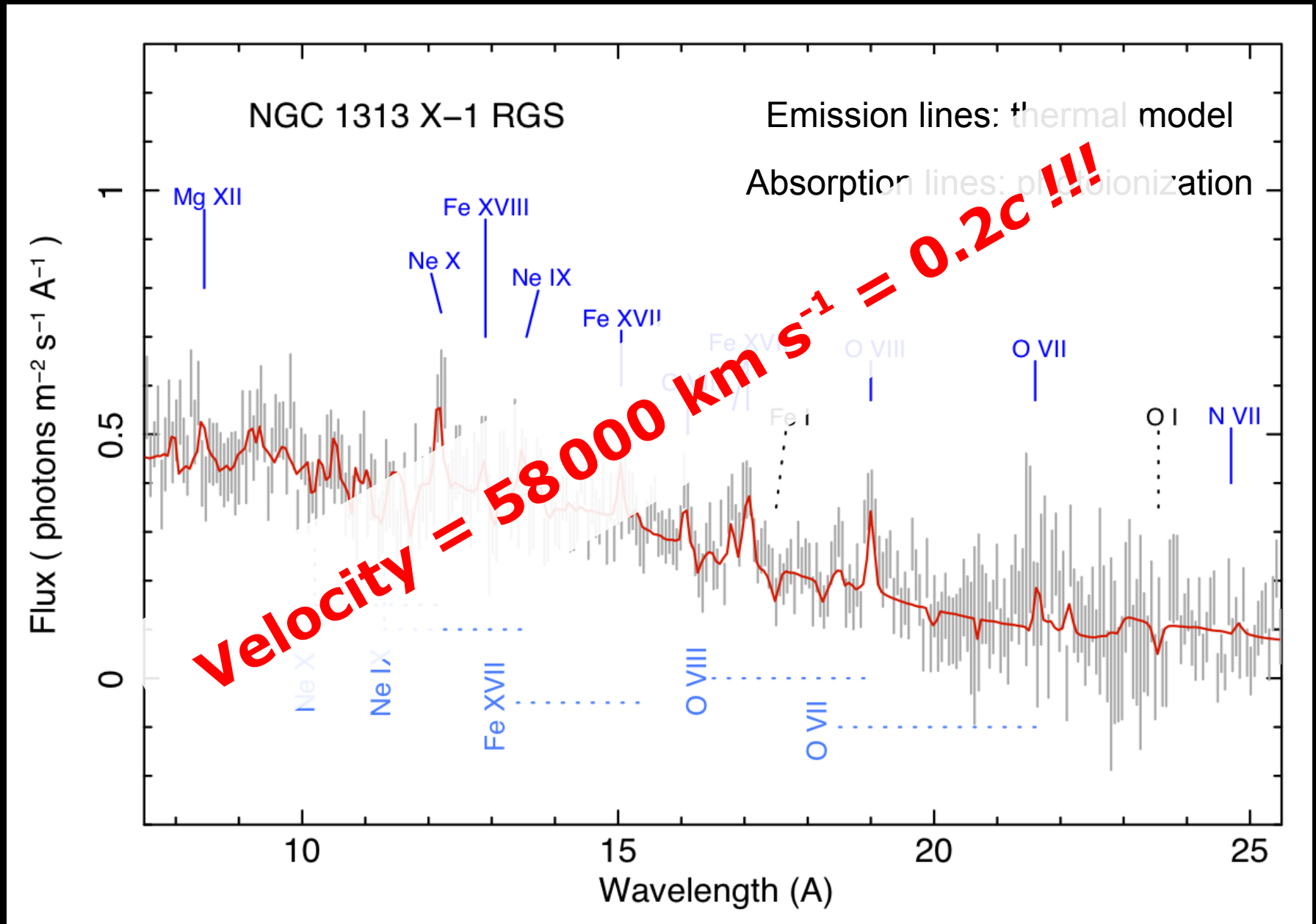
NGC 1313 X-1: RGS spectral residuals



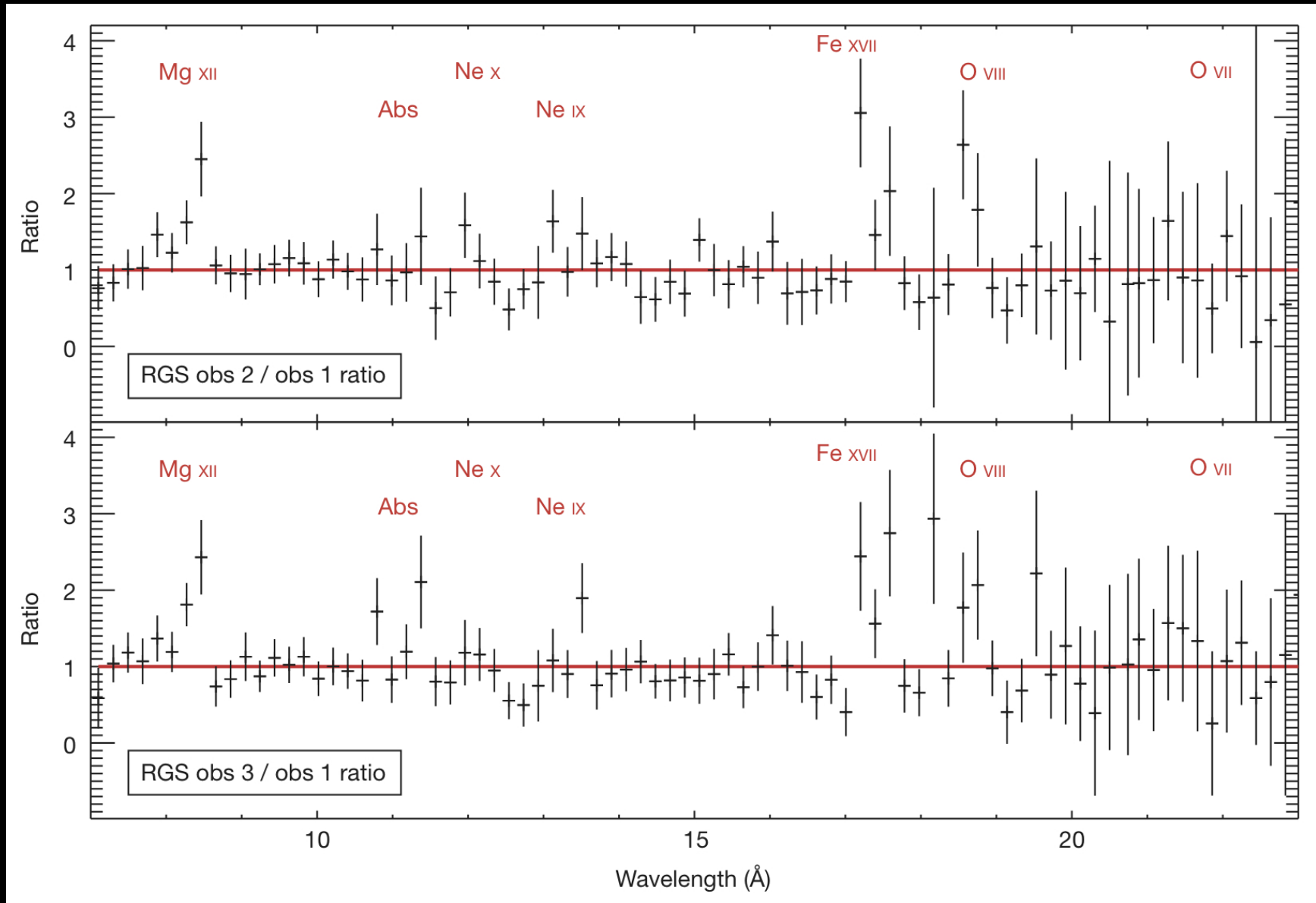
NGC 1313 X-1: physical model



NGC 1313 X-1: physical model

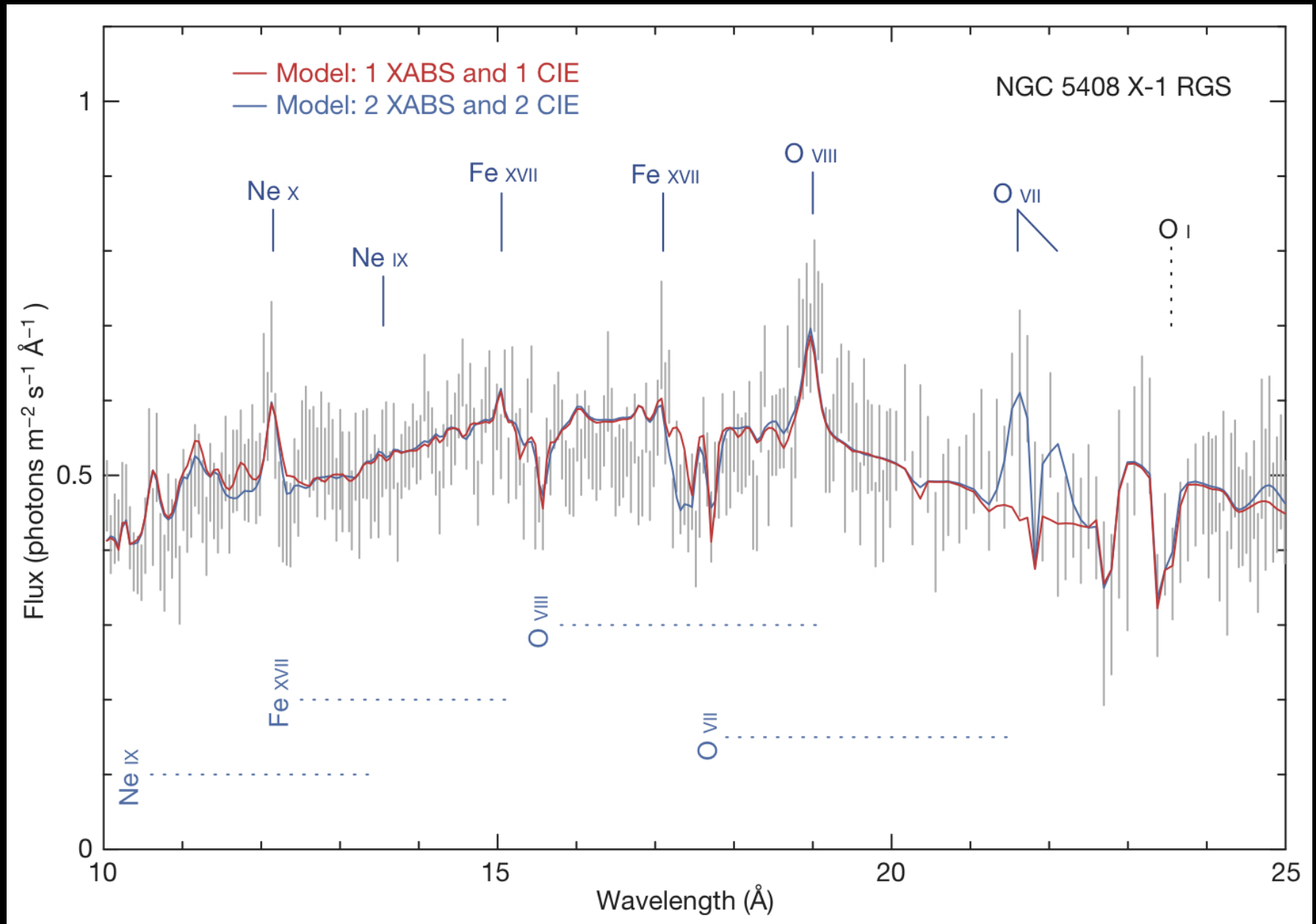


NGC 1313 X-1: spectral variability

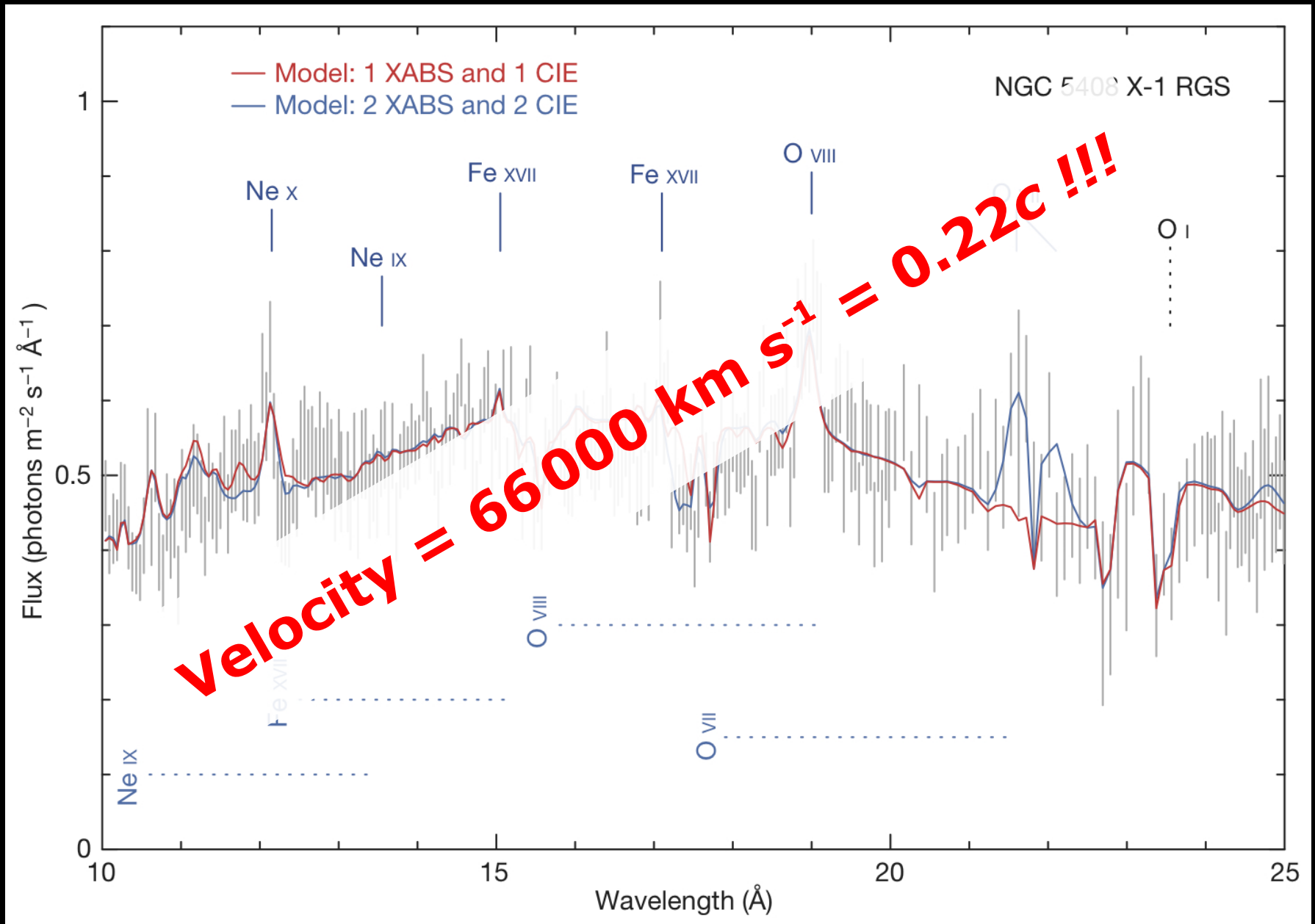


Wind is changing → L.O.S / precession ?

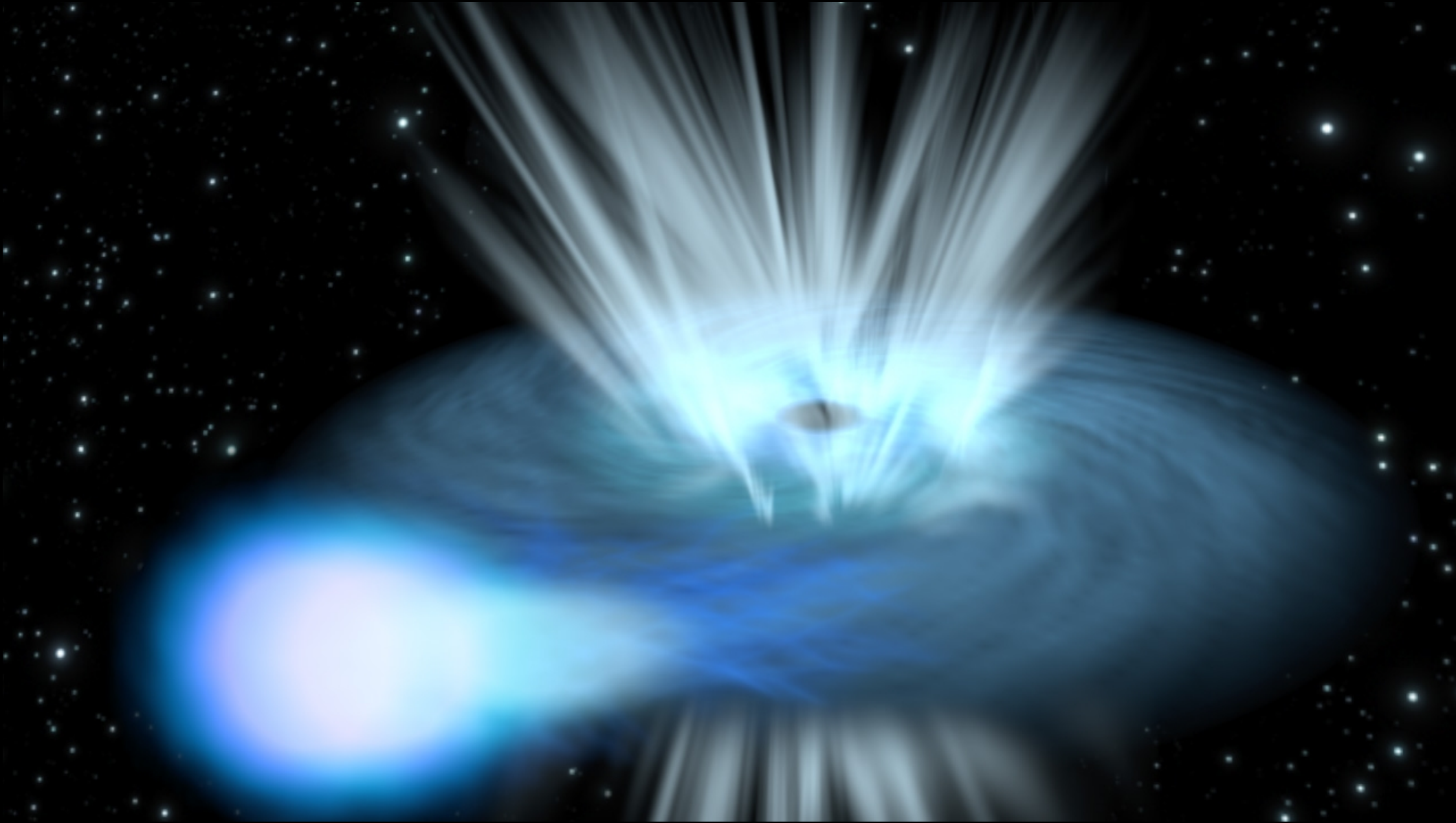
NGC 5408 X-1: physical model




NGC 5408 X-1: physical model



Ultra-Fast Outflows in ULXs !



Ultra-Fast Outflows in ULXs !

Velocity ($0.2c$)  (much) Faster than XRBs

Ultra-fast outflows imply *super-critical* accretion !

(e.g. Poutanen+2007, King+2015)

Emission lines from slow-moving gas

- a) colliding wind (Cooke+78/Oskinova+05)
- b) photoionization of distant gas

Magic current & Next decade

- RGS confirms, amplifies, and resolves EPIC feature:
rest-frame emission + **relativistic blueshifted absorption**
- Consistent with *super-Eddington* accretion
- Variability suggests L.O.S origin

→ Extend to more 10++ ULXs:

ULXs are various, Brand new science, missing “Rosetta Stone”

→ Simultaneous XMM (soft) – Chandra (hard) observations

→ Investigate Feedback