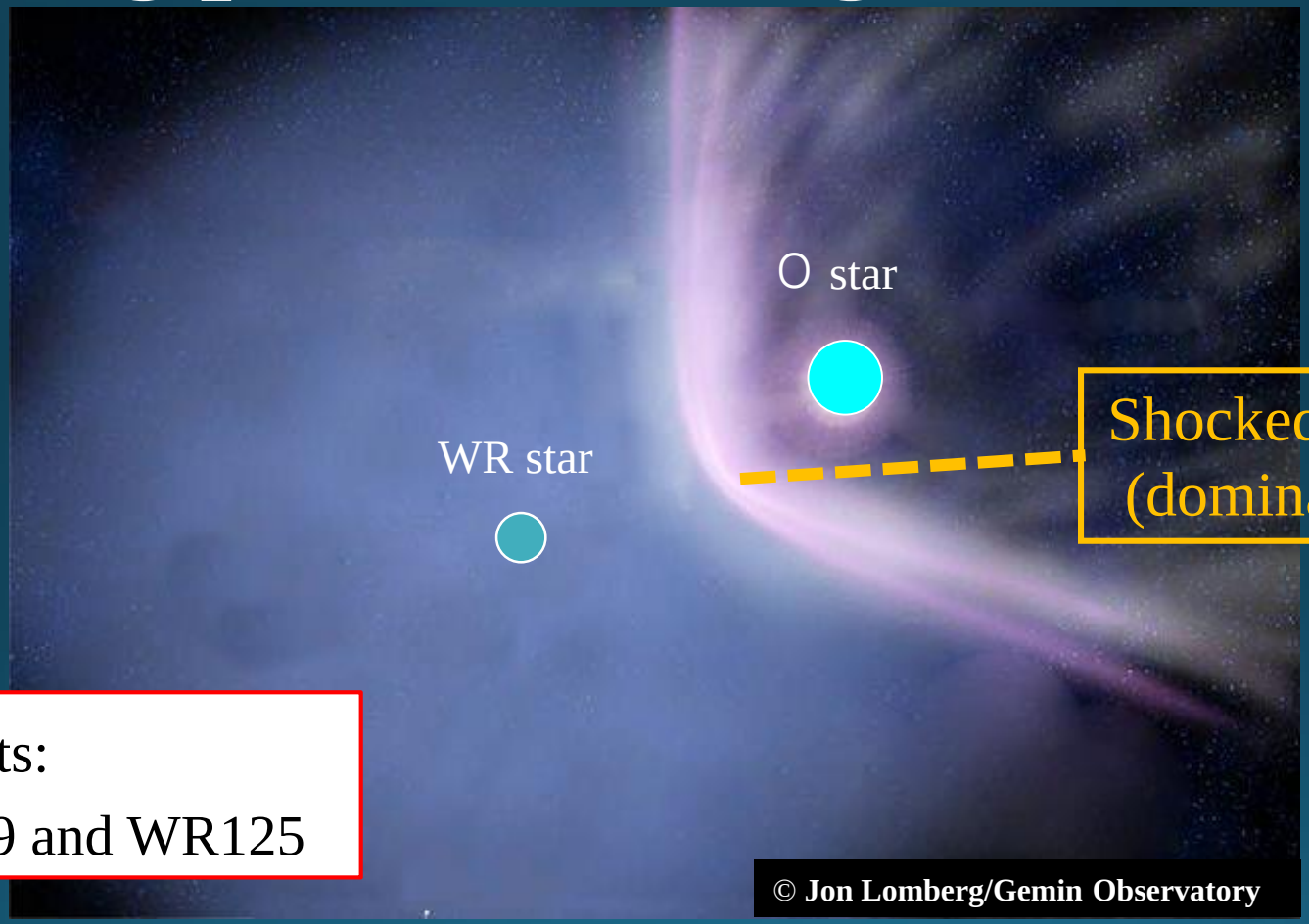
The X-ray monitoring of the long-period colliding wind binaries



Targets:
WR19 and WR125

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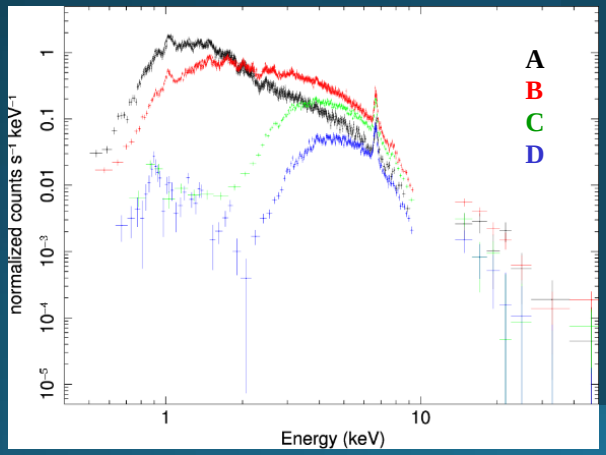
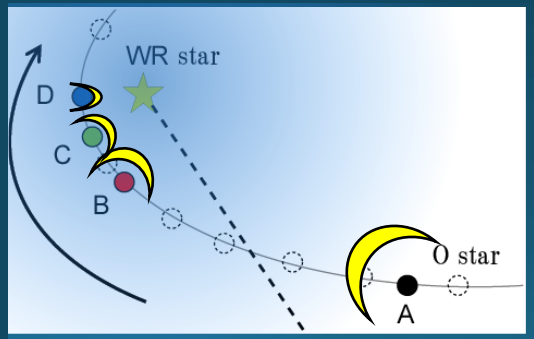
1. Introduction ~ Colliding wind binary

- Colliding Wind Binary (CWB)
  ⇒ CWB is brighter than single star in X-ray band

- eccentric CWBs
  ⇒ rapid variation of physical parameters
  ⇒ good testing site of stellar wind measurement

- X-ray monitoring is useful to measure the wind
  example: WR140 (Sugawara+15)





Geometry at 4 phases

2. Target 1 :WR19

WR19 (WC5+O9)

- Episodic dust maker, CWB
- Long period (P =10.1 yr,
  last periastron～2010)
- Elliptial orbit (e=0.8)
- non-detect@ROSAT/PSPC
- mass-loss rate has not been determined

Next periastron

→ May-June 2017 (now??)

Parameter	Value
Spectrum	WC5+O9
Distance	1.7–3.9 kpc
A_v ($1.1A_V$)	5.6
v	13.85
J	9.78
K	8.55
L'	8.20
[8.0]	7.20

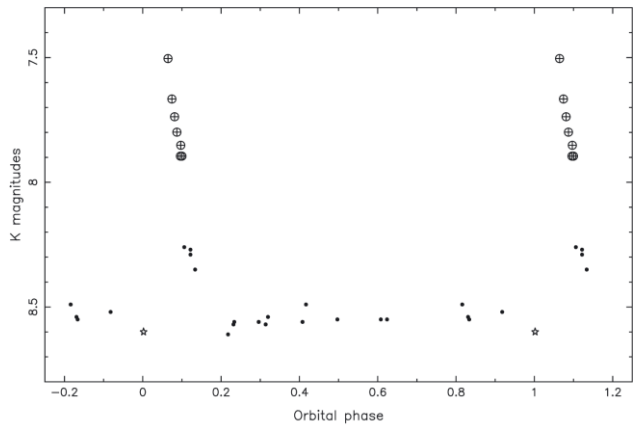


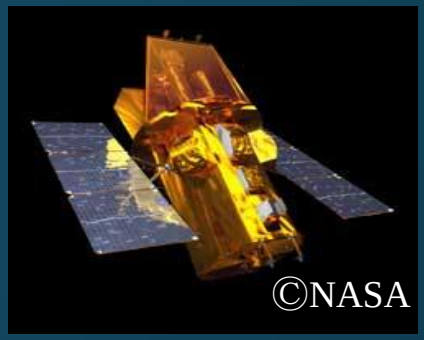
Figure 4. Light curve of WR 19 with K magnitudes from Papers 1 and 2 (●), converted from our [2.28] data (⊕) and from the DENIS survey (⋆).

(Williams+09)

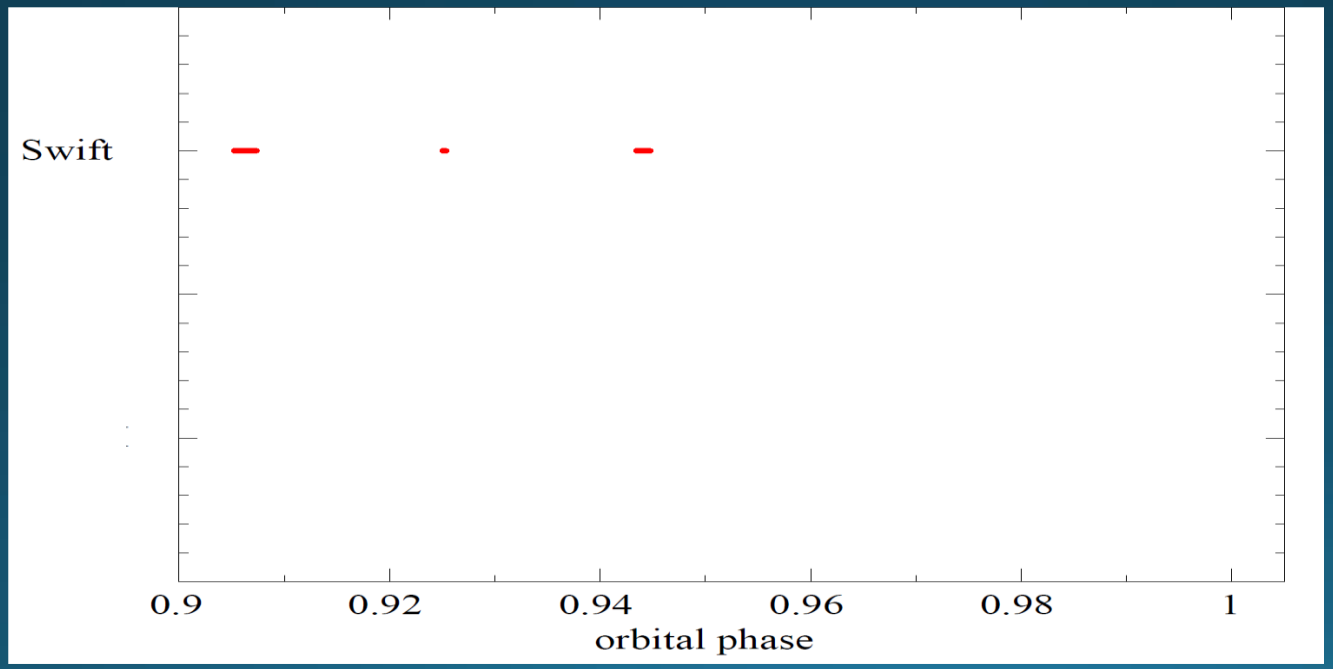
We started the X-ray monitoring observations from last year.

2． WR19: Observations & Results

X-ray has not been detect until last year.
At first, I checked X-ray brightness of using Swift.

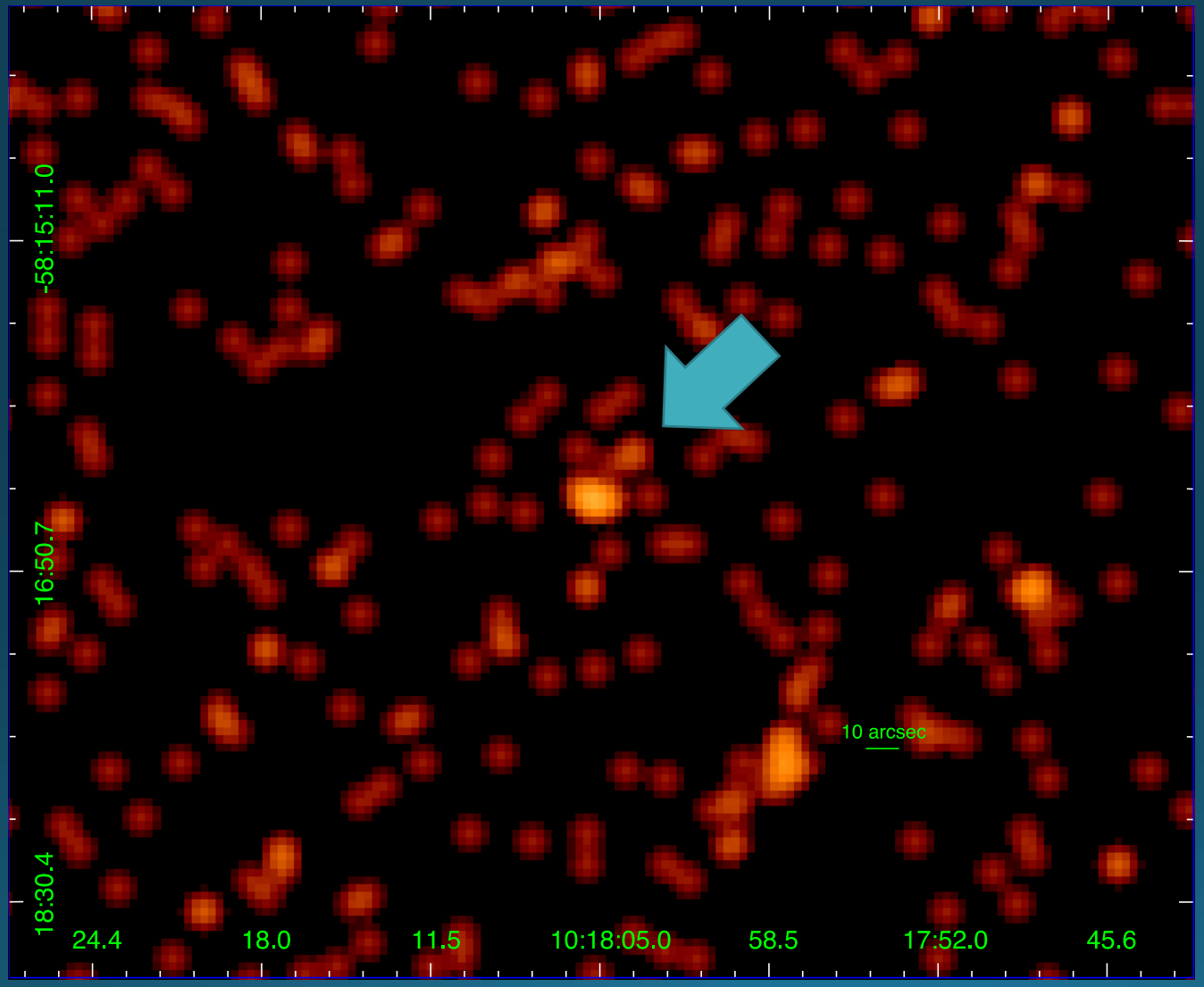


- Satellites：Swift
- Observation period：２０１６/０５/２０~



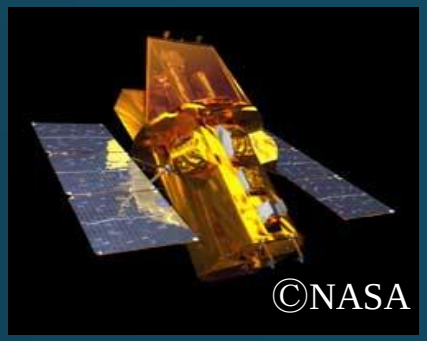
2. WR19: First X-ray detection (Swift/XRT)

0.3-10 keV band image@~18 ksec

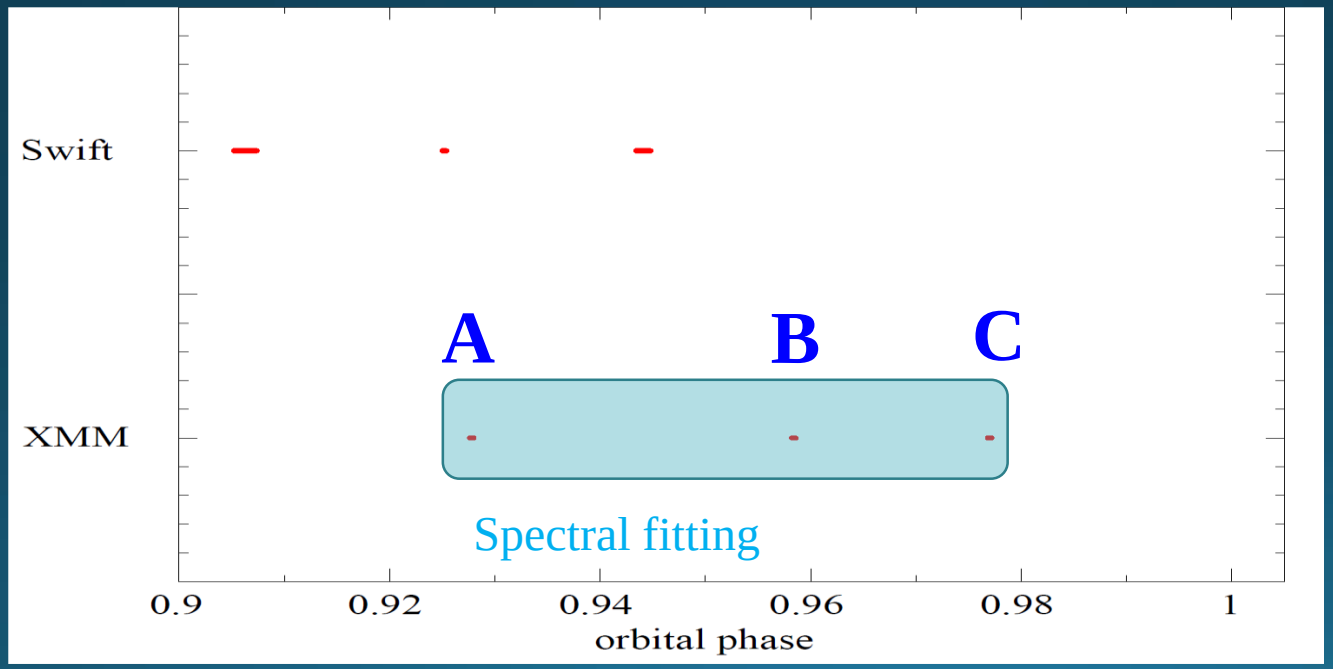


Detect!! → but a few ten photons

2． WR19: Observations & Results



- Satellites：Swift, XMM-Newton　　Total exp.～43ksec
- Observation period：２０１６/０５/２０~２０１７/０２/０９



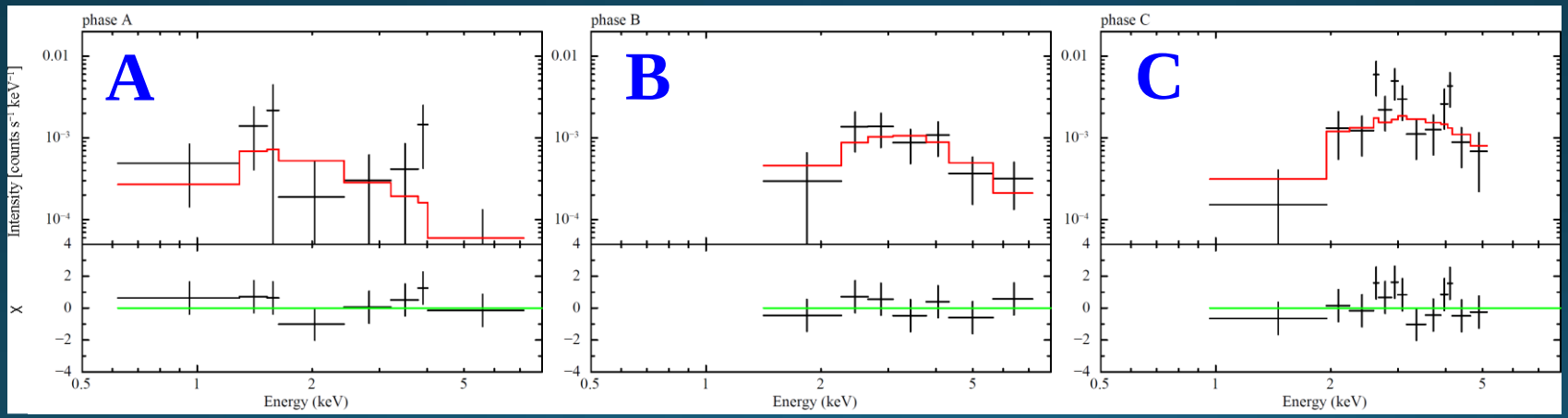
2. WR19: XMM spectral fitting

Model: wabs * (wabs*vapec)

ISM

Thin thermal plasma (local)

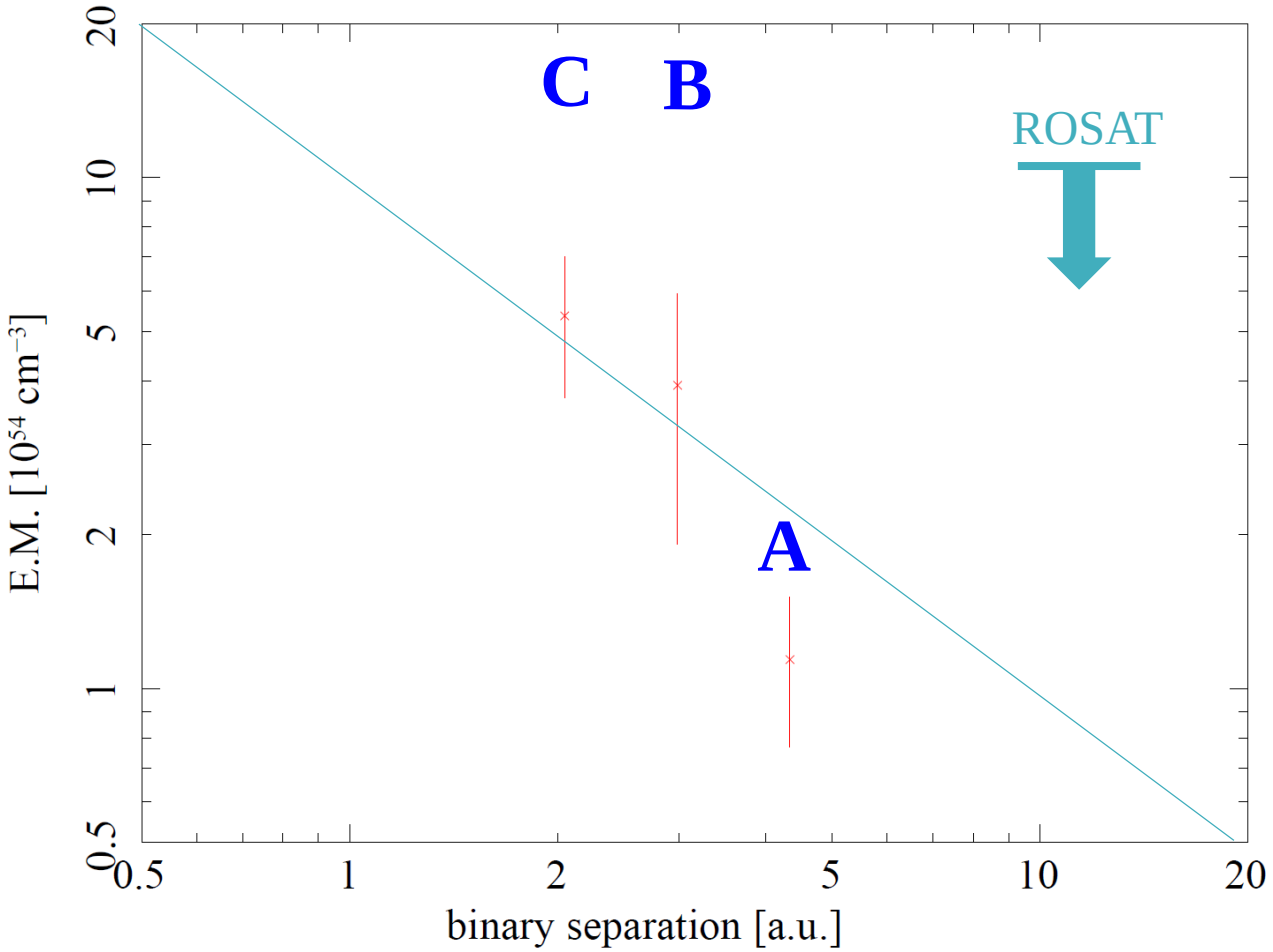
- ISM abs. fixed (N_H=1×10^{22}cm^{-2})
- kT=3keV, Abundance fixed



Phase A: L_X~ 3×10^{32} erg s^{-1} @0.5–10.0keV band

We checked the variation of *E.M.* and local N_H

2. WR19 ~ E.M. variation



As it close periastron, *E.M.* is larger.

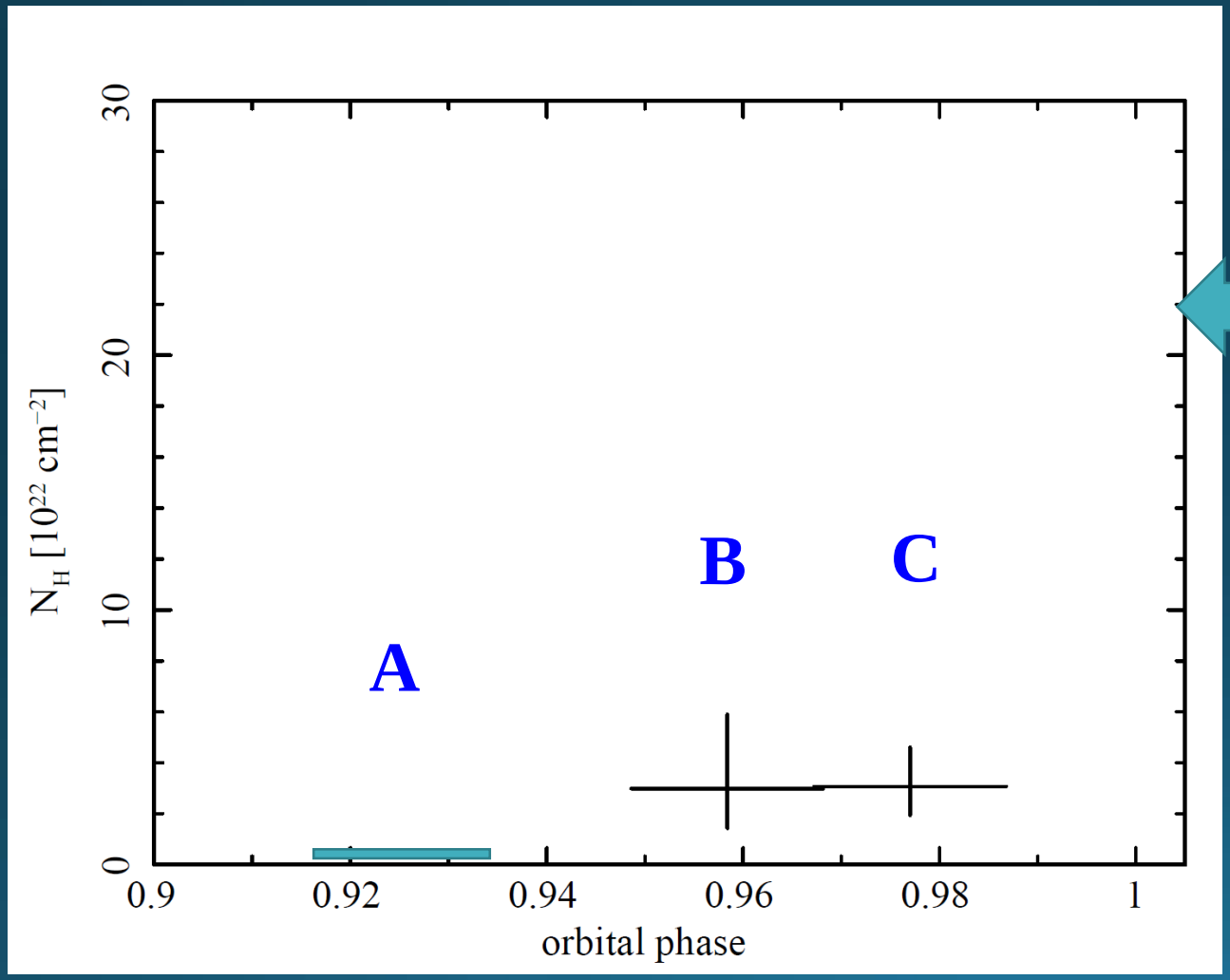
$L_X \propto$ E.M. = electron density × ion density × Volume = D^{-1}

(D^{-2}) (D^{-2}) (D^{3})

***D*: binary separation**

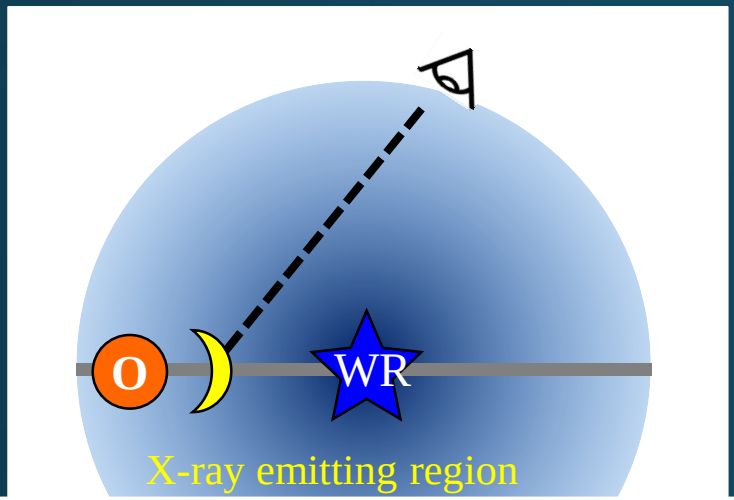
2． WR19: local abs. variation

Model:wabs *(wabs*vapec)



As it close periastron, absorption is little larger. This increase may result from the absorption of WR wind.

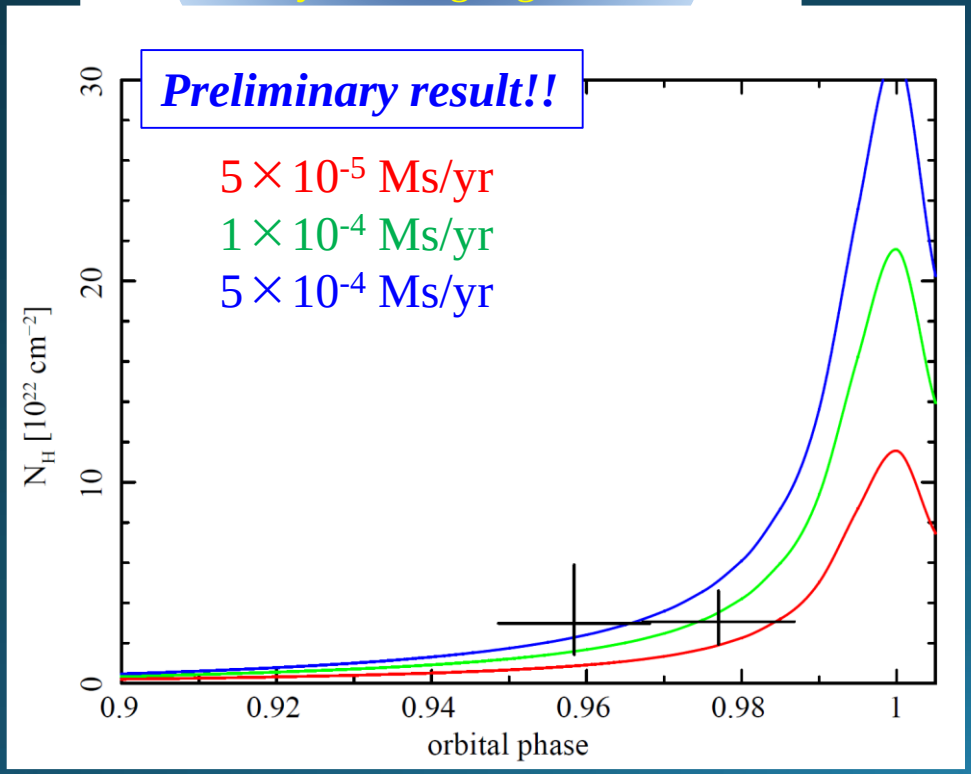
2. WR19: X-ray absorption and mass-loss rate



Observed value

$$N_H = \int_d^\infty \frac{\dot{M}}{4\pi\,\mu\,m_p\,v(r)}\frac{1}{r^2}\,ds$$

In this estimation, we assumed a spherically symmetric wind, and compact X-ray emitting region.



X-ray absorption

→ $\dot{M}_{WR}$=(5～50)×10^{-5} Ms/yr??

On the other hand,

Radio flux (upper limit)

→ $\dot{M}_{WR}$<10^{-4} Ms/yr (Veen+99)

3． Target:WR125

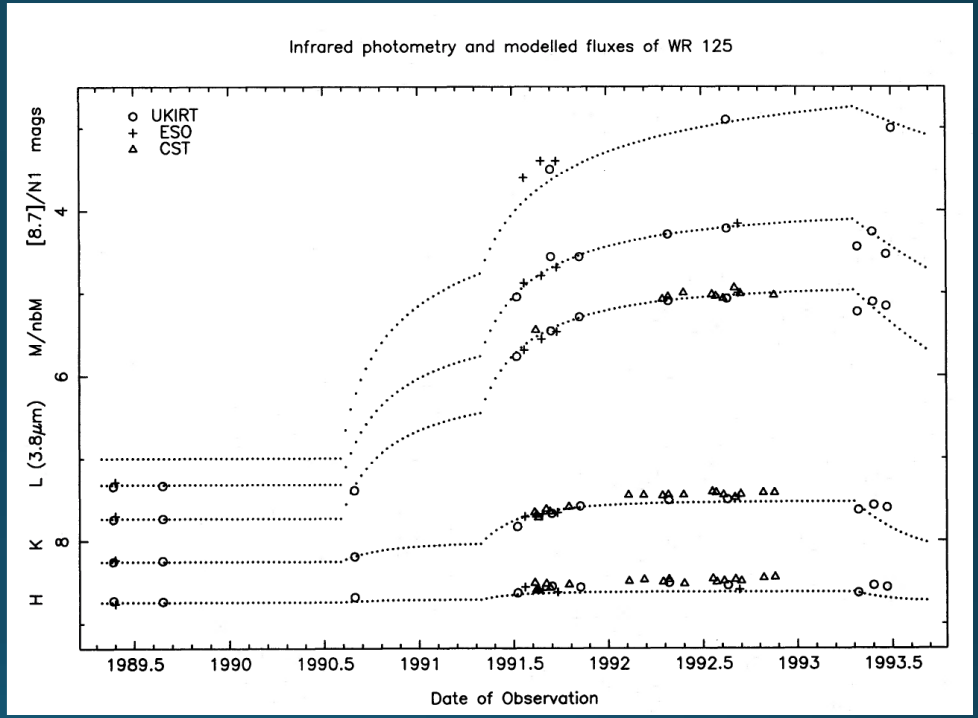
WR125 (WC7+O9Ⅲ)

- dust maker, CWB
- Last periastron → 1991-1992

  ⇒Long period(P >25 yr??)
- orbital parameters → unknown

Next periastron

→ >2016-2017??

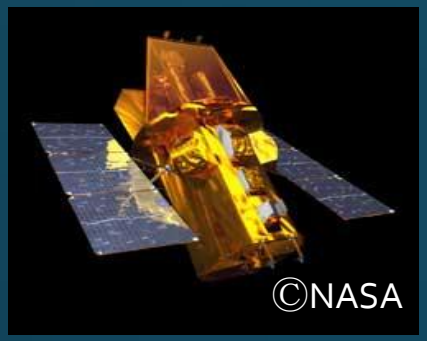


(Williams+94)

Can we limit some orbital and/or stellar parameter using X-ray observation?

We started the X-ray monitoring observations from half a year ago.

3. WR125: Observations & Results



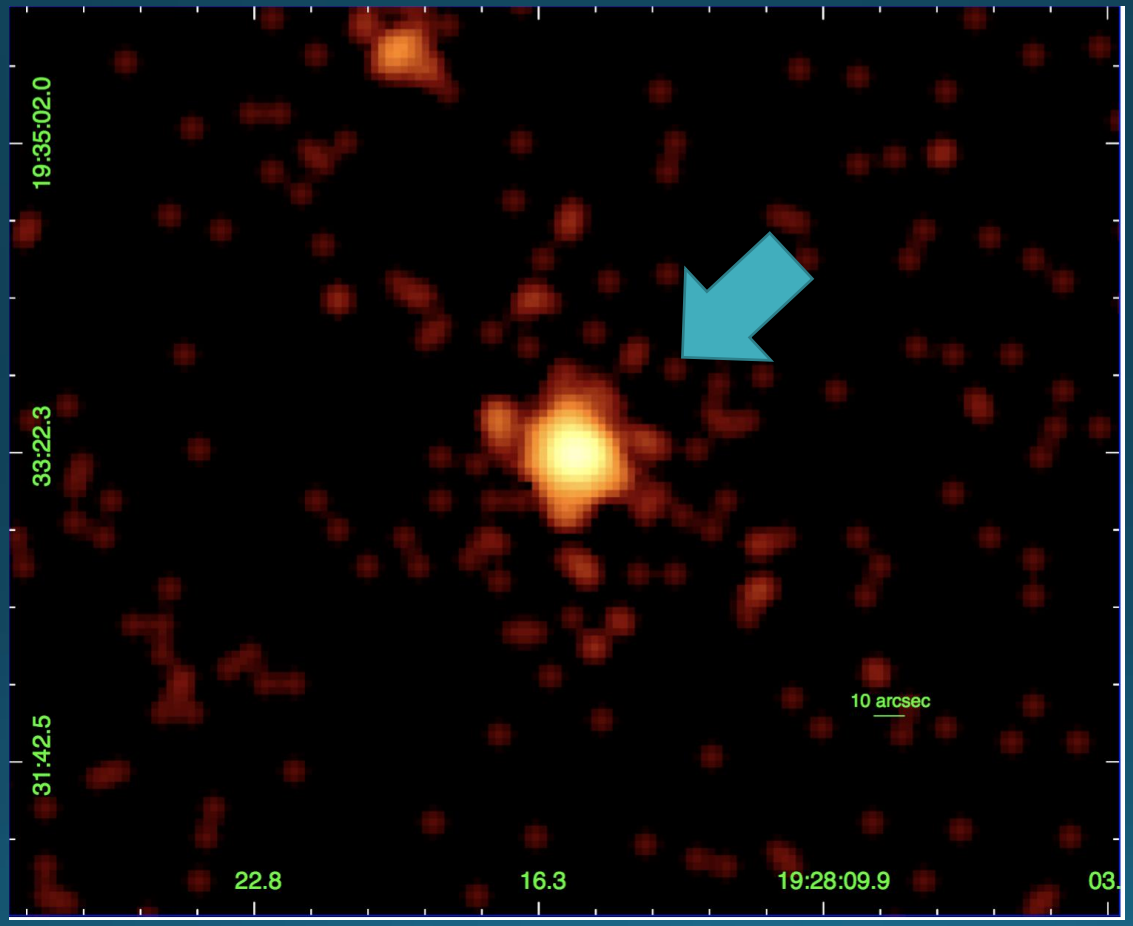
- Satellites：Swift, XMM-Newton
- Observation period： ２０１６/１１/２８~２０１７/０５/１２

Phase	Satellie	OBS start	Exp. Time [ksec]
a	Swift	2016-11-28T01:50	4.8
b	Swift	2016-12-17T13:27	4.7
c	Swift	2017-03:16T06:19	2.3
d	XMM-Newton	2017-05-11T08:26	21.5

Total exp.time ～33 ksec

3. WR125: Swift/XRT image

0.3-10 keV band image@~5 ksec



Bright!!

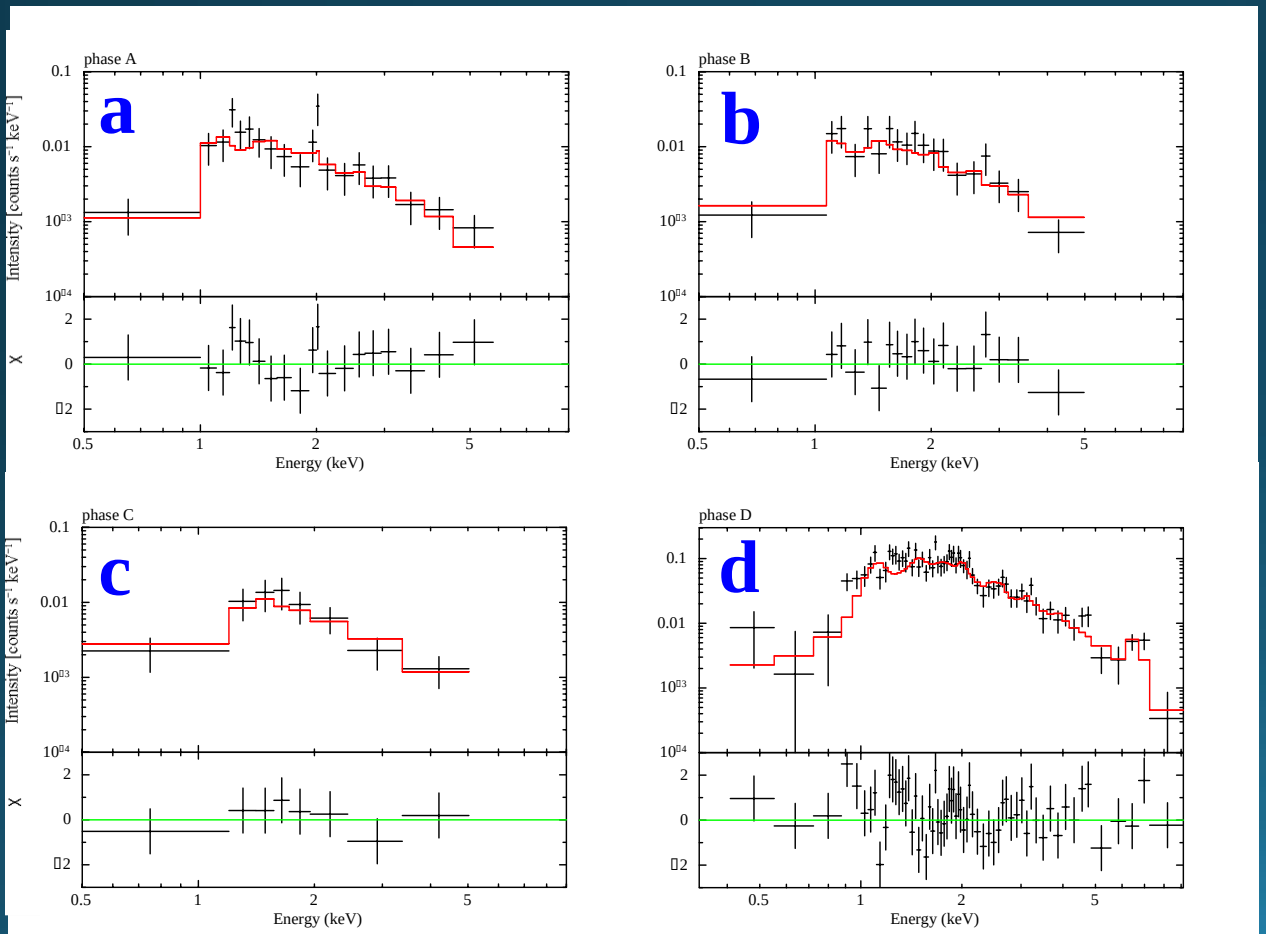
3. WR125: XMM & Swift spectral fitting

Model: wabs * vapec

wabs: ISM

vapec: Thin thermal plasma

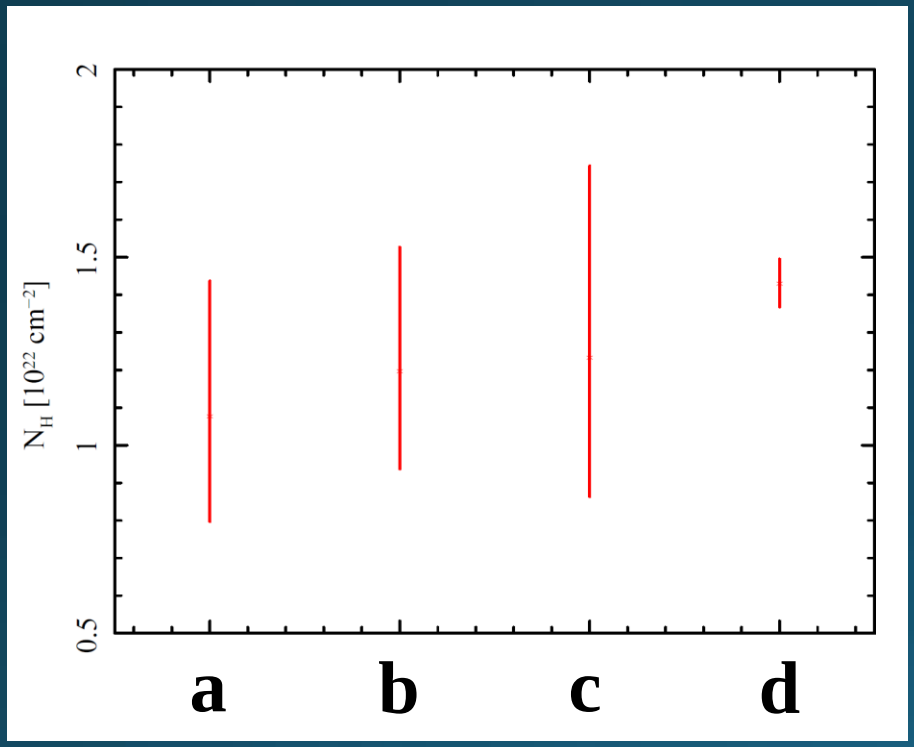
- kT=2keV, Abundance fixed
- L_X~8×10^{32} erg s^{-1}@0.5–10.0keV band

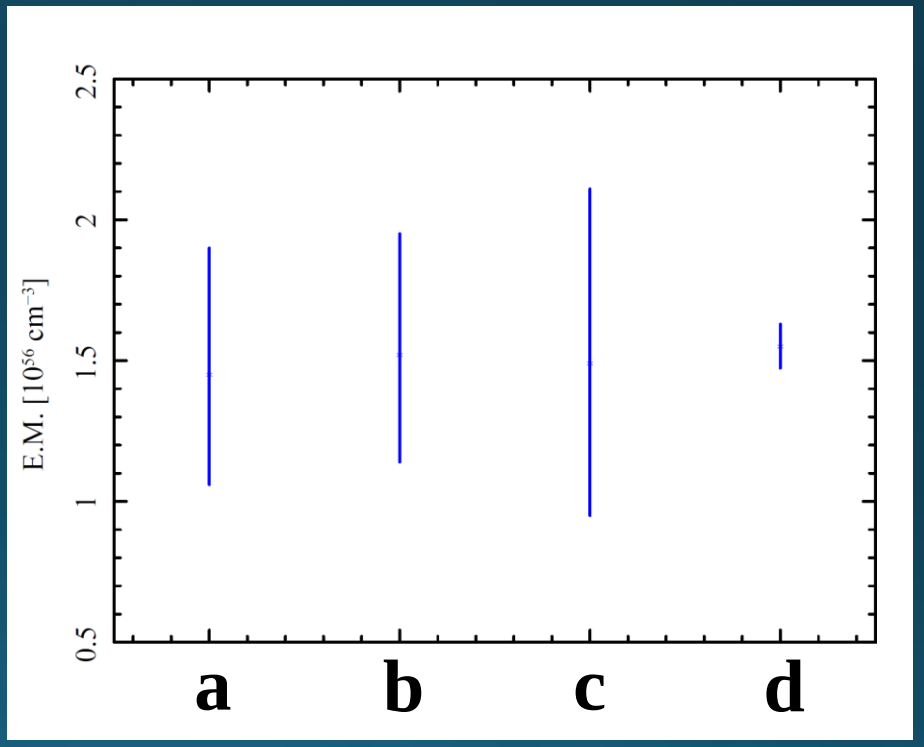


We checked the variation of N_H and *E.M.*

3. WR125: The variation of N_H and E.M.

There are no changes !!





The absorption is roughly larger than the ISM absorption ~7×10^{21} cm^{-2}.

→ WR wind absorption??

At least, this phases are not near periastron.

4. Summary

We started X-ray monitoring campaign of WR19 and WR125

WR19

- We detected the first X-rays
  - $L_X \sim$ 1-5 $\times 10^{32}$ erg/s $\Rightarrow$ Typical L_X for CWB
  - Phase locked variation $\rightarrow$

$E.M.$ (n_e n_i V) $\uparrow$, N_H(local) $\uparrow$

$\Rightarrow$ We are going to check the periastron data.

WR125

- No X-ray variation $\Rightarrow$ Not near periastron (P> 25 yr!!)

$\Rightarrow$ We will continue X-ray monitoring observation