Carbon rich X-ray spectrum of a Wolf-Rayet binary theta Muscae

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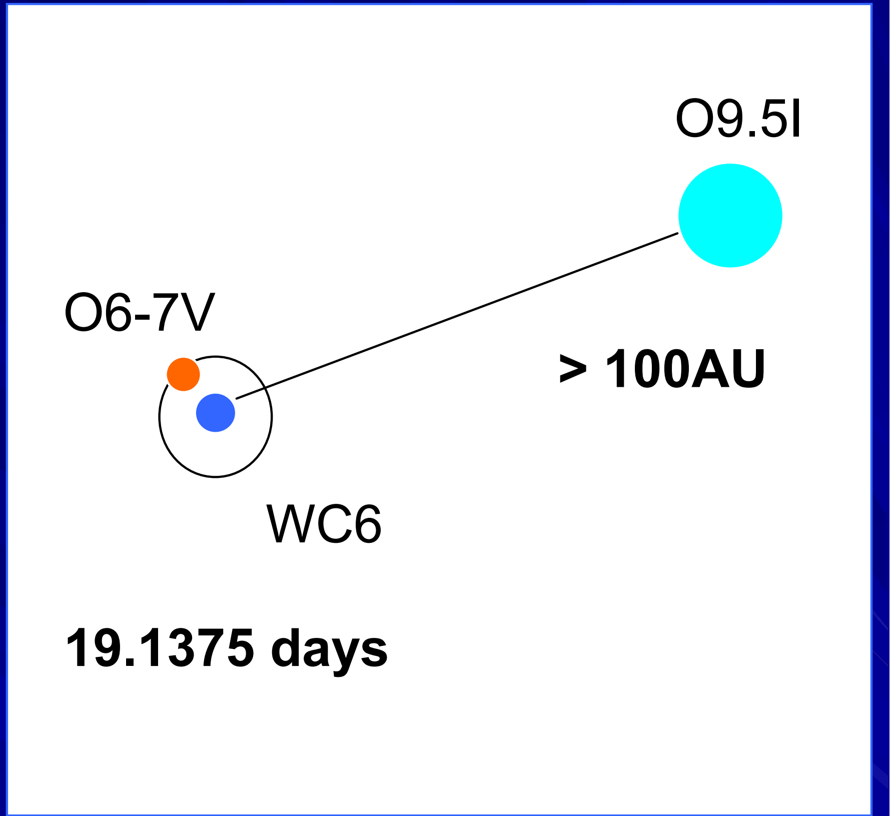
Plan

- Target - theta Muscae -
- Observation & Results
- Summary

Target - theta Muscae -

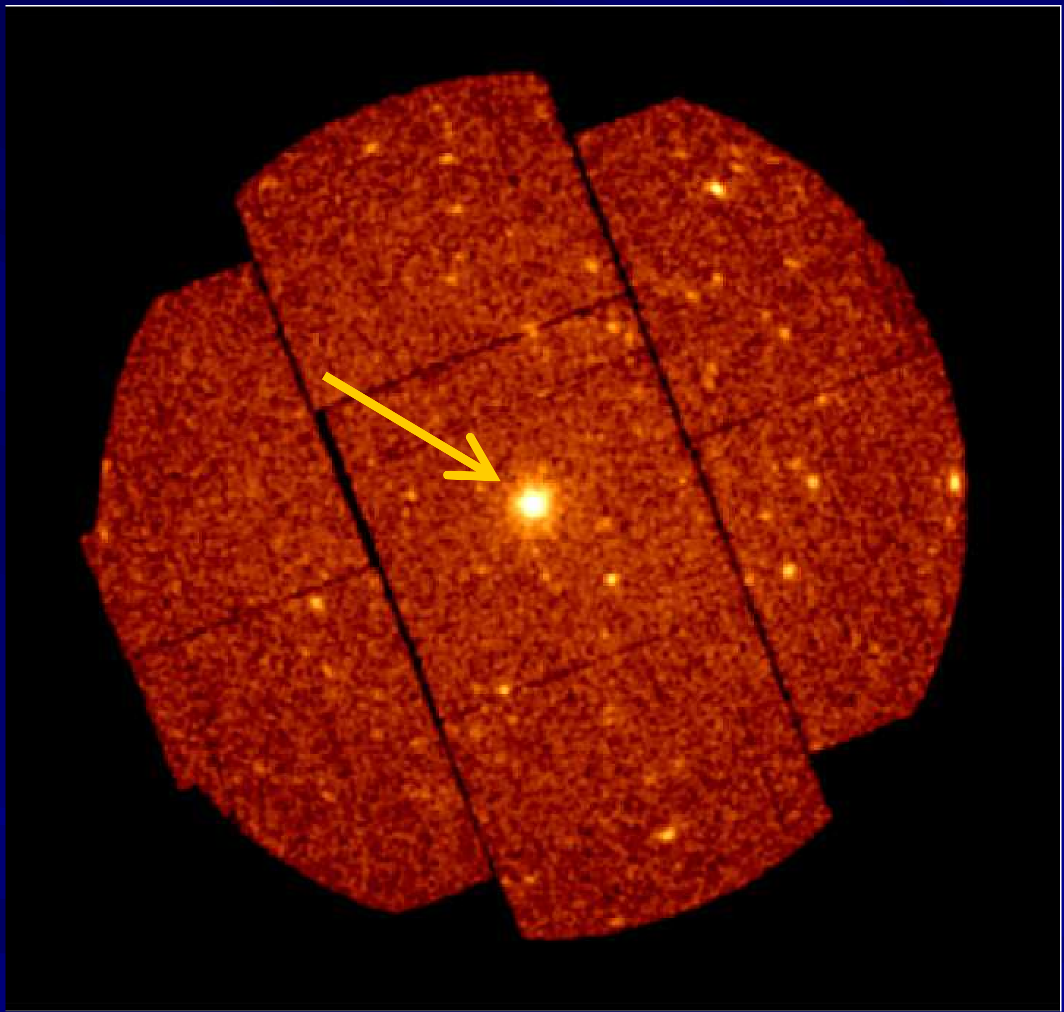
- Triplet system? (WC6+O6-7V+O9.5I)
  - Hill et al.(2002) worked out WC6+O6-7 binary period.
  - Hartkopf et al.(1999) found an O supergiant 46 mas away from the short-period binary.
- X-ray detected by Einstein & ROSAT (Pollock 1987, Pollock et al.1995).



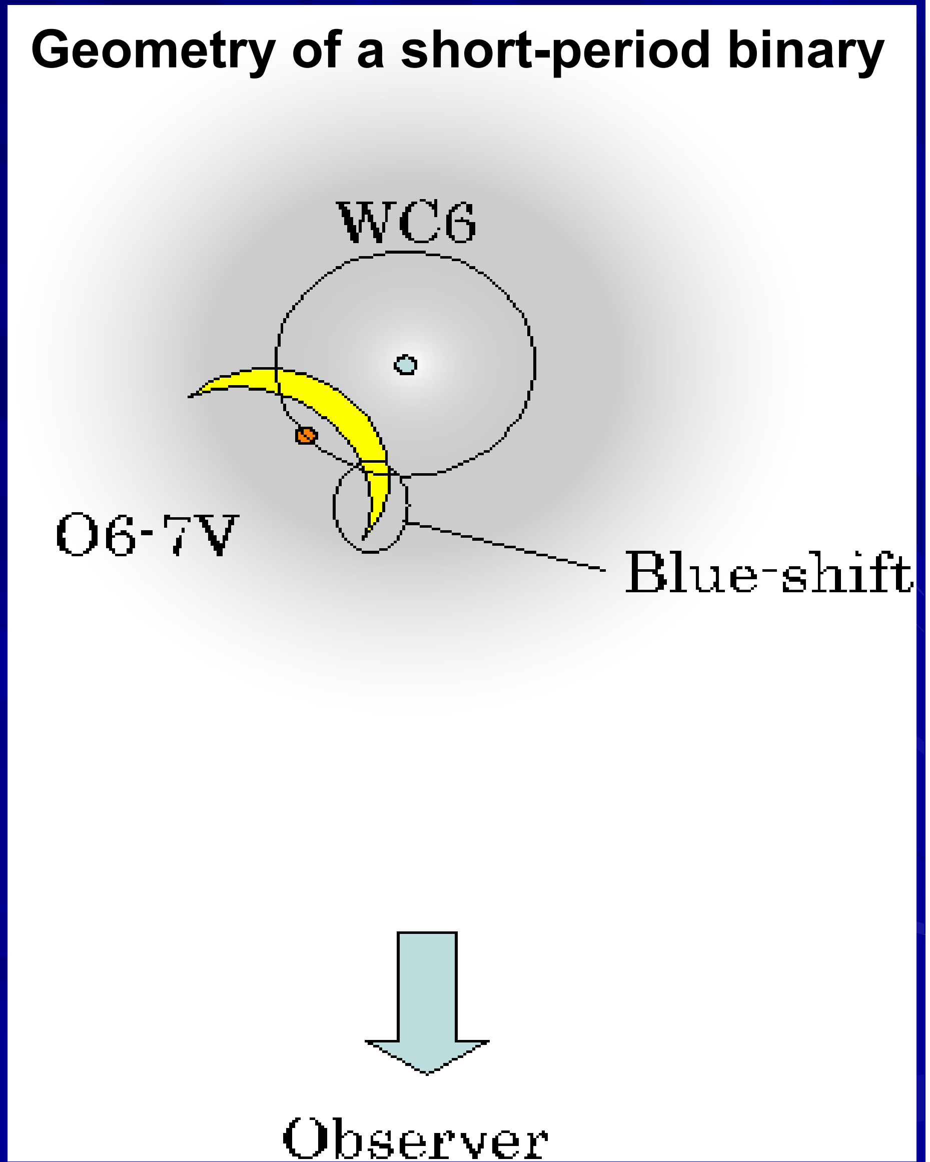
Where is the X-ray emitting region in theta Muscae system?

XMM-Newton observation

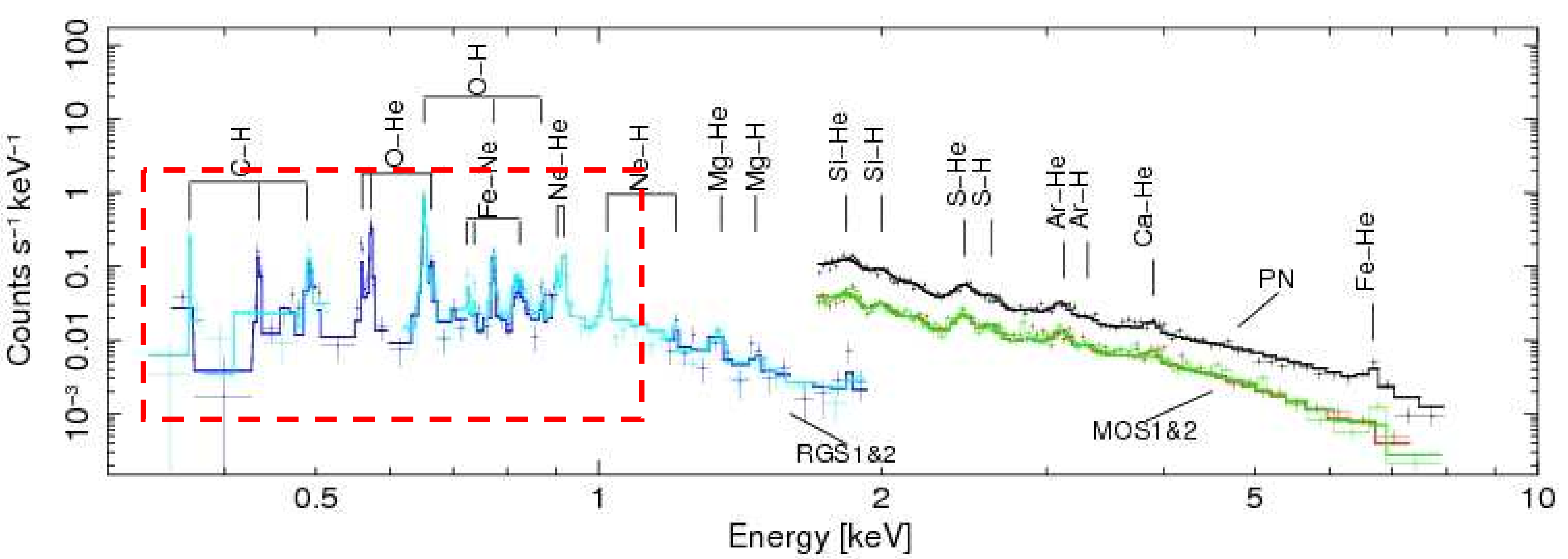
- Exposure time ~ 120 ksec



XMM-Newton MOS1 image (0.3-10 keV band)



X-ray spectrum

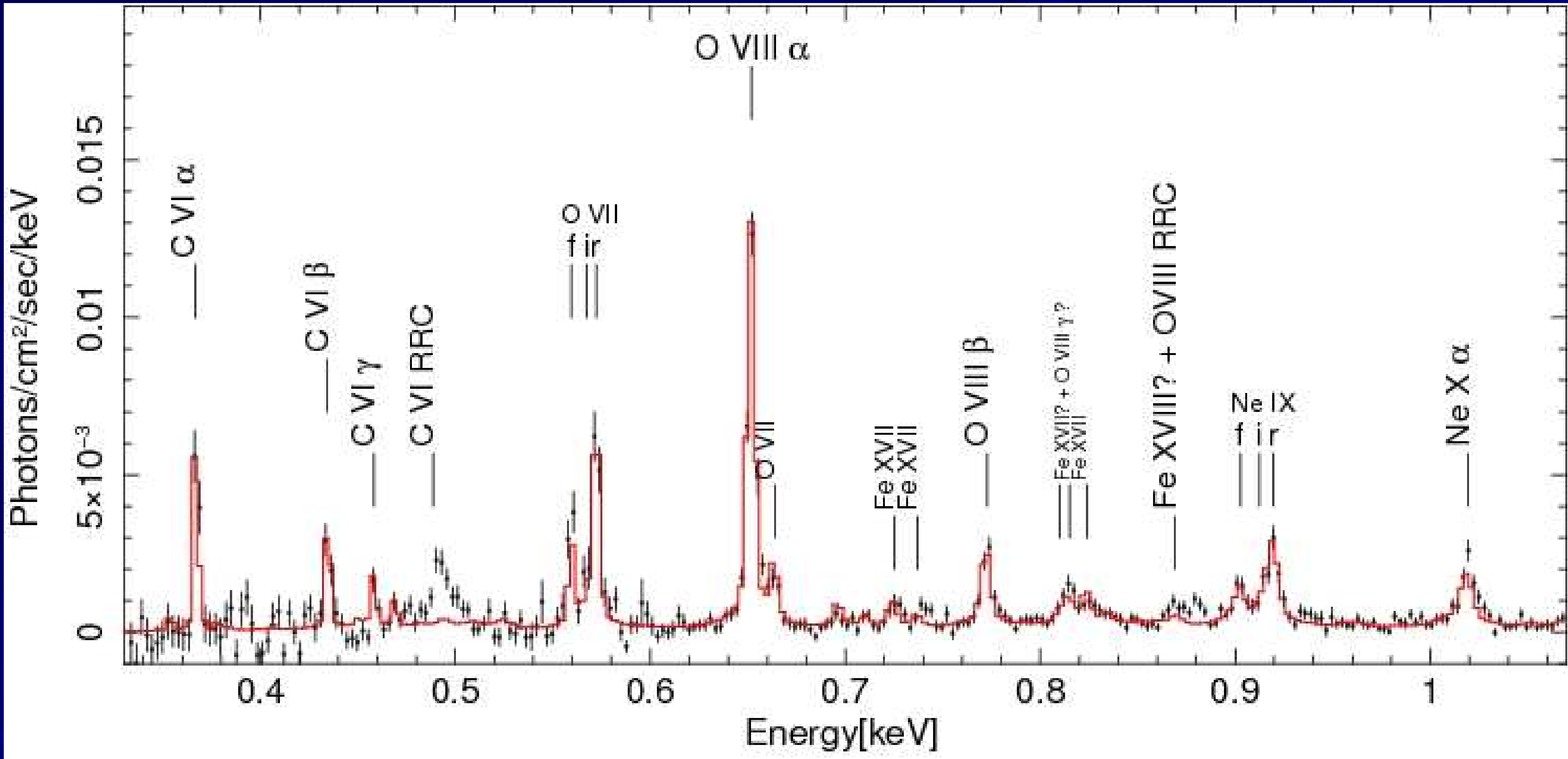


- Multi-temperature plasma (2T vpshock model)

$\Rightarrow$ kT_1 ~ 0.6 keV, kT_2 ~ 3.6 keV

$\Rightarrow$ Upper limit on ionization timescale ~ 5 * 10^{11} s/cm^3

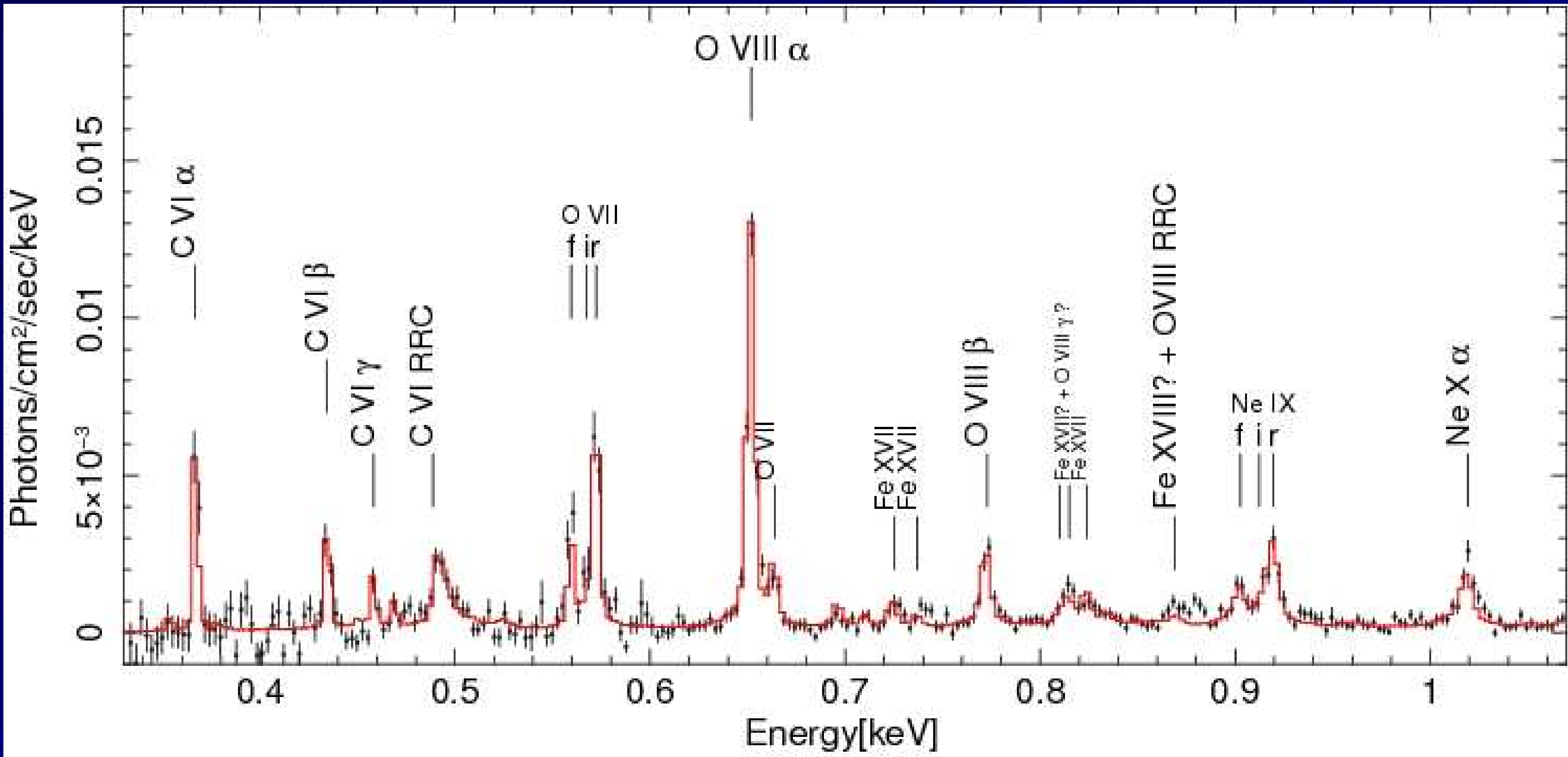
RGS spectrum I



- Detection of the a lot of many significant lines, but no nitrogen line!

=> Abundance of Carbon ~ 3.5 Z_{sun}, Abundance of Nitrogen < 0.1 Z_{sun} (WR stellar wind is dominant)

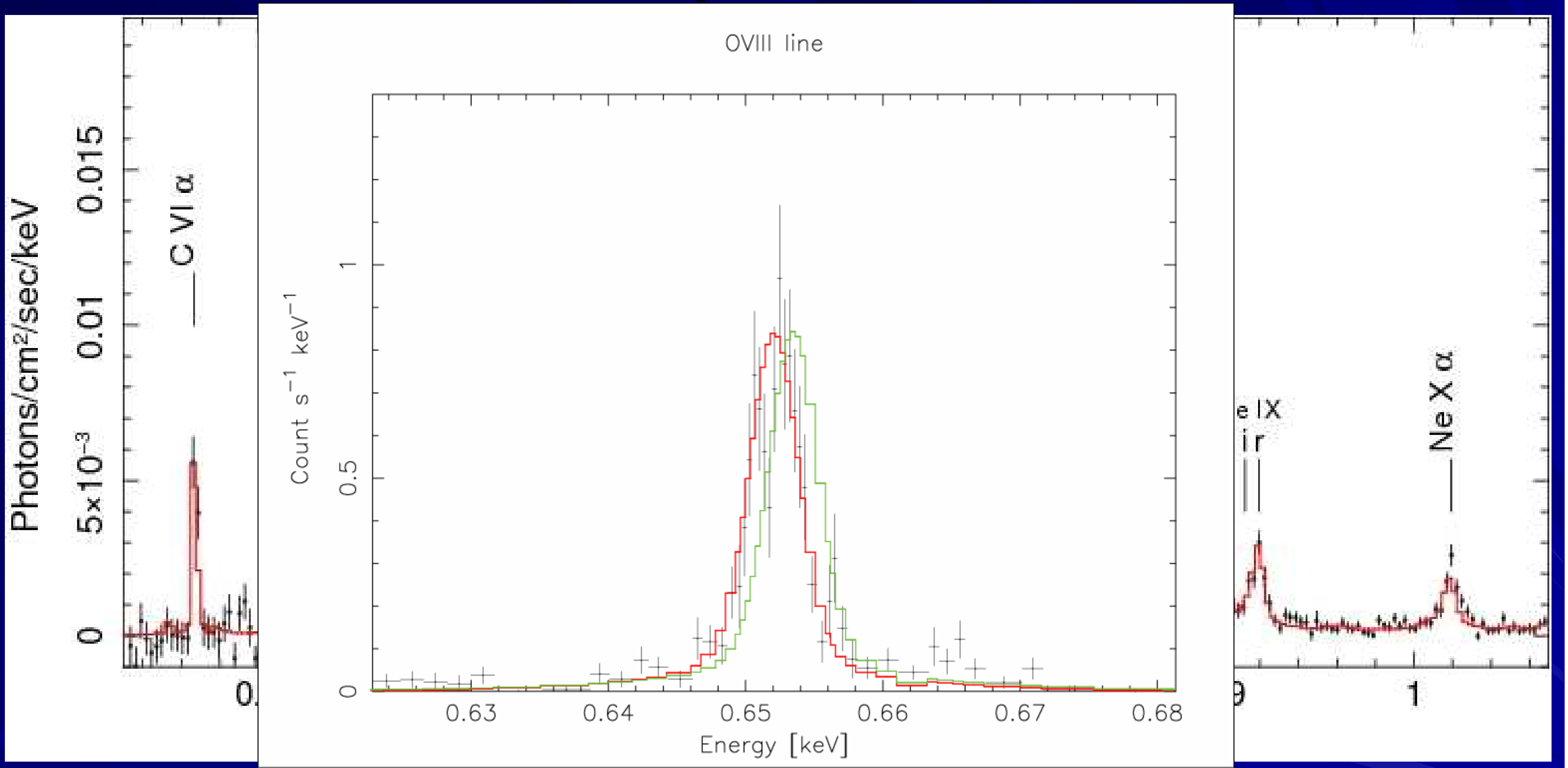
RGS spectrum II



- Radiative Recombination Continua detected

=> kT ~ 5eV , C VI RRC structure is red-shifted by ~500 km/s.

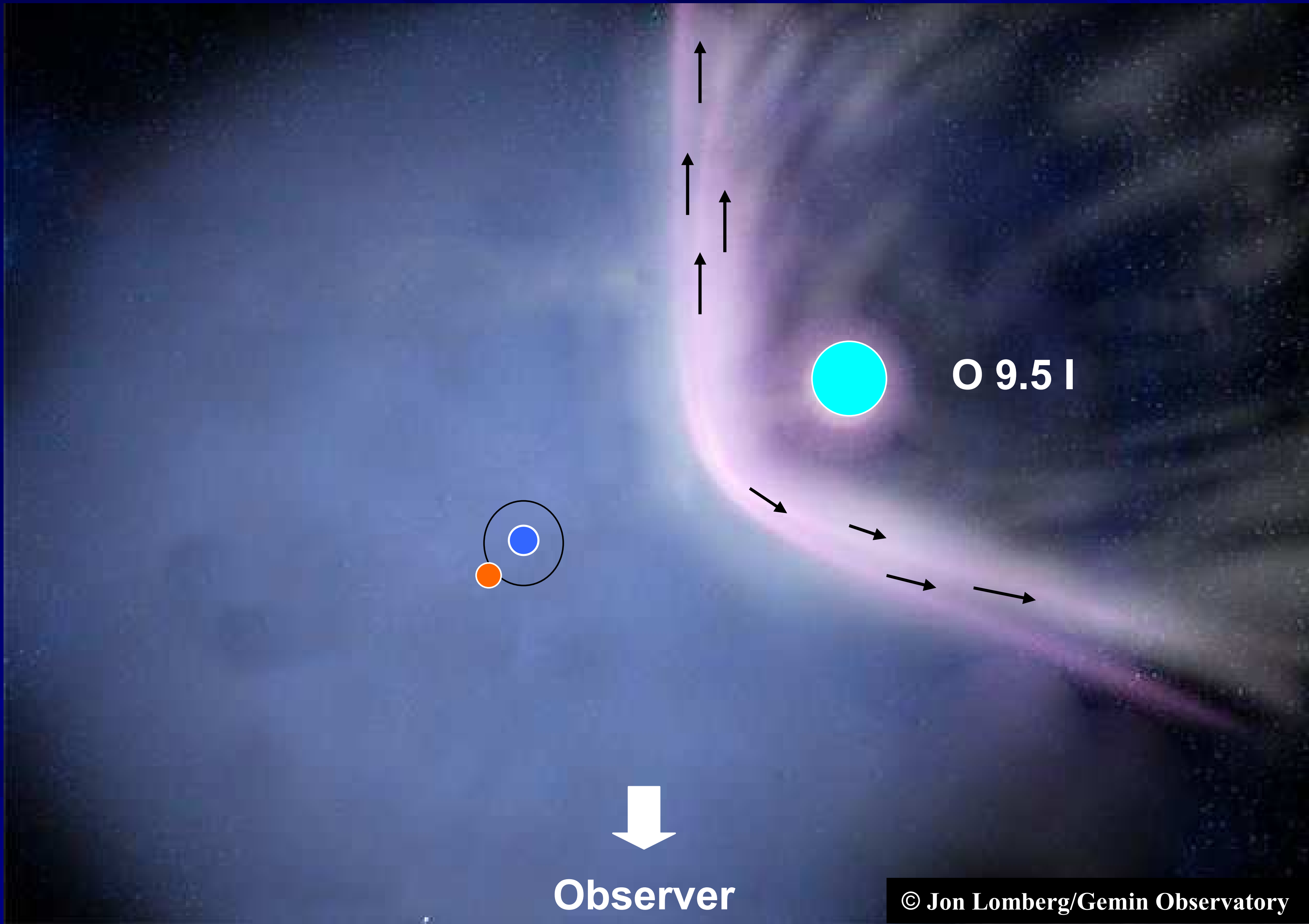
RGS spectrum III



- The emission lines are red-shifted (~ 600 km/s) and broadening (FWHM ~1400 km/s)

WHY?

Our interpretation



Summary

X-ray from theta Muscae shows

1. Multi-temperature plasma
2. $Z_C >> Z_N$ (WR stellar wind dominant)
3. RRC structure (another cooler component)
4. Red-shift of the emission lines

Probably, the X-ray emitting region in theta Muscae system is the colliding wind of a large separated WR binary (WC6+O9.5I).

But, we have a new question.
"Why can't we detect blue-shift in the spectra?"