

Collisionless plasmas in WR140 and η Carinae

X-rays from colliding winds in massive-star binary systems

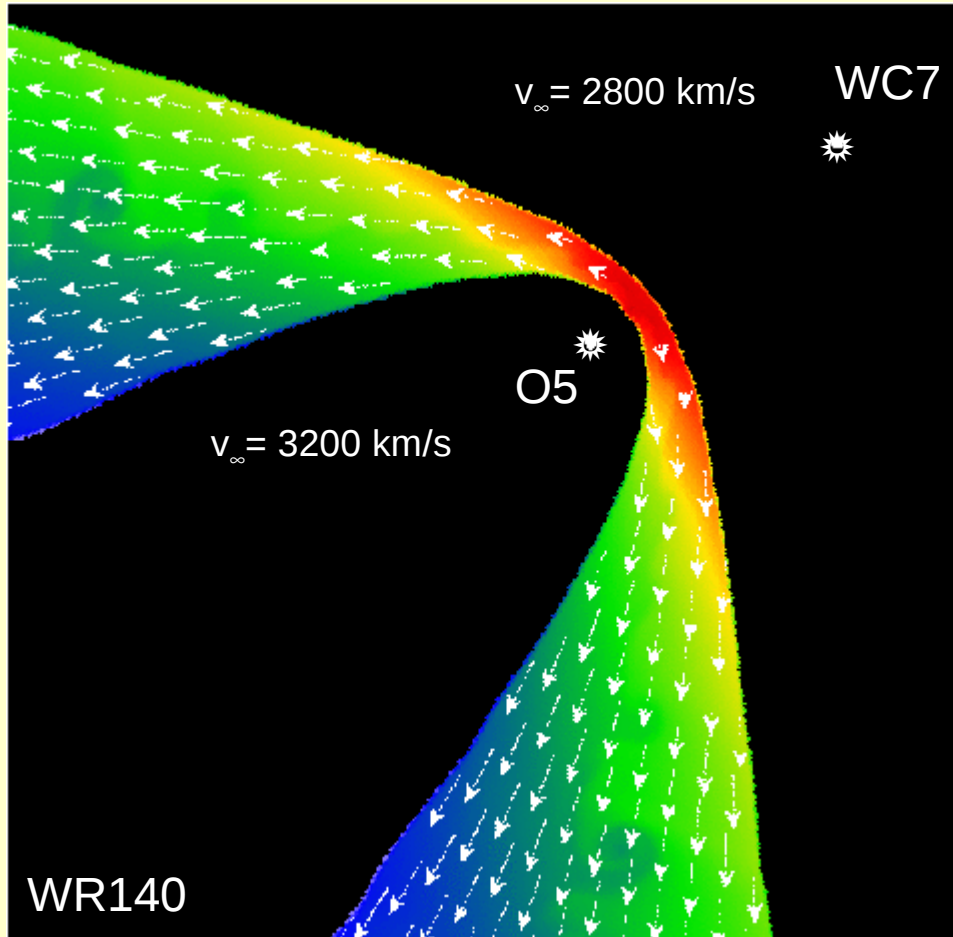
Andy Pollock (ESA-E) & Mike Corcoran (USRA/NASA-US)

Dougherty, Gull, Hamaguchi, Henley, Moffat, Okazaki, Owocki, Pittard, Stevens, Williams

Chandra's First (5/4) P_{WR140} and (20/11) $P_{\eta Car}$ of Discovery : 2009 September 22

Collisionless shocks in colliding-wind binaries

colliding winds \Leftrightarrow counter-streaming plasma flows \Leftrightarrow well-known physical conditions $\{\mu, n, v, T\}$



Stevens, Blondin & Pollock (1992) numerical hydrodynamics

☀+☀ Coulomb collisions in WR140

☀+☀ $L_{\text{ion-ion}} \approx 14(D/a)^2 \text{ AU}$

☀+☀ $L_{\text{ion-electron}} \approx 21(D/a)^2 \text{ AU}$

☀+☀ $L_{\text{ionization}} \approx 8(D/a)^2 \text{ AU}$

☀+☀ plasma physics $\Leftrightarrow \underline{B}$

☀+☀ Alfvén waves

☀+☀ wave-particle interactions

☀+☀ Weibel instability

☀+☀ two-stream instability

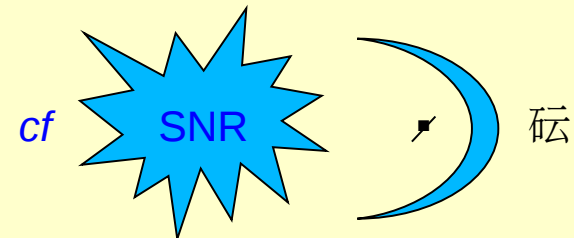
☀+☀ charge exchange

☀+☀ shock precursor

☀+☀ radiation

☀+☀ cosmic rays

☀+☀ electron conduction

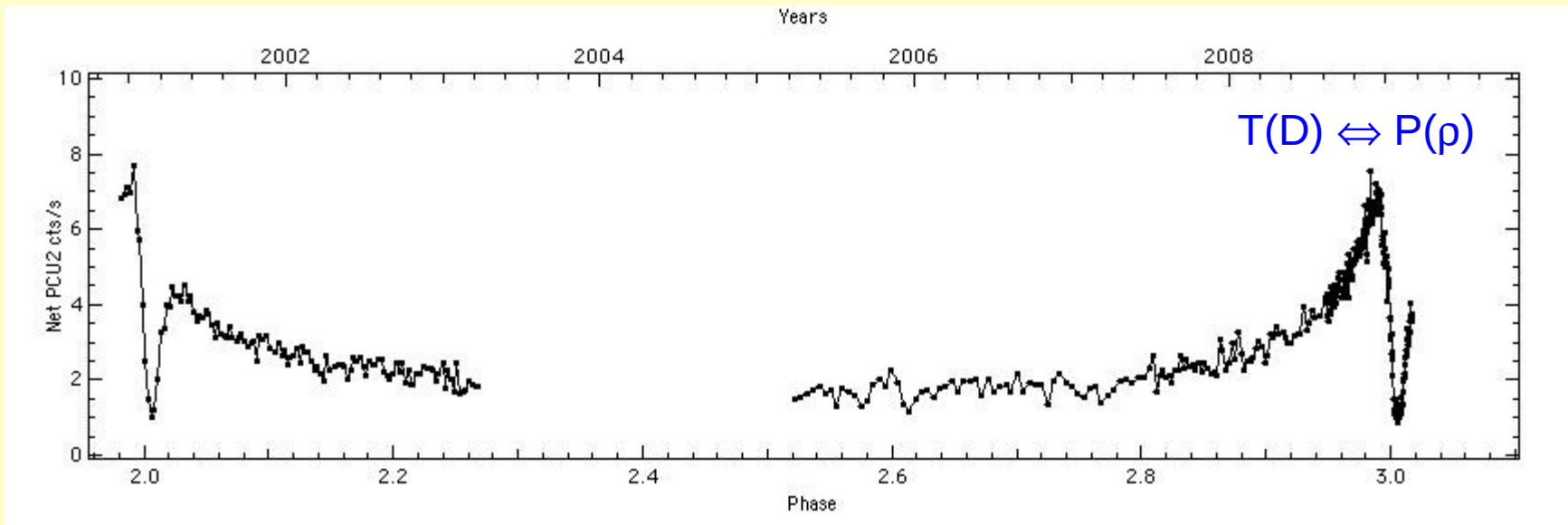


WR140's 2-10 keV X-rays with *RXTE*

D~2AU
n>10⁸cm⁻³

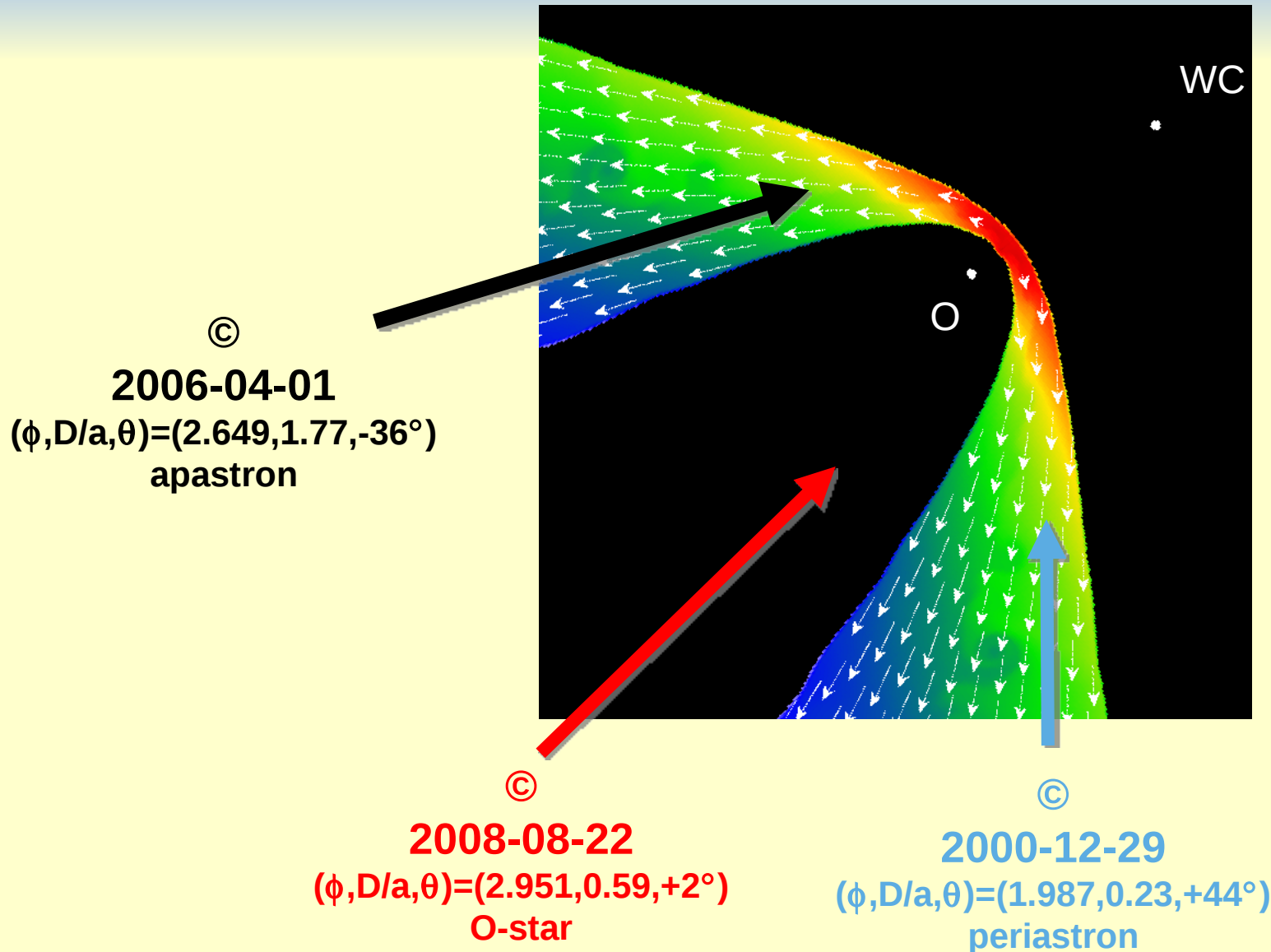
D~30AU
n<10⁶cm⁻³

D~2AU
n>10⁸cm⁻³



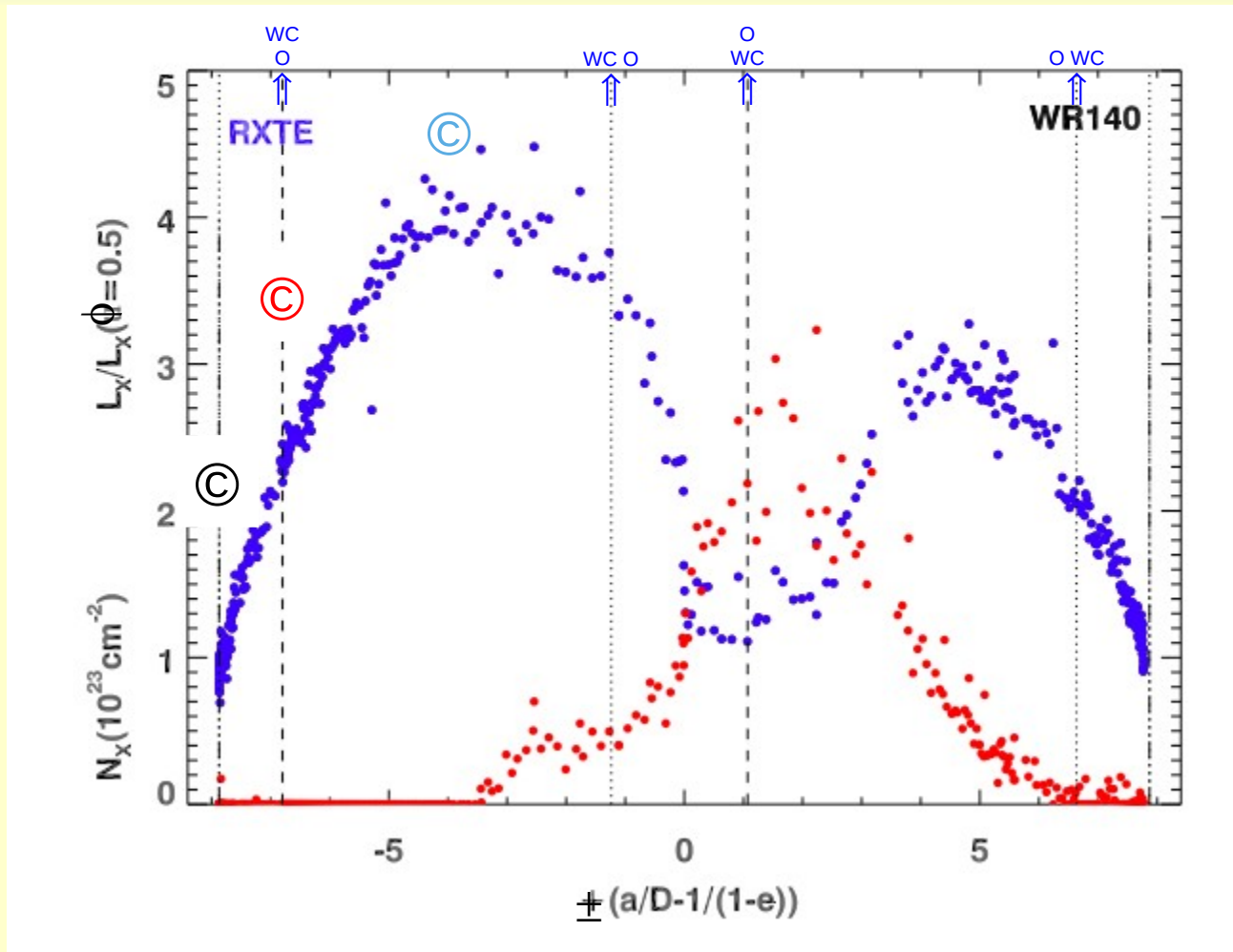
Marchenko+ 2003 orbit : $P=7.937\pm 0.004\text{yr}$ $e=0.881\pm 0.005$ $\omega=46.7\pm 1.6^\circ$ $T_0(\text{MJD})=46147.4\pm 3.7$

Chandra phase-dependent grating spectra of WR140

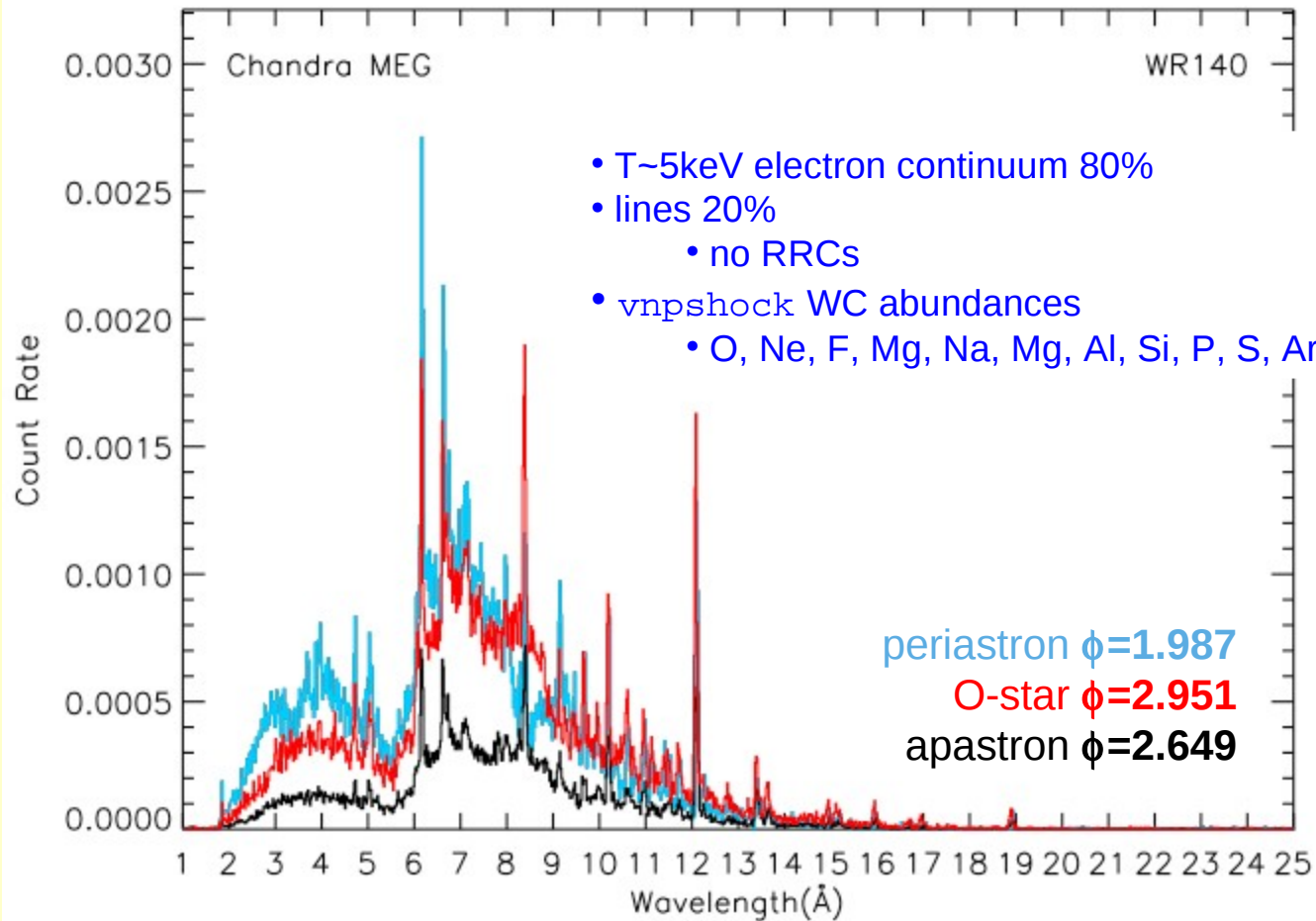


Change of variable $\Rightarrow L_x(D)$ (cf CWB 1/D)

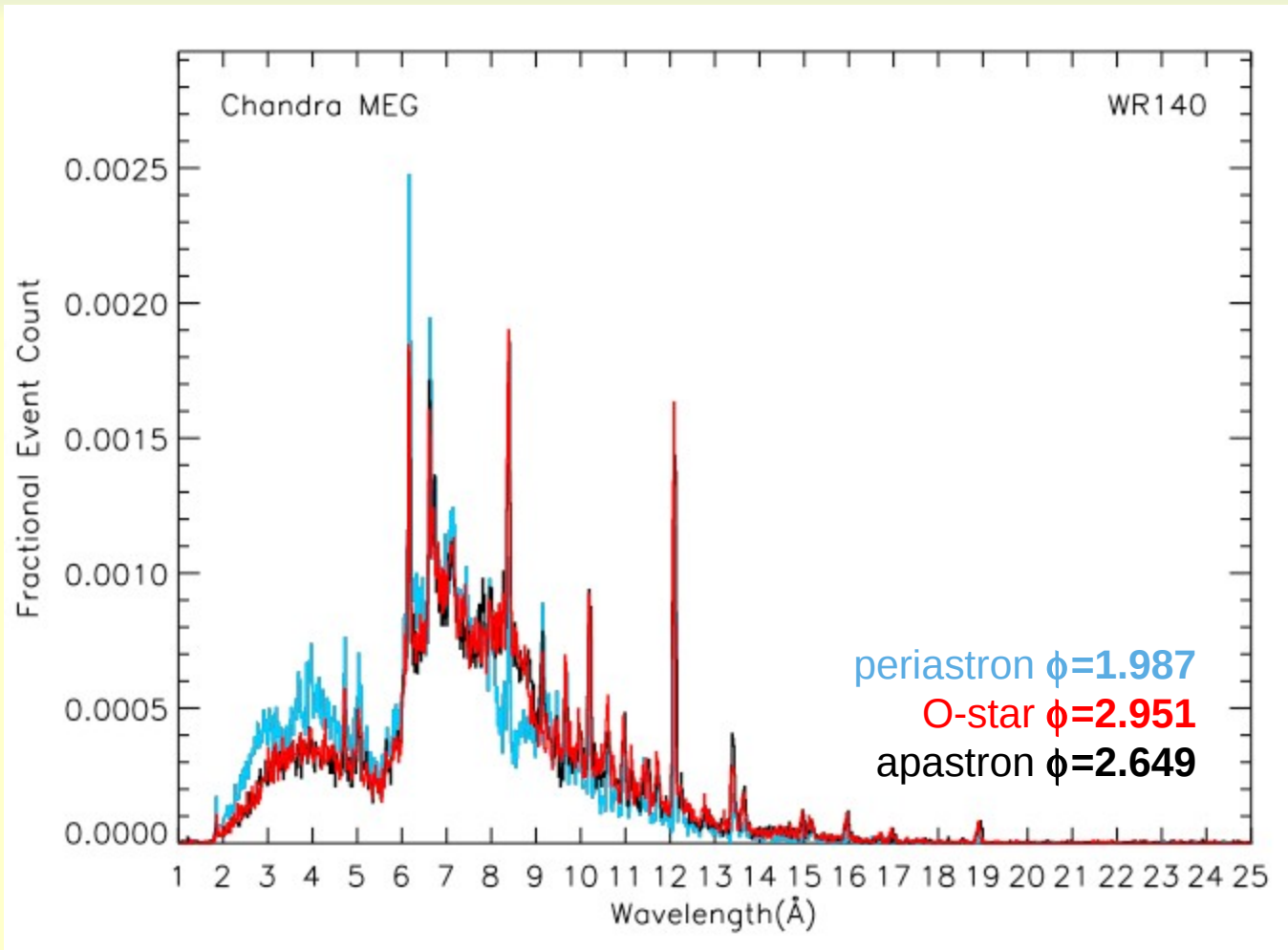
XSPEC> model const(ϕ)*abs(ϕ)*S_x*ISM



WR140 phase-dependent MEG spectra

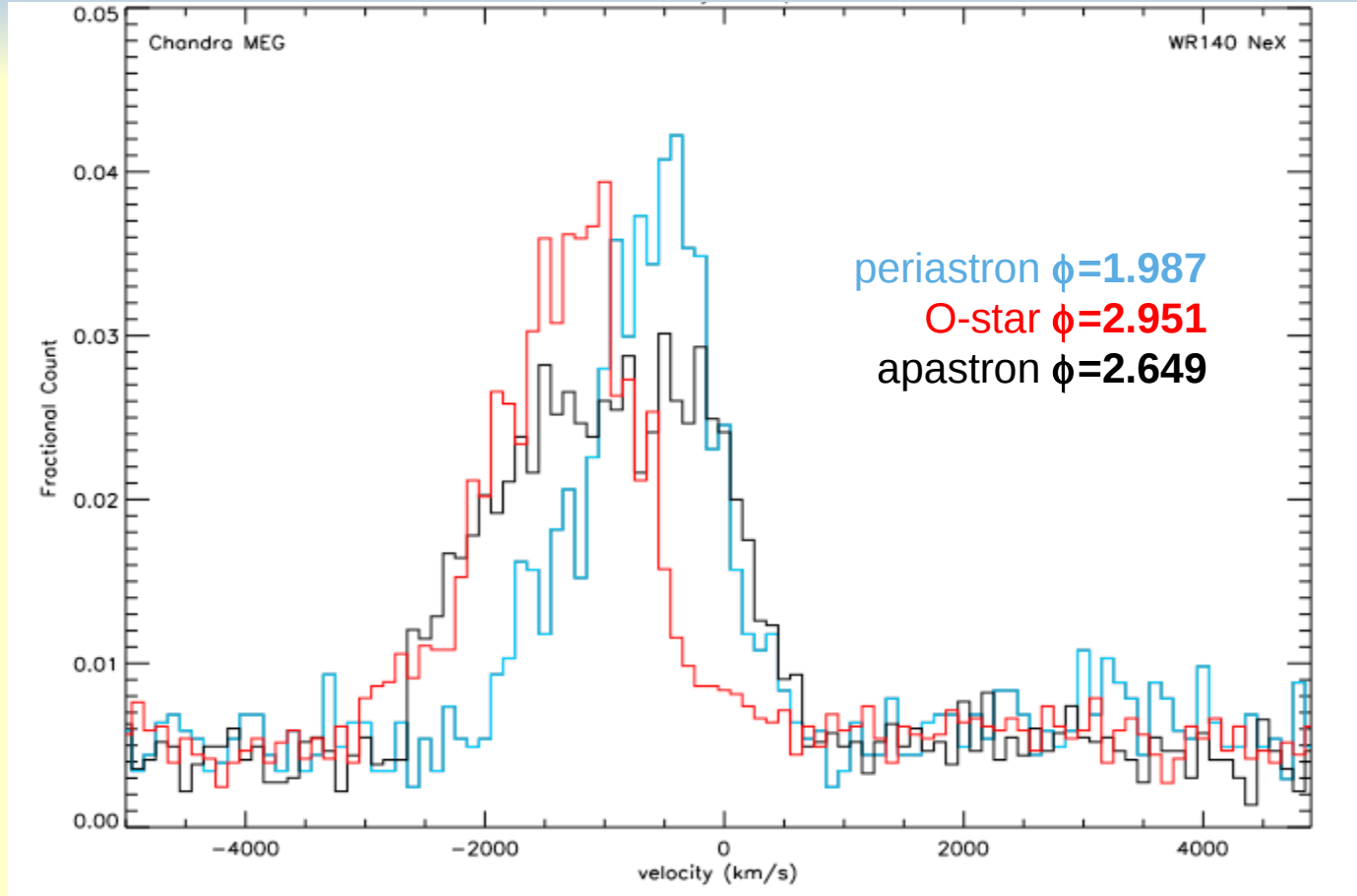


Normalised MEG spectra of WR140



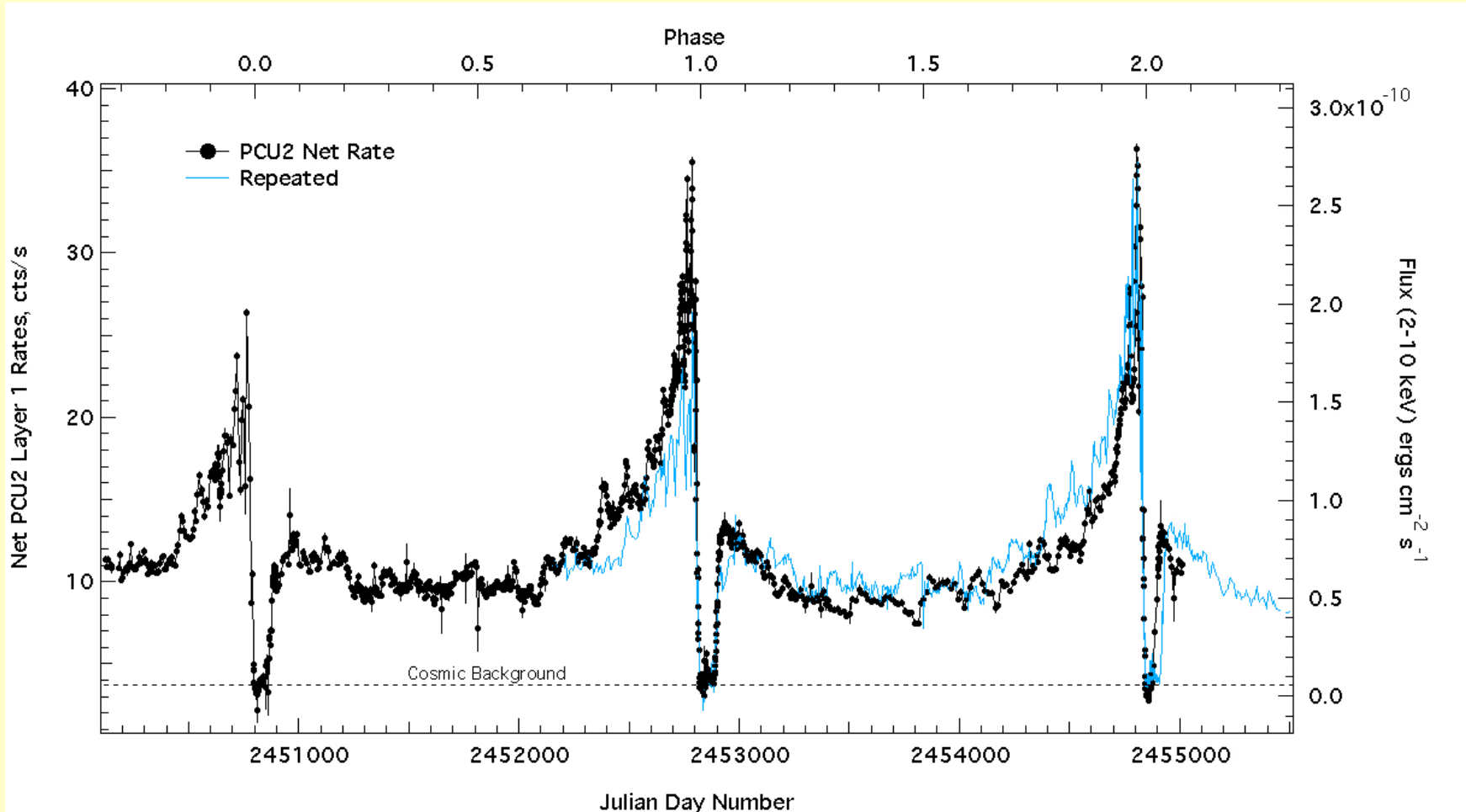
X-ray spectra nearly identical in shape at $\phi=2.649$ and $\phi=2.951$

XUVOIR : WR140 NeX MEG line profiles

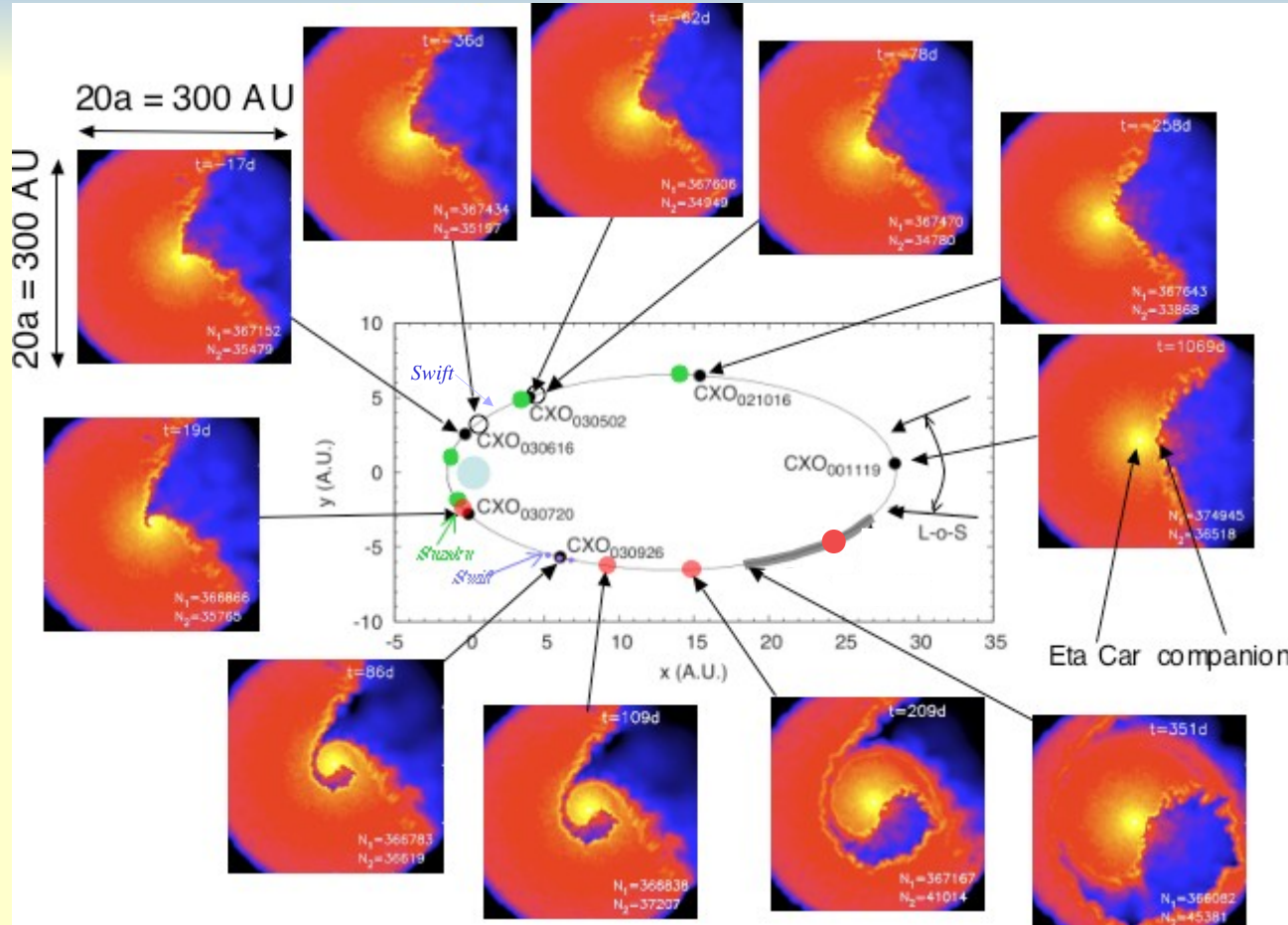


- shocked WC and O5 material mix \Rightarrow no CD !
- $v_{X\text{-ray}}$ increases with IP
- bulk and random components

η Carinae's 2-10 keV X-rays with *RXTE*



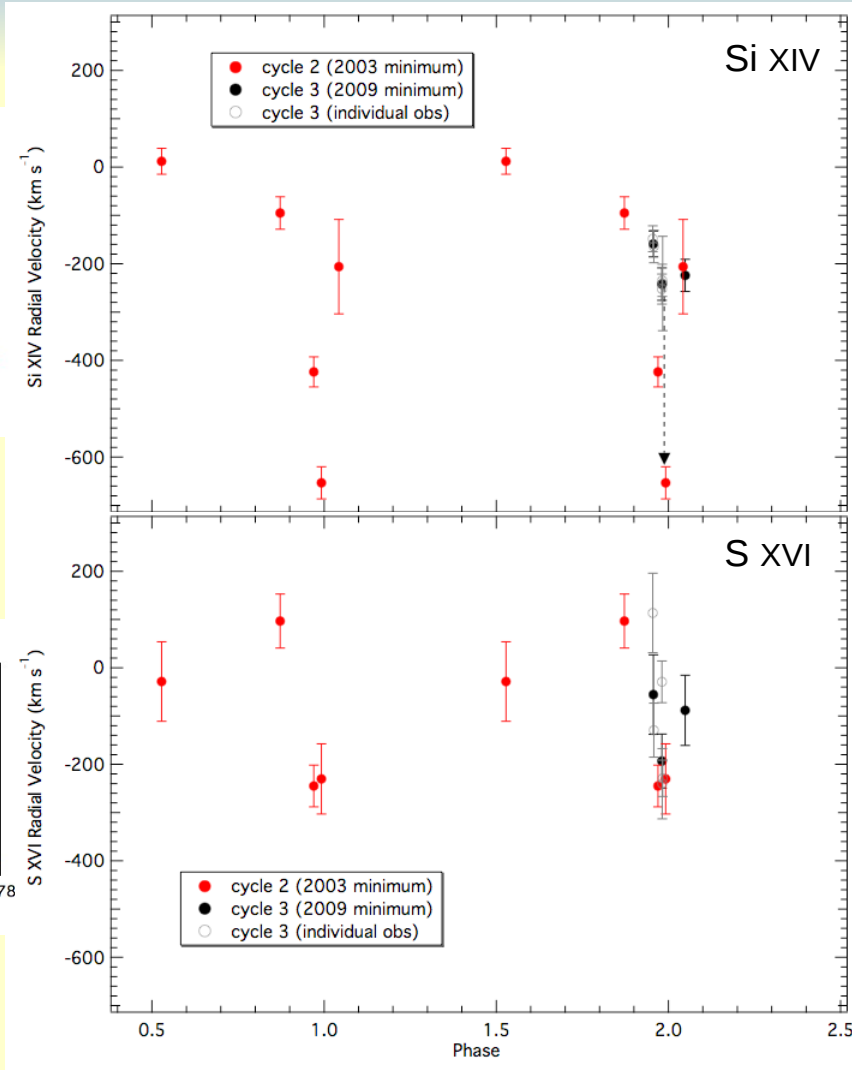
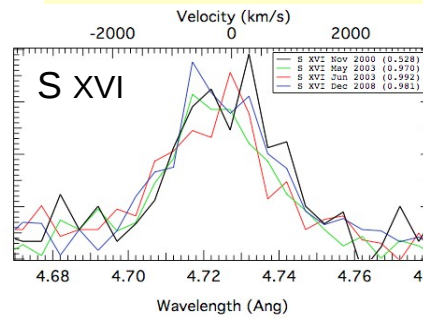
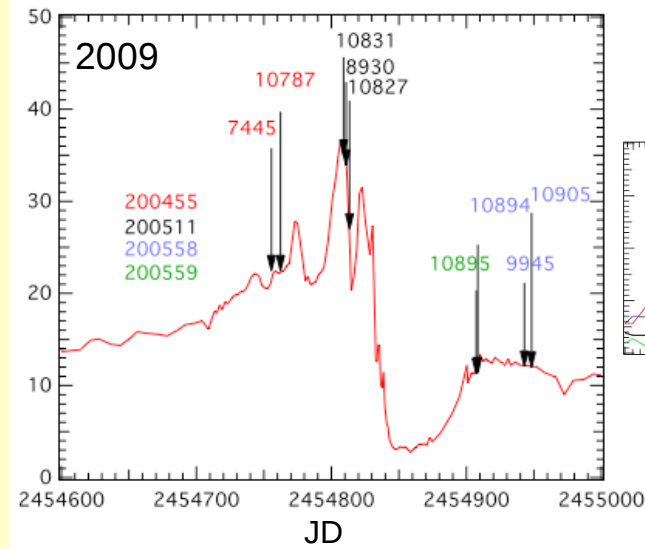
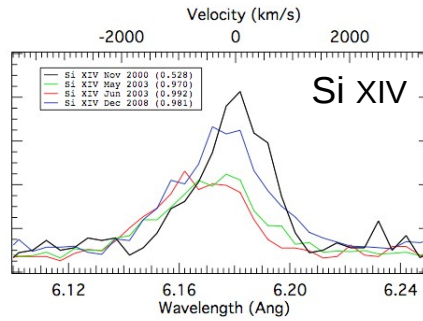
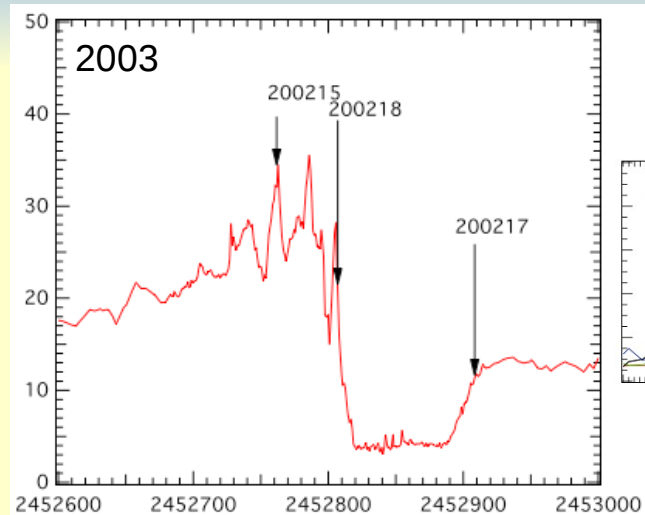
η Carinae X-ray campaign



SPH simulations by A. Okazaki

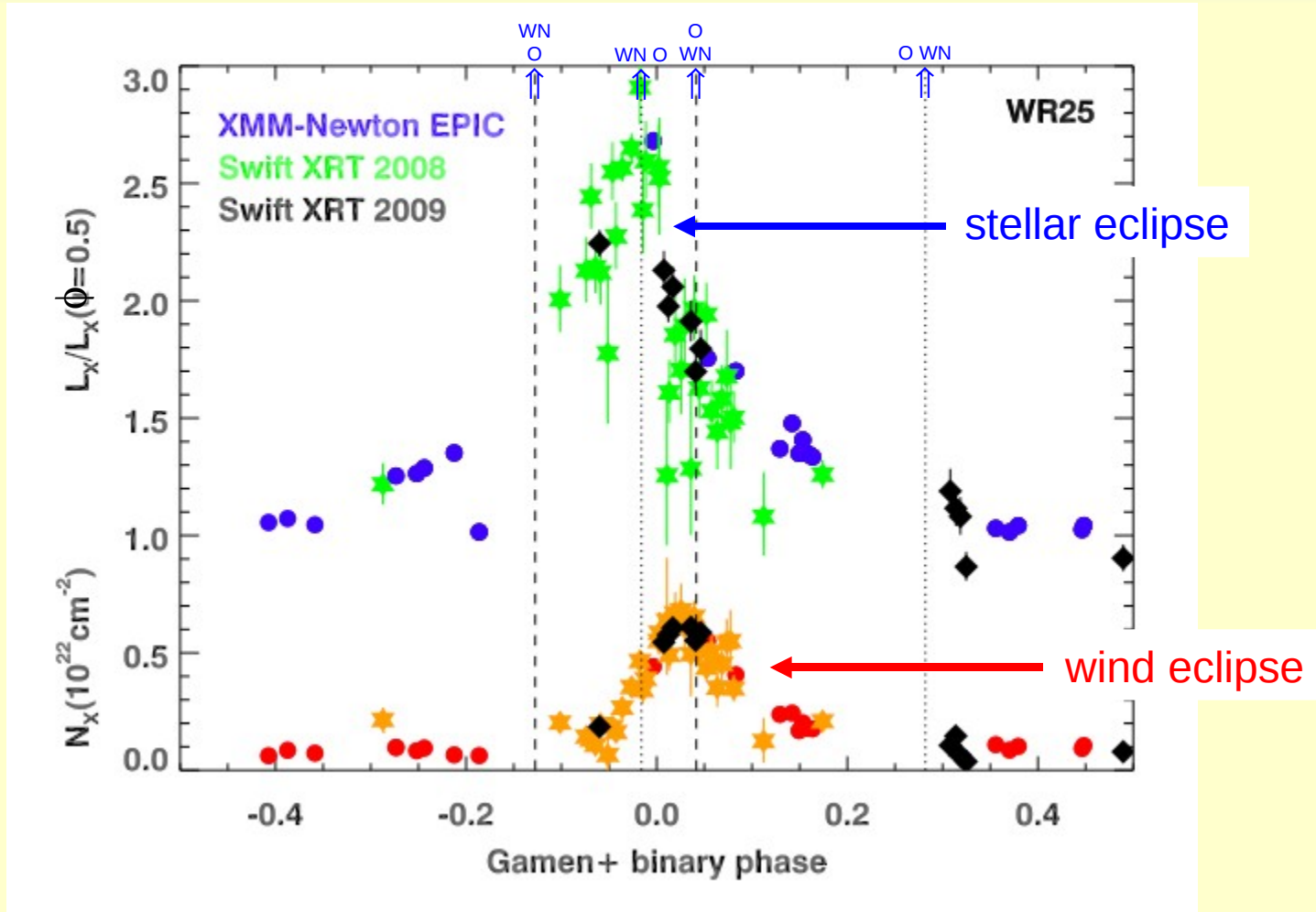
LBV+? : $P=5.542\text{yr}$ $e\sim 0.9$ $a\sim 15\text{AU}$ $\text{inc}\sim 50^\circ$: primary wind dense and slow

η Carinae's X-ray line profiles



Part of the observational future for CWBs

Eclipse mapping of ion lines and electron continuum in WR25 (WN6ha+O)



Gamen+ 2006 orbit : $P=0.5691\pm0.0001\text{yr}$ $e=0.50\pm0.02$ $\omega=215\pm3^\circ$ $T_0(\text{MJD})=51598\pm1$