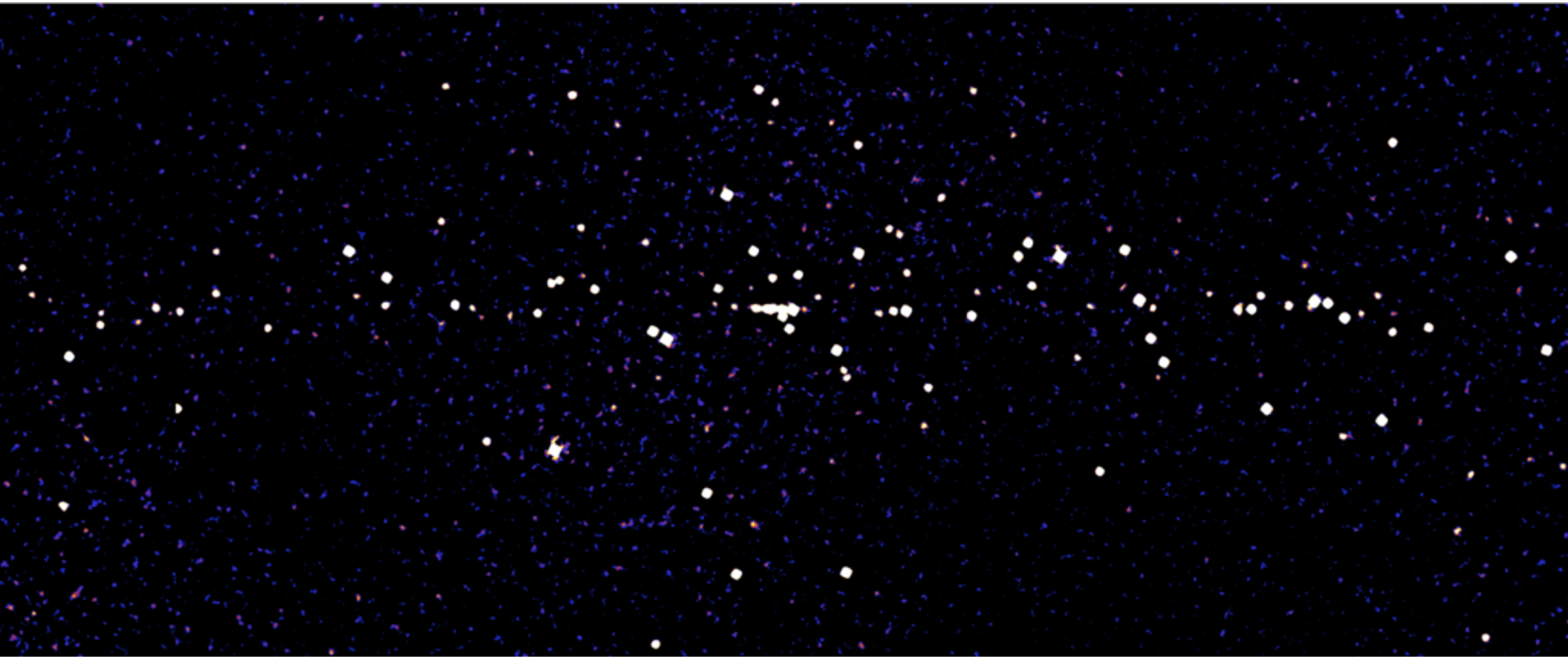
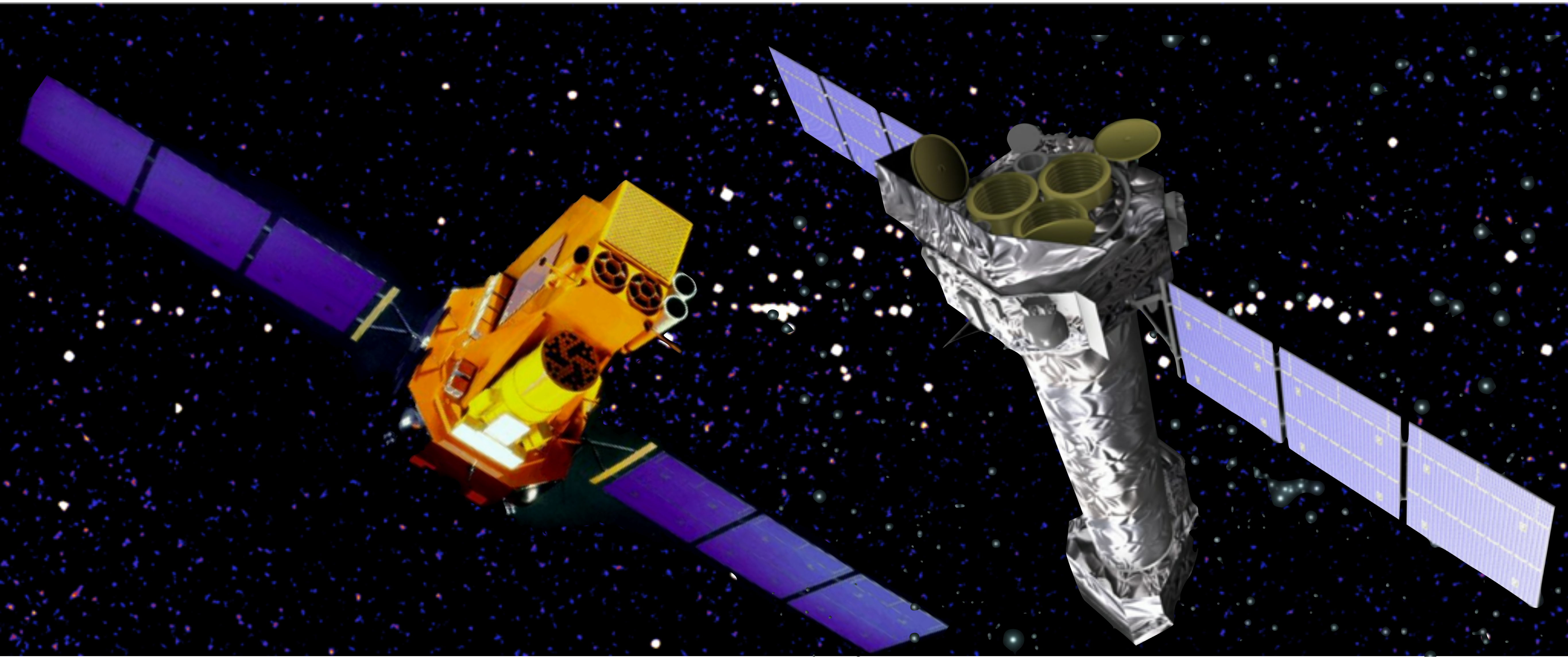
Accretion in supergiant High Mass X-ray Binaries



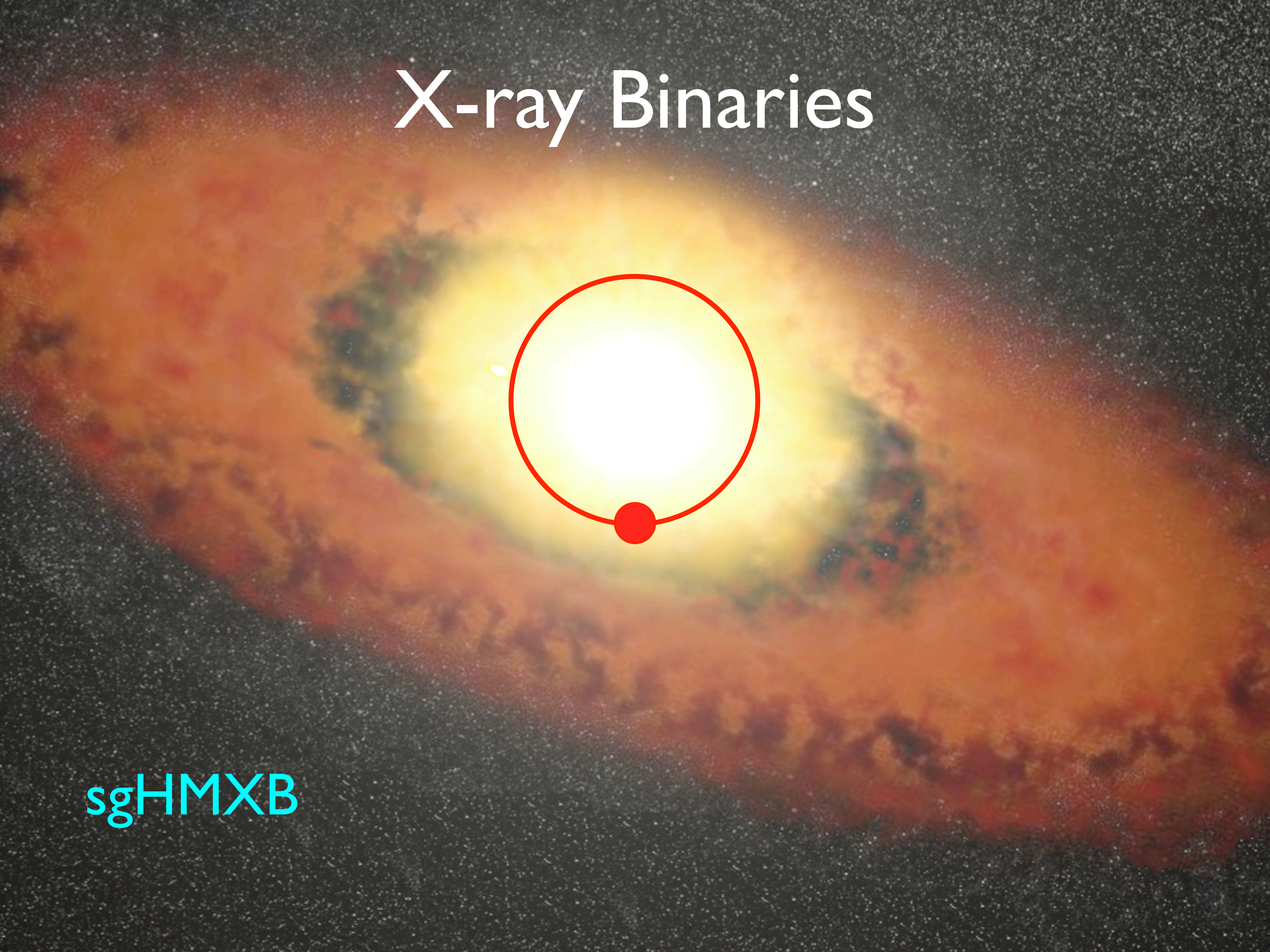
Antonios Manousakis
N. Copernicus Astronomical Center

Accretion in supergiant High Mass X-ray Binaries

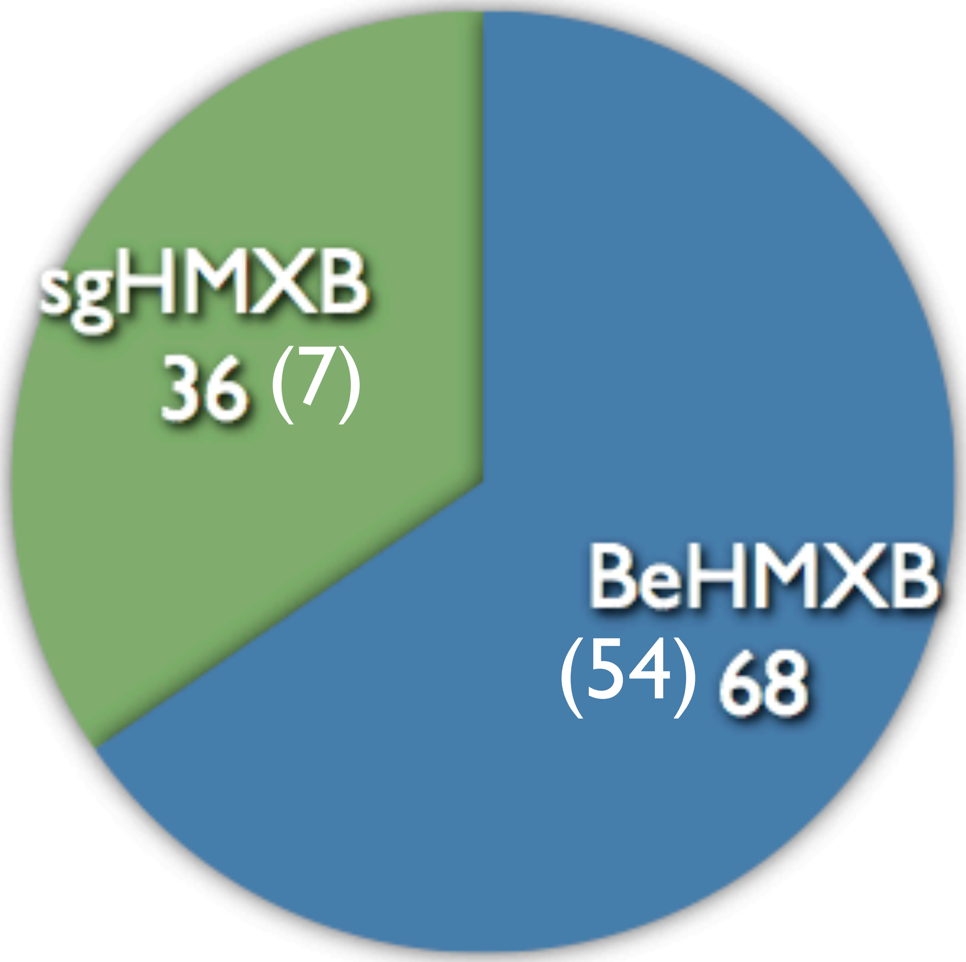


- R. Walter UniGE
- J. Blondin NCSU

X-ray Binaries

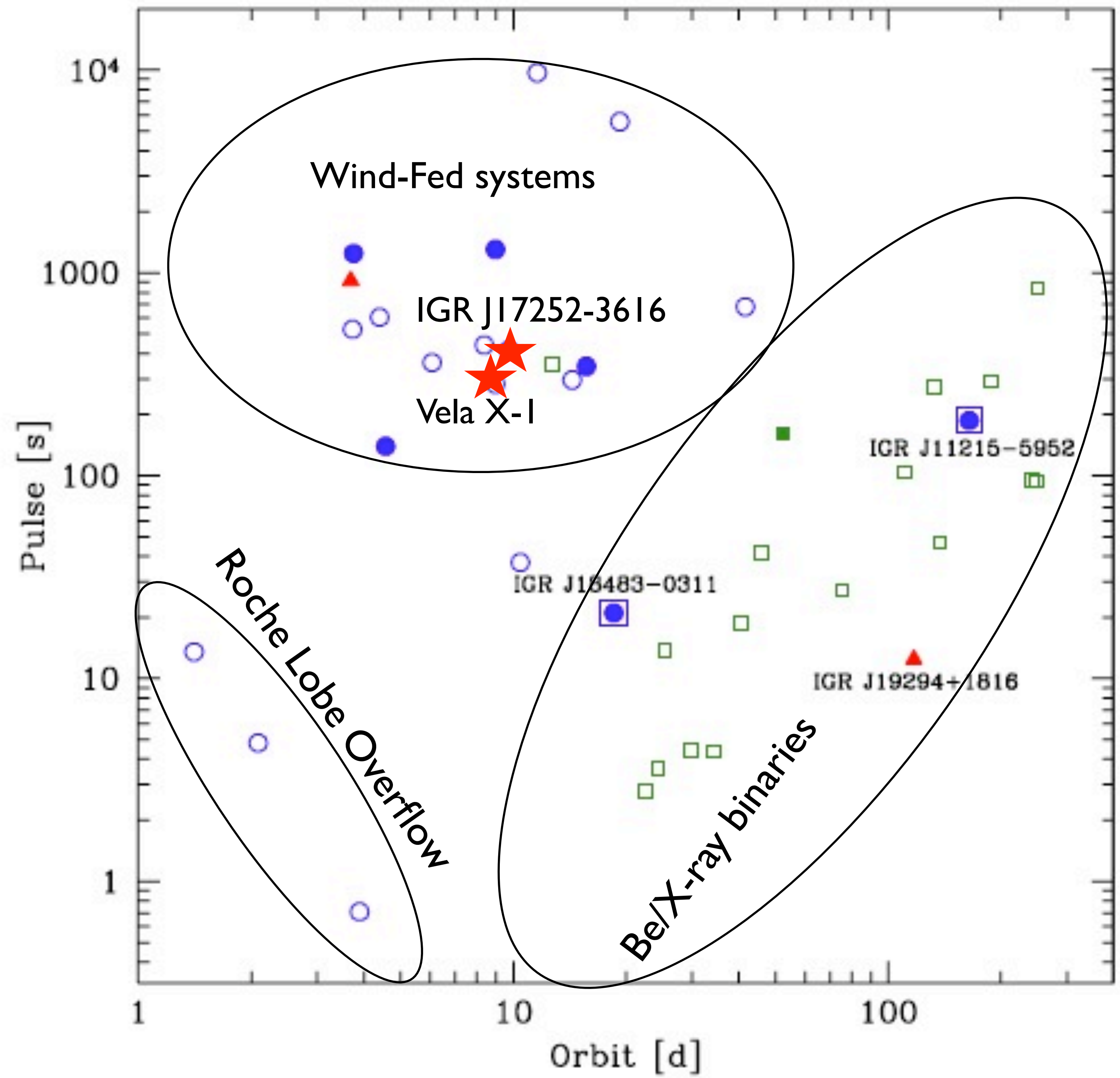


INTEGRAL and HMXBs



Walter et al. 2004 ; Liu et al. 2006
(Liu et al. 2000)

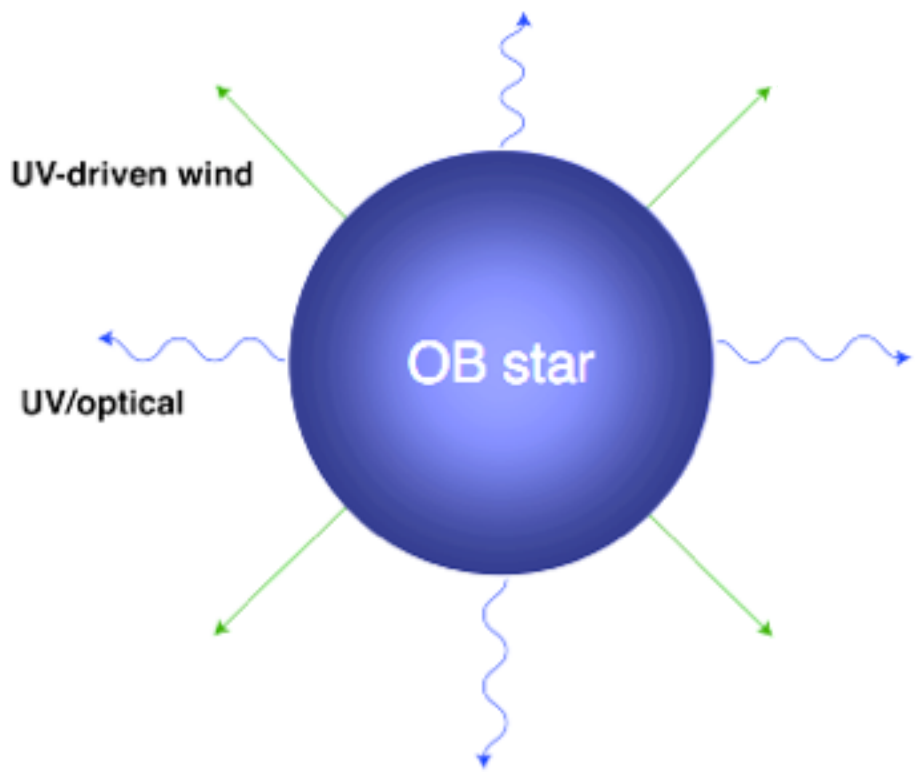
INTEGRAL revealed new classes of sgHMXB: Obscured and Supergiant Fast X-ray Transients

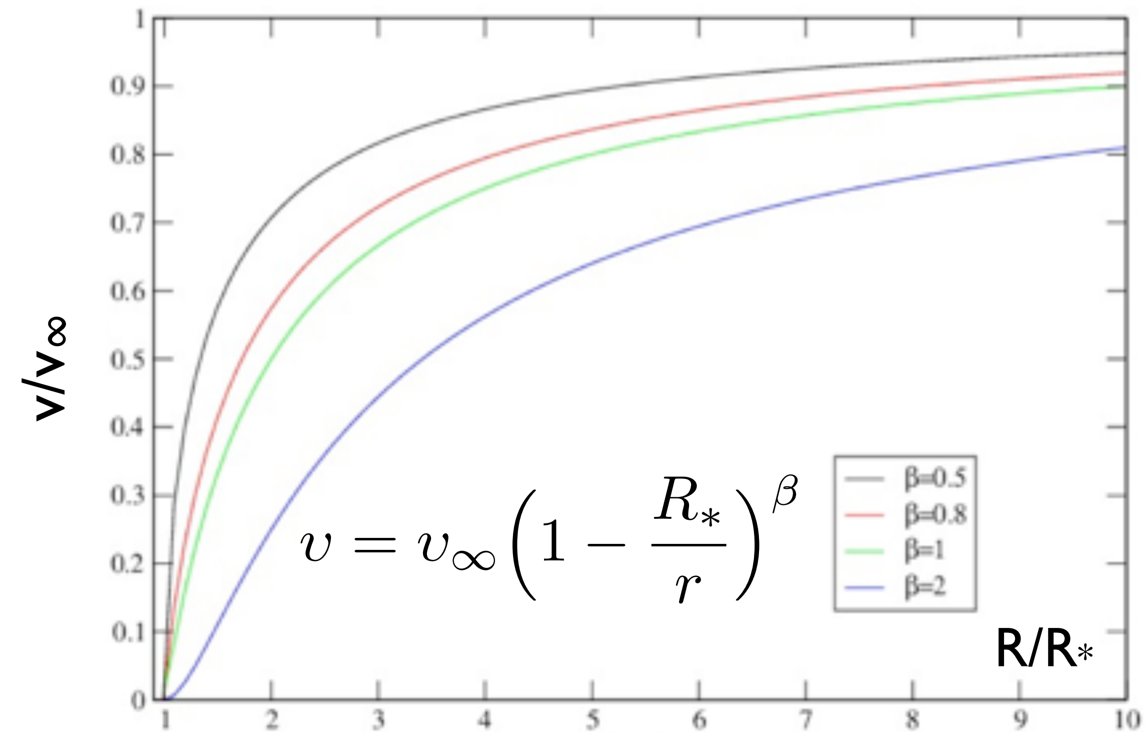


Rodriguez et al. 2009; Corbet 1986

Stellar Winds

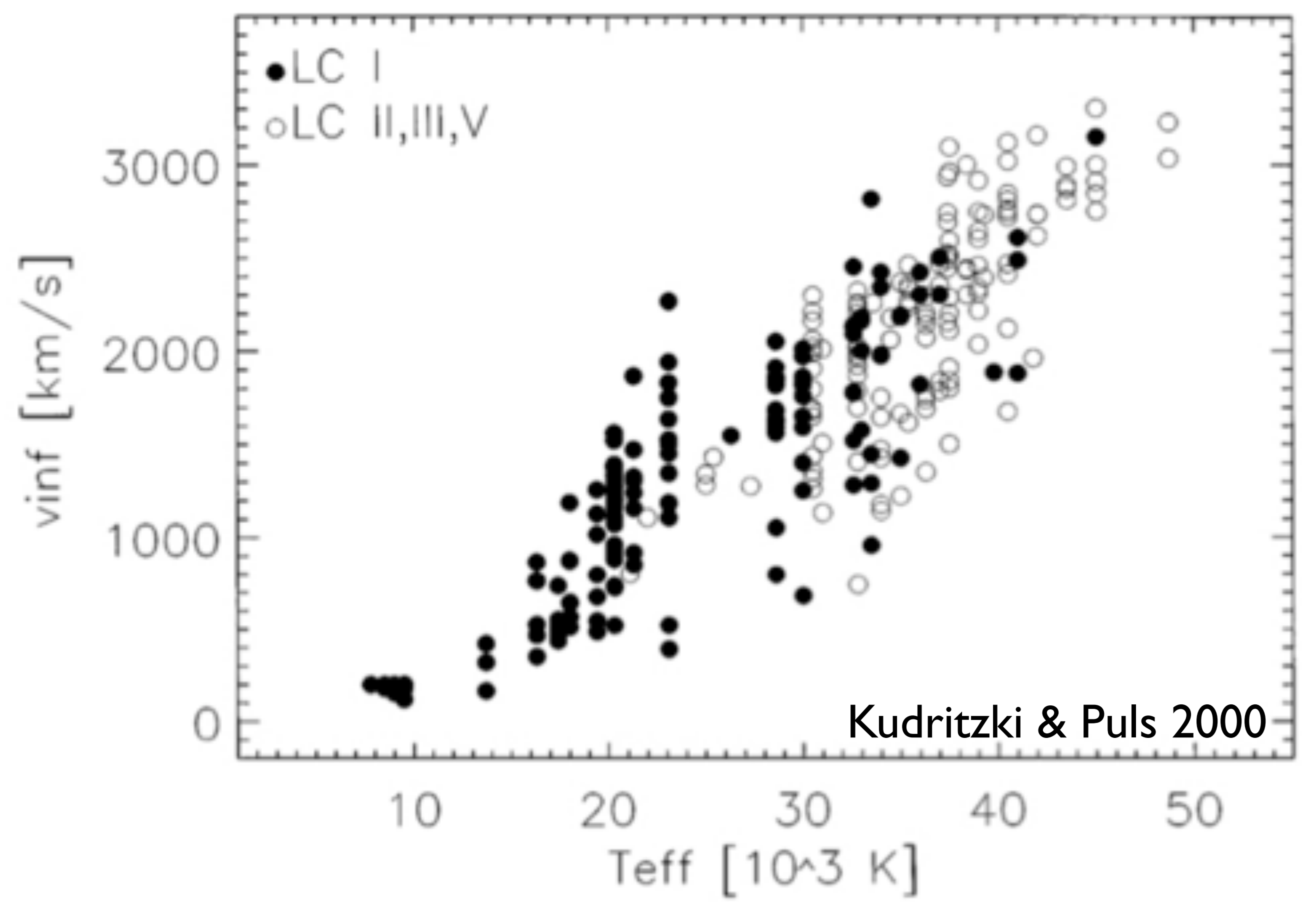
Castor, Abbot and Klein (1975): CAK





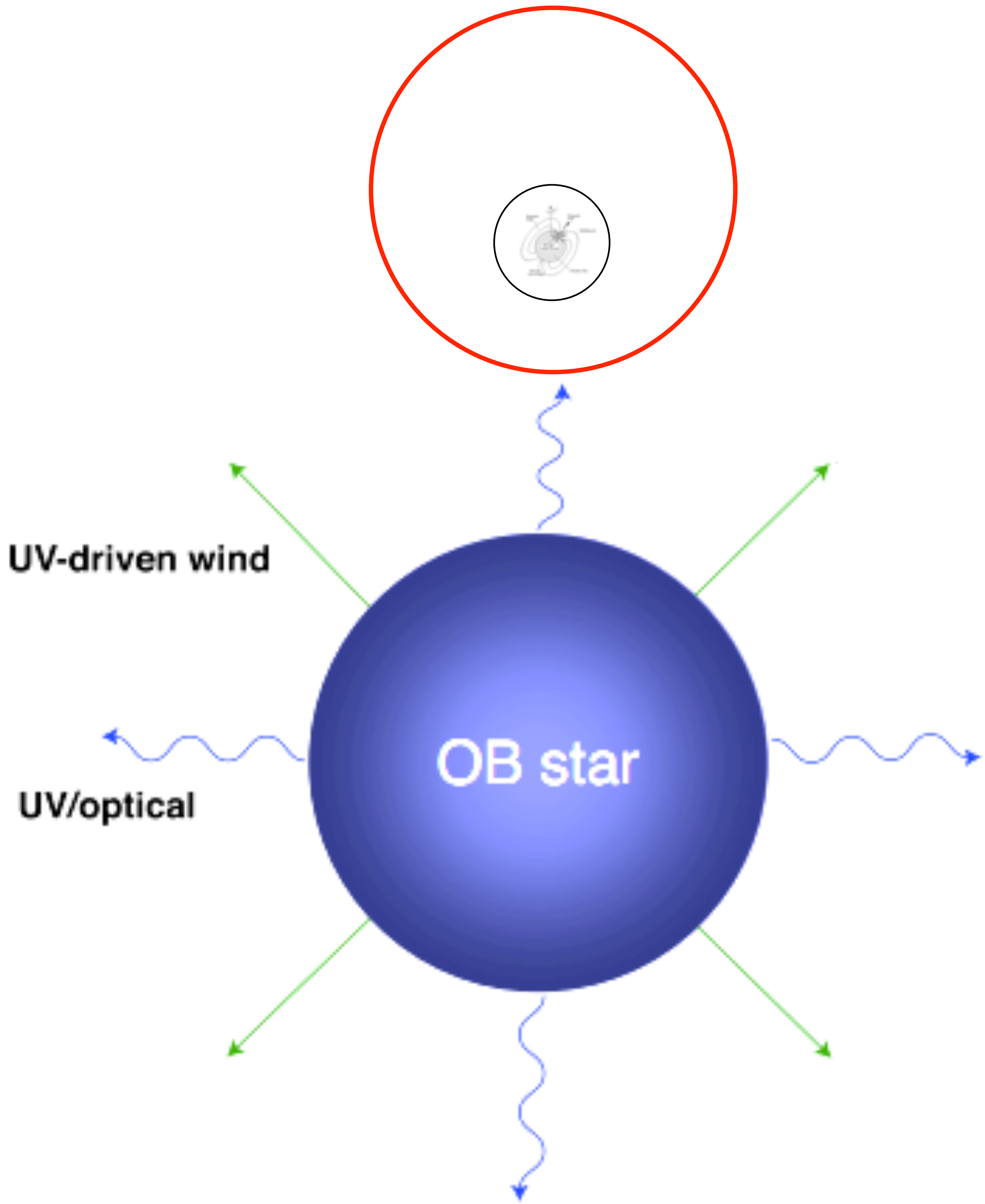
Radiatively driven stellar winds

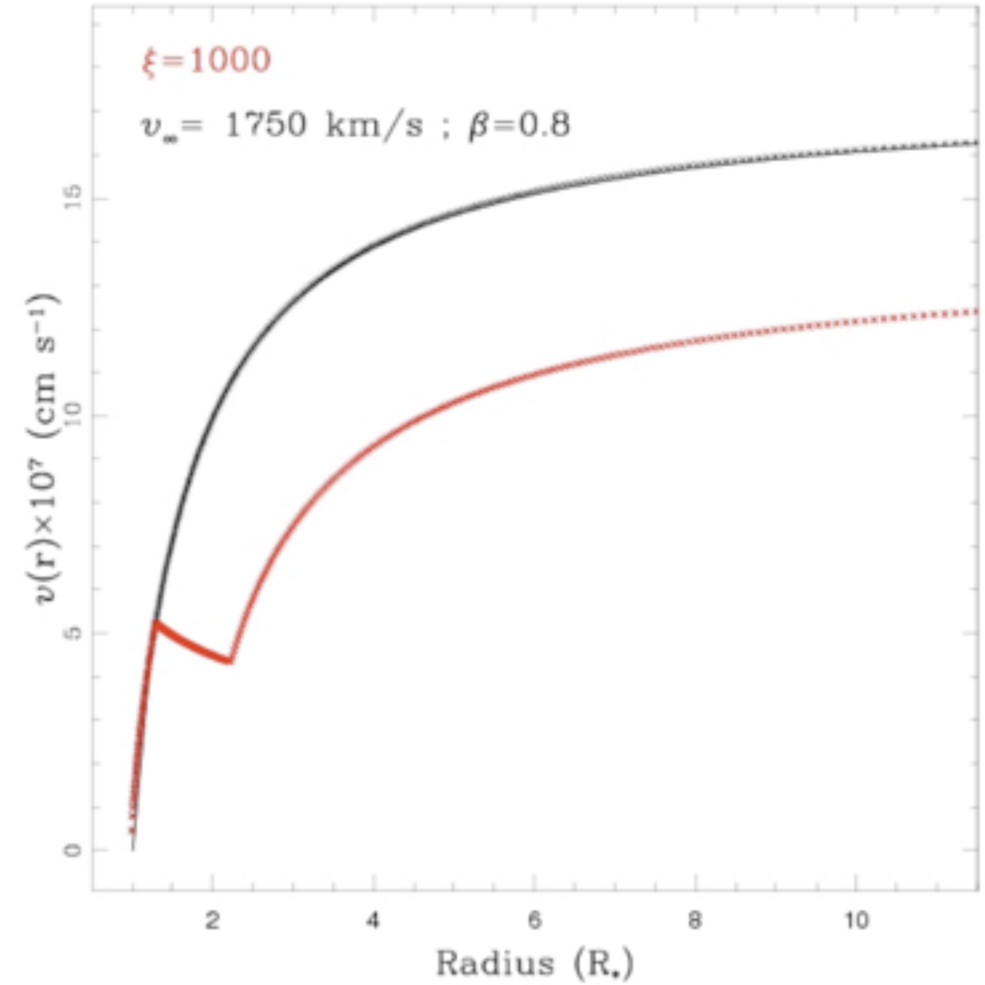
UV absorbed from ions (e.g. C, N, O) and momentum is transferred to the wind

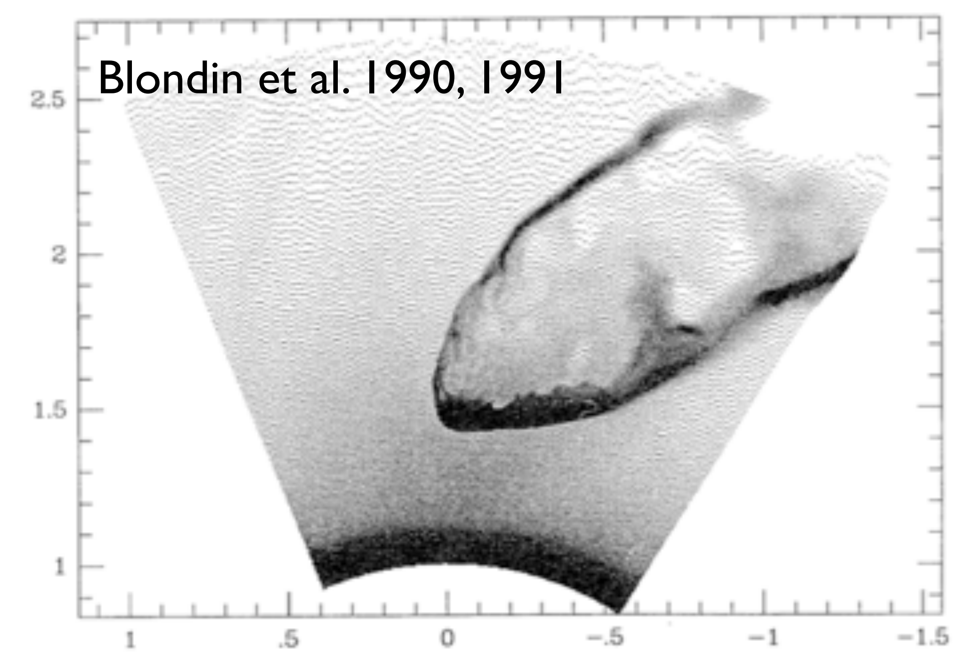


CAK parameters are related to wind mass-loss rate and terminal velocity

Stellar Winds + X-ray source

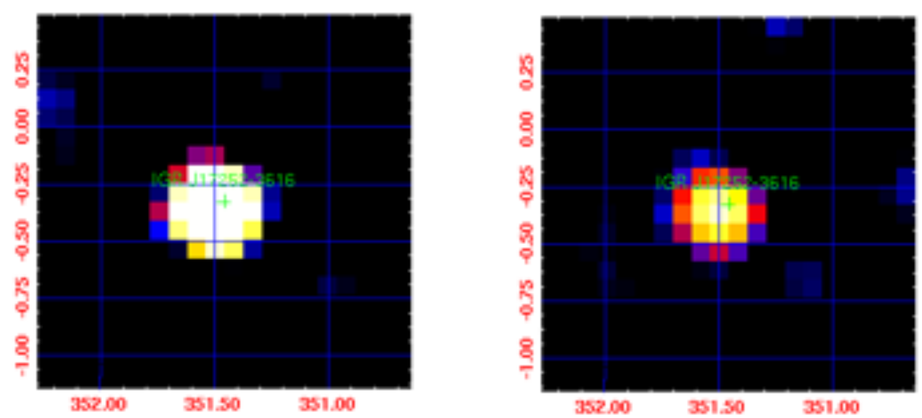


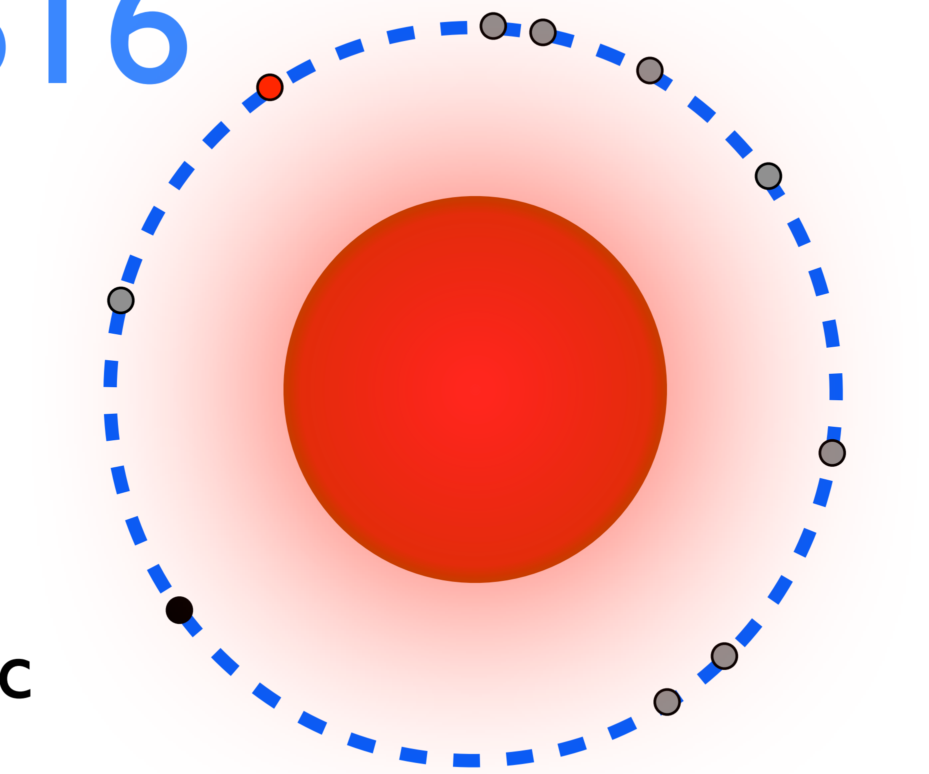




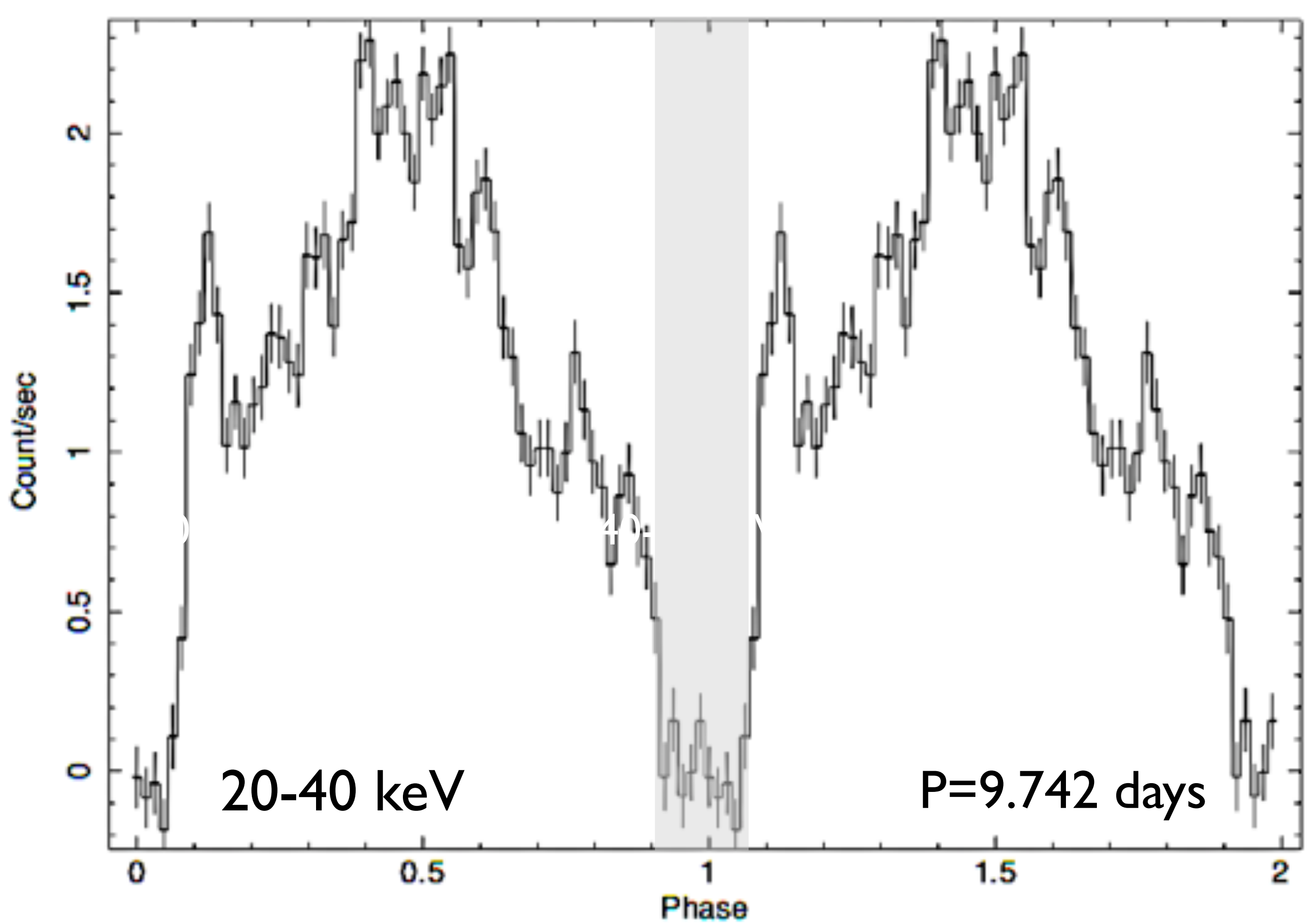
IGR J17252-3616

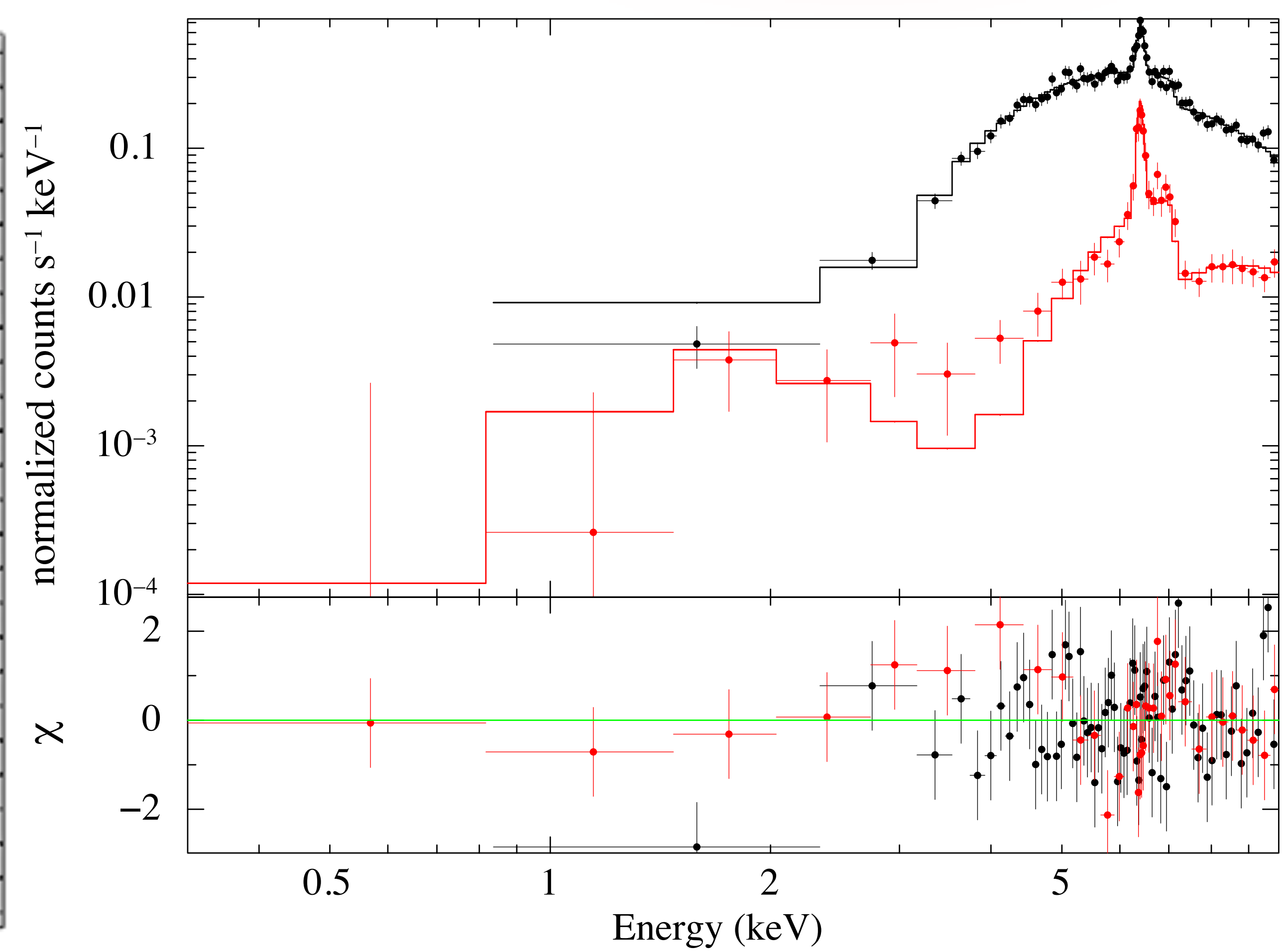
Manousakis & Walter 2011, A&A, **526**, A62





INTEGRAL
from 2003-2009,
exposure of ~ 3.5 Msec





Hydro simulations

Manousakis, Walter, and Blondin 2012, A&A, **547**, A20
ESA Press Release Nov. 9, 2012

☑ Use of VH1
(developed by J. Blondin at NCSU)
☑ Radiatively driven stellar winds (CAK)
☑ Low terminal velocity and moderate mass loss rate are required for large absorption.

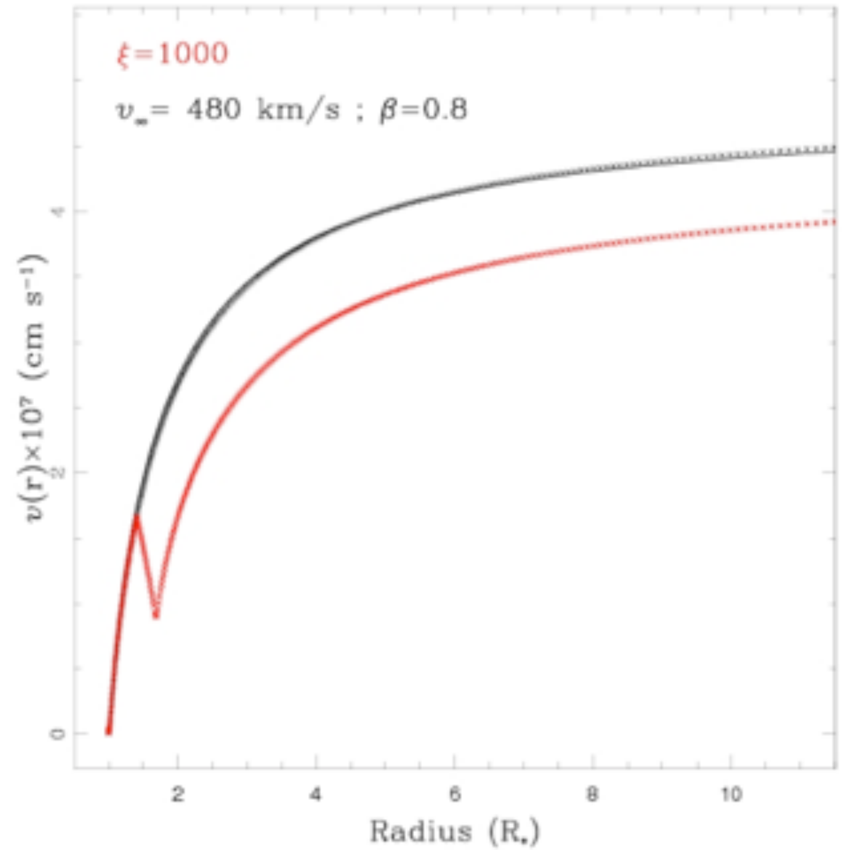
Parameters

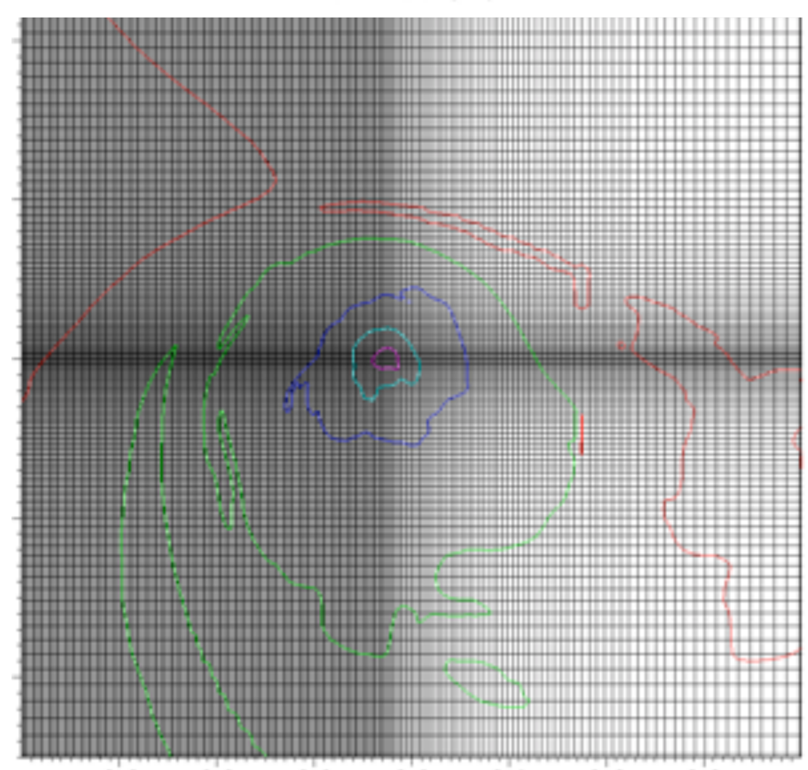
L_*, R_*, M_*, T_*	Derived from optical/IR
α	Orbital solution
ρ_0, CAK-α, CAK-k	Fixed from v_∞ and $\dot{M}_w$
ξ_{crit}	Photoionisation model

Parameters for the wind disruption:

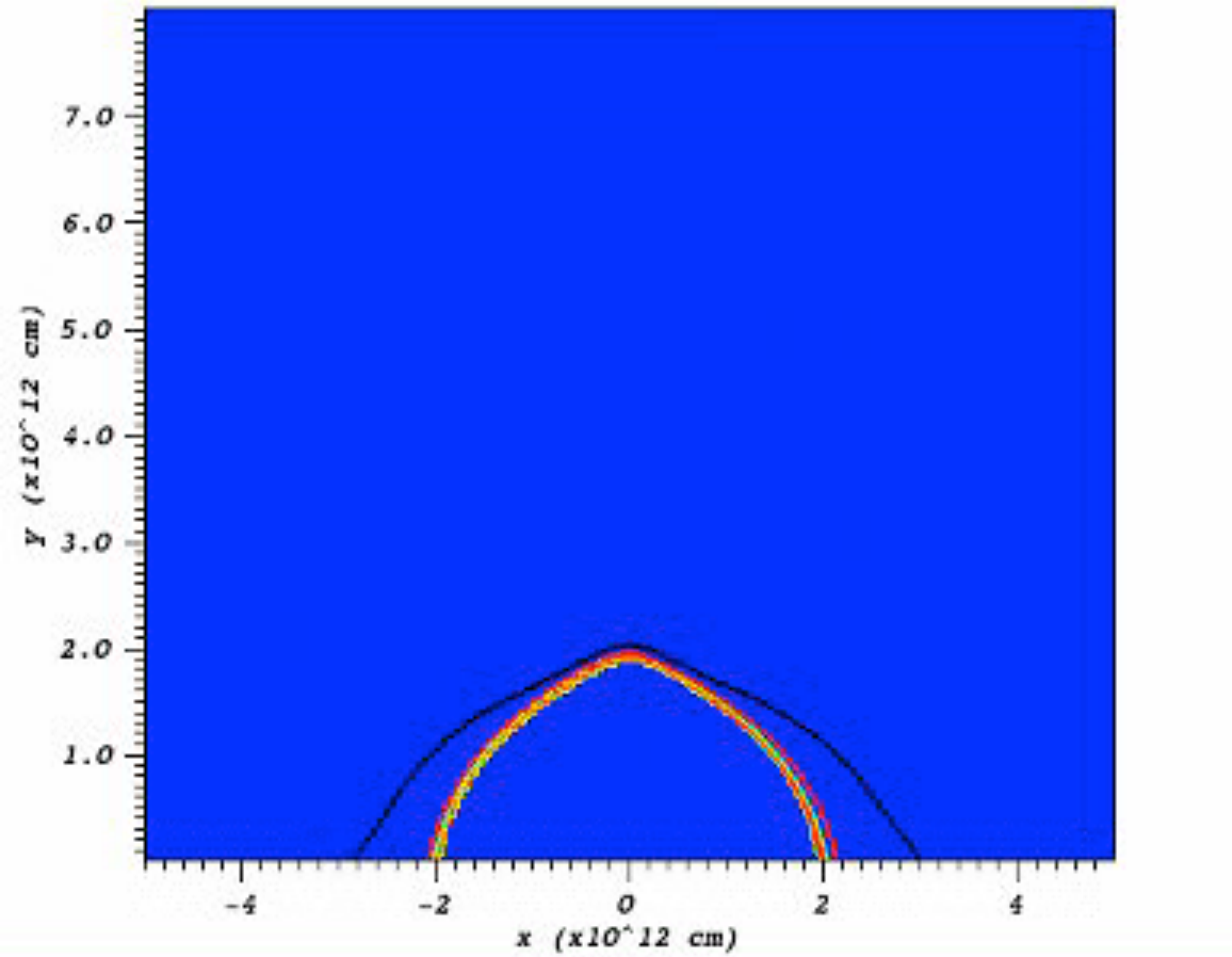
L_X	INTEGRAL/XMM obs.
M_{NS}	may vary (assumed 1.5 $M_\odot$)

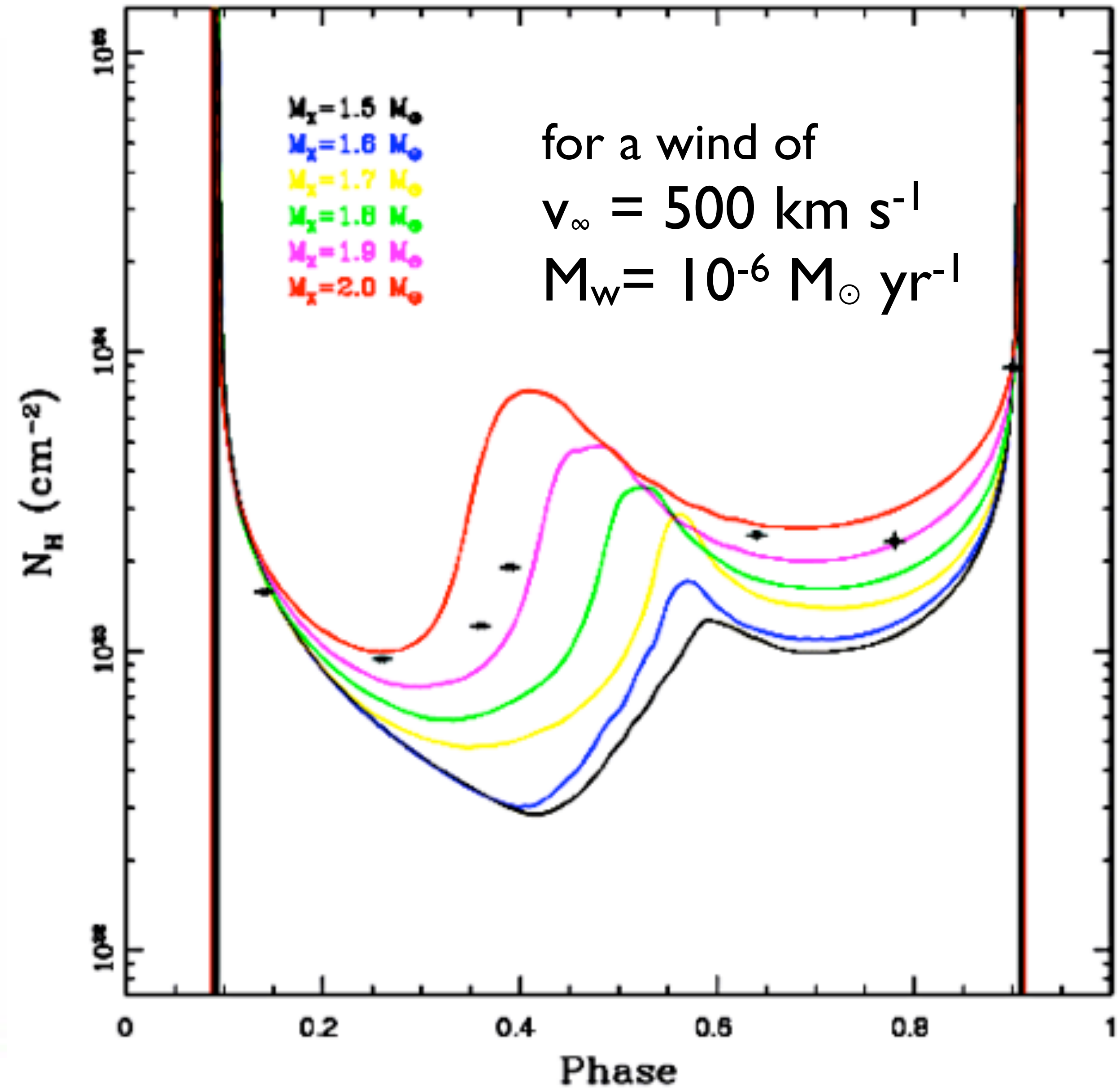
Grid of models for M_{NS}, v_∞, $\dot{M}_w$

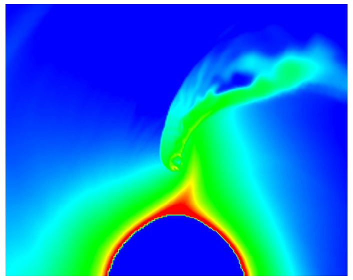


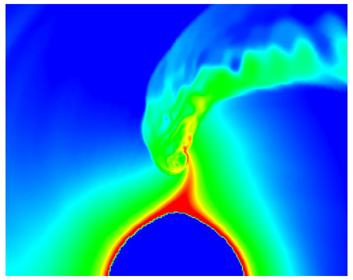


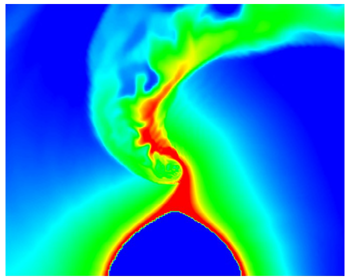
Hydro simulations





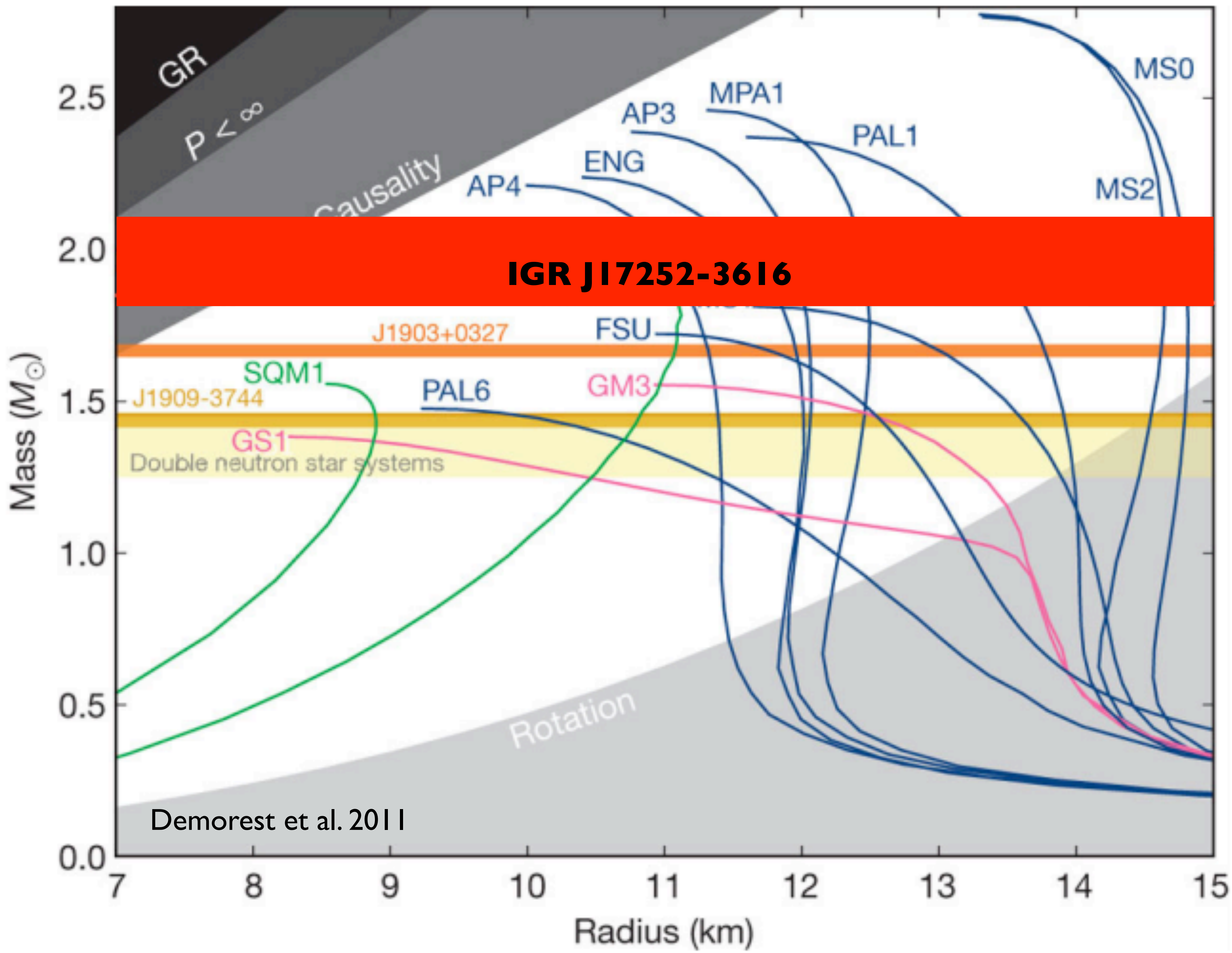




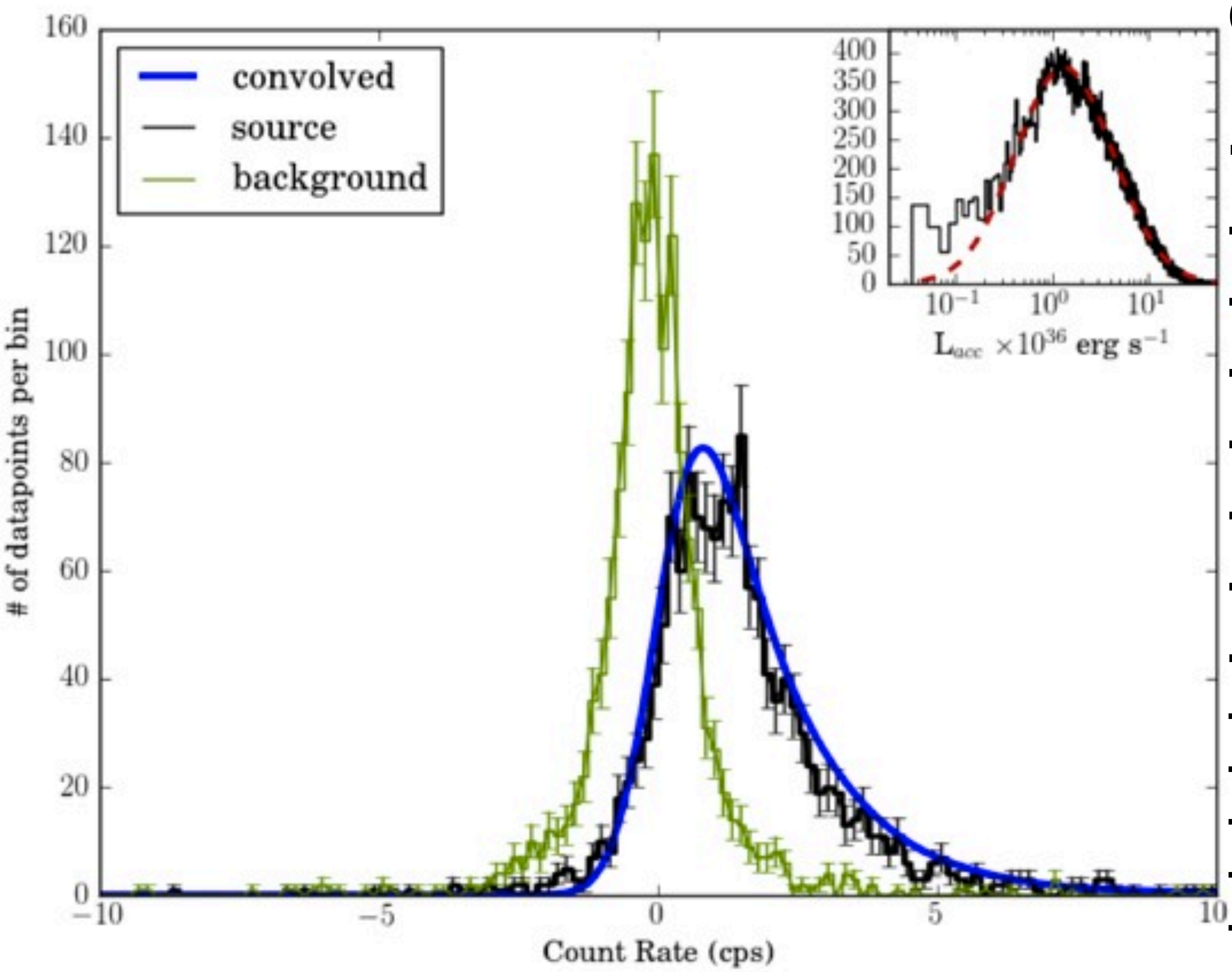


☑ Mass of the NS can be constrained: M_{NS}~1.8-2.1 $M_\odot$

EOS for neutron stars



Simulated vs Observed L_X



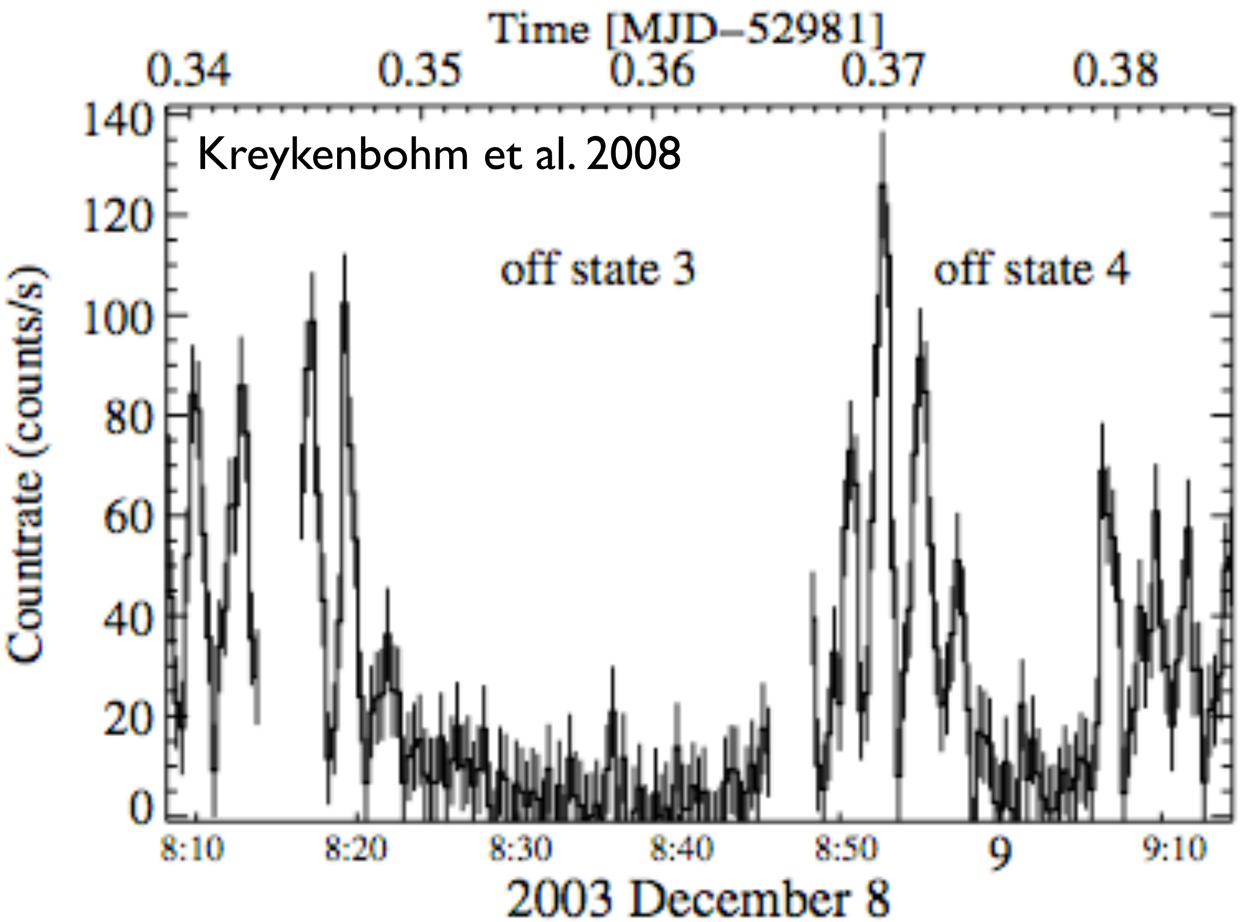
- sim. accretion rate is LogNormal
- the observed L_X as well

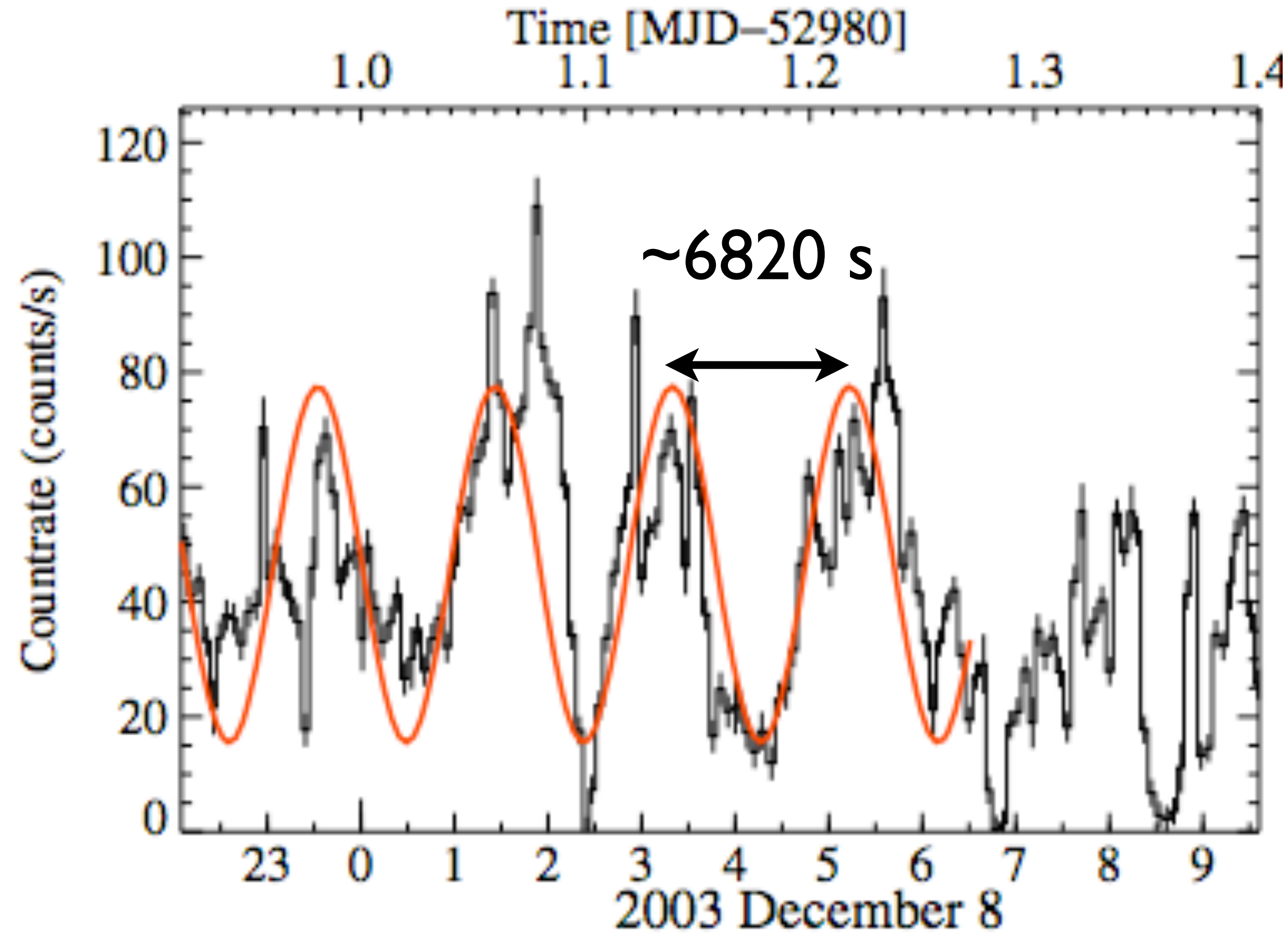
Other observed lognormal dist.:

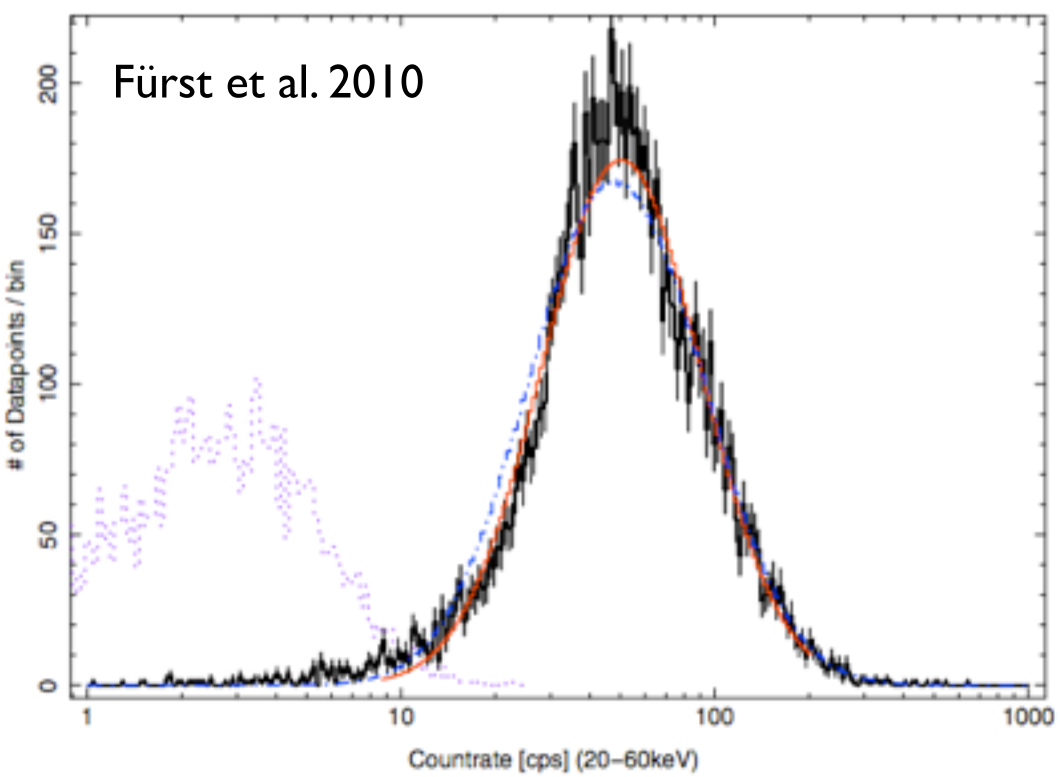
- income in Switzerland
- GRB peak fluence (Li, 1996)
- Coronal Mass Ejection (Aoki, 2004)
- X-ray flux of IRAS 13244 (Gaskell, 2004)
- X-ray flux of Cyg X-1 (Uttley, 2005)
- X-ray flux of BL Lac (Marsher, 2008)
- VHE emission of PKS 2155 (Degrange, 2008)
- X-ray flux of Vela X-1 (Fuerst, 2010)
- airborne bacteria density
- size of crystals in ice creams
- age of marriage of Danish women
- duration of phone conversation
- farm size in England
- age of Alzeimer onset

Self-organized criticality (Bak et al. 1988)?!

Vela X-1 : Data



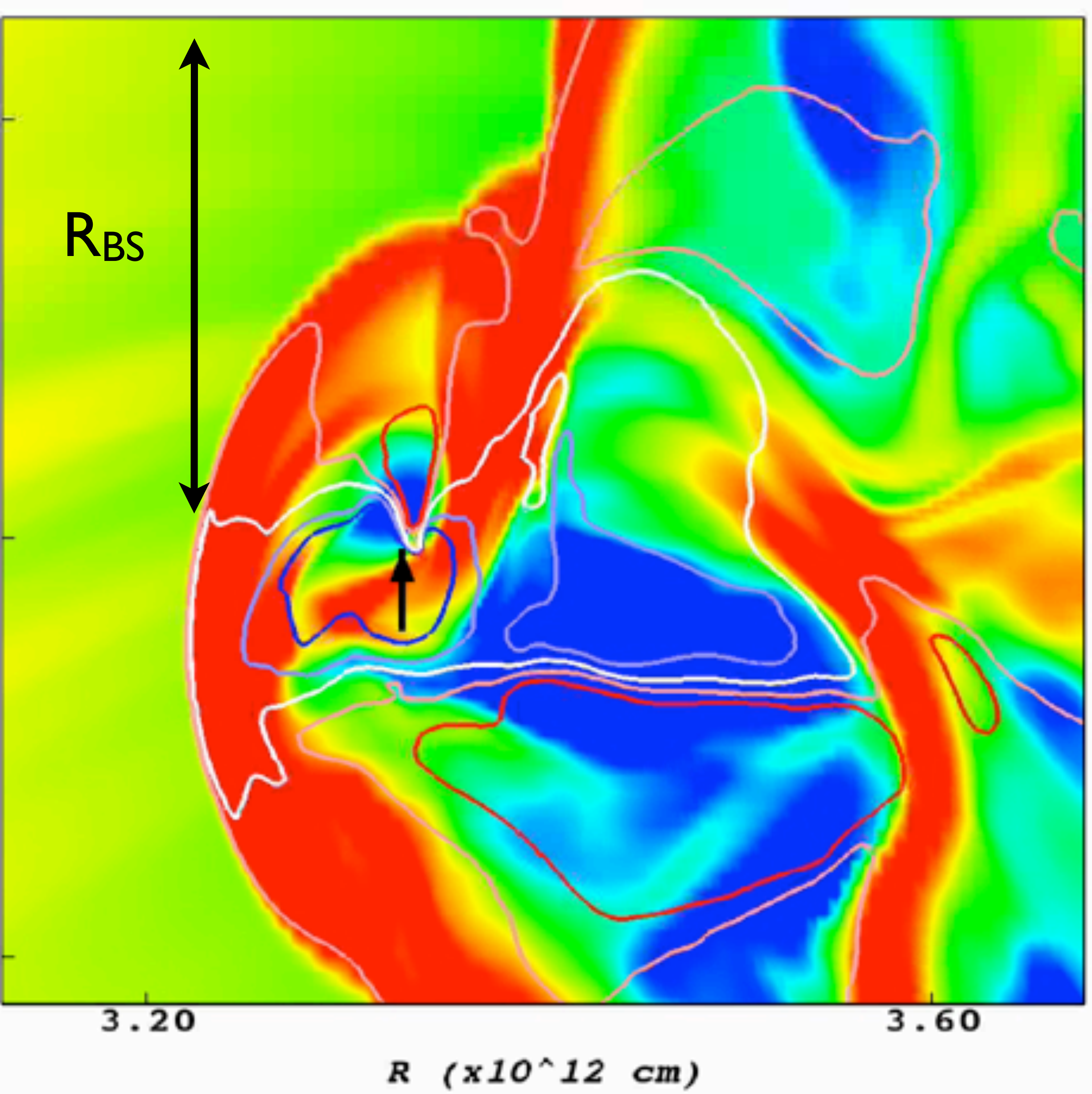


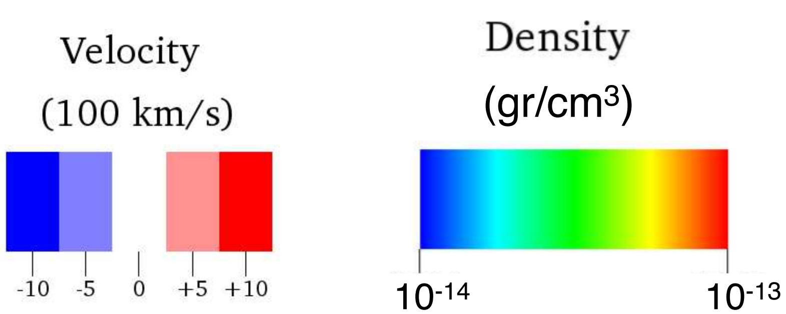


What is the origin of the off-states in Vela X-1?

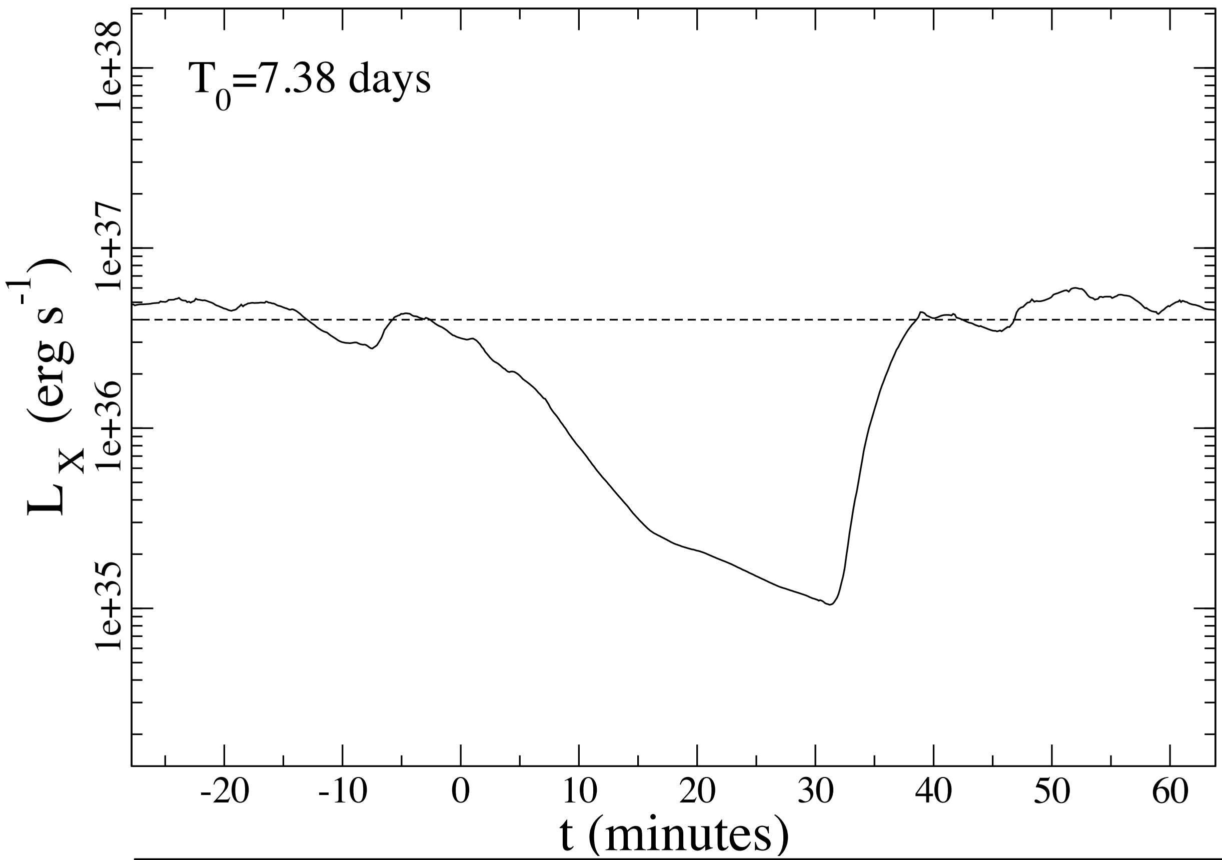
Vela X-1: simulations

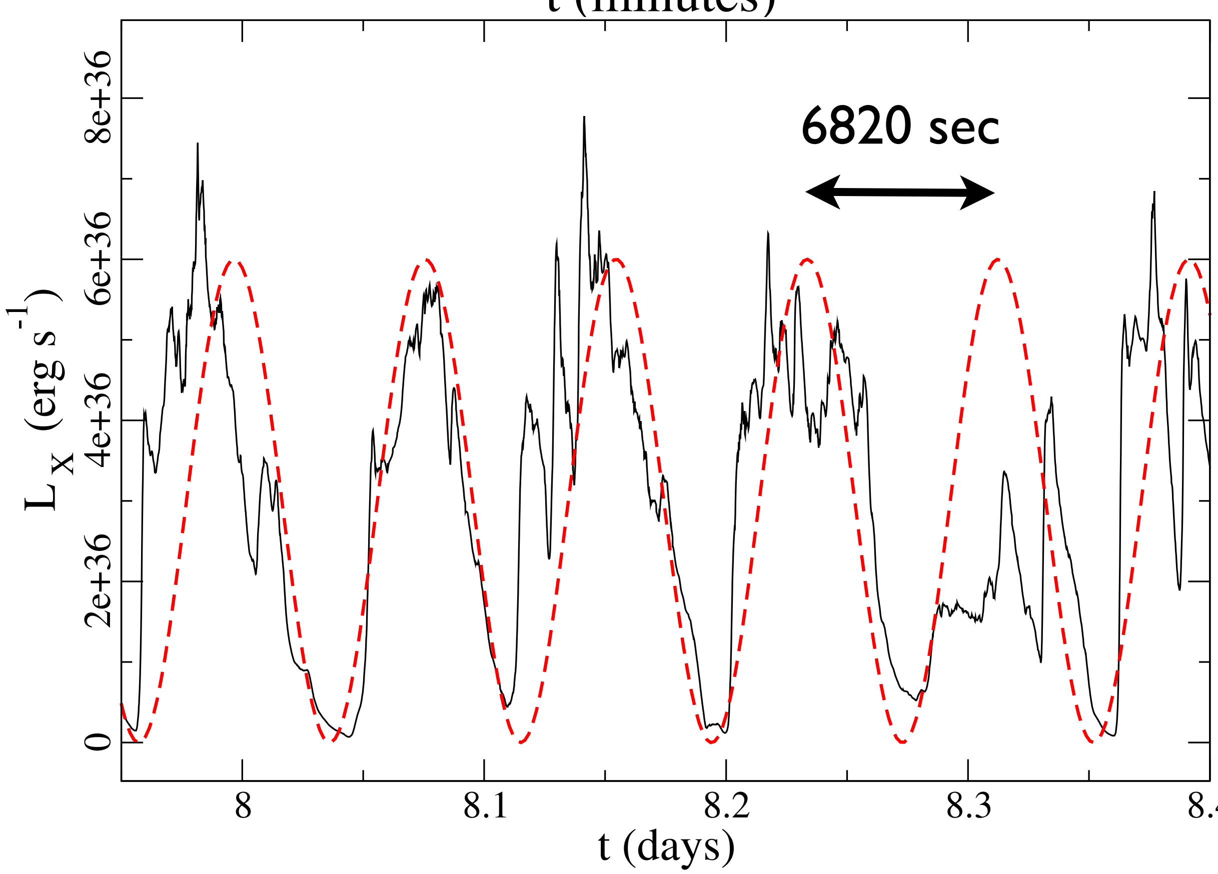
Manousakis & Walter 2013, submitted A&A



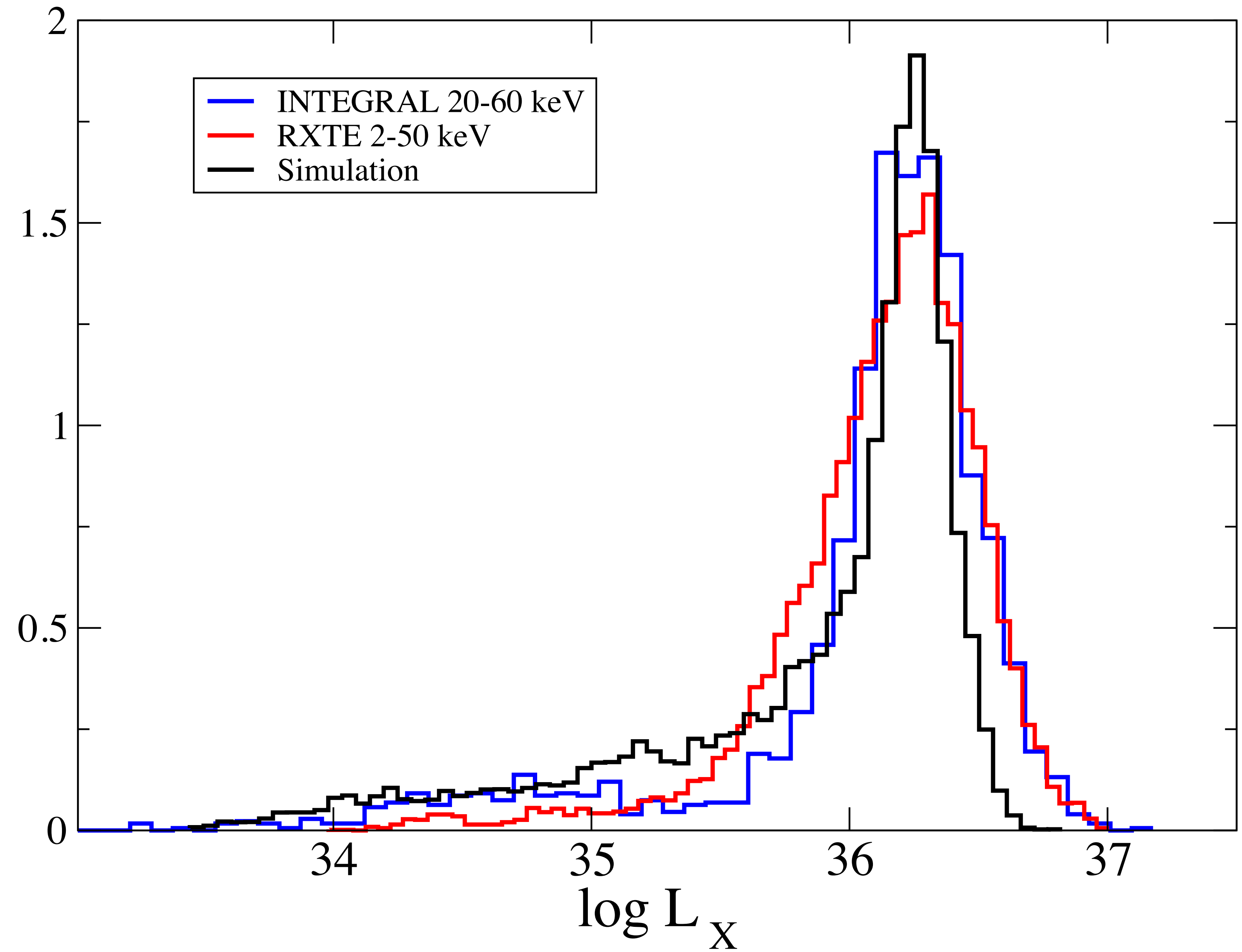


$t_{ff}(r_A) \sim 0.1$ s
$t_{ff}(r_{acc}) \sim 60$ s
$t_{ff}(R_{BS}) \sim 6000$ s





Vela X-1: simulations



- ☑ Variability amplitude matches the observations
- ☑ Log-normal distribution similar to the observed ones
- ☑ Bow-shock variability time-scale matches the observed oscillations

NB: parameters are not tuned to match the observations

Conclusions

- Obscured HMXB can be understood with low wind velocities.

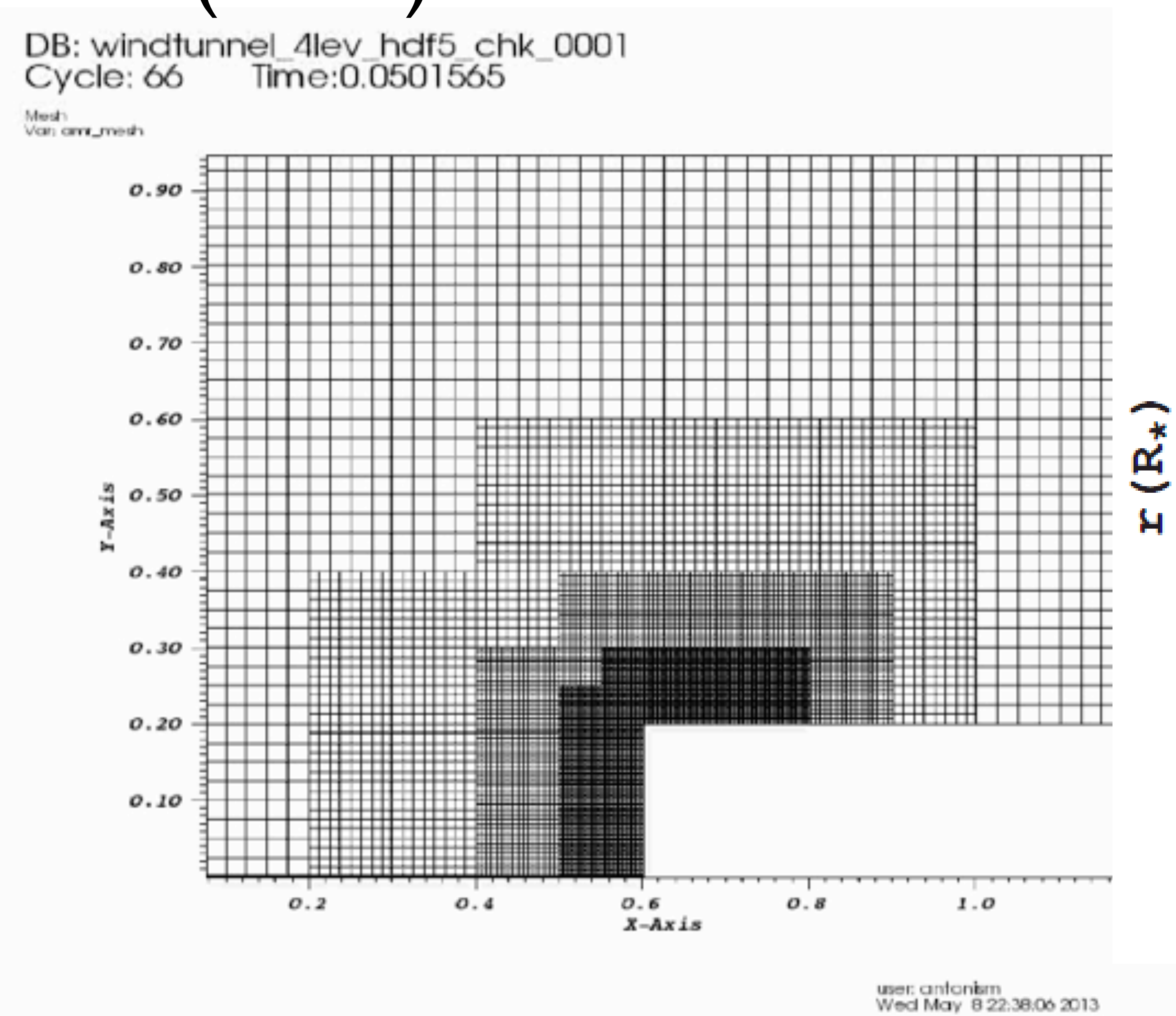
- Comparison of hydrodynamic simulations with observations allows to constrain neutron star mass and orbital radius, independently of dynamical estimates.

- Hydro-simulations produce log-normal distribution of the accretion rates and off-states (and flares).

- Self-organized criticality of the accretion stream (?)

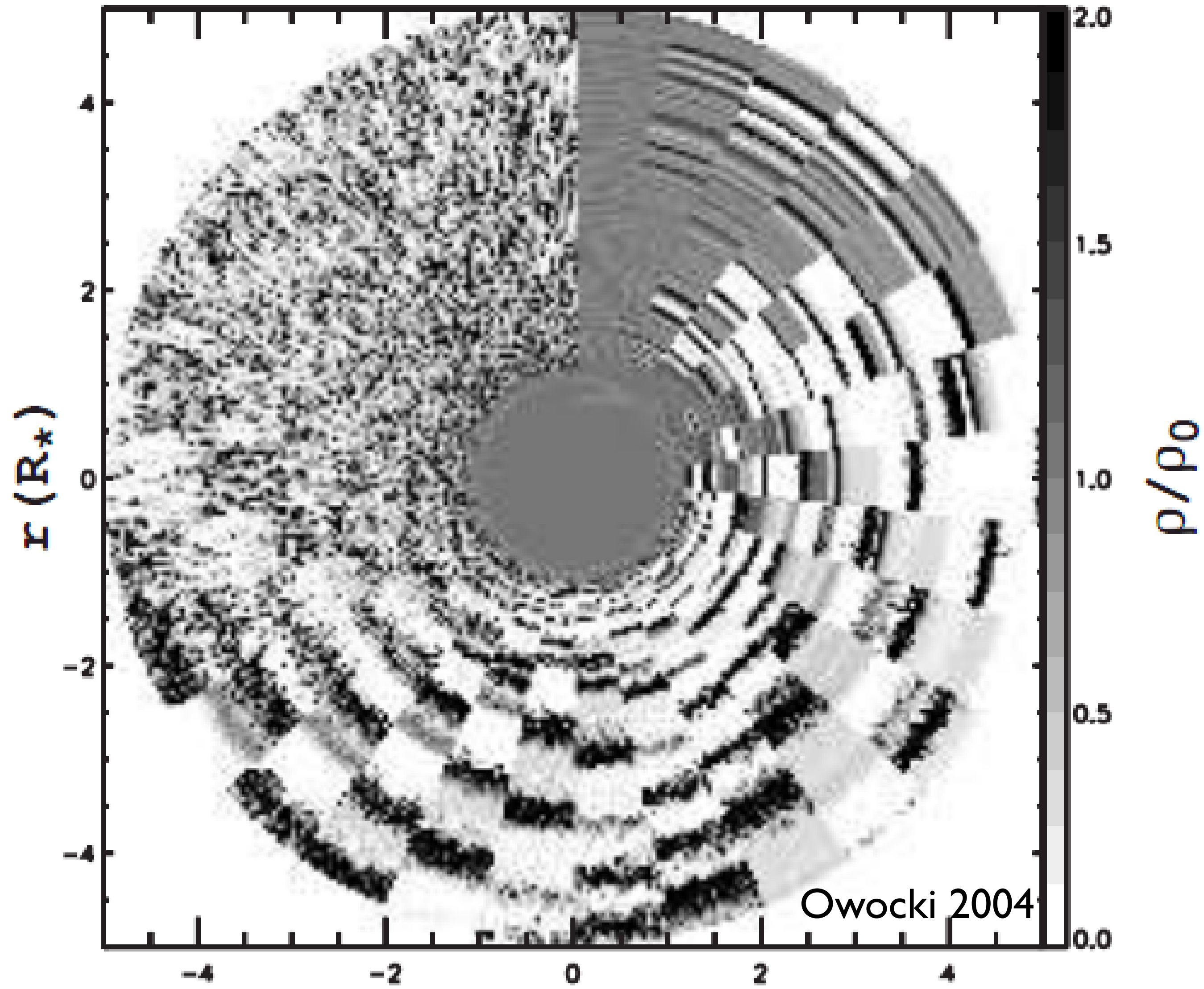
Future Perspectives

FLASH 3D AMR -> (more) realistic sim.



FLASH center U. Chicago

More Realistic Stellar Winds



A. Zdziarski S. Owocki

J. Sundqvist B. Rudak


Thank you for your attention
Questions?