Evidence for enhanced neutrino emissivity from a neutron star soft X-ray transient

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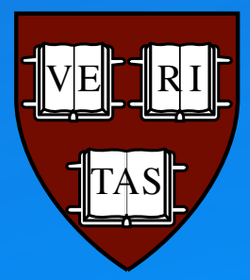
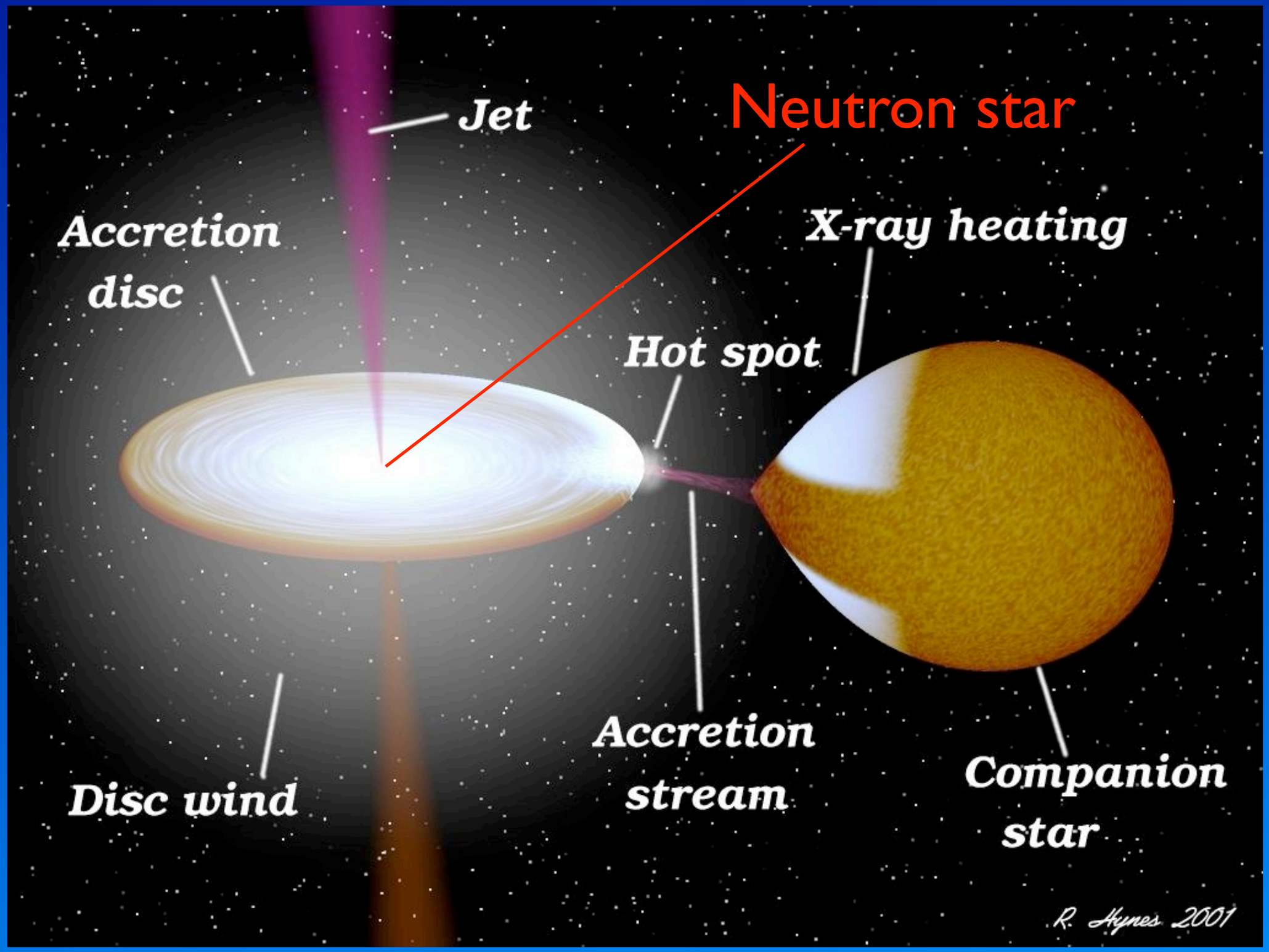
(SRON & CfA)

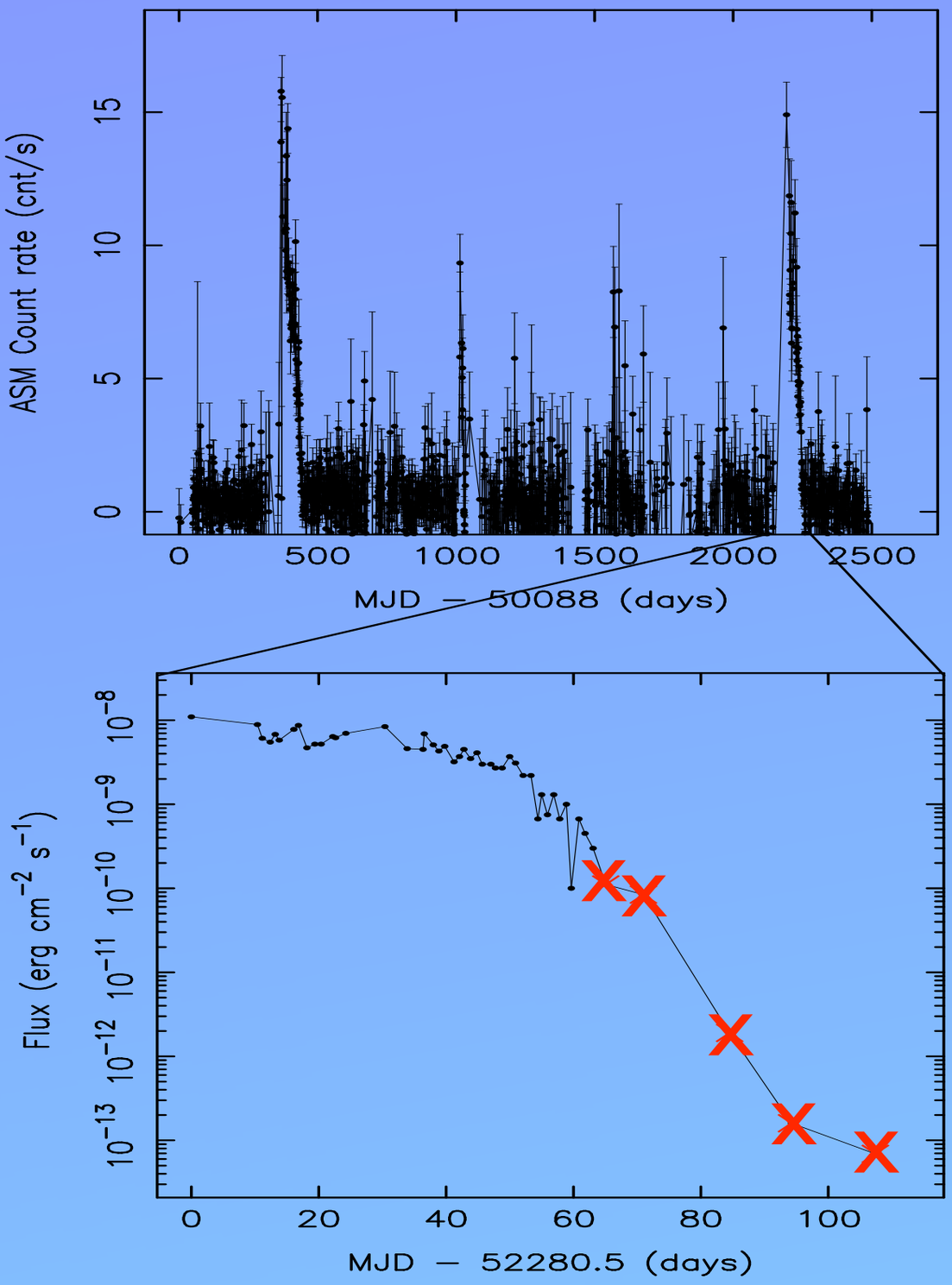


Cartoon image of a soft X-ray transient

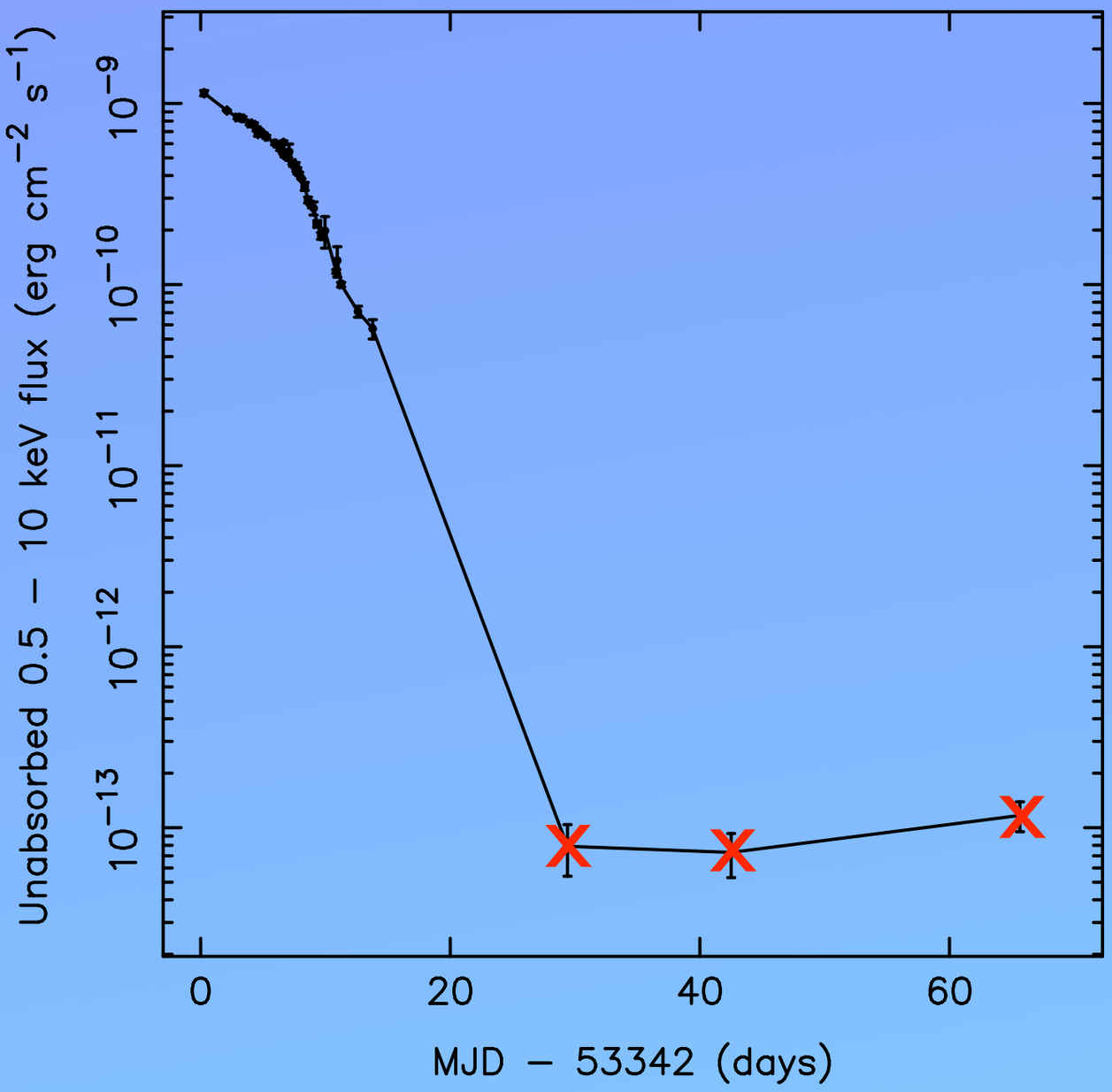


Lightcurves of NS SXTs

XTE J1709-267

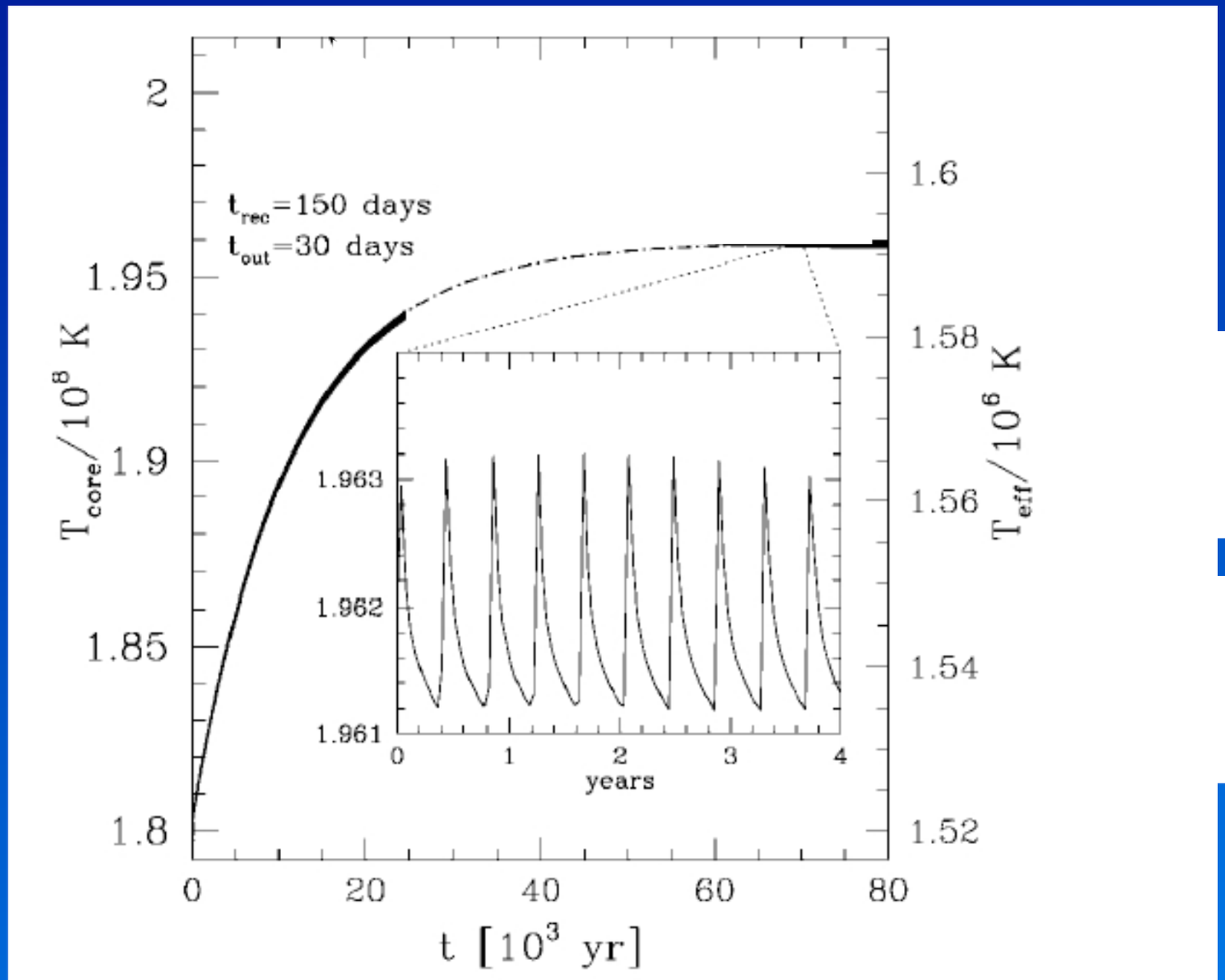


IGR J00291+5934



Jonker et al. 2003, 2004, 2005

Masses from NS X-ray transients in quiescence



$$^{34}\mathrm{Ne} + {}^{34}\mathrm{Ne} \rightarrow {}^{68}\mathrm{Ca}$$

$$^{48}\mathrm{Mg} + {}^{48}\mathrm{Mg} \rightarrow {}^{96}\mathrm{Cr}$$

$$\mathrm{M_{NS}} = 1.4\,\mathrm{M_\odot}$$

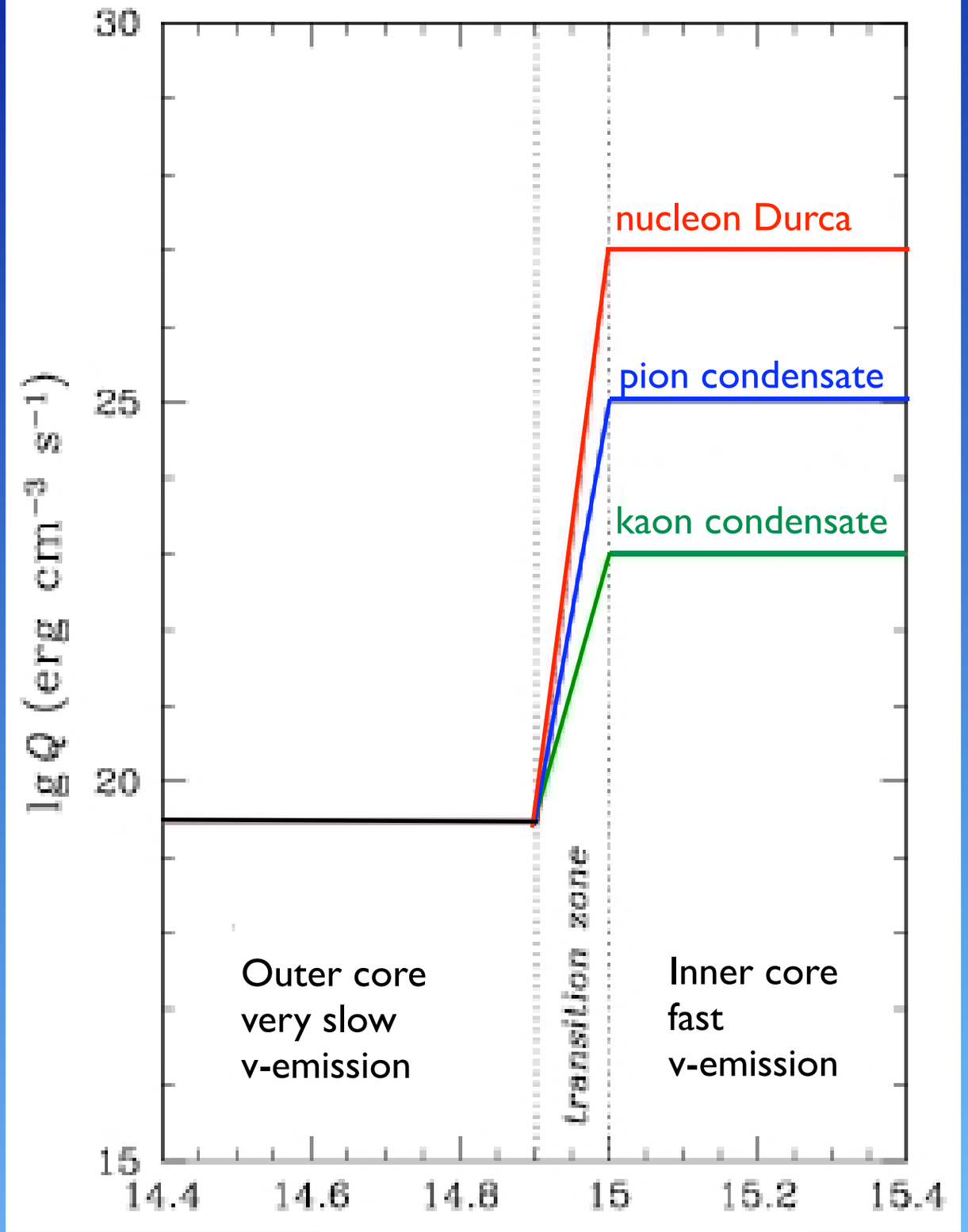
$$\langle \dot{\mathrm{M}} \rangle = 1.46 \times 10^{-10}\,\mathrm{M_\odot\,yr^{-1}}$$

Pycnonuclear reactions: Salpeter& van Horn 1969, Kitamura 2000

Heating of neutron stars: Brown et al. 1998, Colpi et al. 2001

Neutrino cooling processes: fast or slow?

Yakovlev & Pethick 2004 c.f. Page et al 2005



Direct URCA

Nucleon matter $n \rightarrow pe\bar{\nu}$ $pe \rightarrow n\nu$

Quark matter $d \rightarrow ue\bar{\nu}$ $ue \rightarrow d\nu$

Modified URCA

Nucleon matter $nS \rightarrow Spe\bar{\nu}$ $Spe \rightarrow Sn\nu$

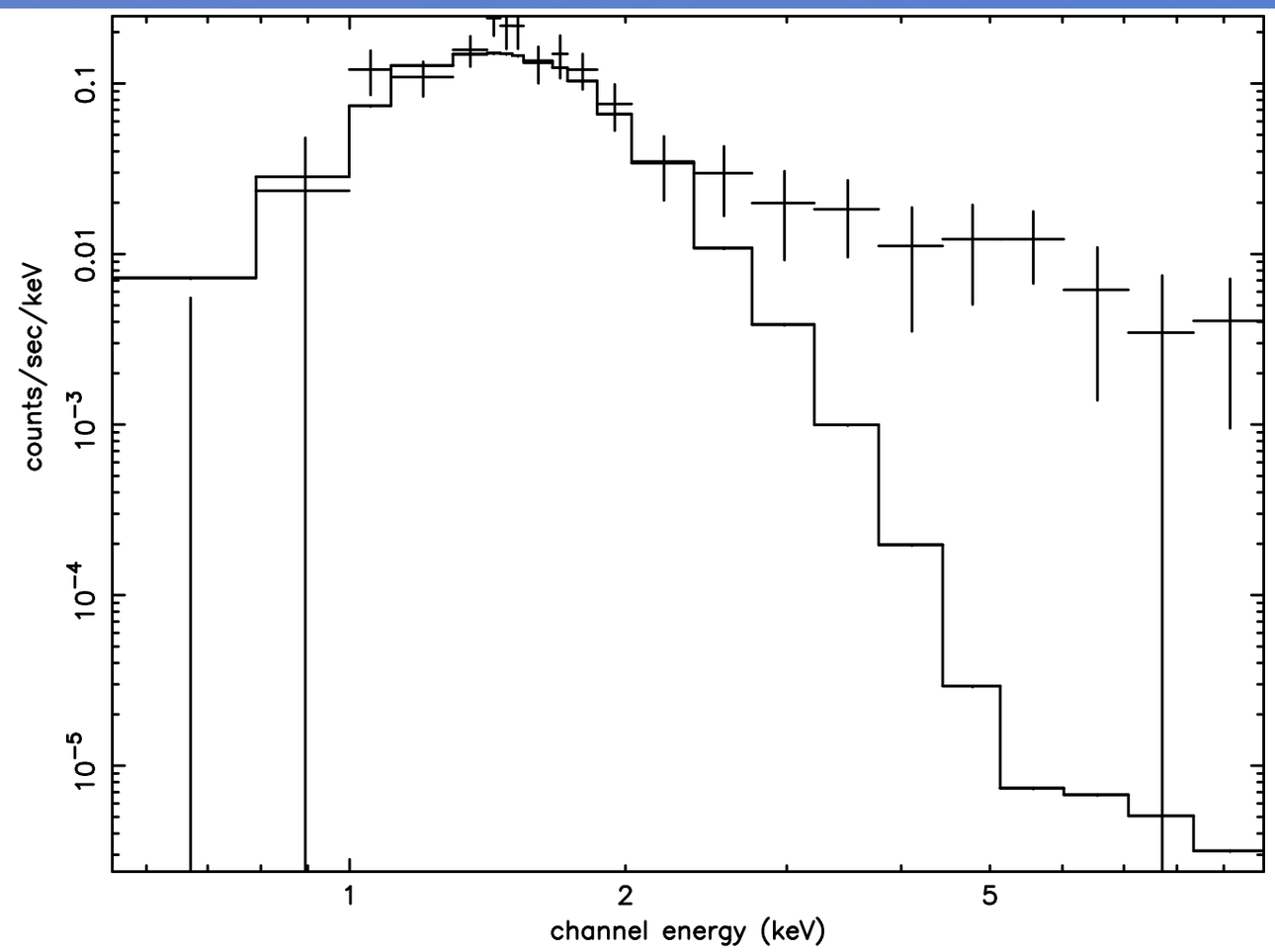
etc

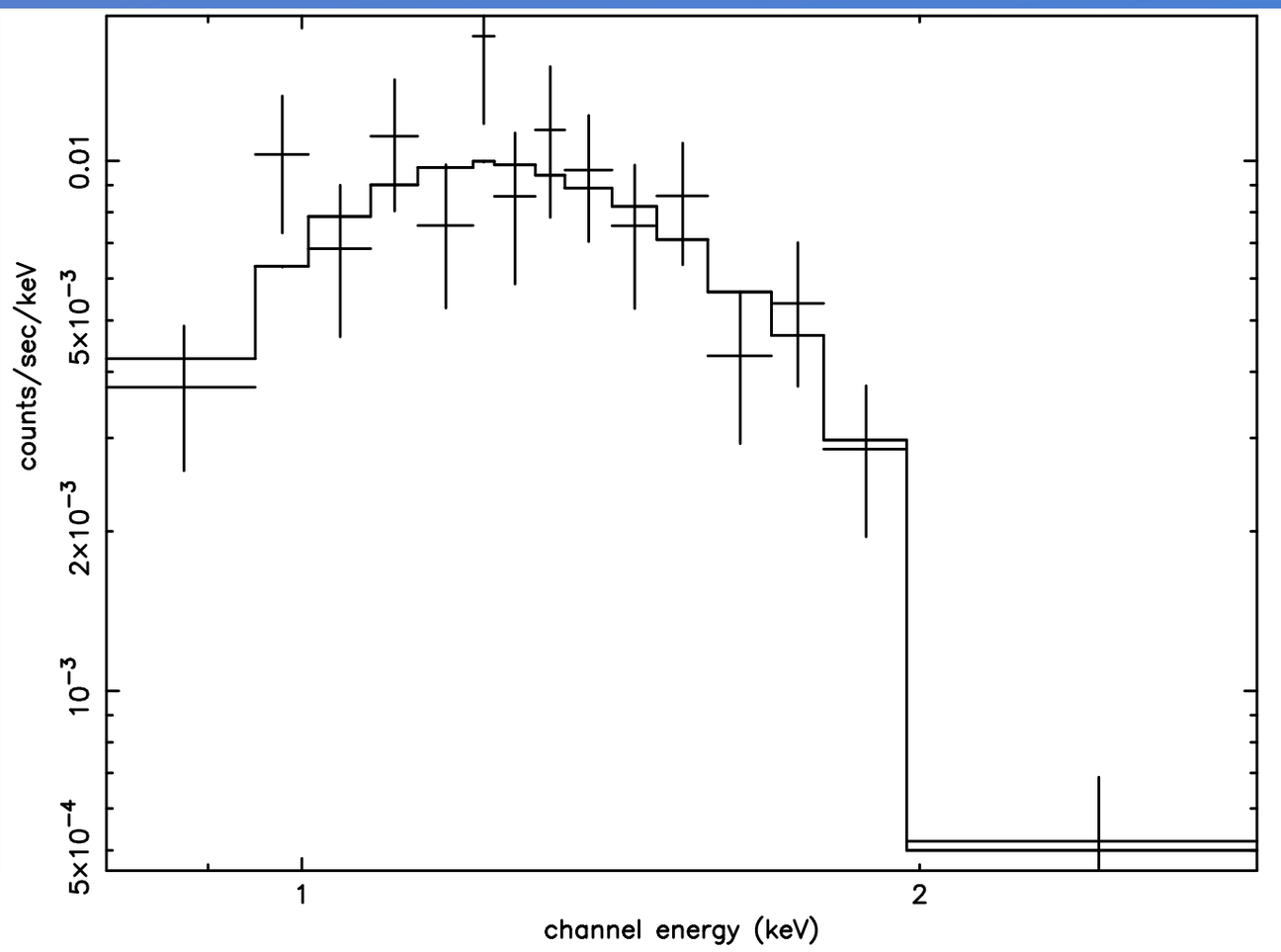
Chandra and/or XMM-Newton X-ray observations of Q NS SXTs:

4U 1608-52

1H 1715-321

Absorbed NSA fit



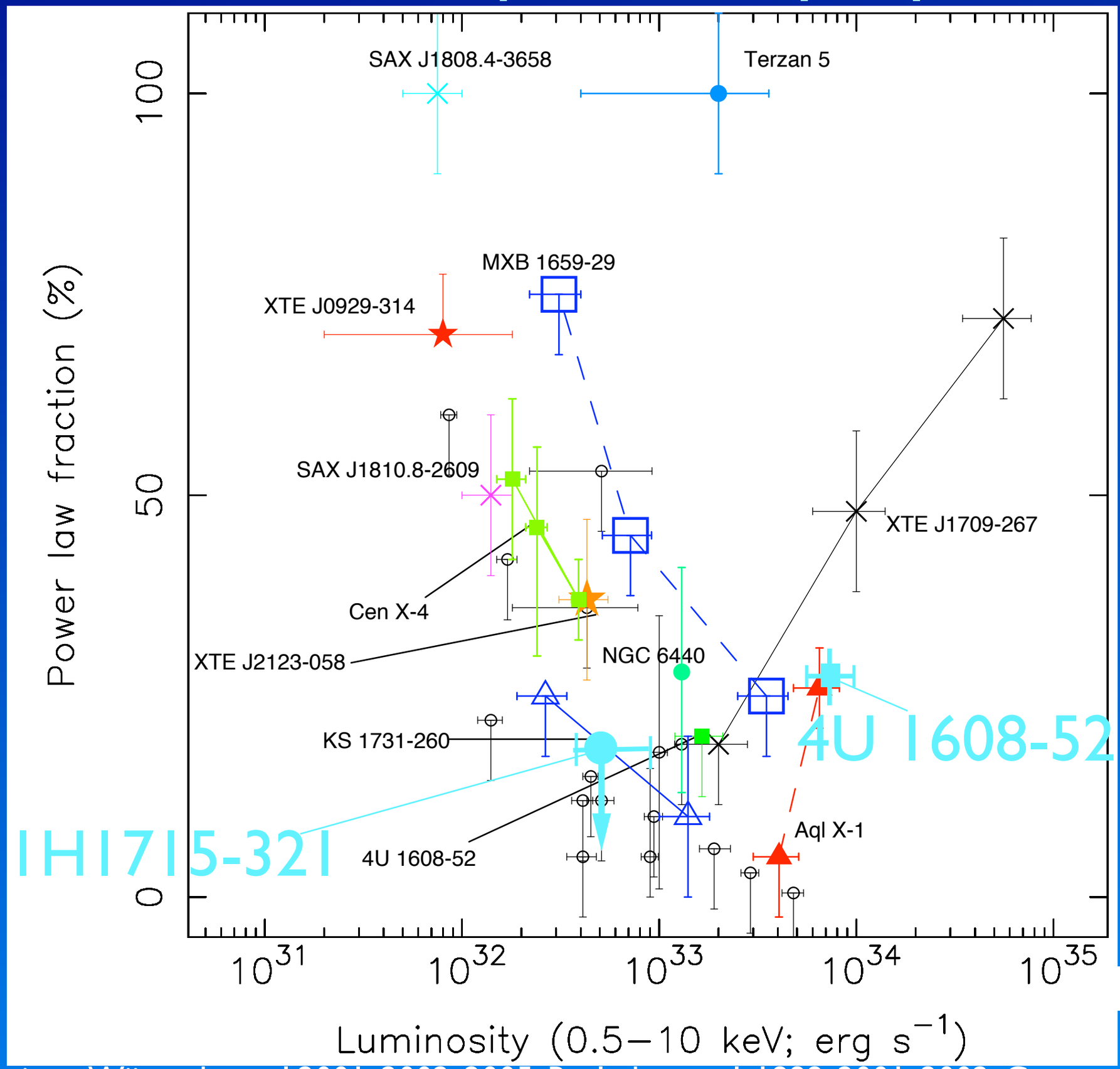


T~1.26 million K

T~1.2 million K

Jonker, Wachter & Mendez et al in prep.

Observed quiescent properties

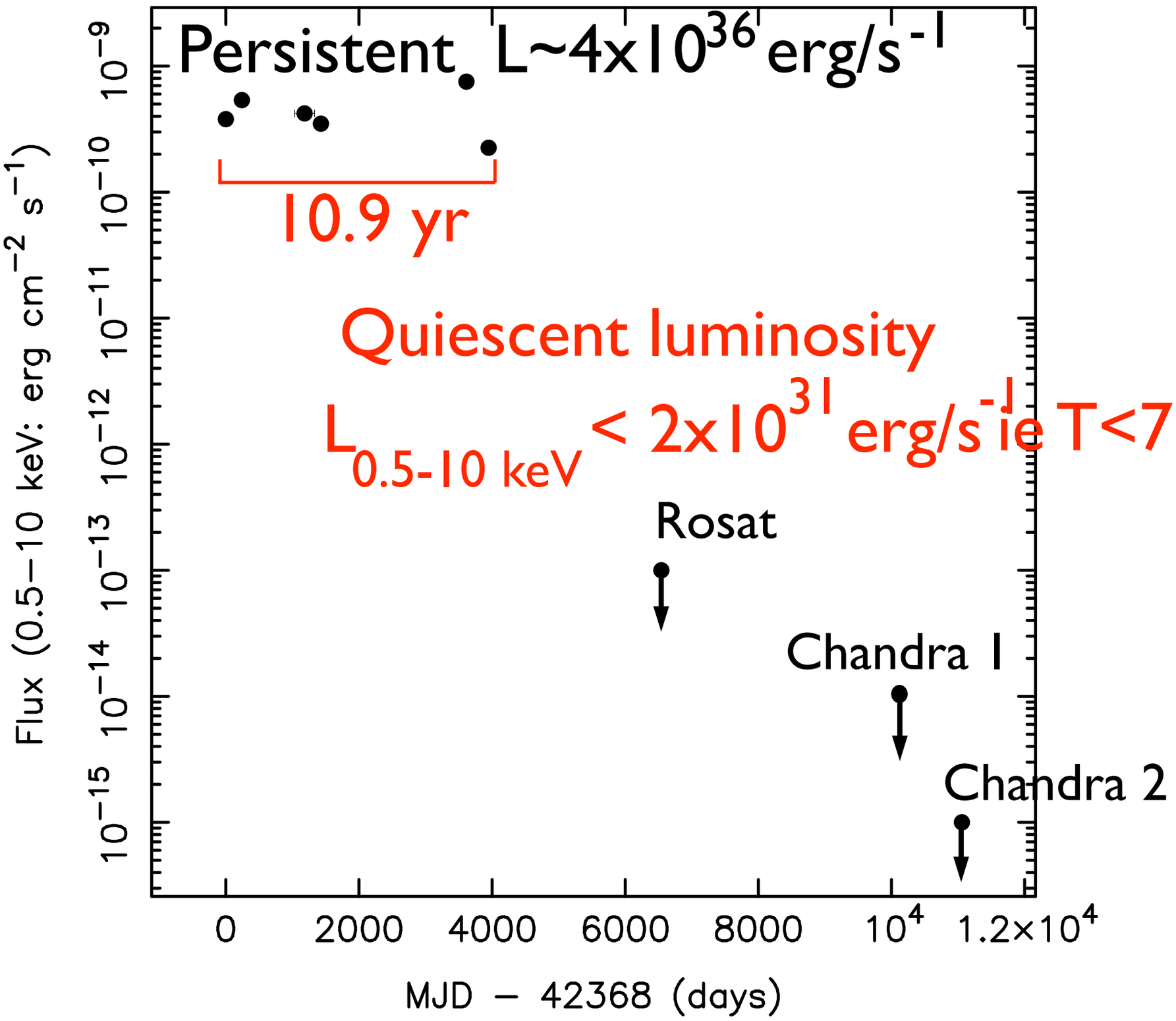


Jonker et al. 2004

Observations: Wijnands et al. 2001, 2002, 2005, Rutledge et al. 1999, 2001, 2002, Campana et al. 2002, Jonker et al. 2003, 2004, 2005, in prep, Tomsick et al. 2003, Heinke et al. 2003

1H 1905+000

Ariel-5, SAS-3, HEAO-1, Einstein, EXOSAT,



Quiescent luminosity

$L_{0.5\text{-}10\ keV} < 2 \times 10^{31}$ erg/s^{-1} ie $T < 7.5 \times 10^5$ K

Jonker et al. in prep

1H 1905+000 KS 1731-260

Fluence (0.01-20 keV)

~0.3 erg cm^{-2} ~2.3 erg/cm^{-2}

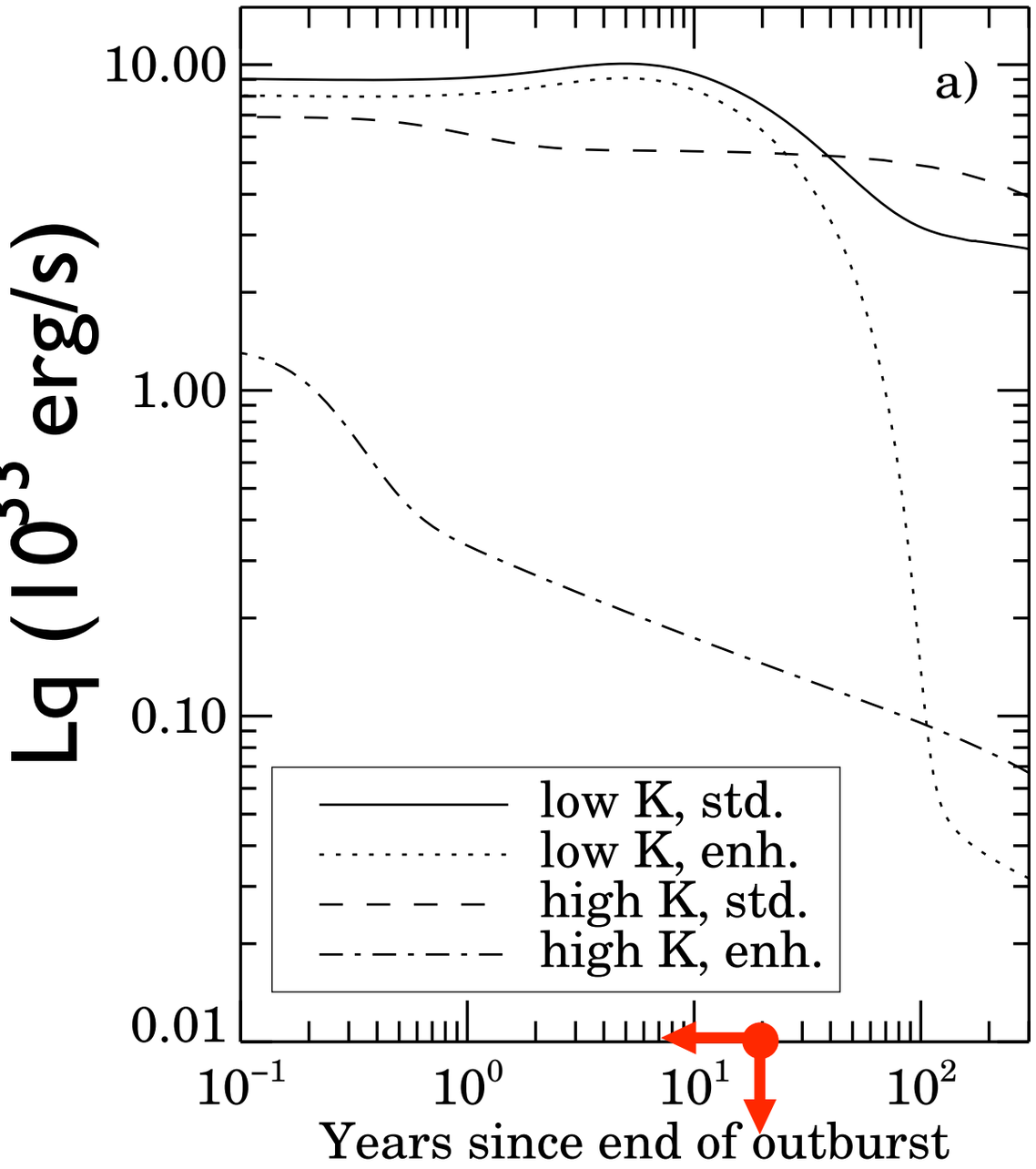
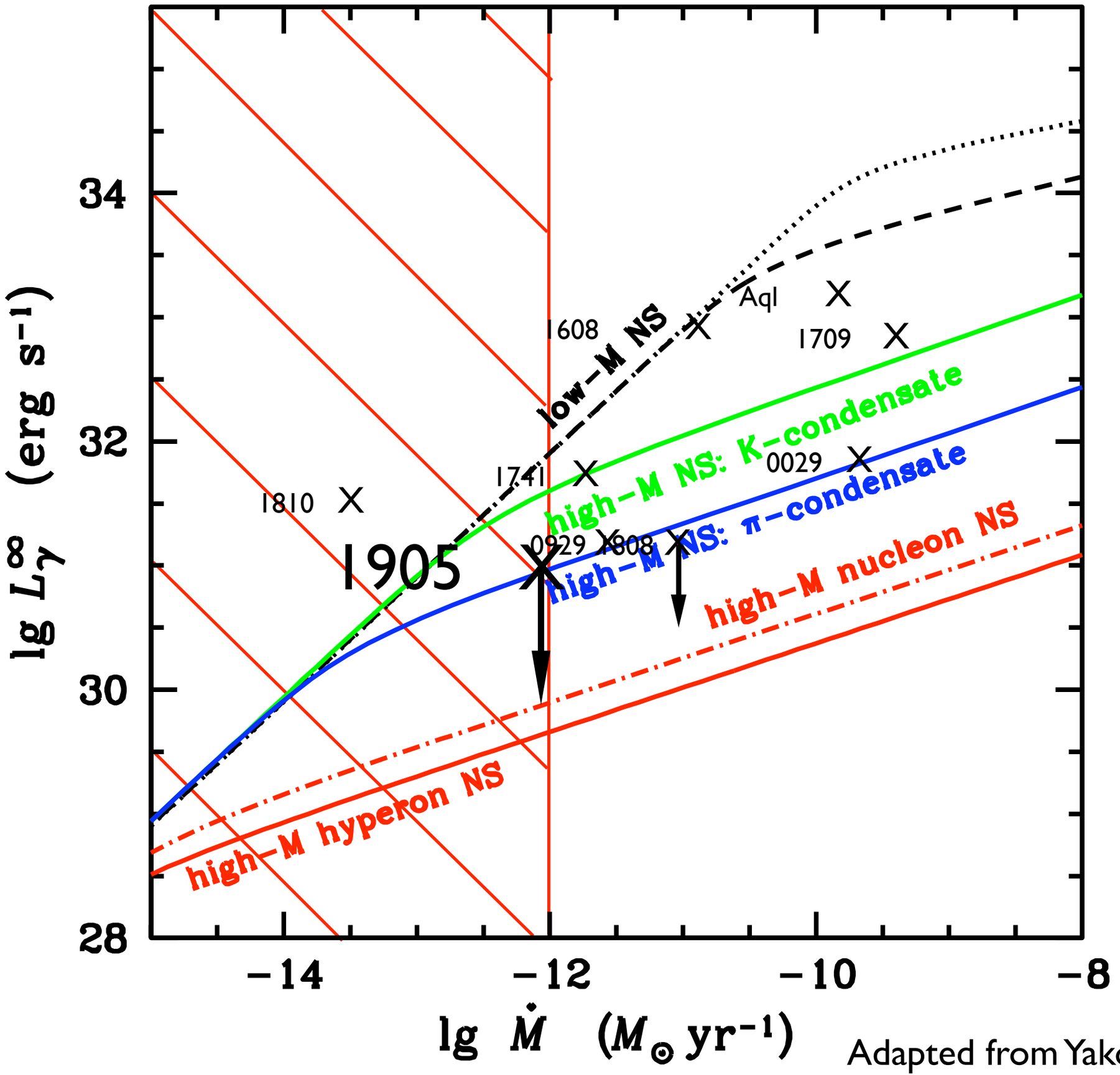
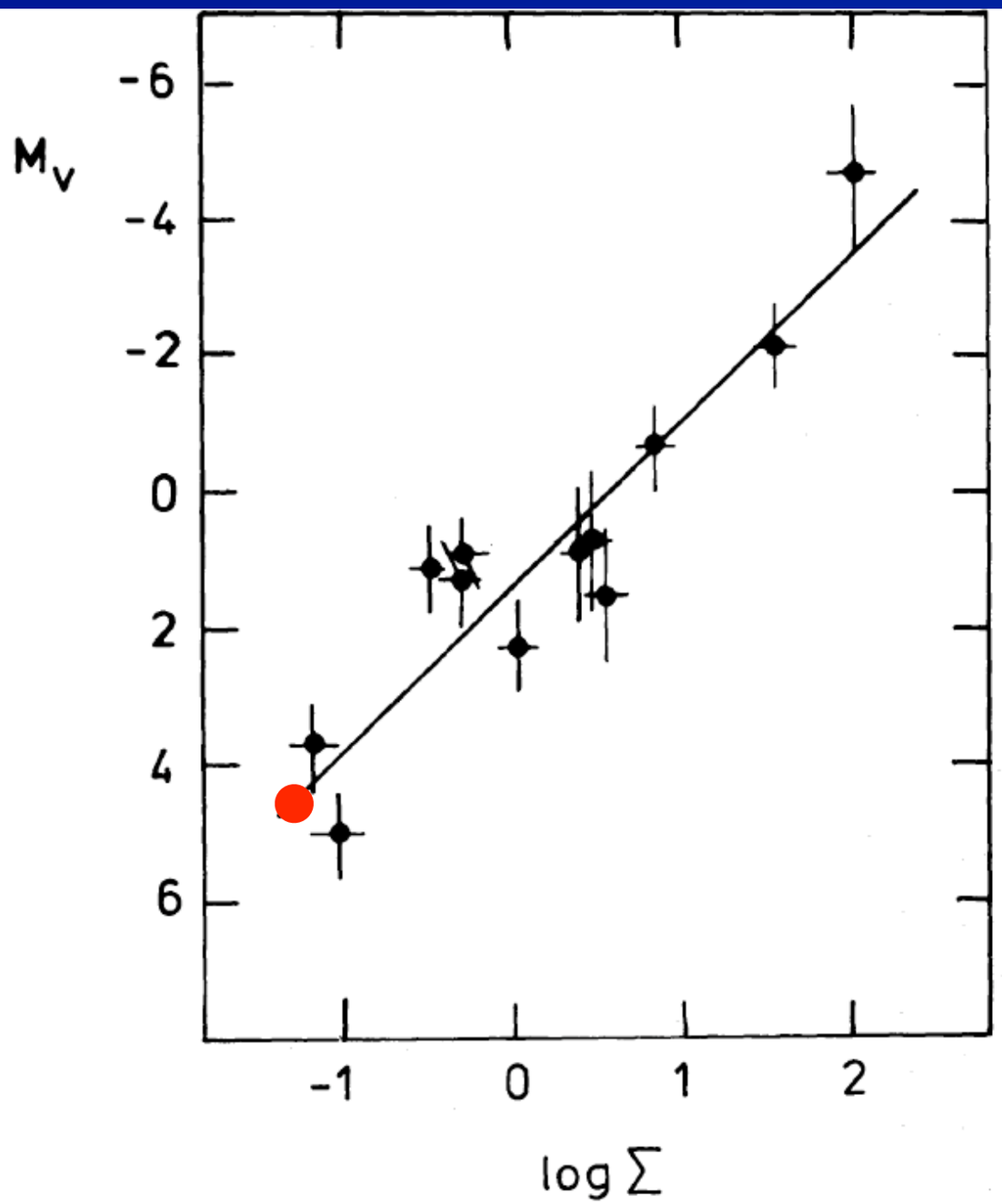


Fig. from Rutledge et al. 2002, calculated for KS 1731-260



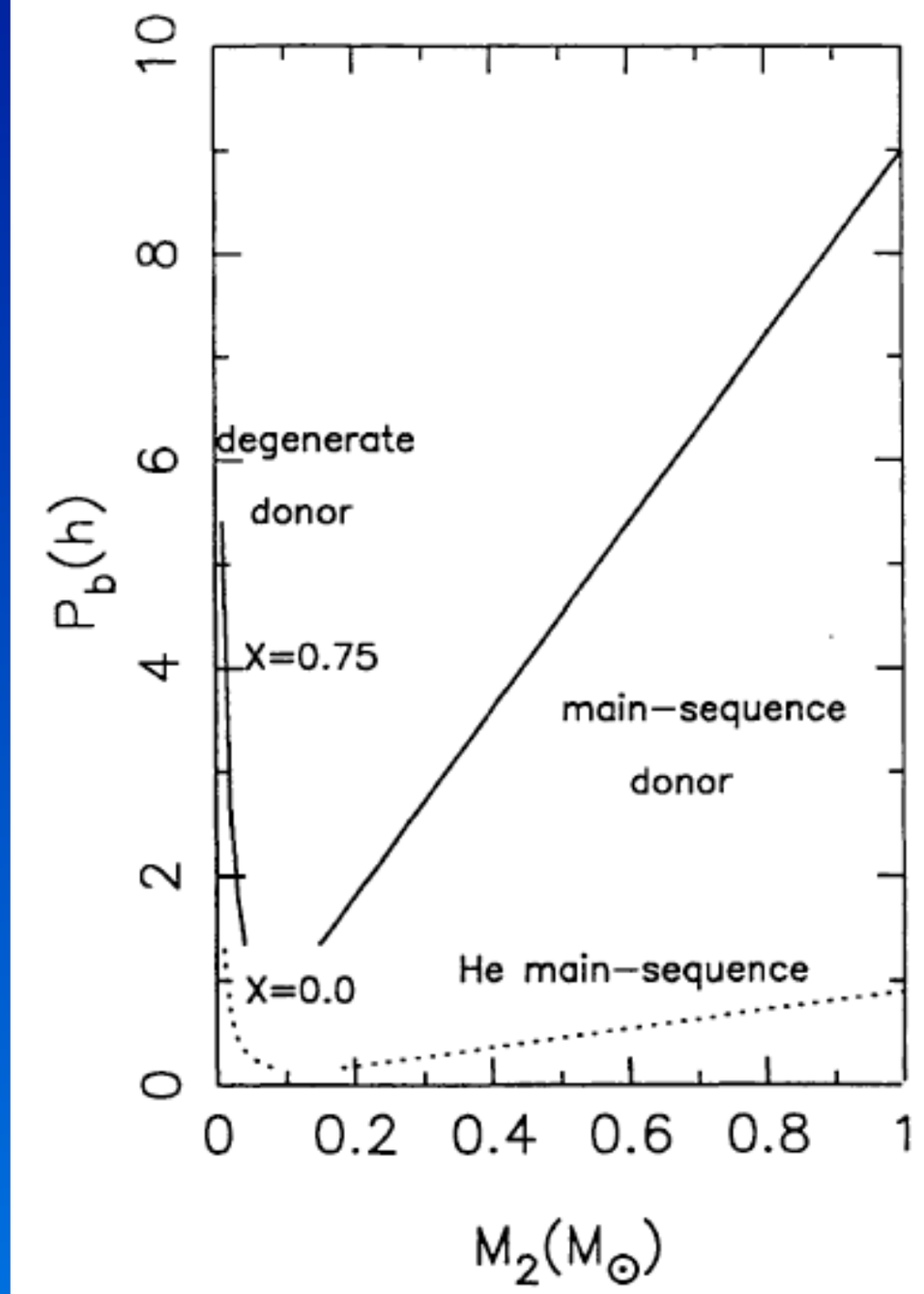
Adapted from Yakovlev & Pethick 2004

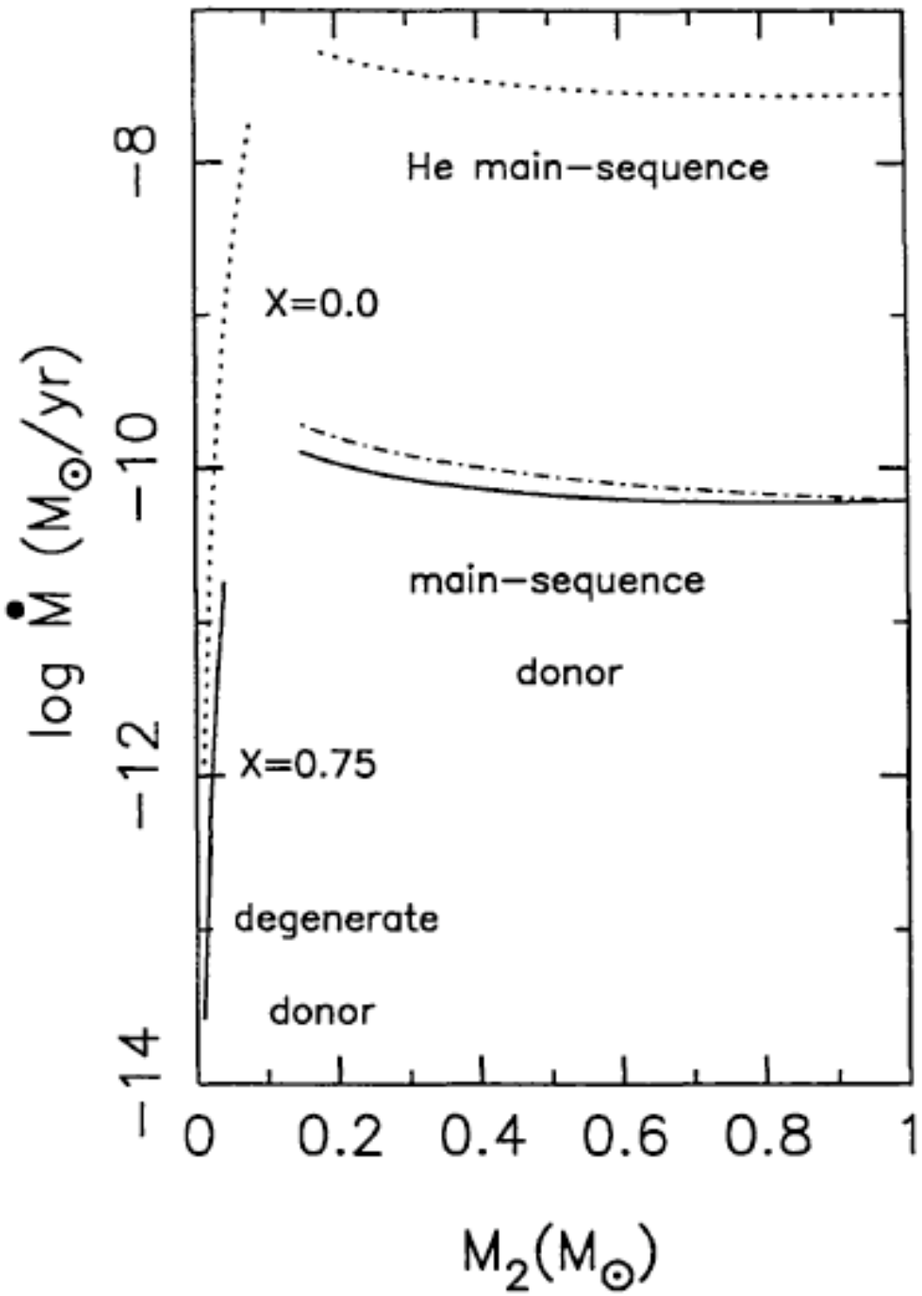


van Paradijs & McClintock 1994

$$\Sigma = (\frac{L_X}{L_{Edd}})^{1/2}(P_{orb}/1hr)^{2/3}$$

Porb 1H1905+000 ~ 20-30 min





Verbunt 1993

Conclusions:

Either

Evidence is mounting that EoS with significant softening can be excluded

The time averaged mass accretion rate is much lower than the mass transfer rate

The pycnonuclear reactions do not heat the NS core as much as thought