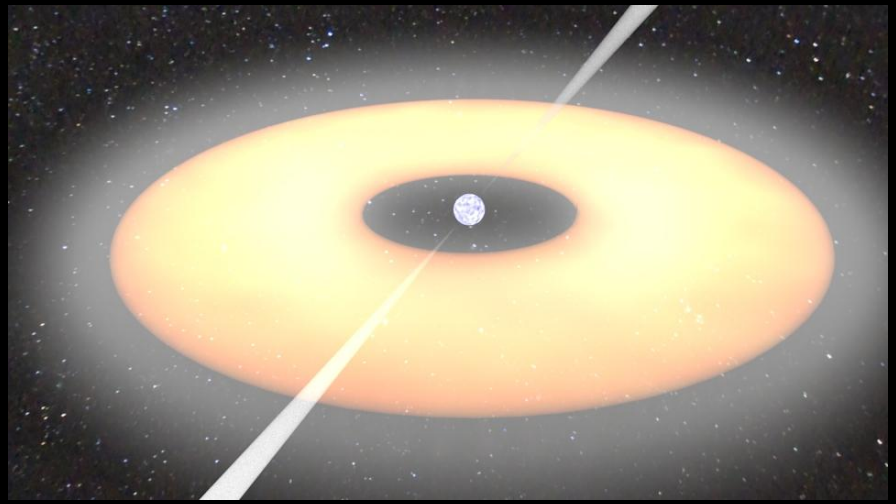
Low-level accretion in transitional MSPs and connection with very faint X-ray binaries



Arash Bahramian

C. O. Heinke, N. Degenaar, R. Wijnands

UNIVERSITY OF ALBERTA

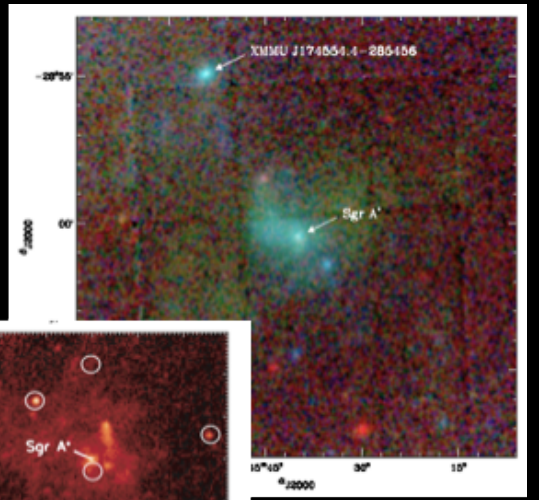
EWASS 2015 - June 25, 2015

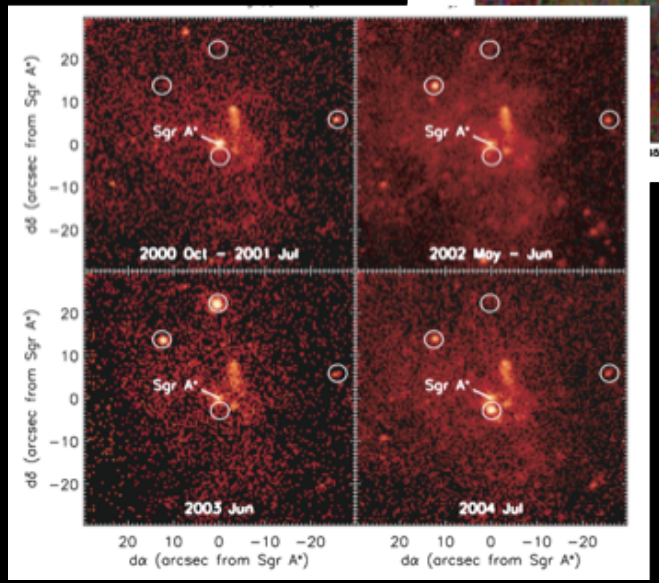
Very faint X-ray binaries

- Several transients with peak L_X=10^{34}-10^{36} erg/s around the Galactic center

- As numerous as bright LMXBs there
(Degenaar+09, +10)

Porquet+05





Muno+05

3 Weird aspects

1: Low peak Lx, low integrated Lx.

2: Time-averaged accretion rates very low

suggestions that exotic systems (brown dwarf donor, IMBH accretor) needed (King & Wijnands 2006)

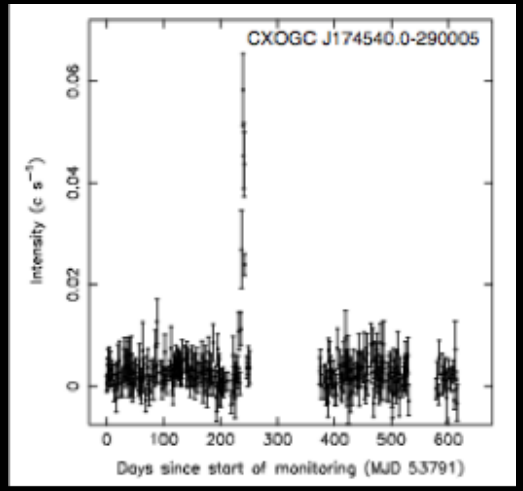
3: Several maintain continuous accretion

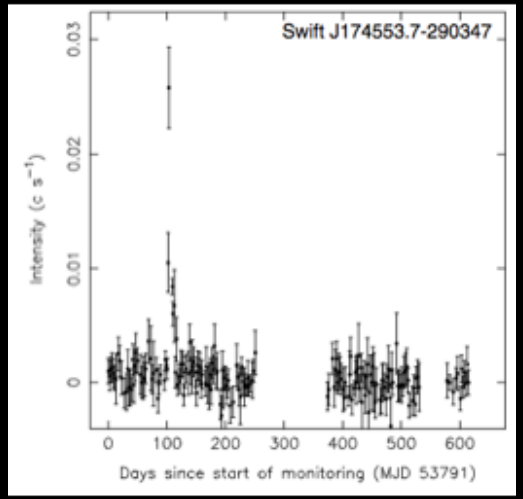
rates too low to keep disk ionized, for months to years.

We argue (at least) 2 kinds of VFXBs; short orbital-period systems with short outbursts, and magnetospherically-choked accretion, lasting longer.

VFXBs: Short outbursts

- Defining peak luminosity $L_X=10^{34}$-10^{36} erg/s
- Many outbursts only a few weeks long (~ 6 with shorter outbursts identified)
- Suggests small disk & short orbital period



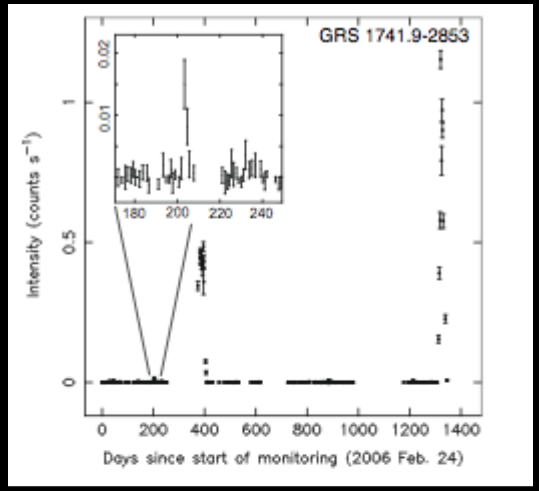


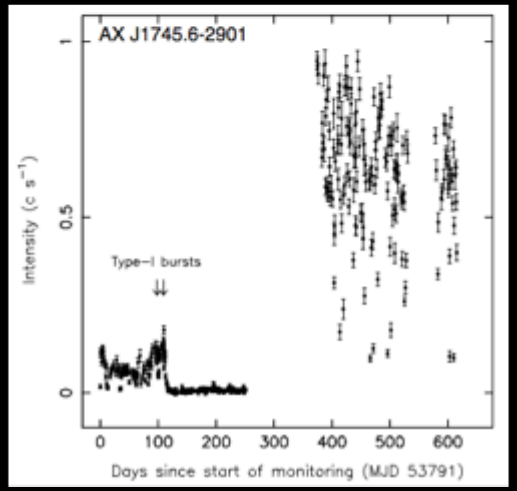
Degenaar+09

VXFBs: Bright outbursts

- Some VFXBs have shown both faint and bright (>10^{36} erg/s) outbursts

- Type 1 X-ray bursts prove NS nature

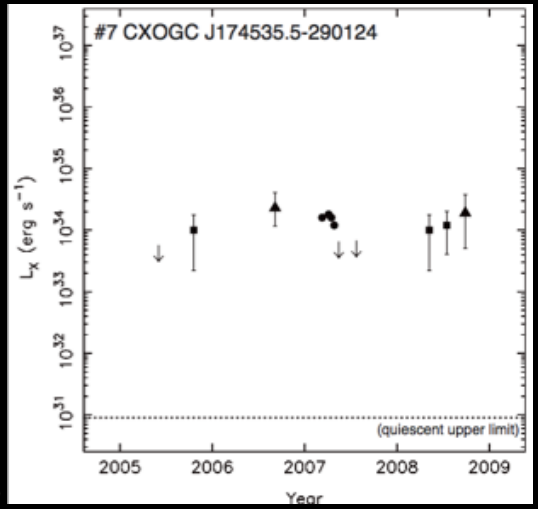




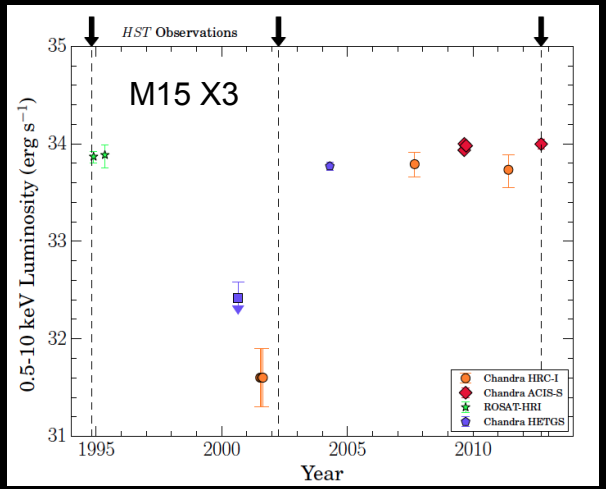
Degenaar+09

Quasi-persistent VFXBs

- several stay at $L_X=10^{34}$-10^{36} for years
- Nature unknown: Some can be slow pulsars, symbiotics, CVs
- At least one has shown bursts, proving NS nature, $L_X\sim10^{34}$



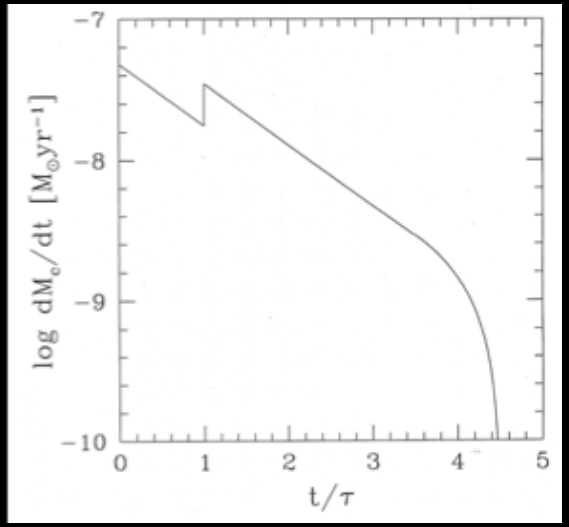
Degenaar+12



Arnason+15

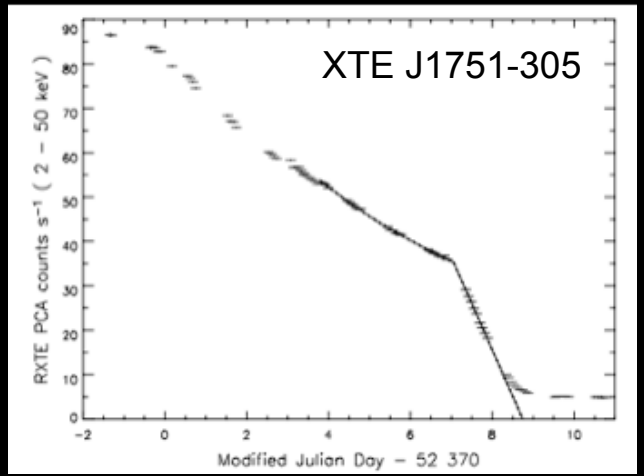
Lightcurves

Predicted lightcurve
(King & Ritter+98)



- Modeling outburst decay based on disk-instability model:
  - Exponential decay while irradiated
  - Linear decay afterwards

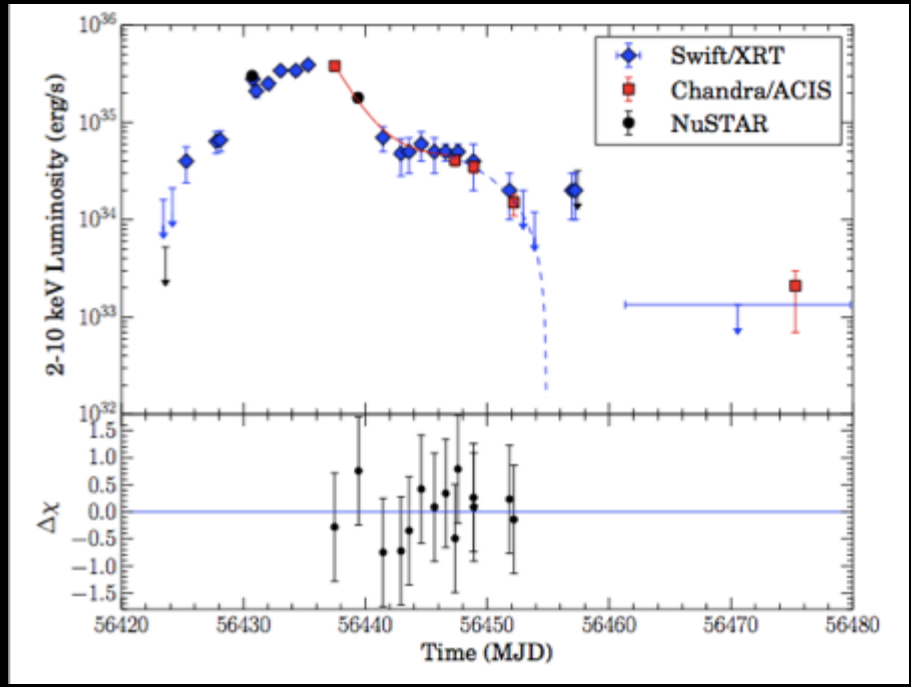
- This fits some LMXBs but **not all**



Observed lightcurve and fitted model
(Powell+07)

Fitting VFXB lightcurves

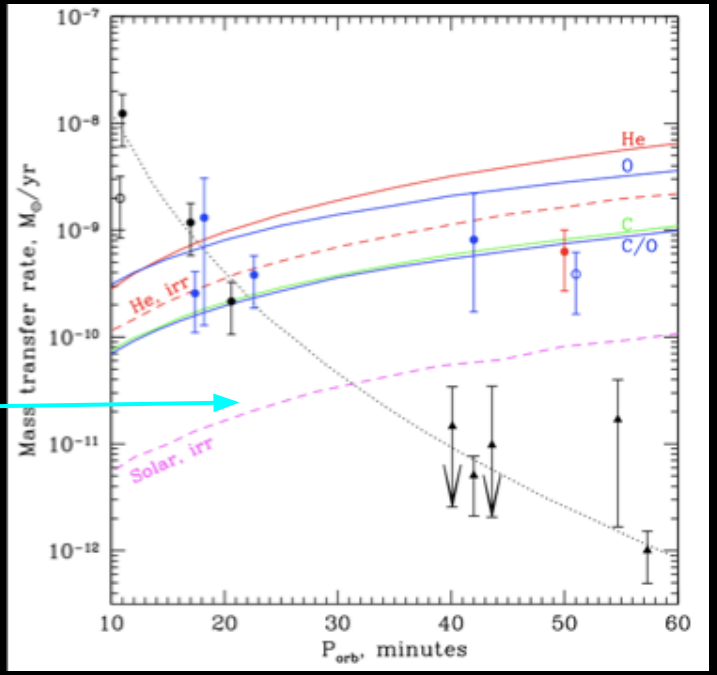
- We fit 3 short outbursts of VFXBs with Exp+linear decay model
- Decay well-described by model: suggesting consistency of VFXB short outbursts with models
- Comparison with well-known systems suggests P_{orb} ~ 1hour (Heinke+15)



CXO J174540-290005
(Data: Koch+14, Fit: Heinke+15)

Quasi-persistent VFXBs

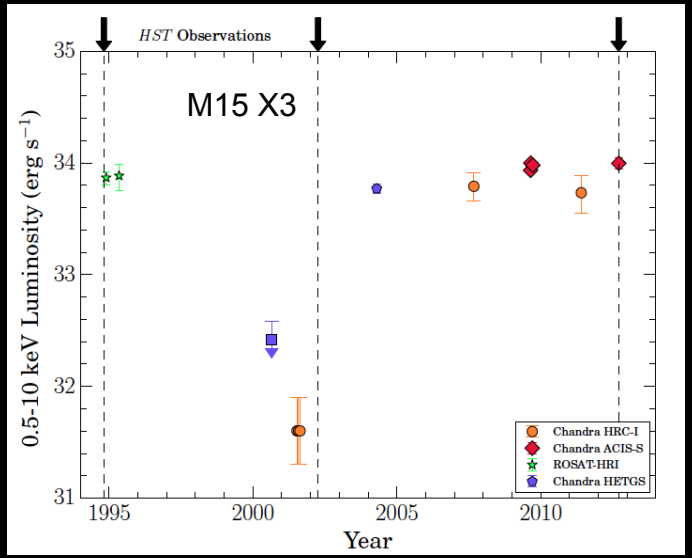
- Quasi-persistents break standard disk theory
- Below 20-30 minutes, UCXBs can keep disks stably accreting; but L_X must be $>10^{35}$ erg/s.
- At short periods, GR sets minimum Mdot.
- LMXBs with stable accretion at few*10^{34} erg/s need new physics



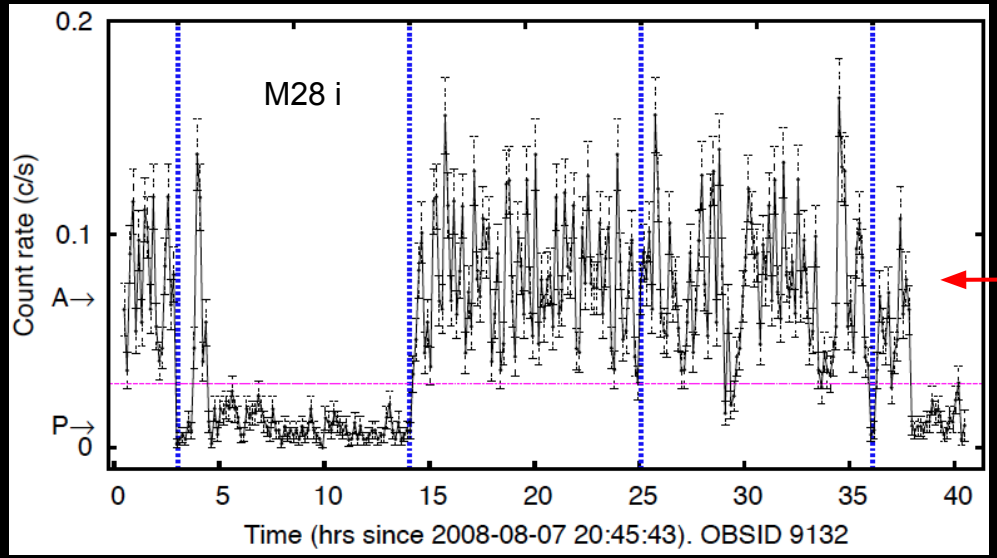
UCXBs vs. evolution prediction (dotted) & stability lines. Transients as triangles, dots persistent. (Heinke+13)

A possible answer: Transitional MSPs?

- Some quasi-persistent VFXBs show intermediate L_X; like tMSPs (Degenaar+14)



Arnason+15

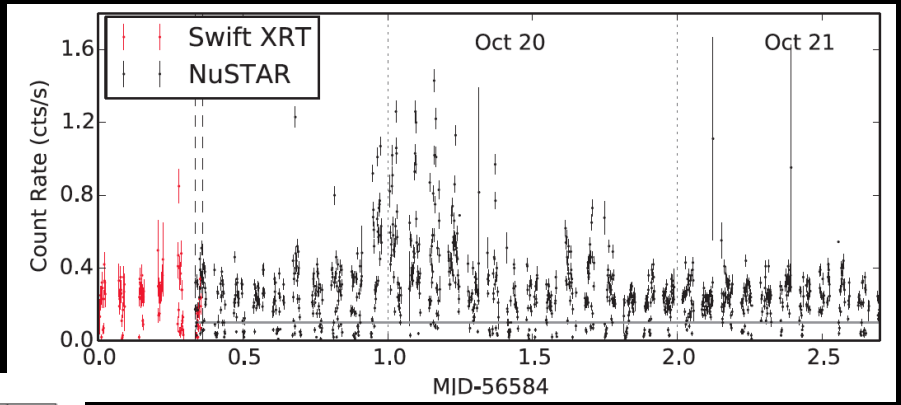


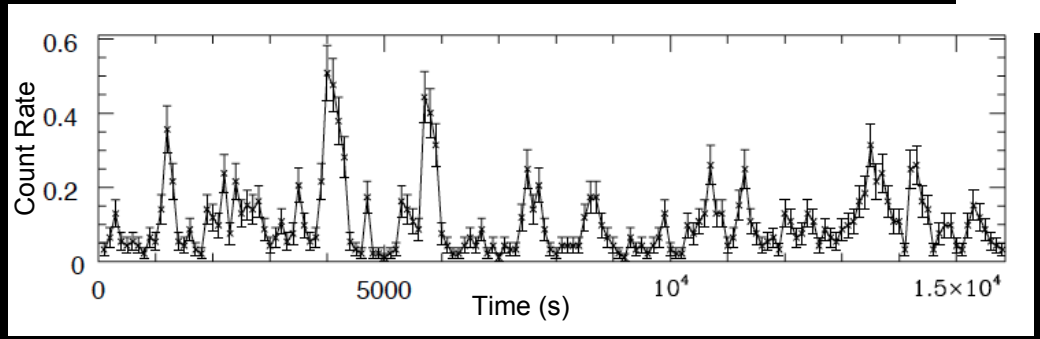
Linares+14

A possible answer: Transitional MSPs?

- Similar flaring behaviour is observed in VFXBs and tMSPs

PSR J1023+0038
Swift & NuSTAR lightcurve, 100 s bins
7e32<Lx<1e34
Relatively hard (1.1<Γ<1.7)
Tendulkar+14





NGC 6652 B
Chandra lightcurve, 100 s bins,
5e33<Lx<~1e35
Hard (Γ=1.3±0.1), Stacey+12

Conclusion

- Behaviour of transient VFXBs can be described by disk instability models.
- However, behaviour of quasi-persistent VFXBs requires new physics.
- Behaviour of quasi-persistent VFXBs are similar to tMSPs:
  - Staying in intermediate states (~few*e33 erg/s)
  - Similar flaring behaviour
- We suggest quasi-persistent VFXBs might be tMSPs

Thank you