Type-I Burst as a Probe of the X-ray Binary Corona

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On behalf of:

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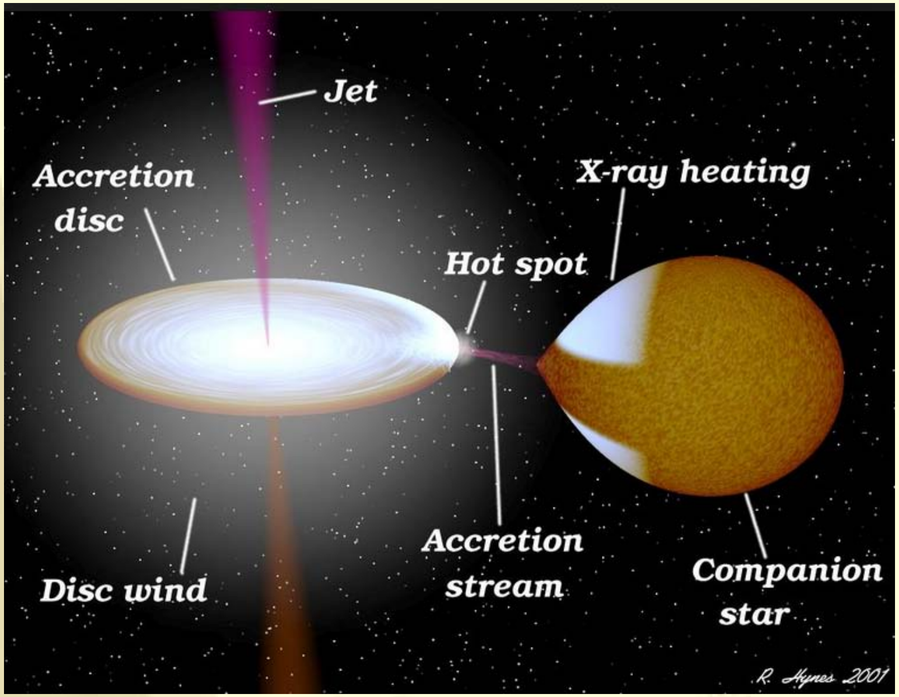
Outline

- 1. Introduction
- 2. The feedback of type-I bursts to the corona
  - (1) The case of IGR J17473-2721
  - (2) A general sample
- 3. Conclusions

Introduction

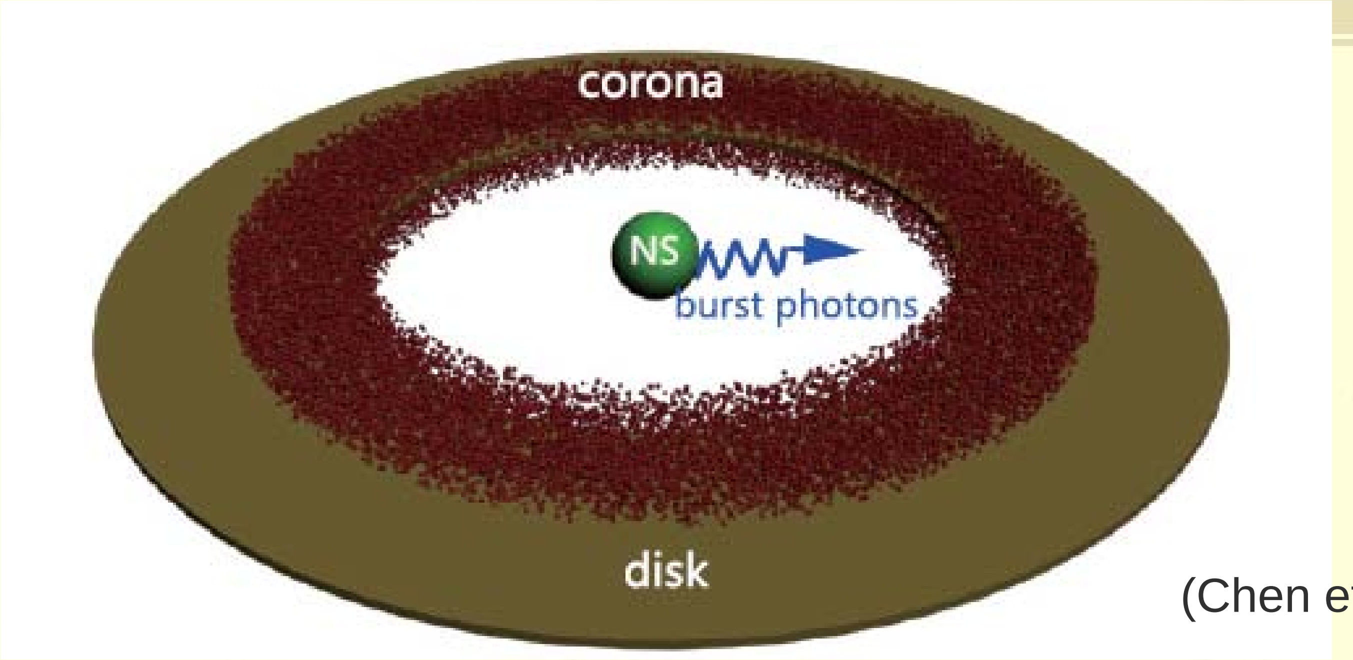


- The spectra of Low Mass X-ray binary:

Soft / Thermal components:
neutron star & accretion disk

Hard/ Comptonized components:
Corona or Jet

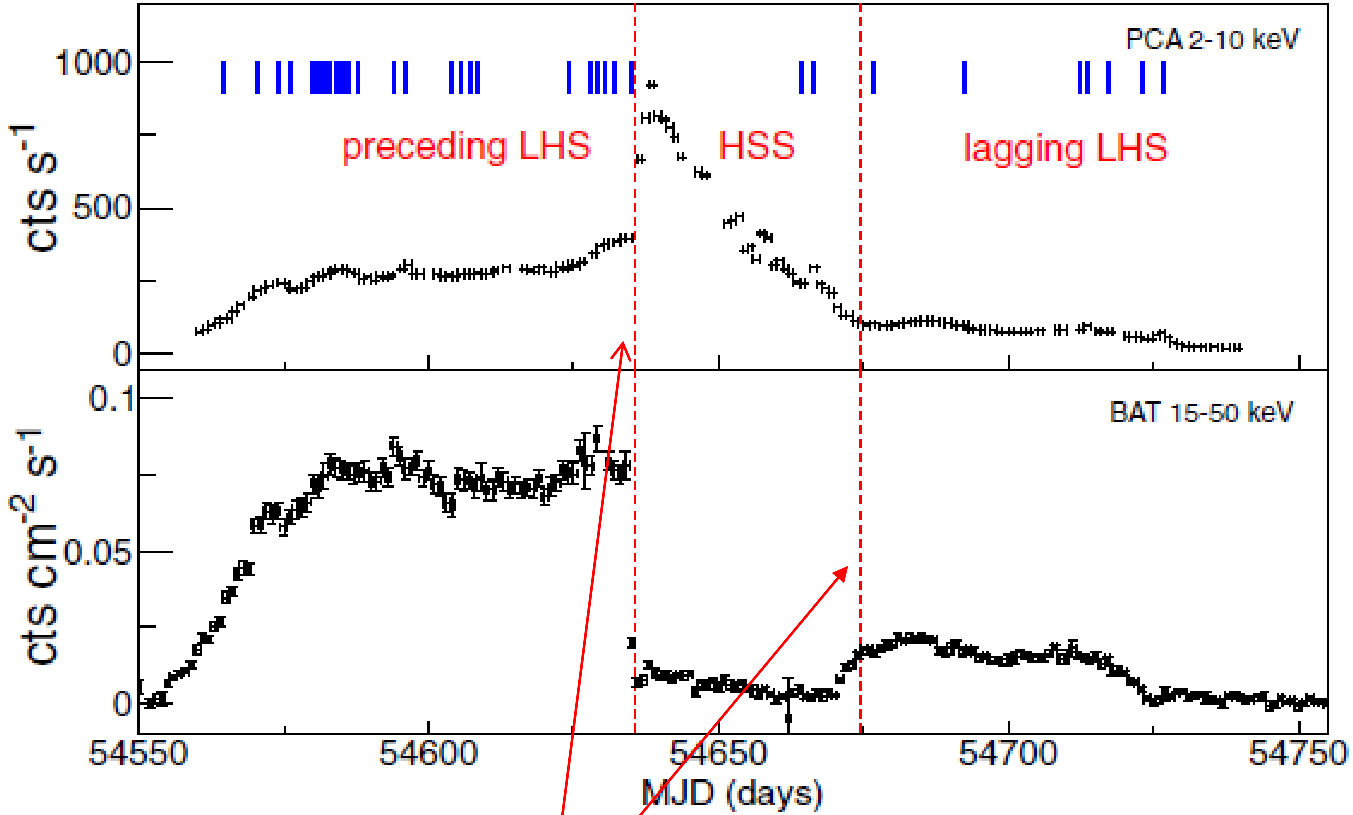
A corona in a region close to the compact object is usually invoked to account for the hard X-ray emissions but a direct observational evidence is still missing



(Chen et al ,2012)

- Origin of Corona
- Formation Timescale

Origin of Corona	Formation Timescale
Disk evaporation (Meyer et al. 1994)	~days
Magnetic re-connections (Zhang et al. 2000)	~milliseconds



Light curve of IGR J17473-2721

Chen et al. 2012

LH/HS transition:

cooling or reheating of the corona in days

To decode the corona puzzle one needs the proper probe:

1. intense soft X-rays
2. short time scale

BH XRB: none

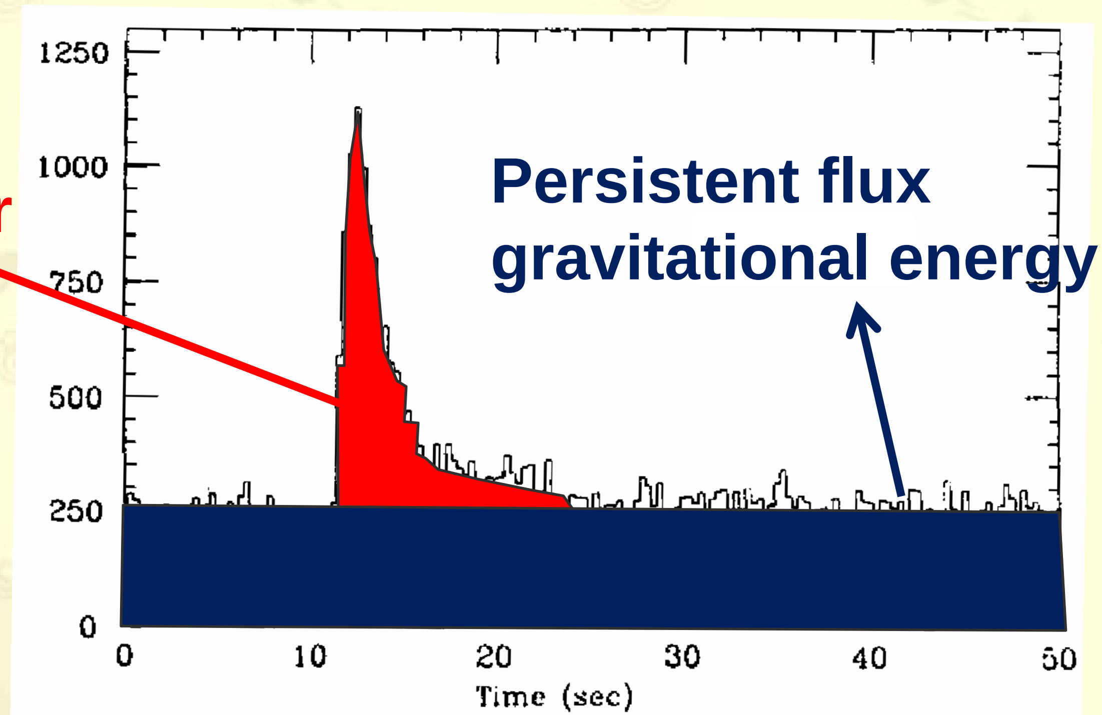
NS XRB: the thermal nuclear flare (type-I bursts)

Proper probe: type-I bursts:

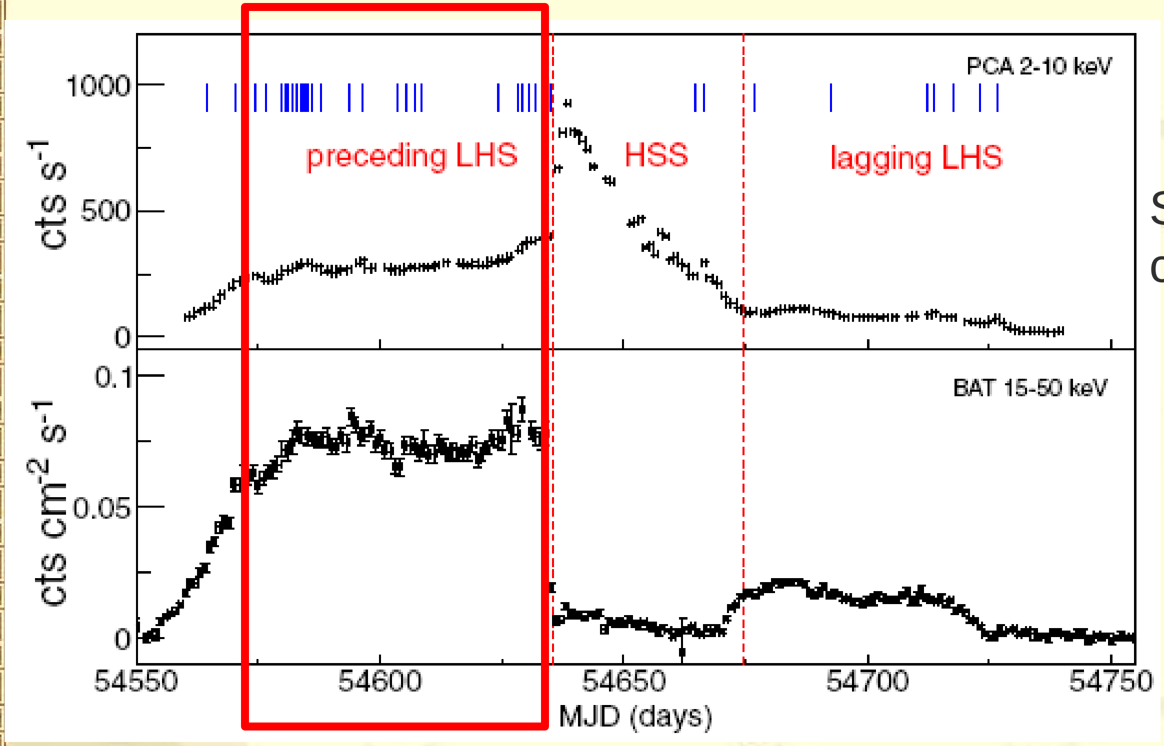
Thermal nuclear explosions on the surface of neutron star.

- a sudden increase and an exponential decay, modeled by a blackbody with T~3keV
- Tens to hundreds of seconds

Burst flux thermonuclear energy

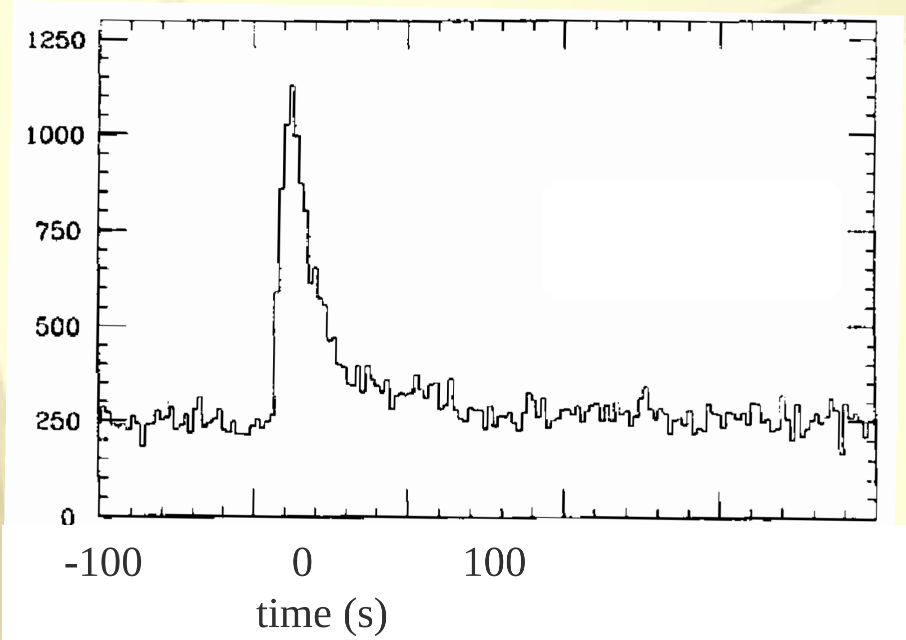


The feedback of type-I bursts to the corona --IGR J17473-2721

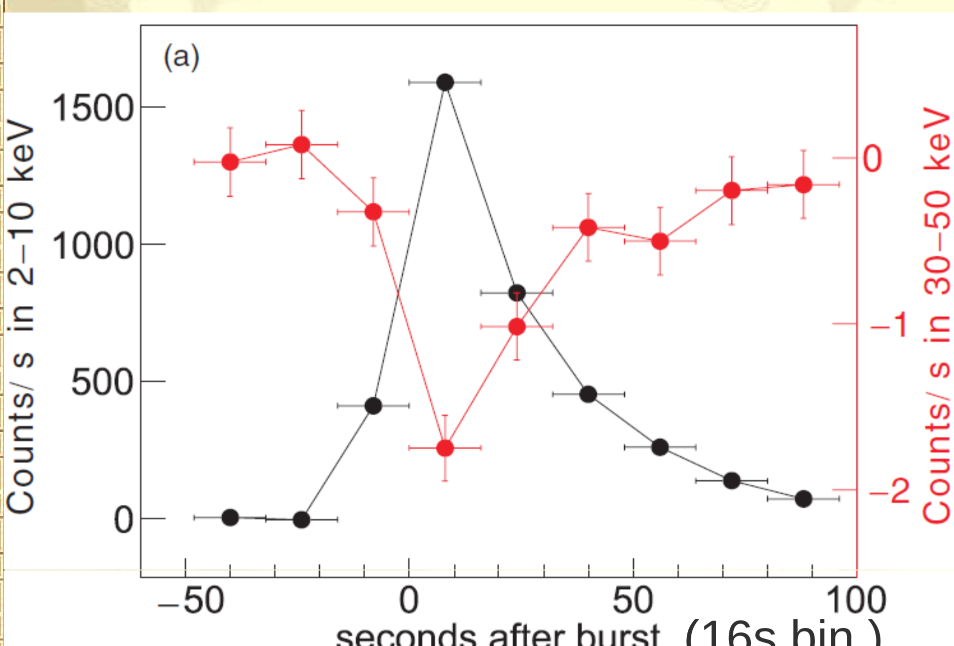


Soft and hard X-ray light curve covering the 2008 outburst.

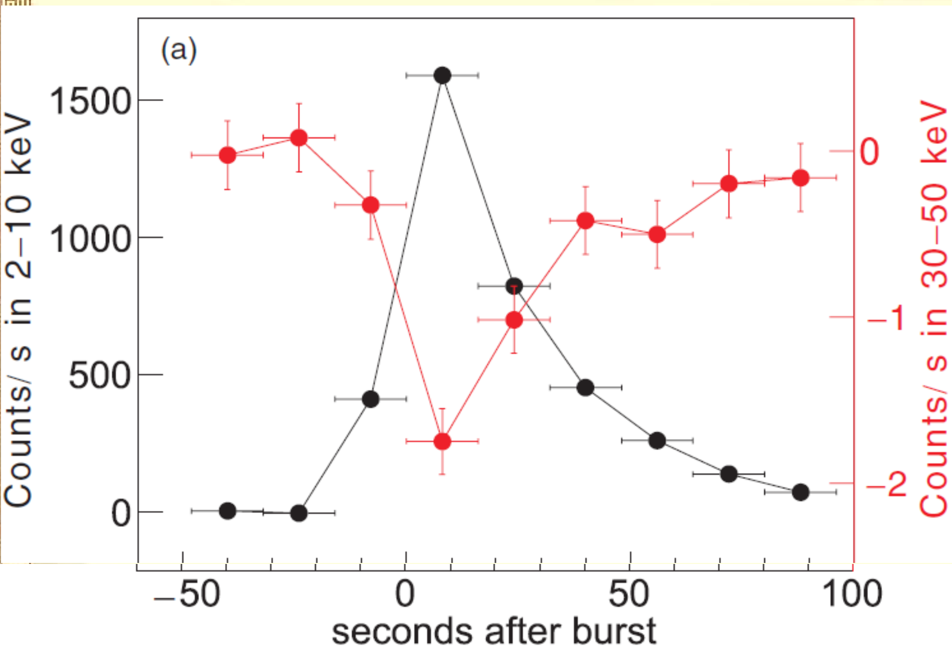
The 2008 outburst experienced a two-months preceding low/hard state (LHS) and a lagging LHS with respect to the high/soft state (HSS)

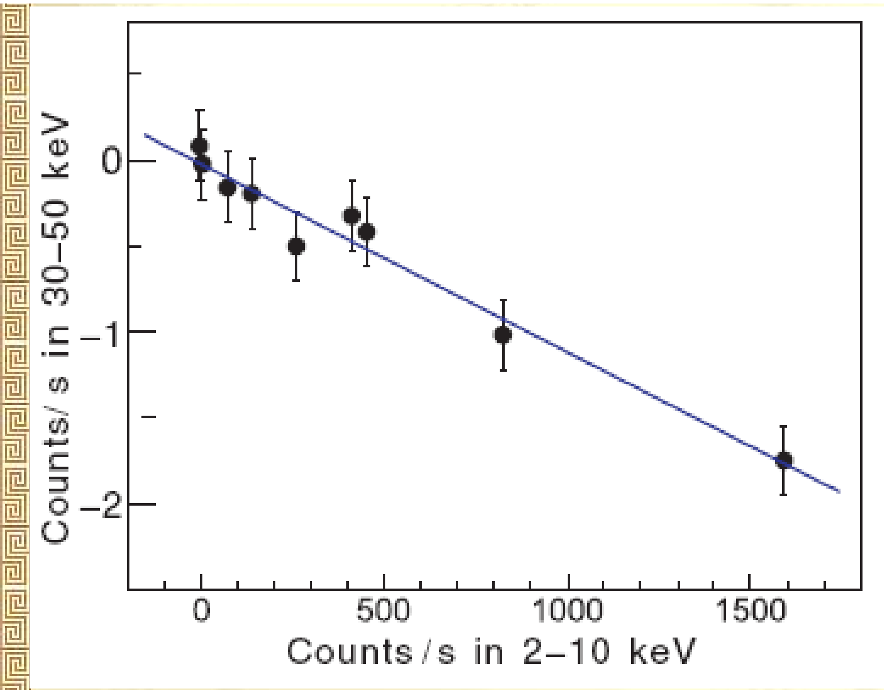


- X-rays light curve 48 s before and 80 s after the flare peak are regarded as the background and are subtracted for each burst in soft and hard X-ray.



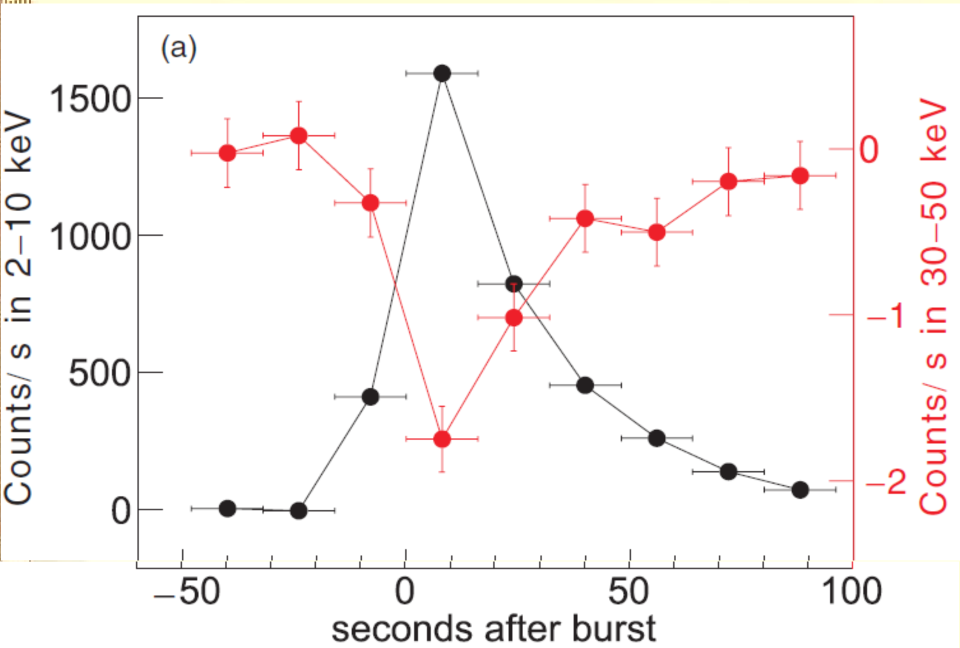
- After the persistent emission is subtracted off, bursts are combined for those located in the preceding LHS





- The 30–50 keV profile is anti-correlated with 2–10 keV profile under a correlation coefficient of -0.89.

- The 30–50 keV X-rays lag the 2–10 keV X-rays by 0.7 ± 0.5 s.



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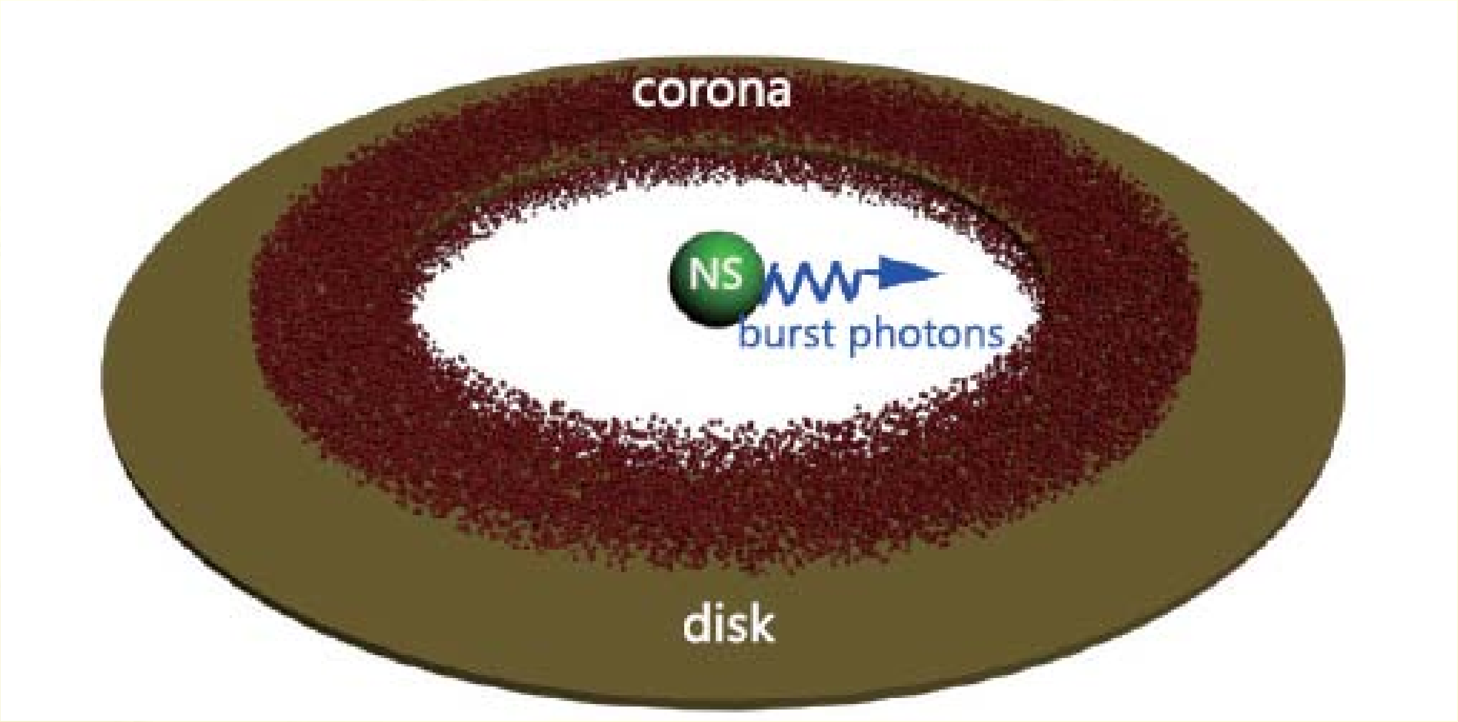
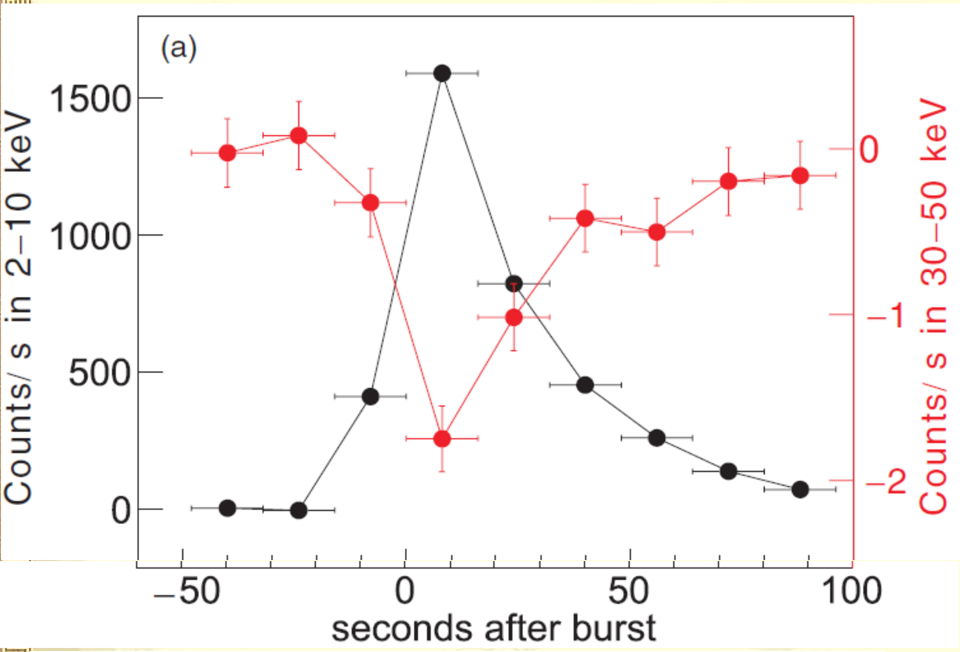
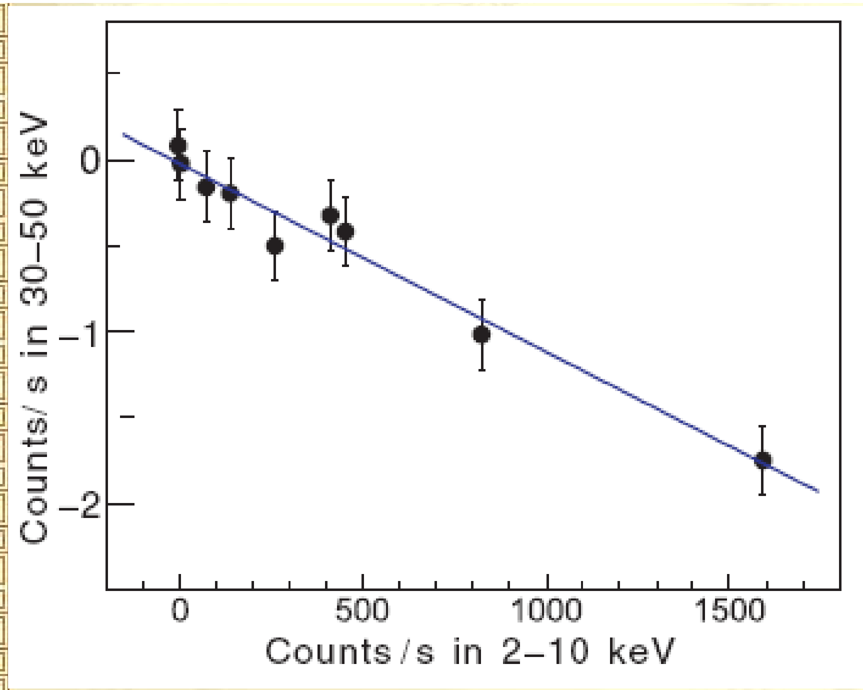
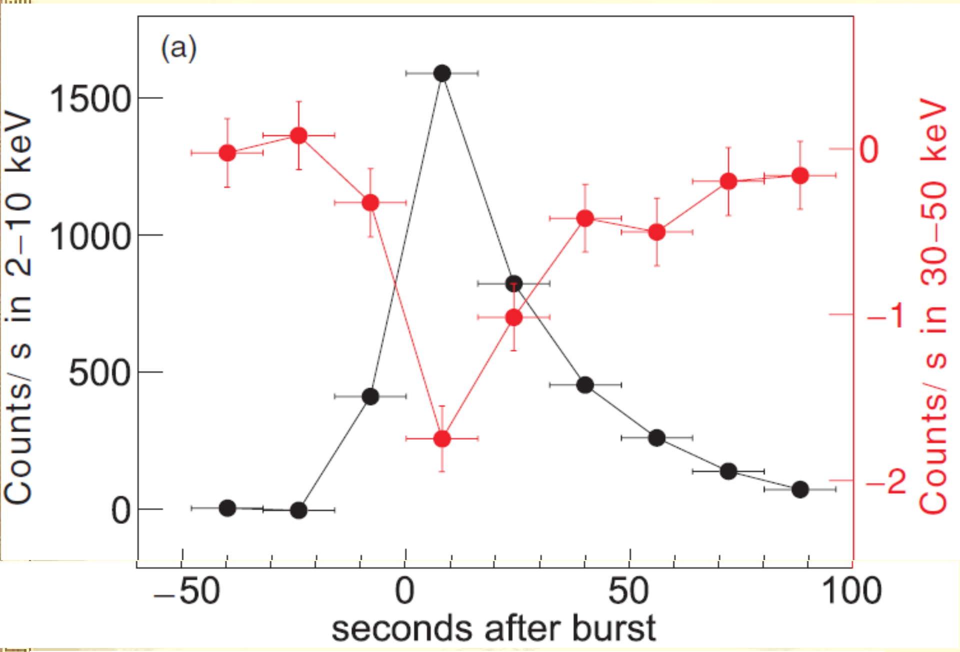


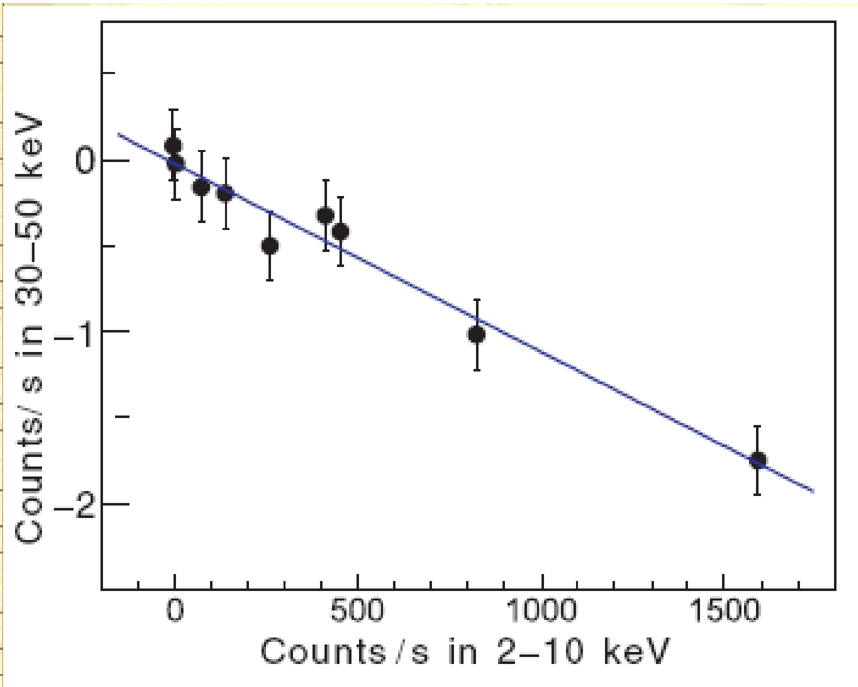




- The hard X-ray shortage is likely from the cooling of corona, but not from the cooling of jet:

1. The hard X-rays in low/hard state of atolls are corona dominated
2. The opening angle of the NS surface respect to jet is too small for effective Compton cooling.
3. The direction of type I burst and jet are both outwards in which effective cooling could not happen





- Dynamical time scales of seconds.
- Disk evaporation: days
- Magnetic re-connection: seconds or less

The feedback of type-I bursts to the corona -- A general sample

Is it universal to NS XRBs?

A general sample:

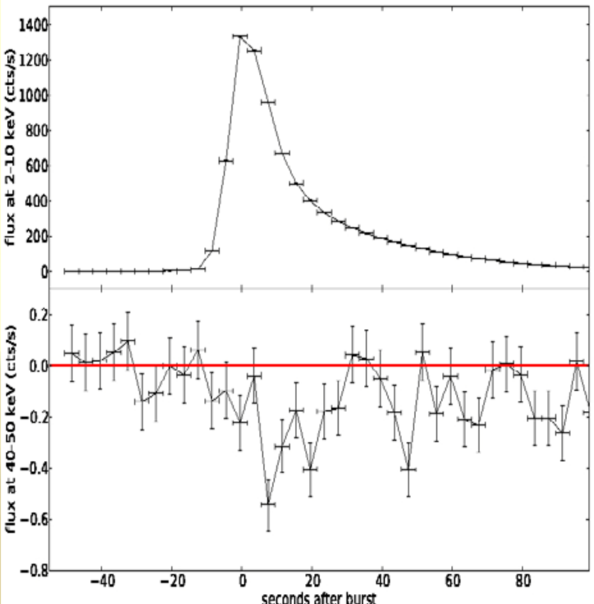
all atoll sources with RXTE observations, burst number > 5

4U 1608-52
4U 1702-429
4U 1728-34
EXO 0748-676
4U 0513-401
x1735-444
4U 1820-30
HETEJ1900.1-2455
1M 0836-425
EXO 1745-248

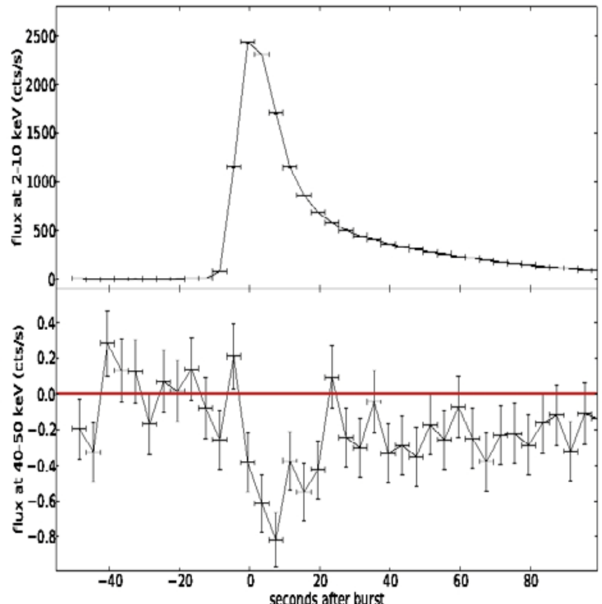
IGR J17511-3057
SLX 1744-300
SAX J1750.8-2900
4U 1705-44
4U1636-536
KS 1731-260
XTE J1759-220
IGR J17473-2721
Aql X-1
GS 1826-238

4U 1916-053

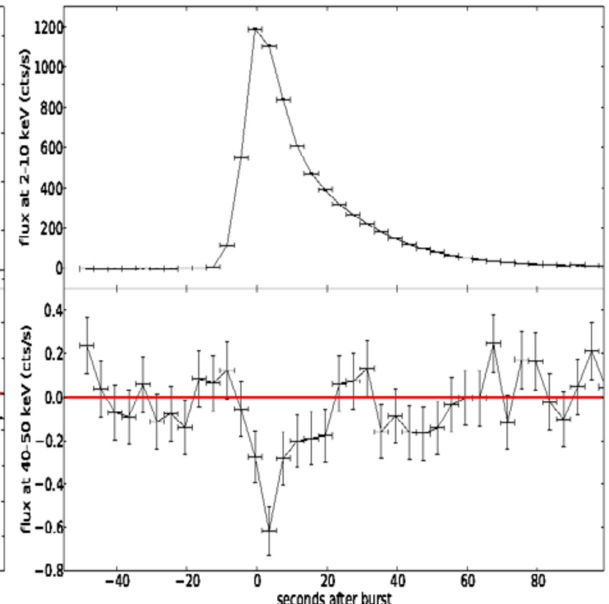
Ji et al. 2014a,b, 2013
Chen et al. 2012, 2013



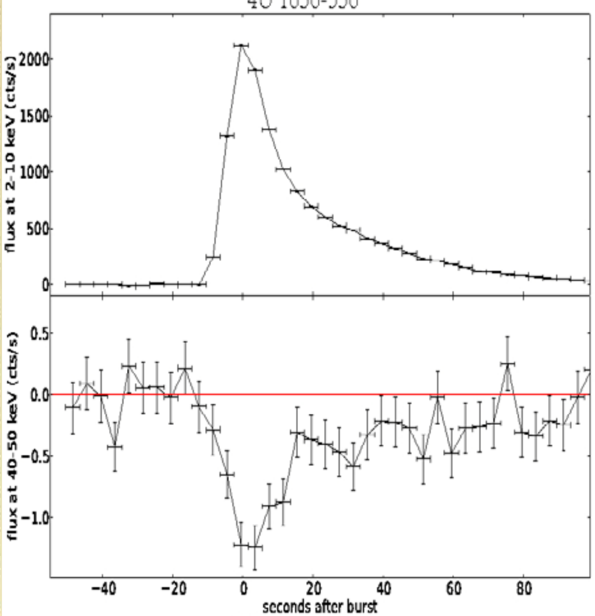
4U 1636-536



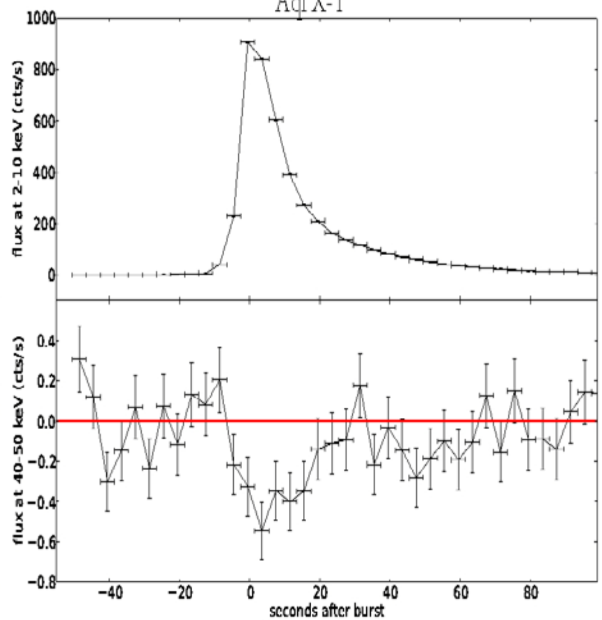
Aql X-1



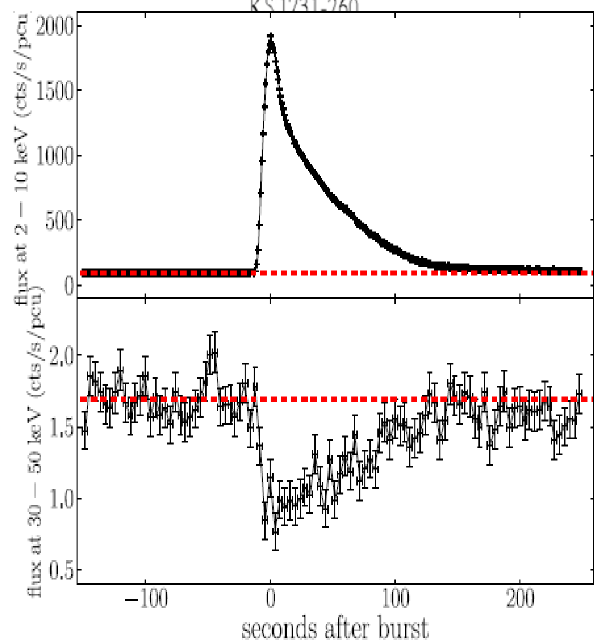
KS 1731-260



IGR J17473-2721



4U 1705-44



GS 1826-238

Conclusion

- A tiny life cycle of the corona may serve as the first evidence of directly seeing the rapid disappearance and formation of a corona in an XRB.
- The corona cooling during Type I burst is observed in a small sample of atoll sources.