Sabancı Üniversitesi

X-Ray and OIR observations of GX 339-4 - 2011 outburst decay -

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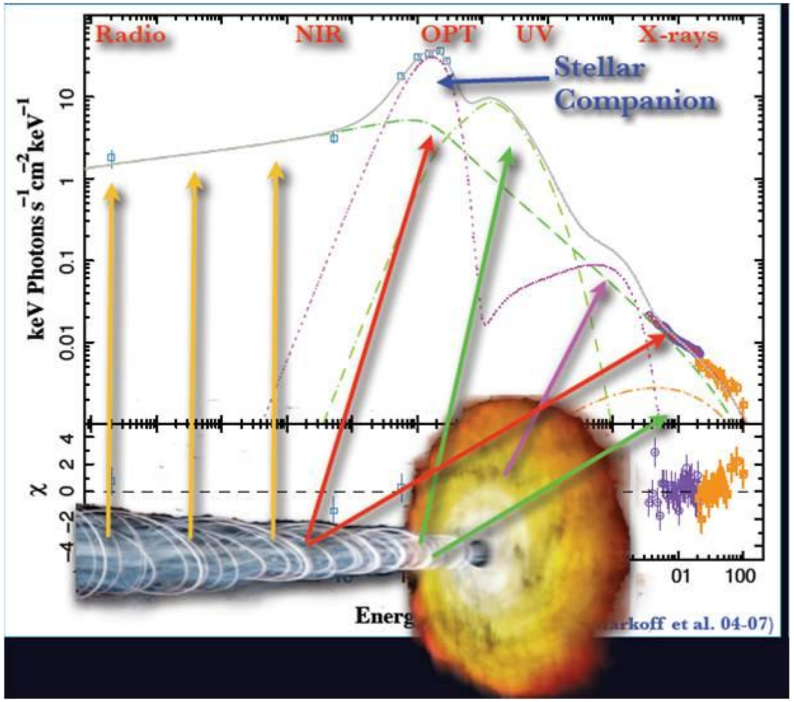
Aim

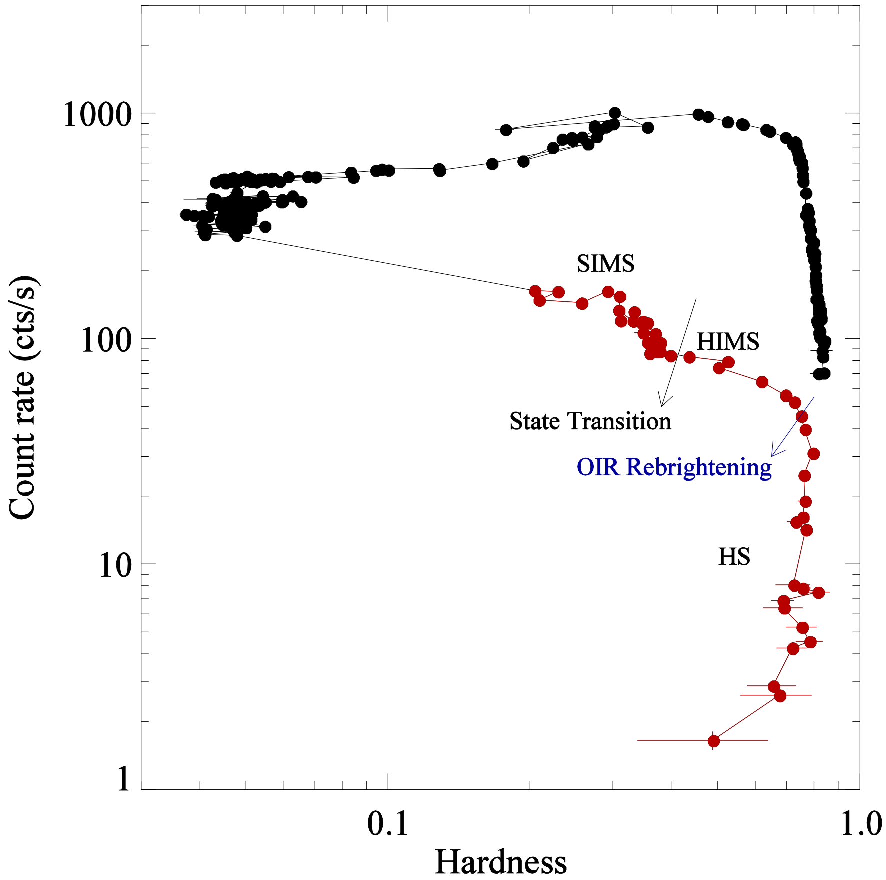
To establish observational links between accretion and jet, and to constrain the jet properties.

Method:

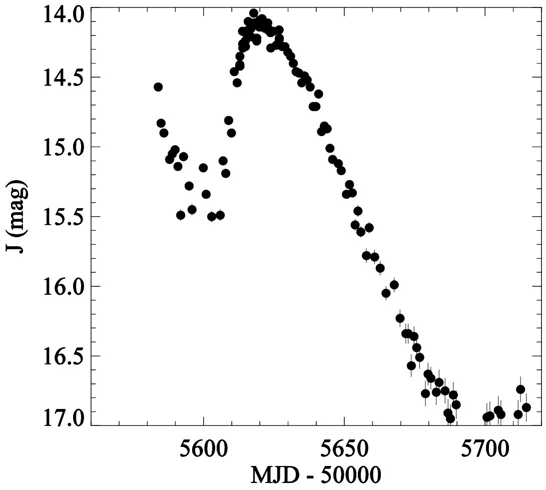
- Characterizing the X-ray spectral and temporal evolution to track the accretion. (RXTE and Swift)
- Characterizing the OIR light curves to track the jet activity. (SMARTS)
- Comparing the transitions in X-rays and OIR.
- Isolating the jet emission and producing SEDs.



HID of the entire outburst



OIR Brightening



X-Ray evolution

Spectral Analysis:

photoabs(diskbb+smedge*power law)

Temporal Analysis:

FFT + Lorentzians → variability + QPOs

SIMS: weak variability, type B qpos, soft spectrum ($\Gamma \approx 2.4$), comparable amount of diskbb and PL fluxes.

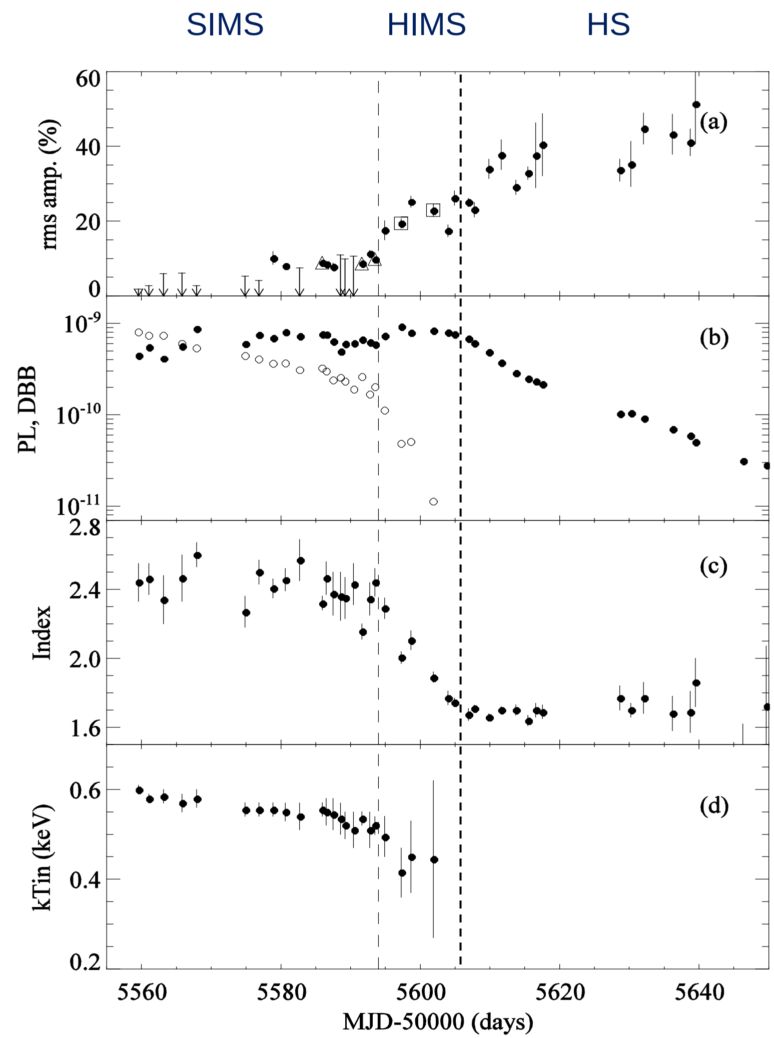
HIMS: higher variability, type C qpos, hardening spectrum, high PL flux and low diskbb flux.

HS: highest variability, hardest spectrum ($\Gamma \approx 1.7$), only PL component is present and it is decreasing.

Transition luminosities

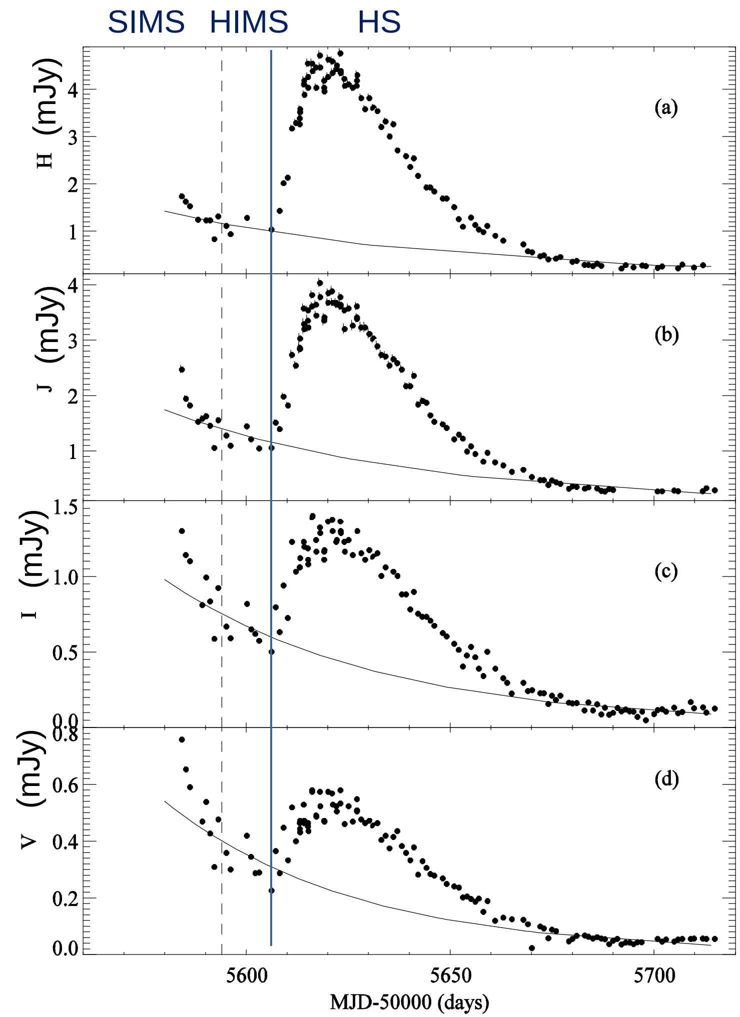
SIMS-HIMS: $L_{1\text{-}200\ \mathrm{keV}} \approx 2\%\ L_{edd}$

HIMS-HS: $L_{1\text{-}200\ \mathrm{keV}} \approx 1.4\%\ L_{edd}$



Jet signature in OIR LCs

- The decay is interrupted by ~70 days of brightening in all bands.
- Brightening started on MJD 55,604
- OIR LCs have variability in time scale of days.



OIR brightenings in 4U 1543-47 and XTE J1550-564:

- SED of the OIR excess was consistent with the optically thin jet syncrotron emission
- OIR brightening was associated with a radio brightening.

For this decay, there is also a radio association (remember Stephane’s talk).

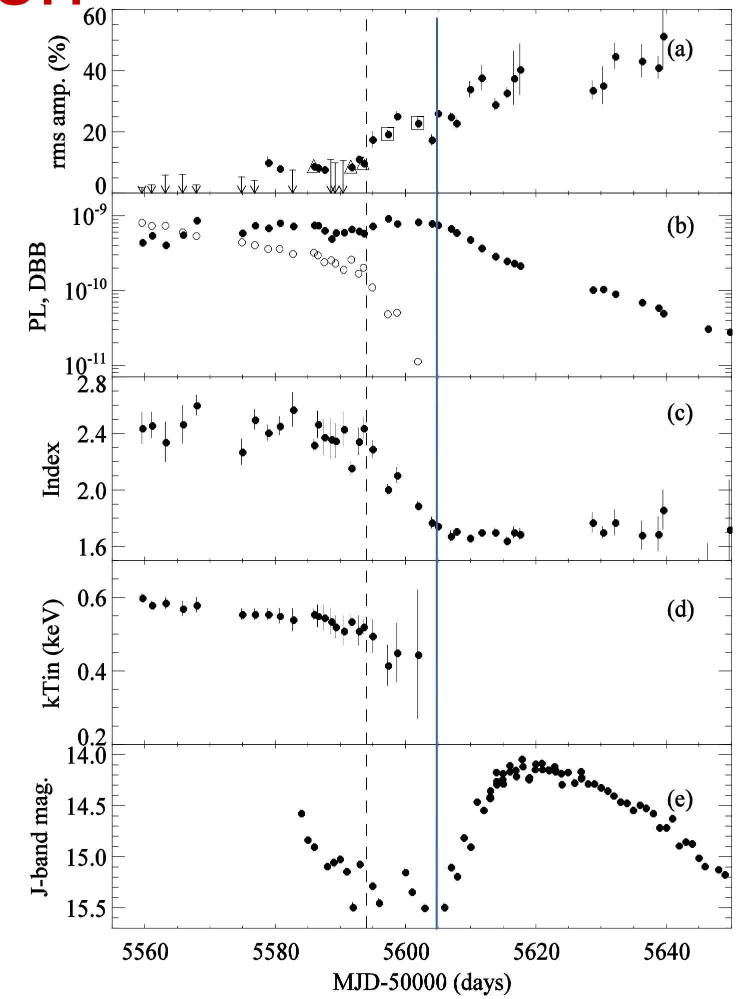
Accretion-jet connection

- $L_{1\text{-}200\ keV} \approx 1.4\%\ L_{Edd}$ at the start of the brightening.
- PL flux increases and dominates the X-ray emission ~12 days before the brightening.
- OIR brightening occurs when the photon index reaches its hardest.

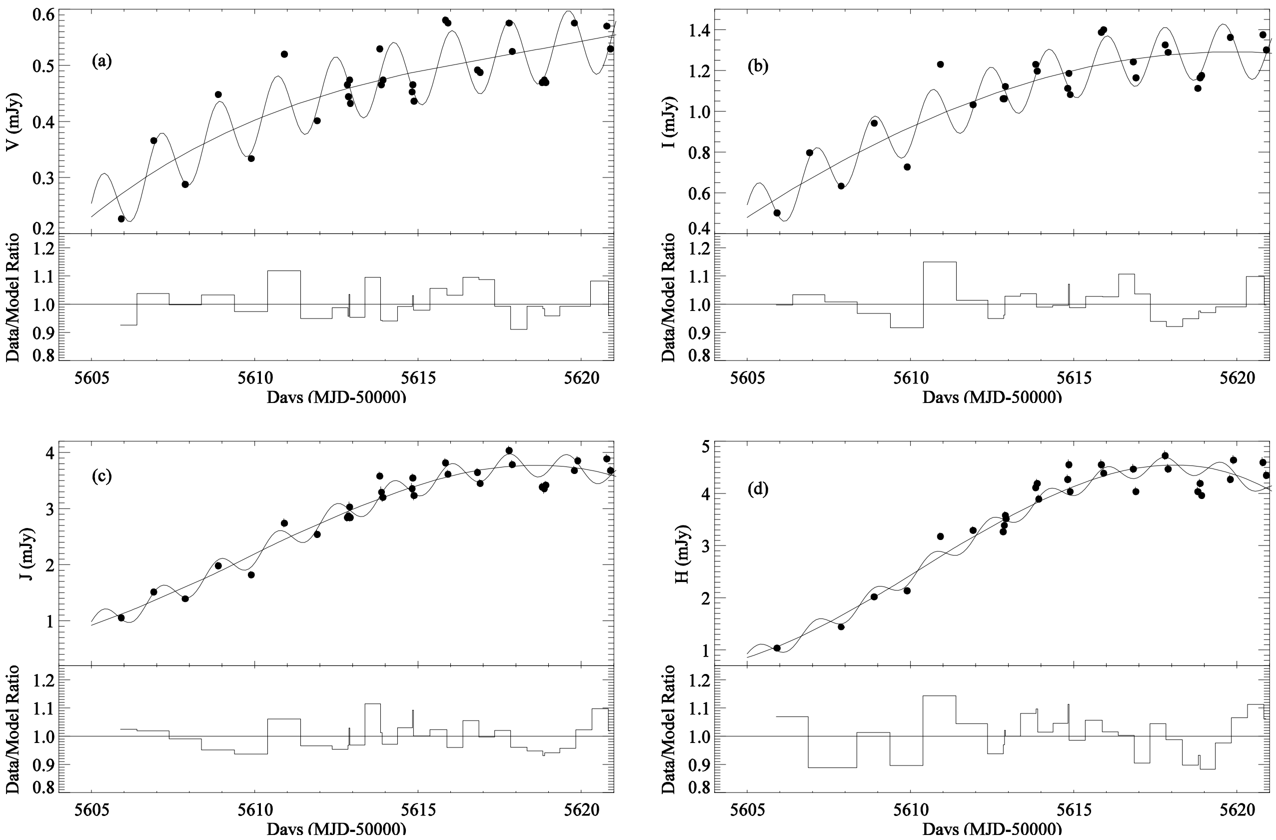
Similar to 4U 1543-47 (2002), XTE J1550-564 (2000) and GX 339-4 (2005)

X-rays dominated by jet synchrotron emission?

- No clear indication of the softening of the spectrum.
- No clear sharp change in the evolution of variability.



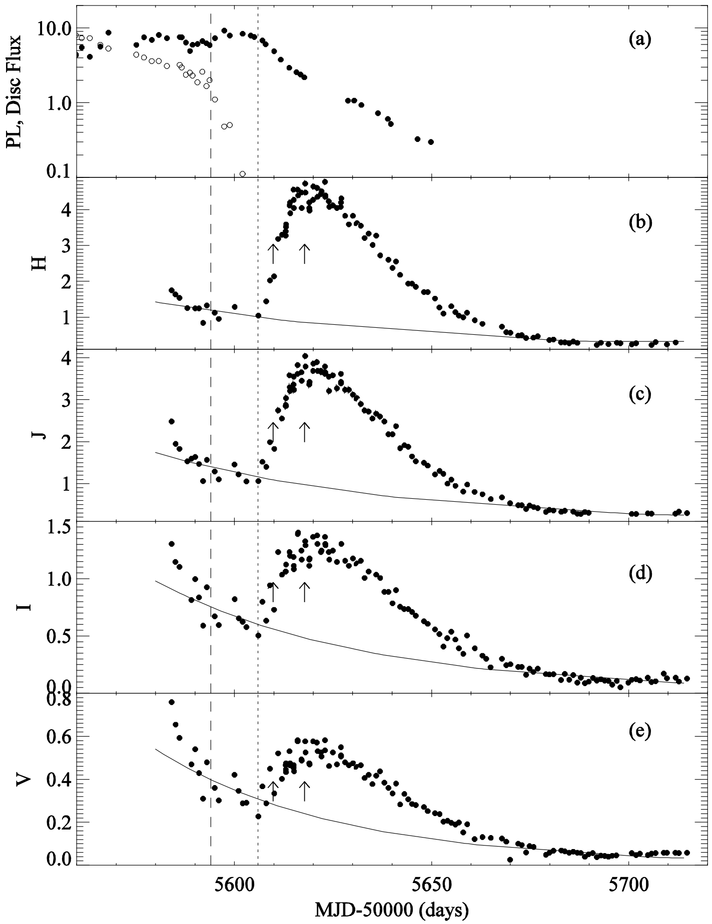
A closer look at the OIR LCs



Periodic modulations with the binary period of the system (1.77 days) just on the rise of the brightening in the V, I and J bands. Confidence levels are 3.69σ, 3.78 σ, 2.78 σ for the V,I and J, respectively.

X-ray irradiation of the companion.

Why do we see the binary period only on the rise of the brightening?



Before the brightening:

Cooling is so high that the corona is smalll. No effective illumination on the companion's surface.

Only the variations produced in the disk are present

Rise of the brightening:

As the cooling lessens, spectrum hardens, and corona becomes larger.

Corona effectively illuminate the companion star.

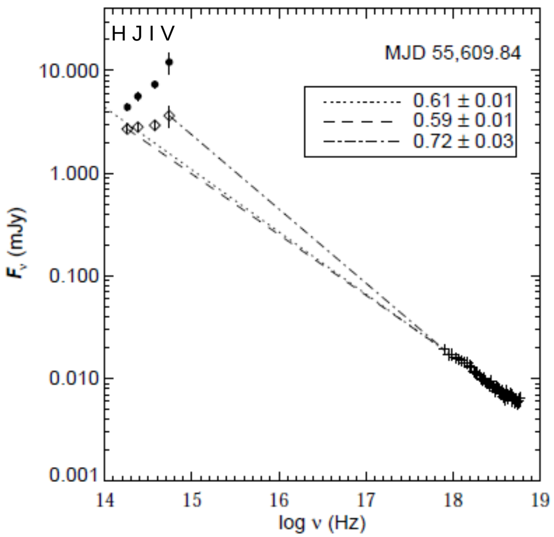
At the peak

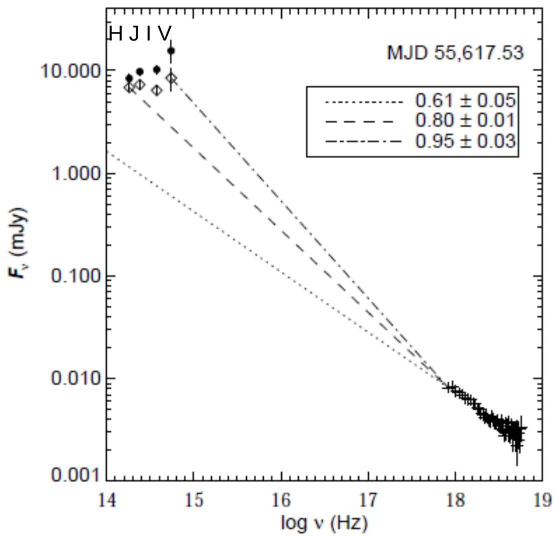
The lack of modulations is likely due to strongly variable jet synchrotron emission. (Rahoui et al. 2012)

After the peak

Low PL flux. Insignificant X-ray irradiation of the companion.

Jet SEDs





“Flat” jet SED in OIR.

$S_\nu \, \alpha \, \nu^\alpha$

- If the break is at a lower frequency, an additional component is required. Such as the post-shock component.
- An excess in OIR spectrum is also seen by Rahoui et al. (2012).

If the jet break is at V:
•α= 0.72 - typical optically thin jet synchrotron.
•Pjet/Pacc=18 % - typical

If the jet break is at H:
•α= 0.59 - typical optically thin jet synchrotron.
•Pjet/Pacc=5 % - typical

If the jet break is at V:
•α= 0.95 - higher than typical optically thin jet synchrotron.
•Pjet/Pacc=95 % - very high

If the jet break is at H:
•α= 0.80 - typical optically thin jet synchrotron.
•Pjet/Pacc=32 % - slightly higher

Summary of Results

- Characterized the X-ray evolution and showed the X-ray conditions just before jet launch.
- Discussed why the brightening is due to compact jet.
- Modulations with the binary period only on the rise of the OIR brightening is detected and we discussed a scenerio to explain the variabiltiy pattern in OIR light curves.
- Discussed the location of the jet break and nature of the jet emission.