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ON THE OPTICAL – X-RAY CORRELATION FROM OUTBURST TO QUIESCENCE IN LMXBs: THE REPRESENTATIVE CASES OF V404 CYG AND CEN X-4

Bernardini, Russell, Stella, Koljonen, Hynes, Corbel

2016, ApJ, 826, 149

Shining from the heart of darkness:
Black hole accretion and jets
Kathmandu
October 18, 2016

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- LMXBs
- Open questions
- Previous studies
- Our results
- Conclusions

LMXBs

NS or BH primary, accreting from a low mass companion ($M<M_{\odot}$)

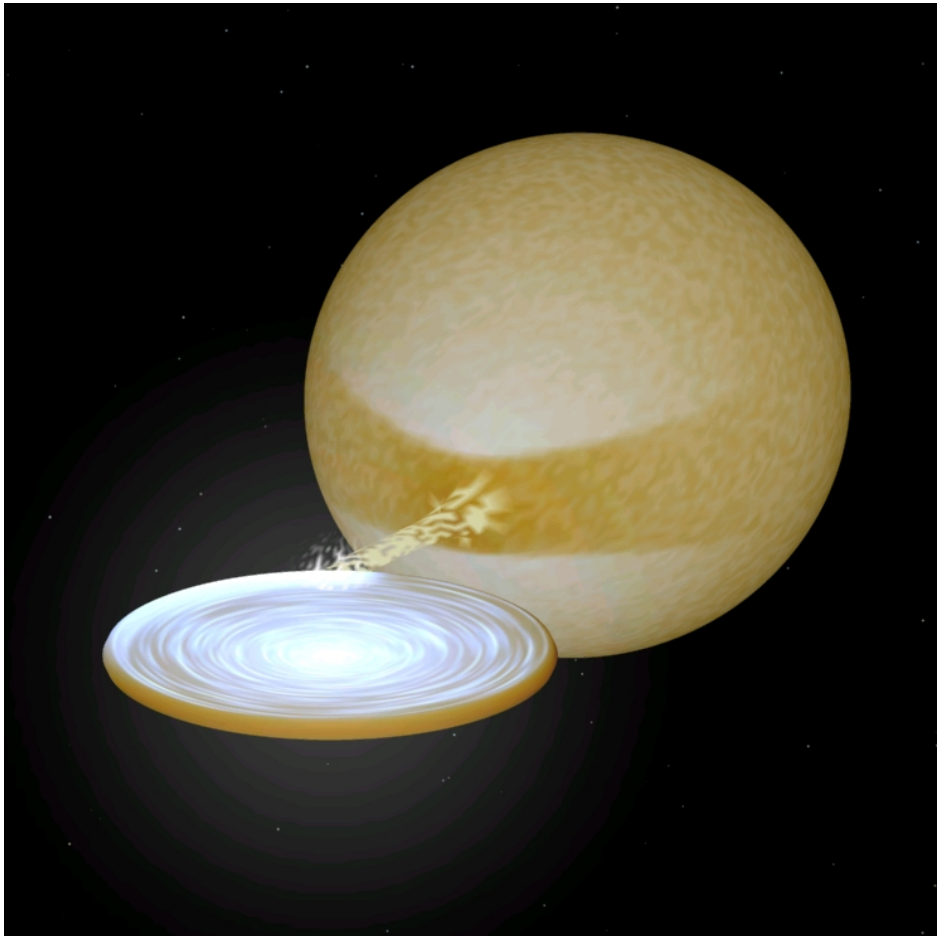
Transient LMXBs

Outburst

Lasting weeks to years
$L_X \approx 0.1\text{-}1\ L_{Edd}$

Quiescence

Lasting up to decades
$L_X \approx 10^{-8}\text{-}10^{-4}\ L_{Edd}$

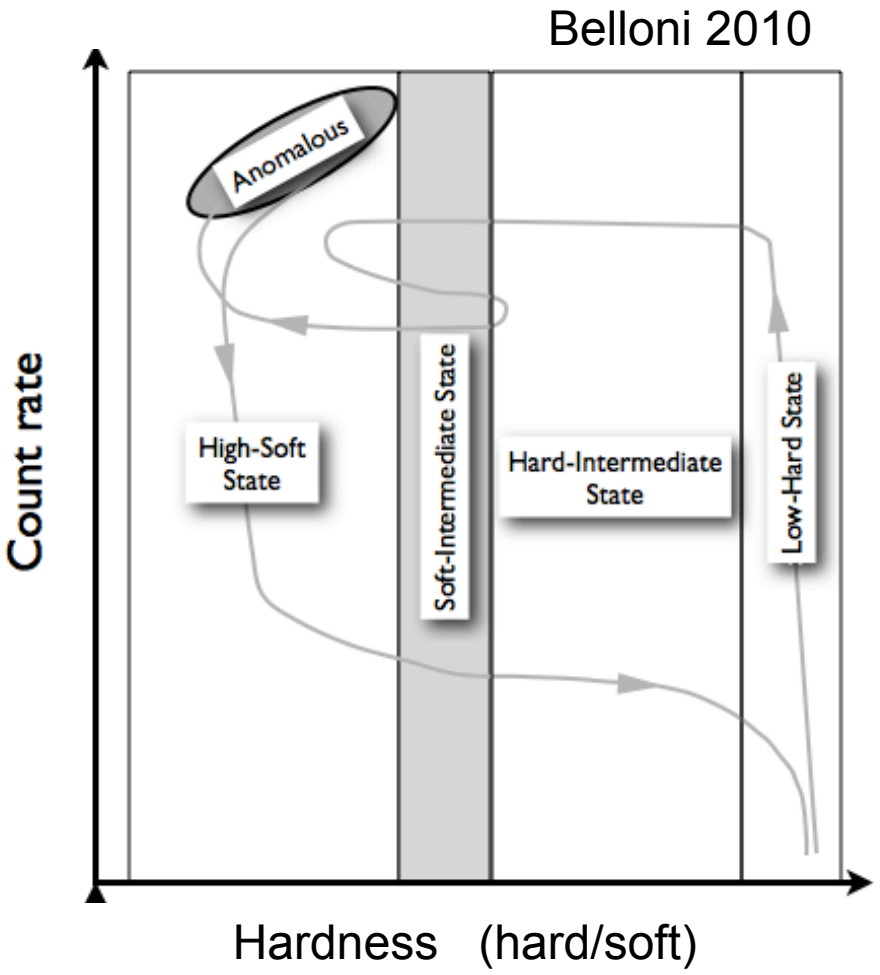


Hard state and quiescence

Outburst hard state and quiescence share similar properties, e.g.

BHXB: Compact Jet detected in both

How similar are they?



Open questions

- Optical, IR, and UV several competing emission mechanisms: Jet, X-ray reprocessing, Intrinsic emission from the disk

What is the dominating emission process at different wavelengths?

- Excess emission in the optical, IR and UV respect to the companion star.

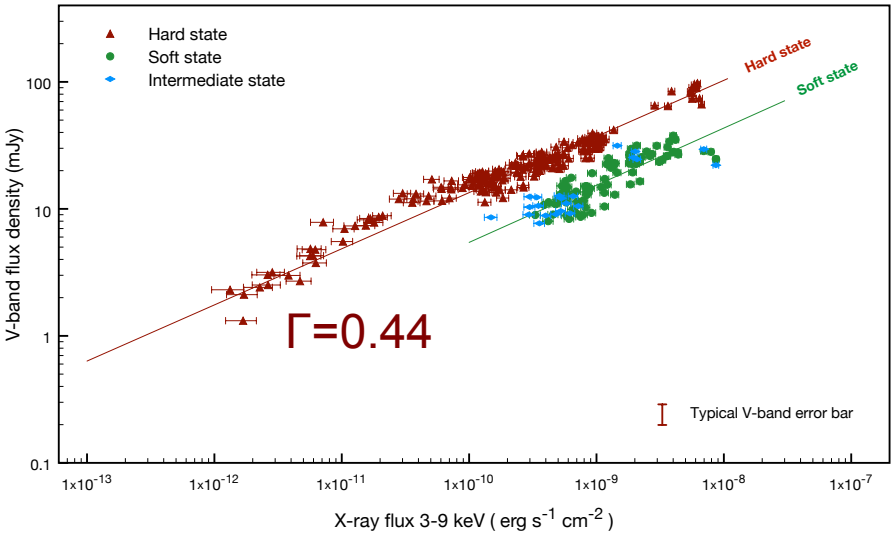
What is producing this excess and where in the binary system does it come from?

Previous studies

Changes in the emission properties at long wavelengths (radio, OIR, UV) linked to spectral changes in the X-ray

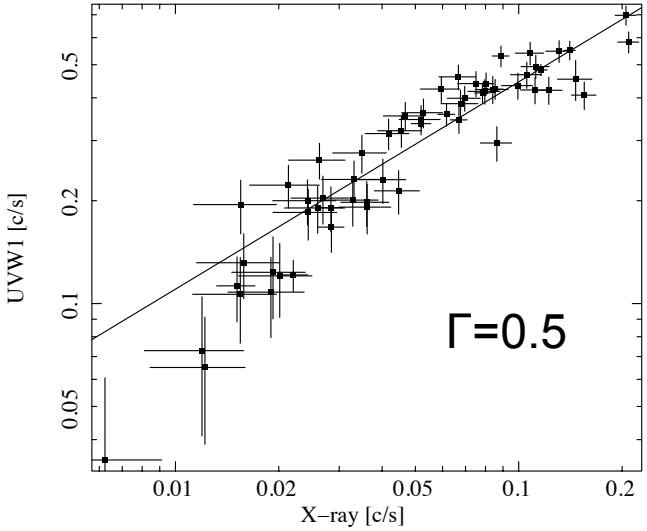
Correlation studies can provide insight on the emission process
Slope ⟷ Emission process

BH GX 339-4 in OUTBURST



Coriat 2009

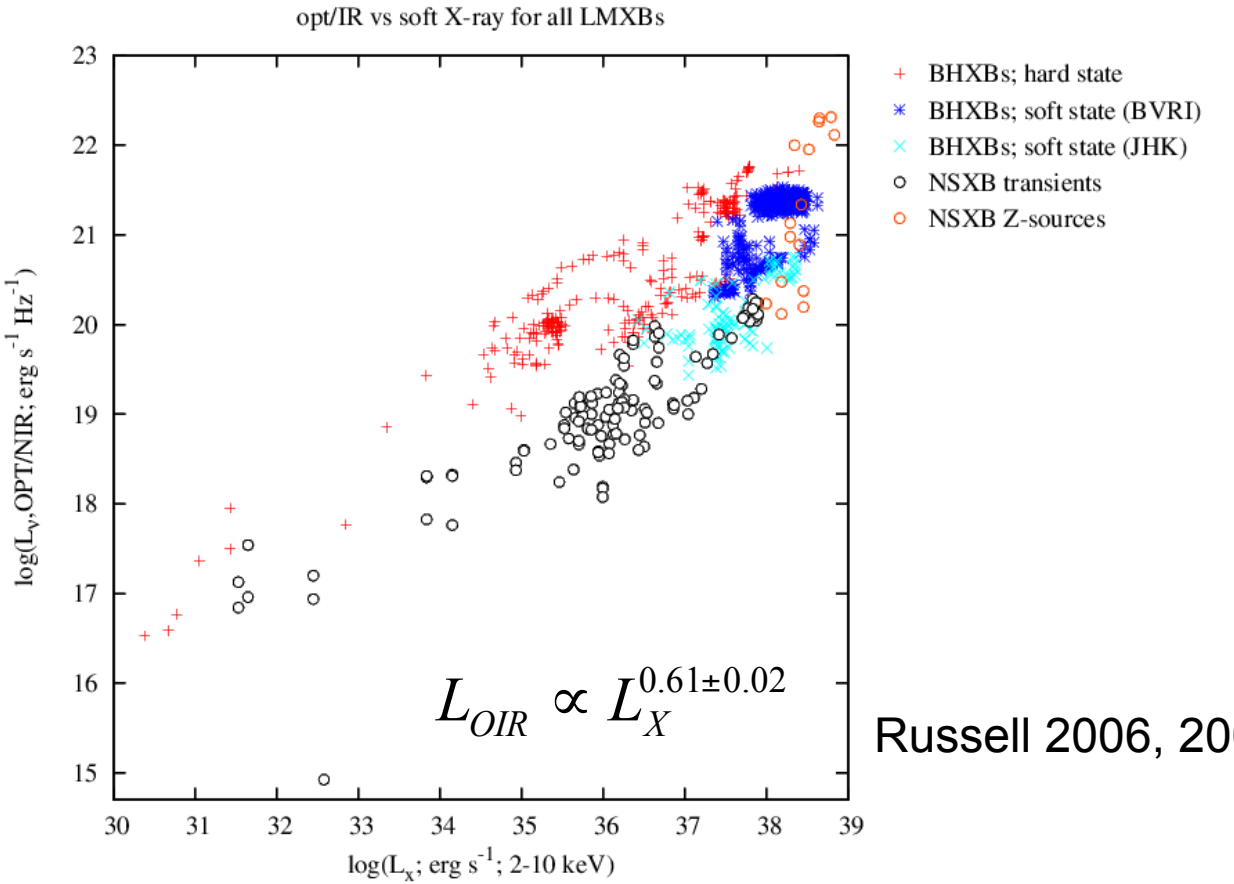
NS Cen X-4 in Quiescence



Bernardini 2013

Previous studies

Globally, BH are a factor 20 optically brighter than NS.



Russell 2006, 2007

- **What emission mechanism is producing the correlation?**
- **Why BH are optically brighter than NS at a given X-ray luminosity?**

Our results

A study from outburst to quiescence of a single object is missing

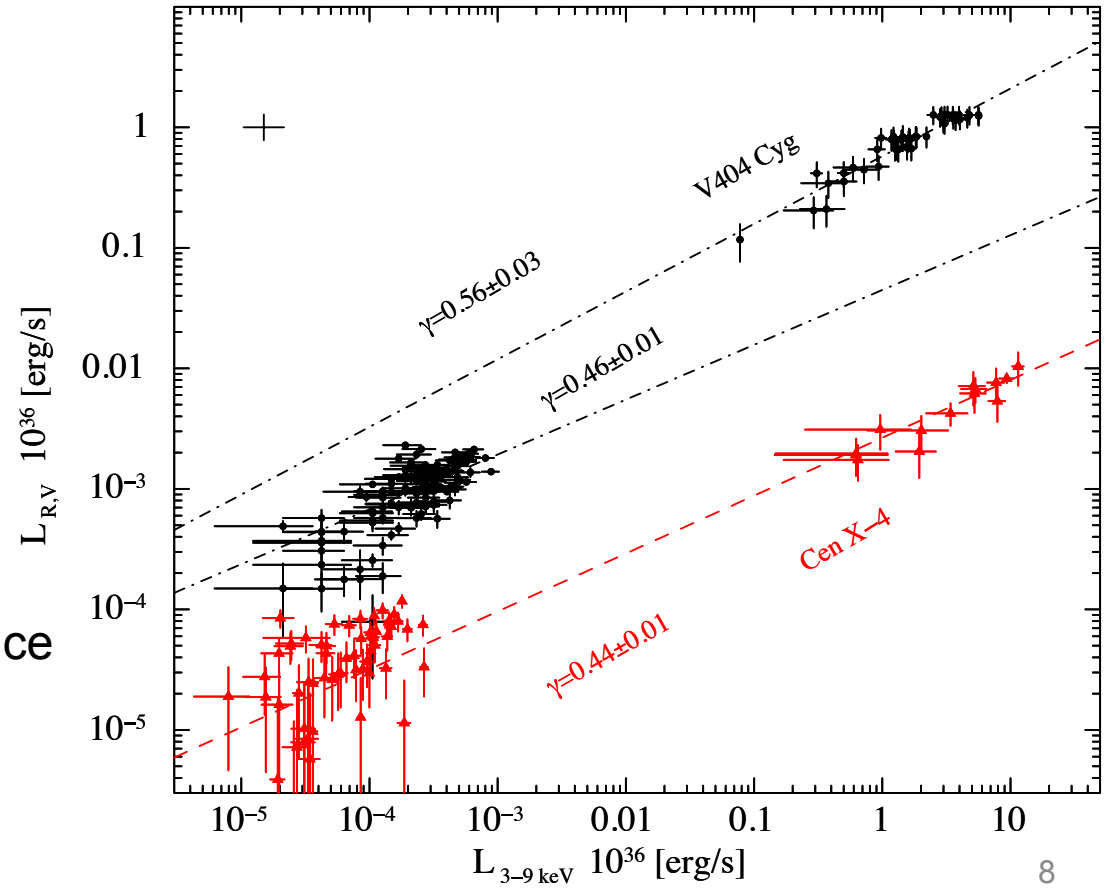
We compare for the first time a BH and NS from outburst to quiescence

BH – V404 Cyg
NS – Cen X-4

Strong Correlation

Break in BH correlation

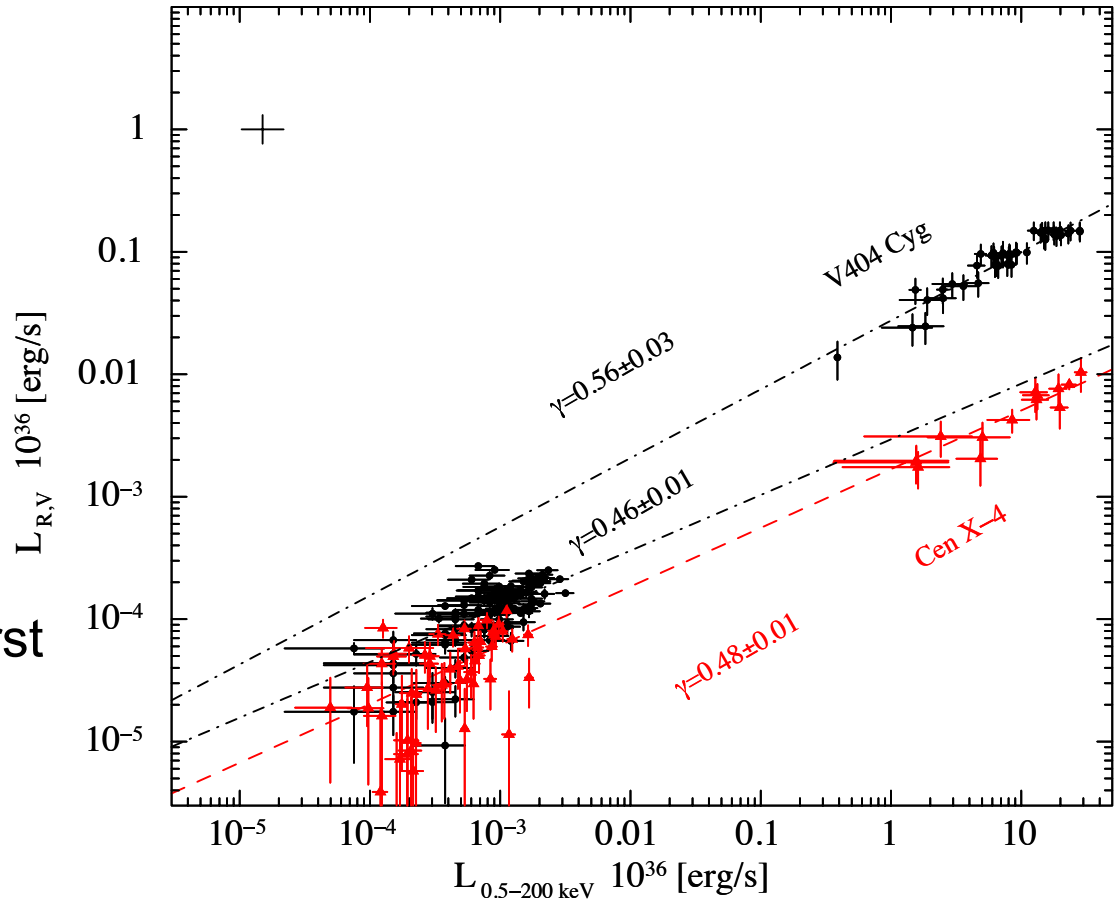
BH x300 opt. brighter in outburst
BH x25 opt. brighter in quiescence



Our results

1. **We account for the bolometric X-ray (0.5-200 keV) luminosity**
2. **We account for the difference in disk size and compact object mass**

Consistent in quiescence
BH still x20 brighter in outburst



There must be another mechanism making the BH brighter in outburst

Our results

What is this mechanism?

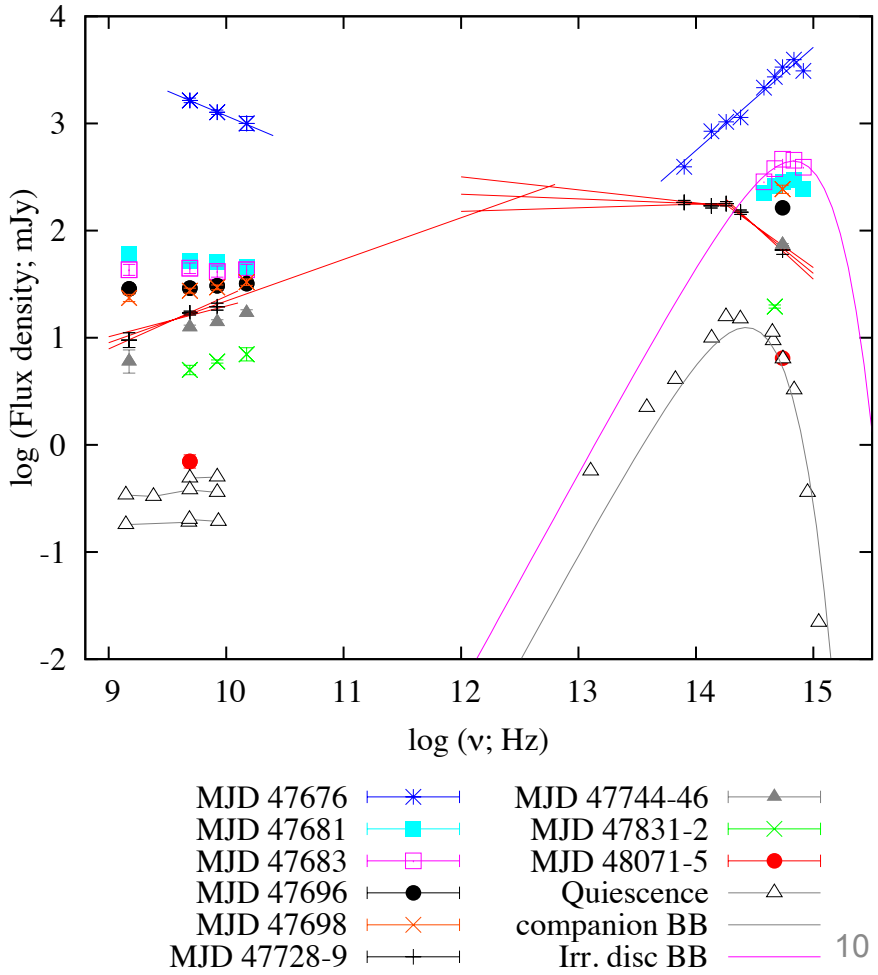
From SED we estimate the Jet contribution in the optical band for the BH

Hard state:

Jet is 90 % of the optical flux

Quiescence:

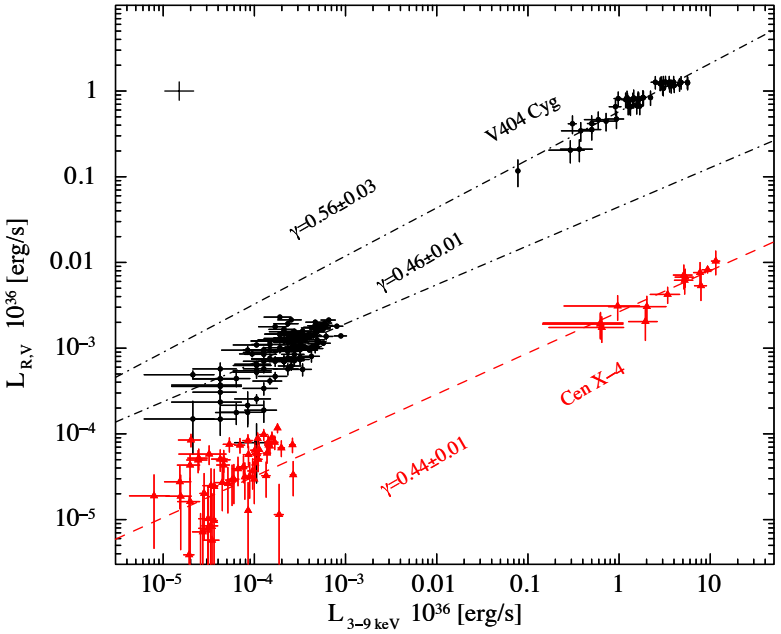
Jet contribution is marginal



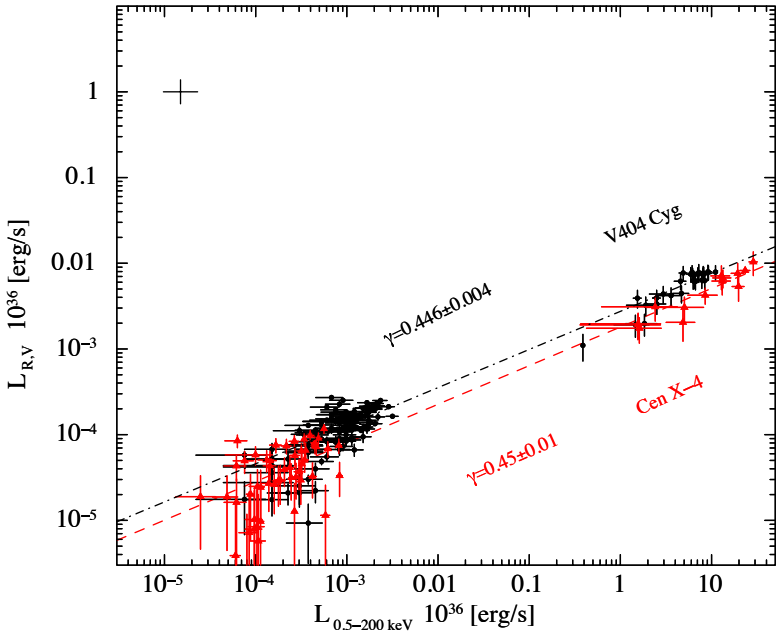
Our results

1. We account for the bolometric X-ray (0.5-200 keV) luminosity
2. We account for the dominant jet contribution for the BH in outburst
3. We account for the difference in disk size and compact object mass
4. We account for the emission from the NS surface in quiescence

Before corrections



After corrections



Conclusions

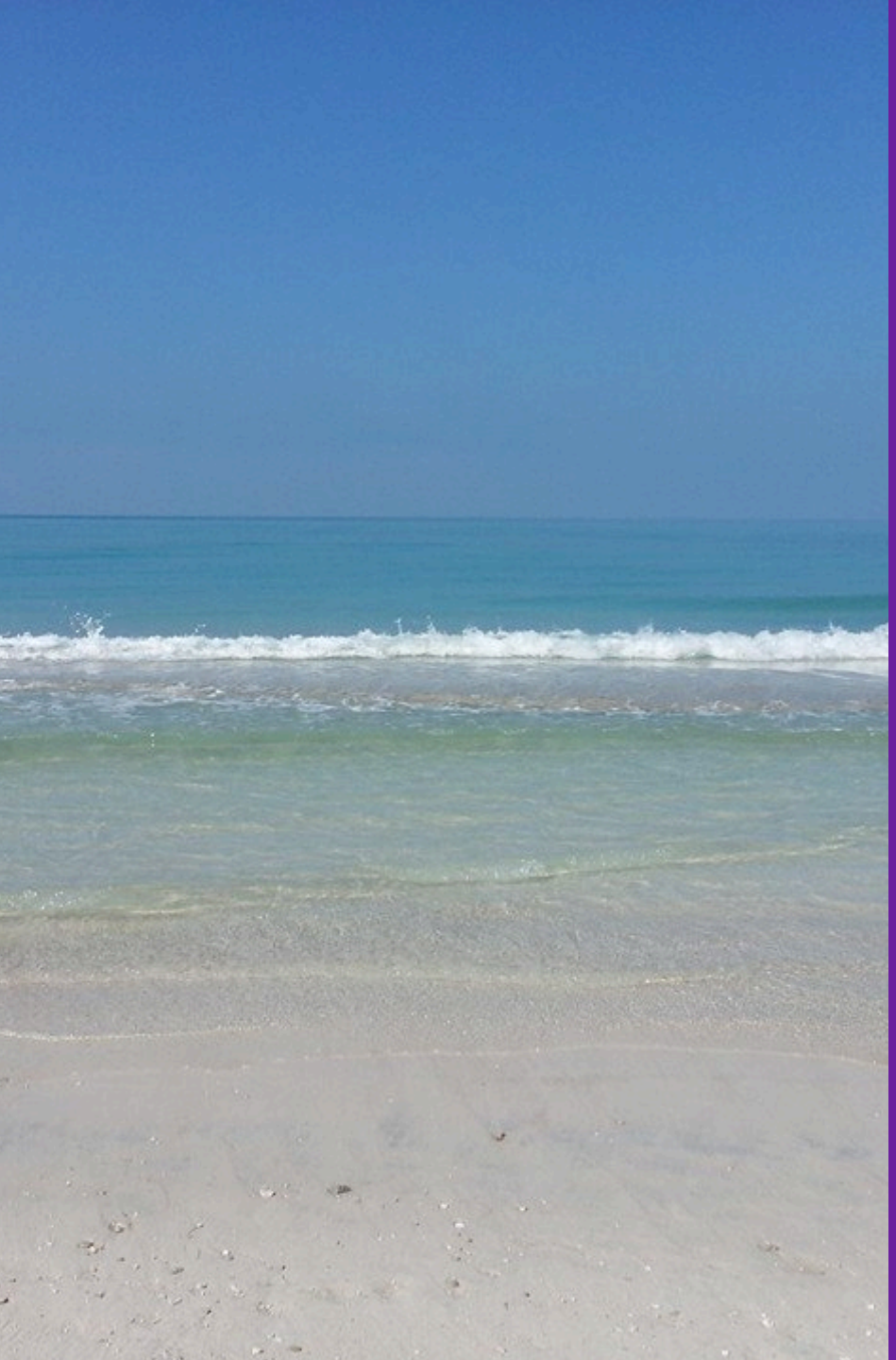
1. If known differences between V404 Cyg and Cen X-4 are taken into account they behave very similarly.

- Larger BH mass
- Larger BH accretion disk
- Larger BH X-ray bolometric emission
- Strong jet contribution in BH outburst (marginal for the NS)
- Emission from the NS surface in quiescence

2. We likely found the dominant emission process in opt. (companion subtracted)

	Outburst	Quiescence
BH	Jet (+ Reprocessing)	Reprocessing
NS	Reprocessing	Reprocessing

3. Next:
Test this procedure on a larger number of sources (if possible)



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THANKS!