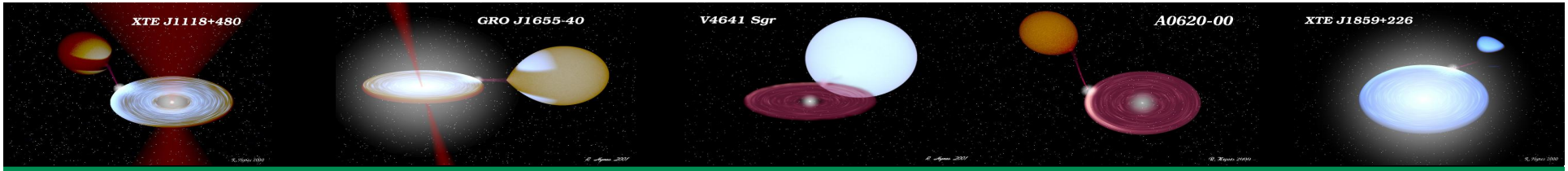


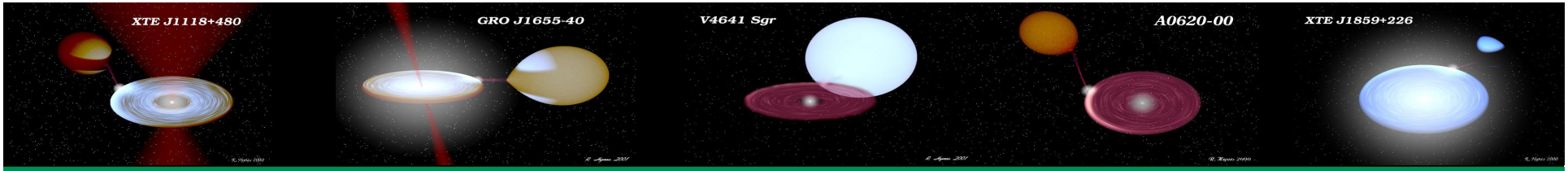
WATCHDOG

A Two-Decade Long All-Sky Study of the Galactic Black Hole X-ray Binary Population

Bailey Tetarenko
University of Alberta

UNIVERSITY OF ALBERTA

Shining in the Heart of Darkness: Black Hole Accretion and Jets – Nepal 2016



Collaborators on This Project

- Greg Sivakoff
- Craig Heinke
- Jeanette Gladstone

- Ann Hornschemeier
- Hans Krimm
- Serena Repetto
- Erik Rosolowsky
- Alex Tetarenko

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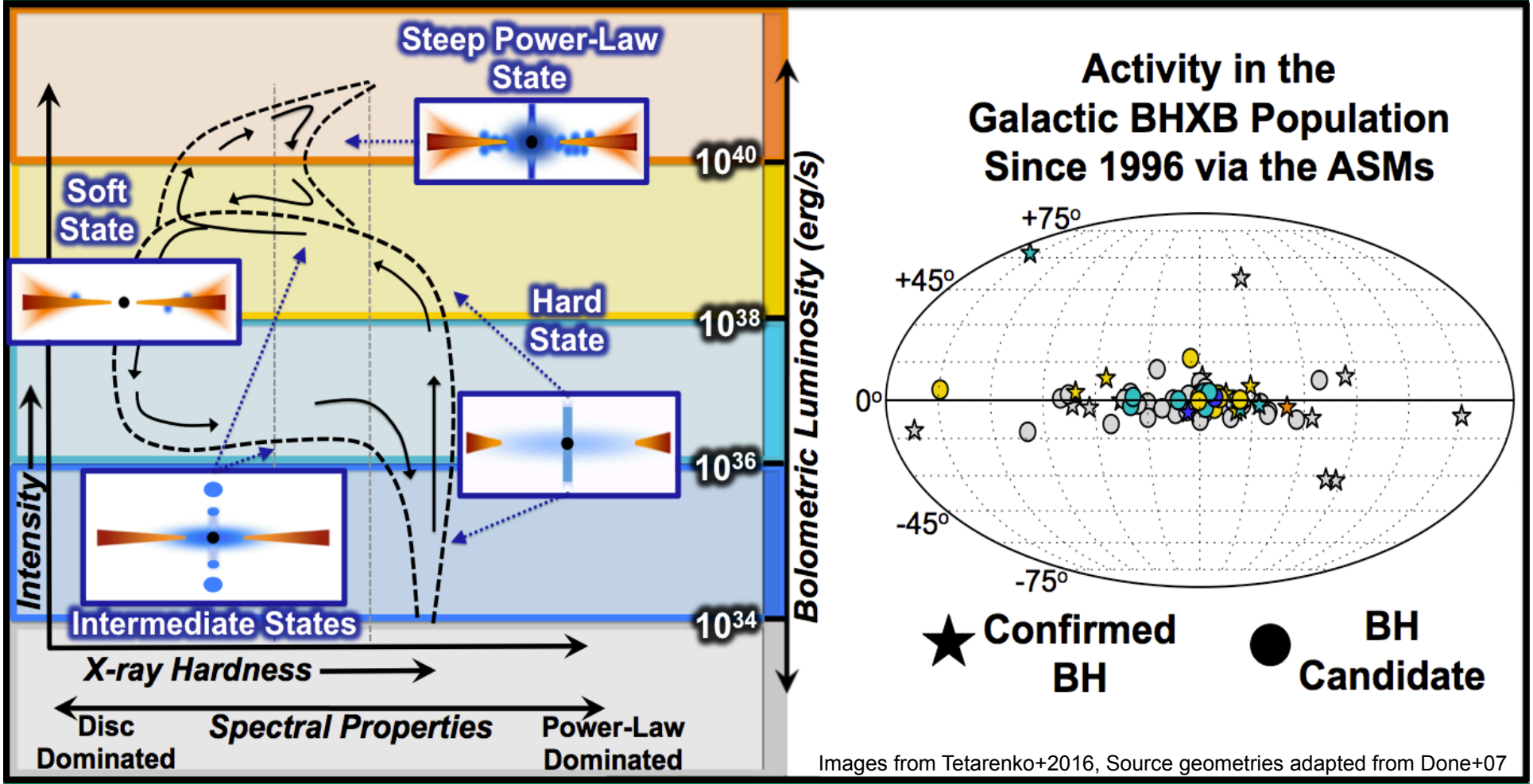
The All-Sky Monitor Perspective



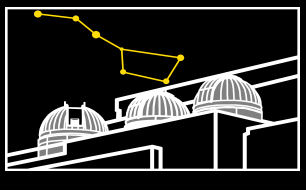
Images from Tetarenko+2016, Source geometries adapted from Done+07

Why Population Studies?

Population studies are our best option to understand the wide range of physics involved in the formation and evolution of accreting binary systems harboring stellar-mass BHs

Current Problems:

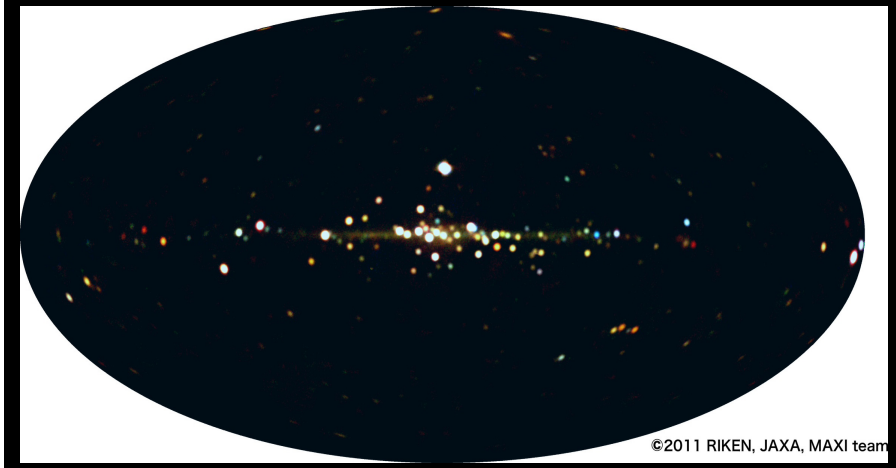
- Current theoretical framework doesn't fully describe outburst behaviour
- observational data limited by small sample sizes
- physical mechanism(s) dictating state transitions remain largely unknown
- the known sample is not representative of true population



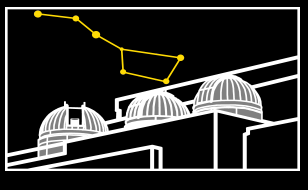
The *WATCHDOG* Resource

the Whole-sky Alberta Time-resolved Comprehensive black-Hole Database Of the Galaxy …

is an all-sky X-ray study of the current state of the known BH and BHC X-ray binary population

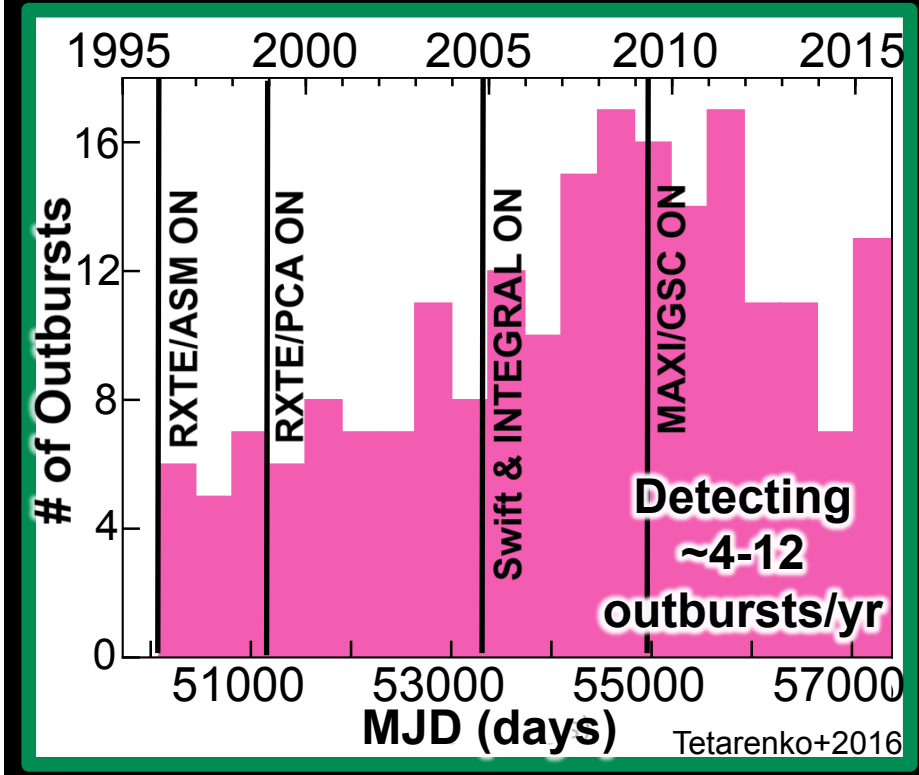


- Built to operate as an interactive online interface
- Uses the vast data archives available to us via the All-sky instruments aboard INTEGRAL, MAXI, RXTE, and Swift.
- Probes the whole transient X-ray sky across decades of time

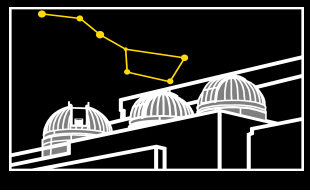


WATCHDOG Outburst Tracker

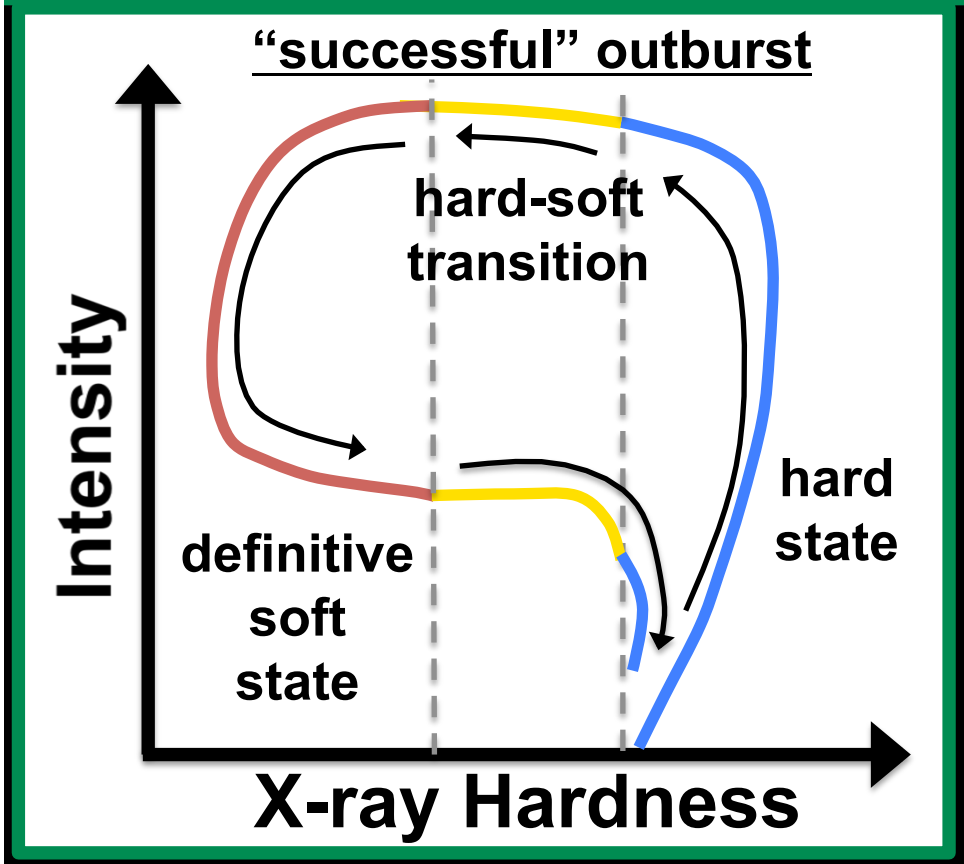
The first of its kind, this comprehensive algorithm has the ability to discover and track outbursts using the all-sky instruments aboard four separate telescopes

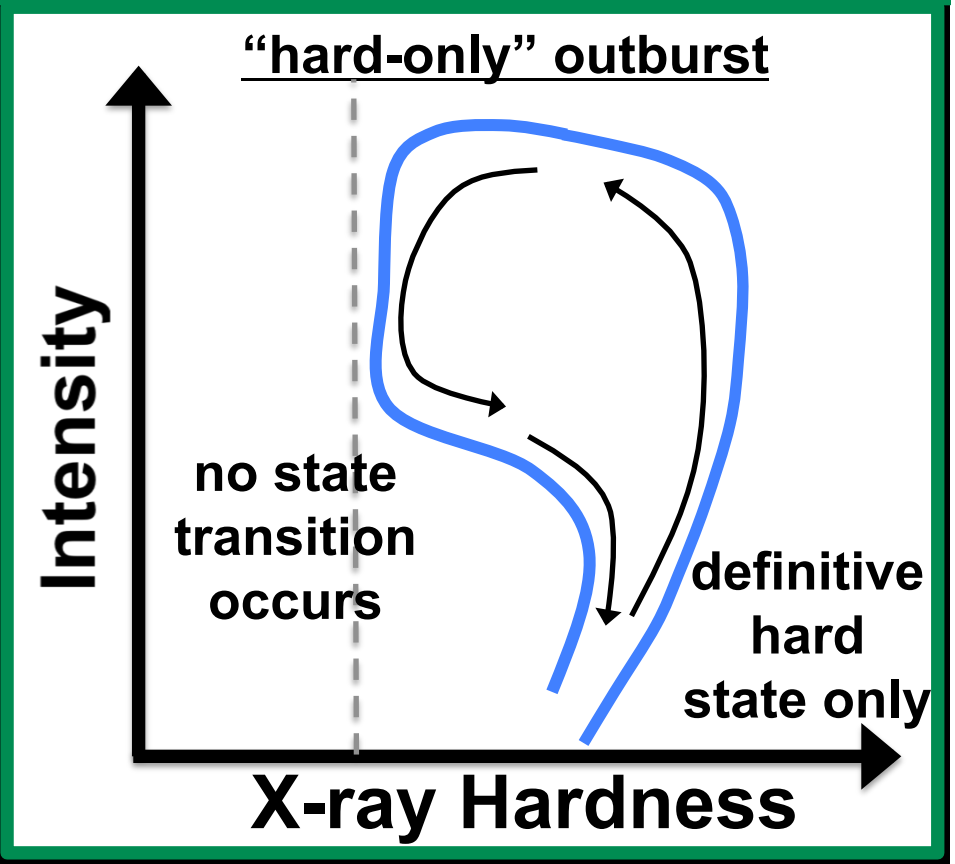


- Detects transient outburst events:
  $L_{X,bol} > 10^{36}$ erg s^{-1}
  ($f_{X,bol} \sim 10^{-10}$erg cm^{-2} s^{-1} or a few mcrab)
- Performs long-term monitoring of persistently accreting sources
- So far, detected >140 separate outbursts occurring in 48 transient sources
- Interactive detection app uses the tracker results to provide accurate detection rate estimates that can be used to plan observations

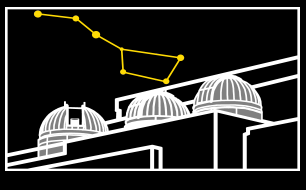


WATCHDOG Outburst Classification Tool

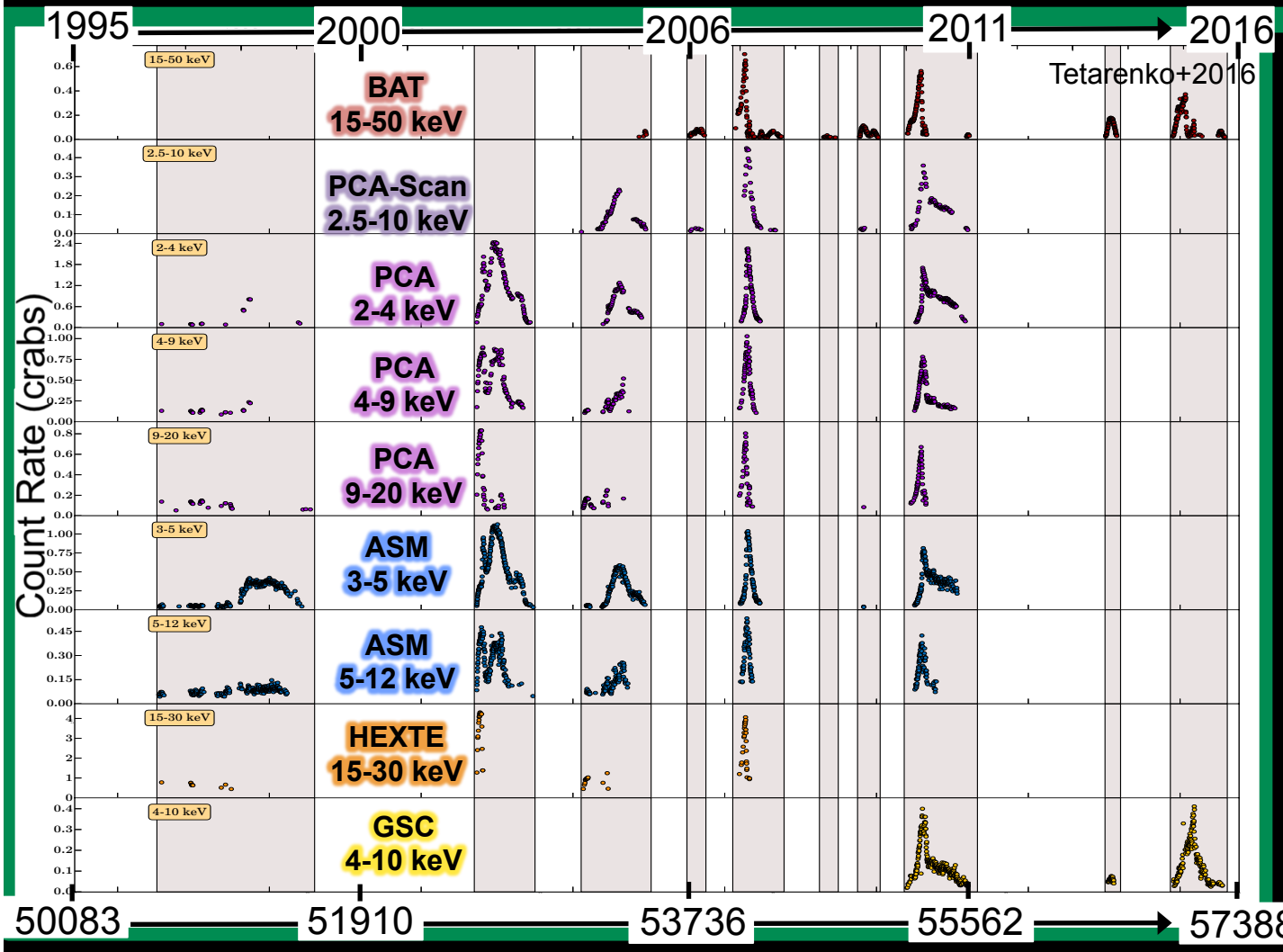




Uses the empirical hardness ratio parameter, computed via a Markov Chain Monte-Carlo method, to categorize outburst behavior into two classes.



Characterization of the long-term temporal and spectral evolution observed in BHXBs

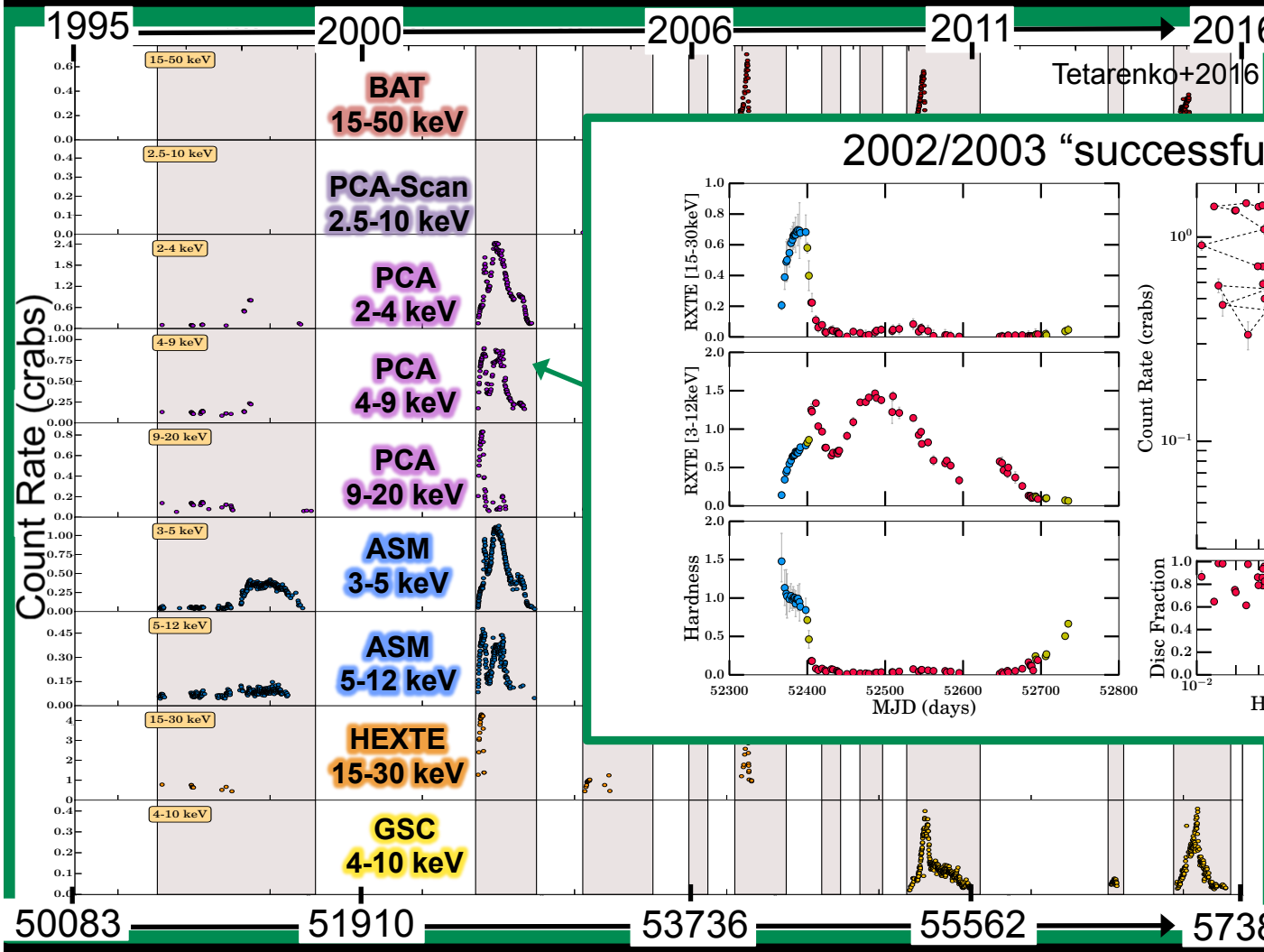


EXAMPLE:

20 Years Of Activity in GX339-4

WATCHDOG's algorithms detect, track accretion state, and classify outbursts using only long-term light-curve data

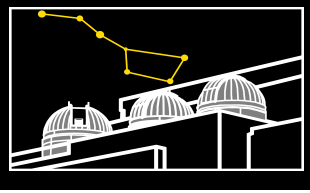
Characterization of the long-term temporal and spectral evolution observed in BHXBs



EXAMPLE:

2002/2003 "successful" outburst

only long-term light-curve data



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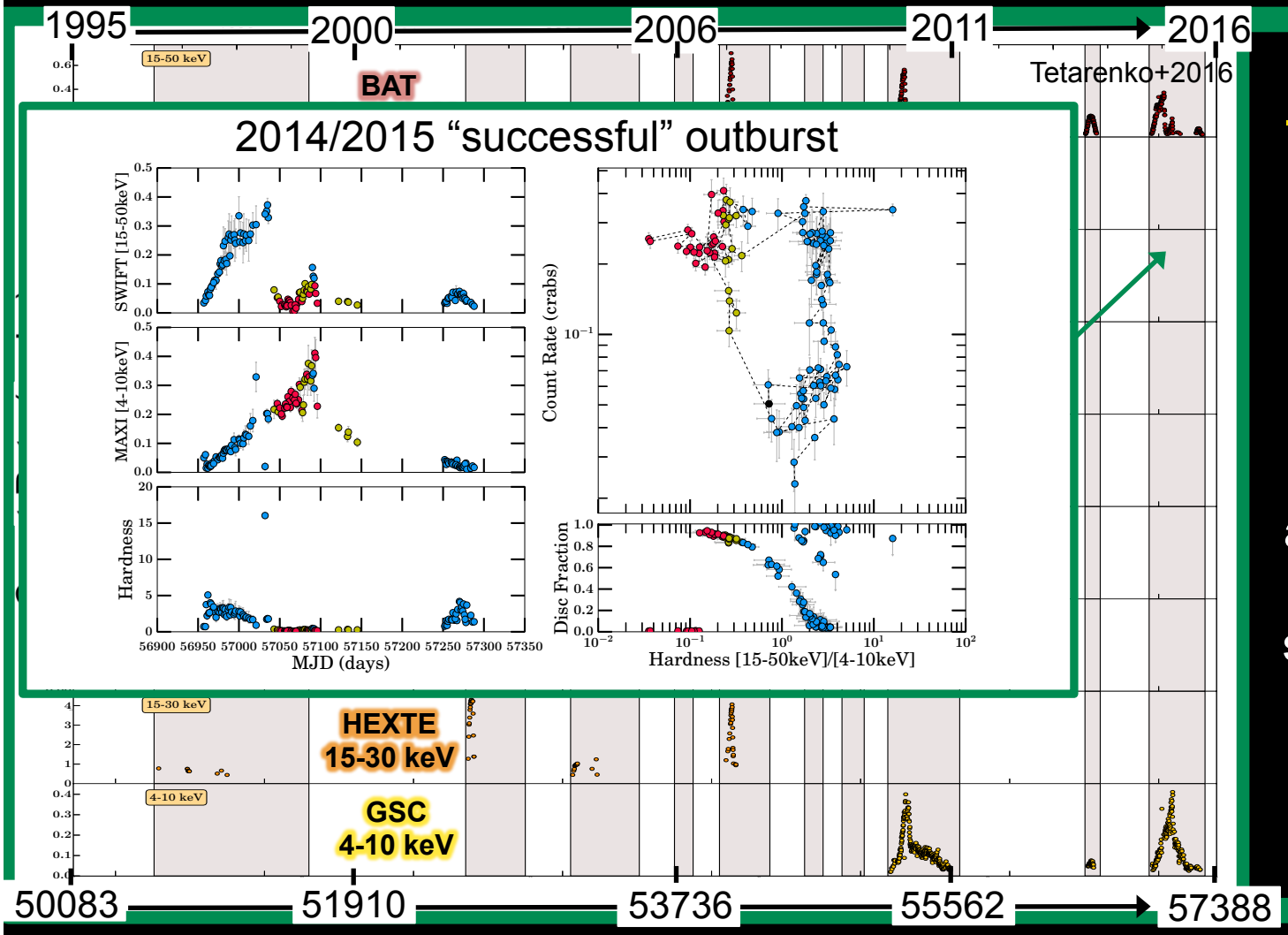

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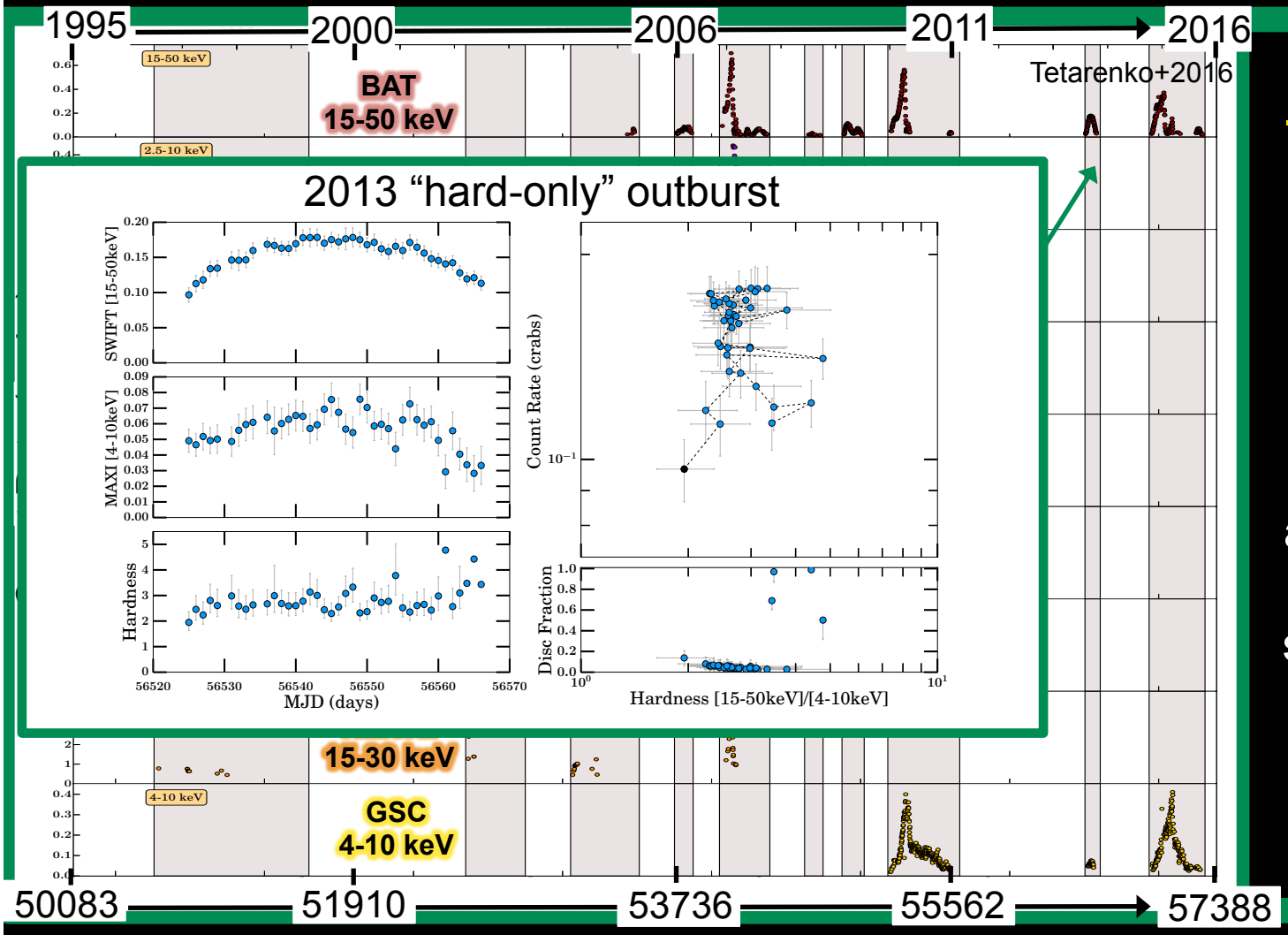

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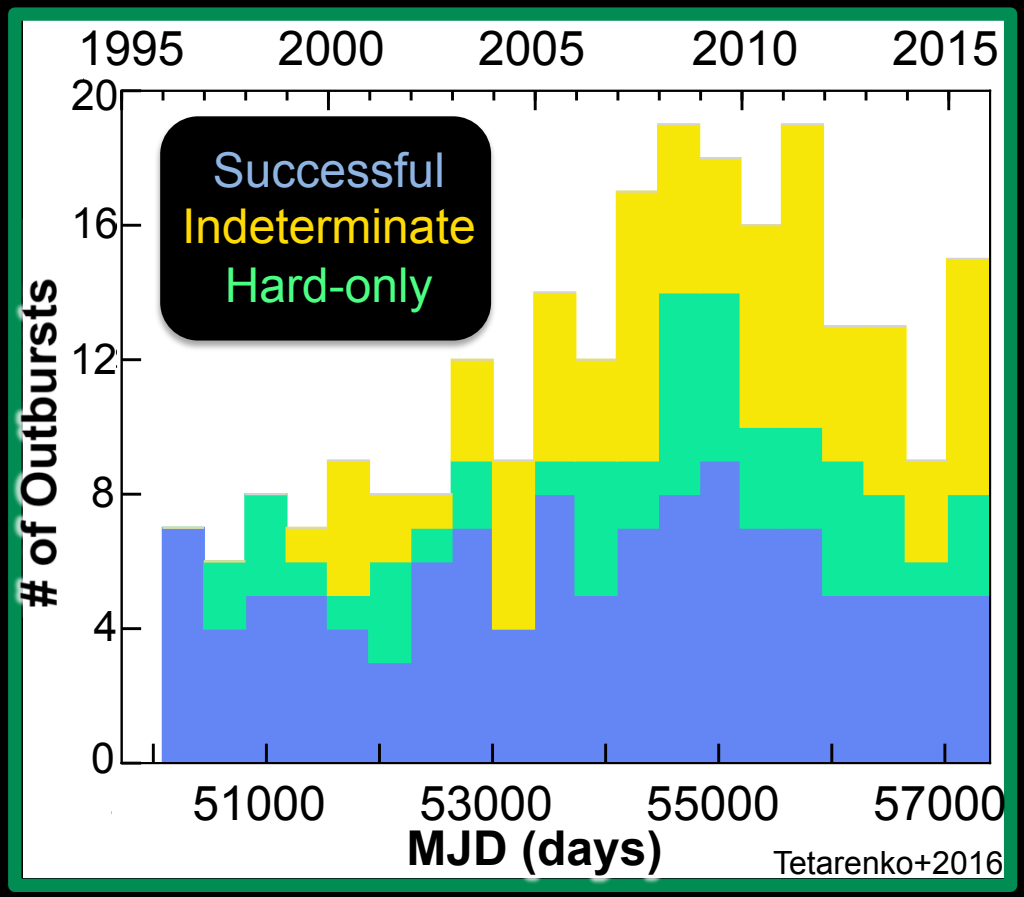
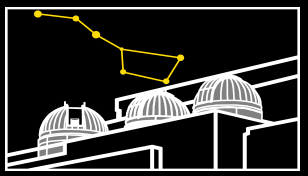
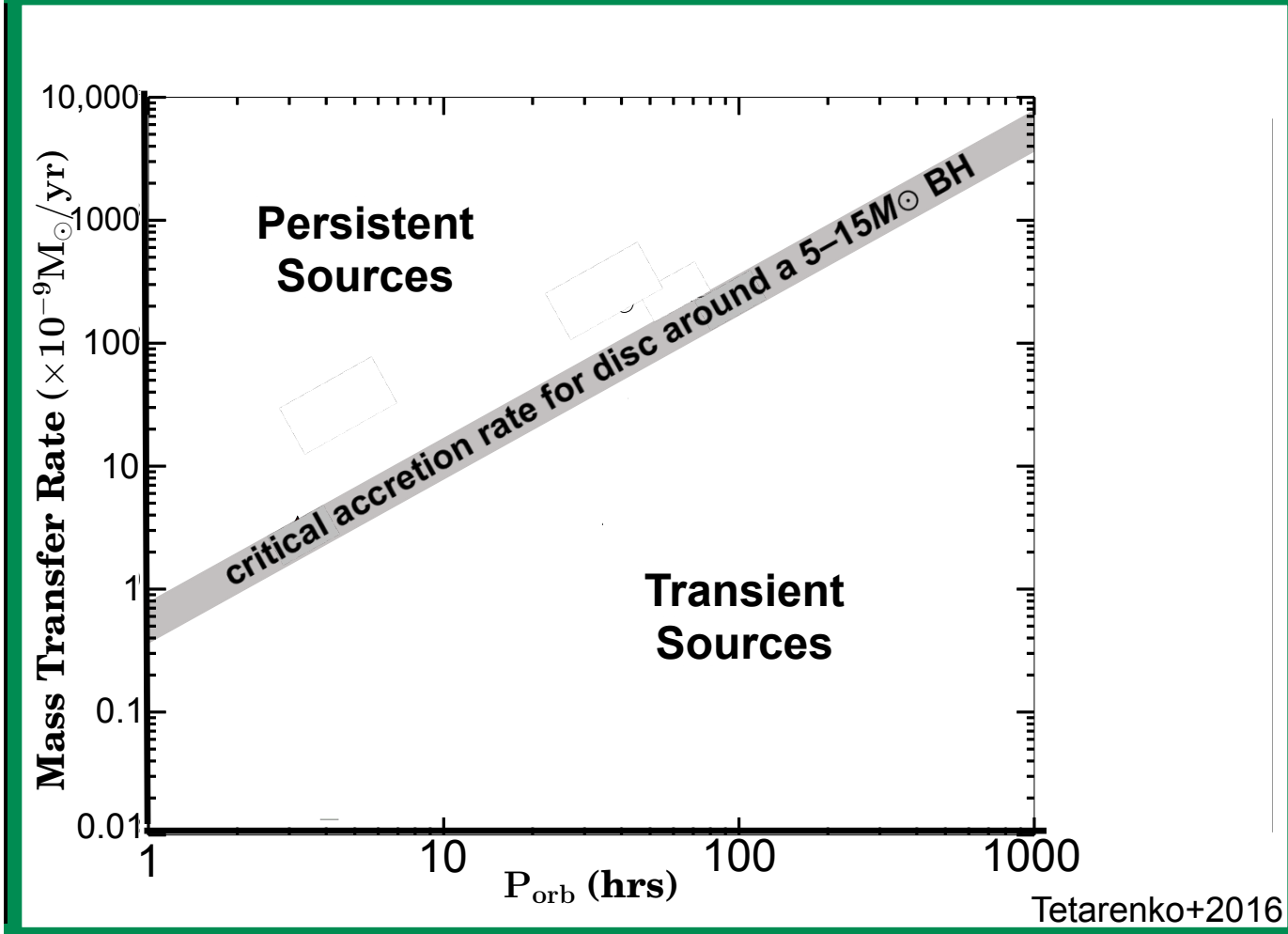
Prevalent “Hard-only” Behaviour



- Exhibited in both transient and persistently accreting systems
- Of 92 classified transient outbursts, ~40% do not involve a state transition
- There is a steady appearance of these “hard only” outbursts over the last ~50 years



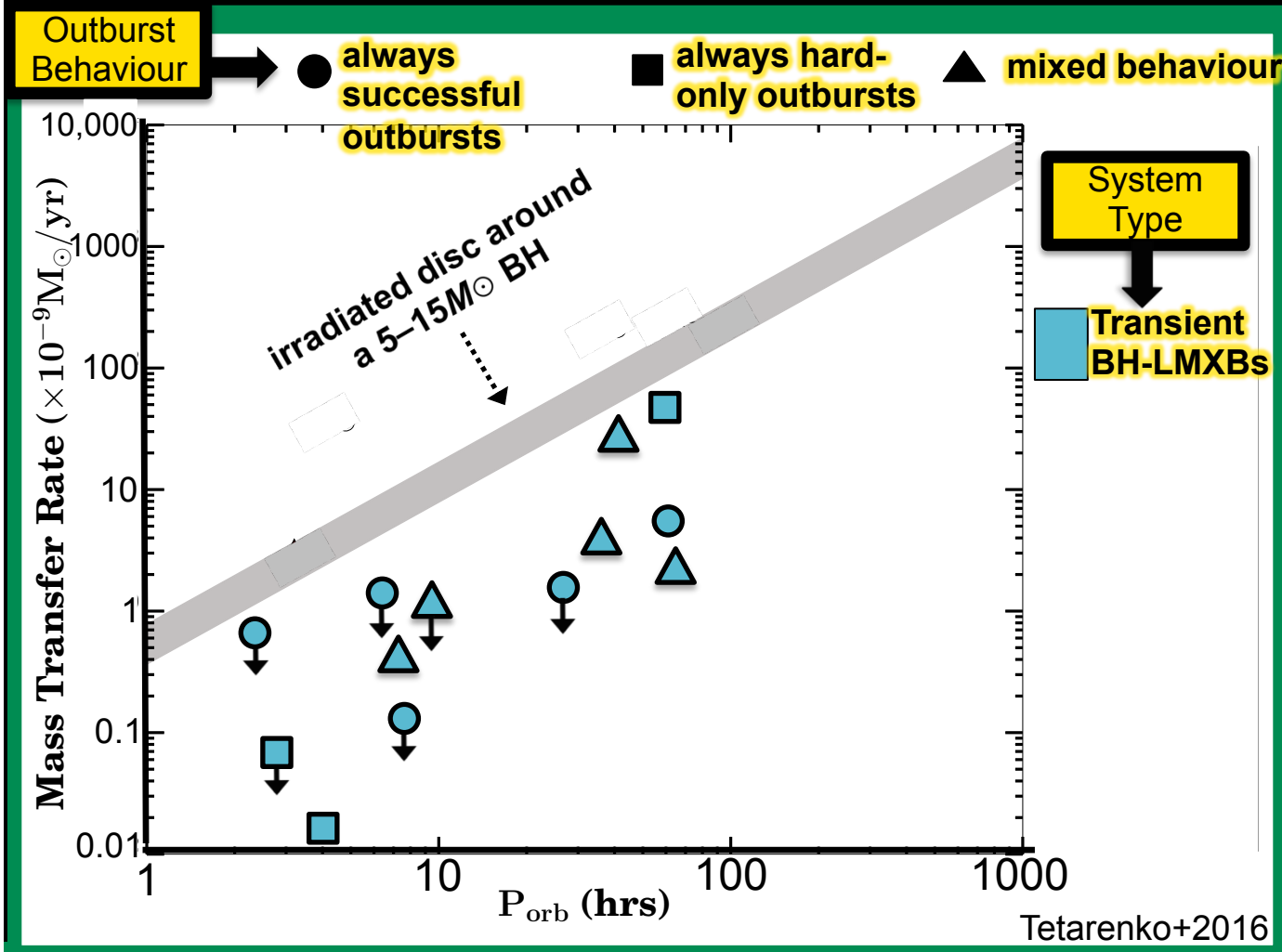
Mass-Transfer History of the Galactic Population



Tetarenko+2016

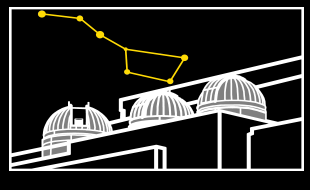
Using WATCHDOG, we have derived a two-decade long mass-transfer history for the entire transient and persistent BH population in the Galaxy

Mass-Transfer History of the Galactic Population



- We observe:

-scatter in transient srcs



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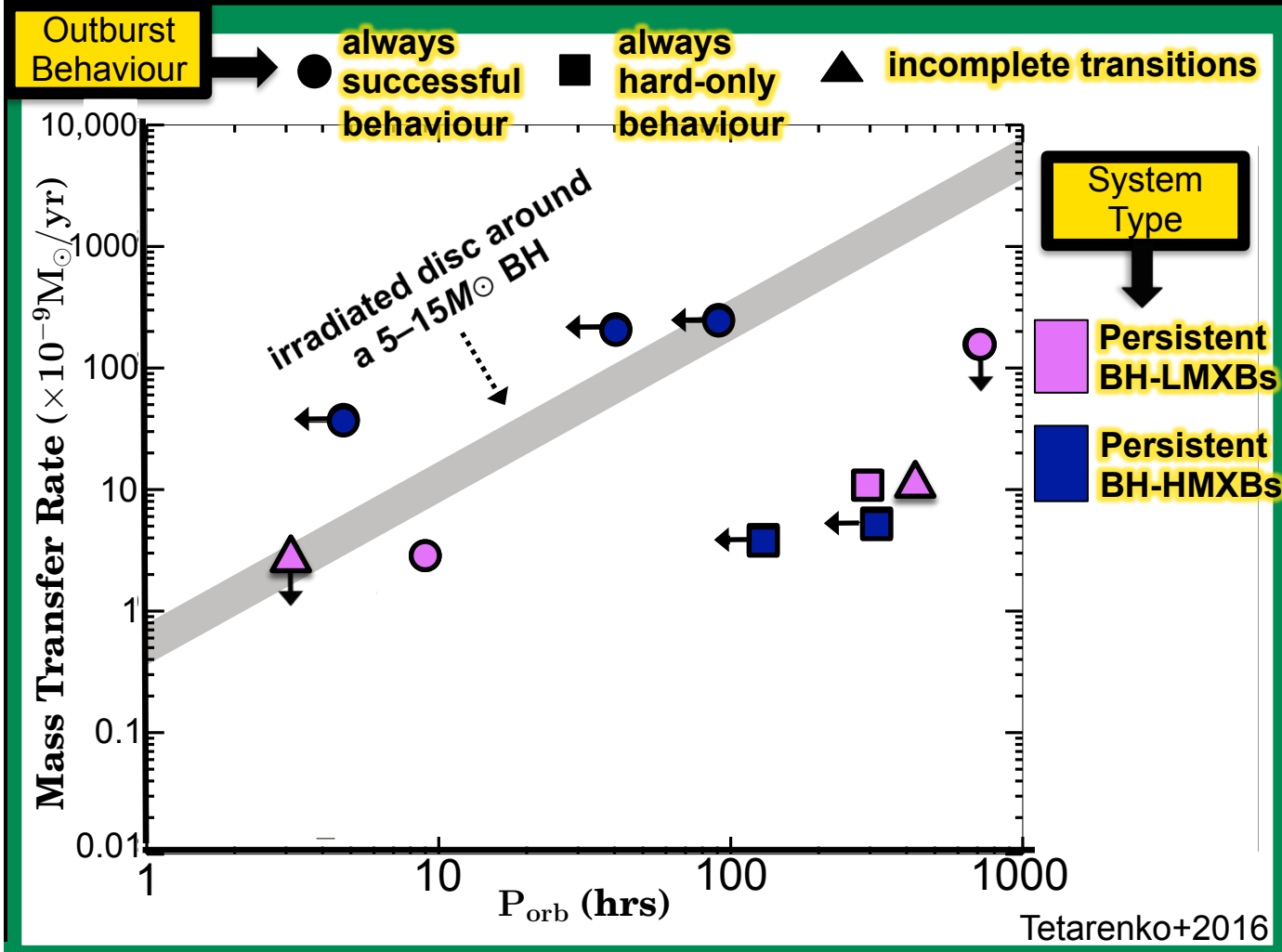

- We observe:

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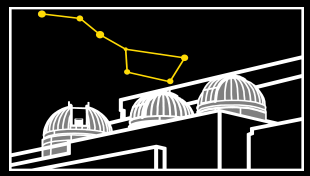
- Persistent srcs below critical accretion rate



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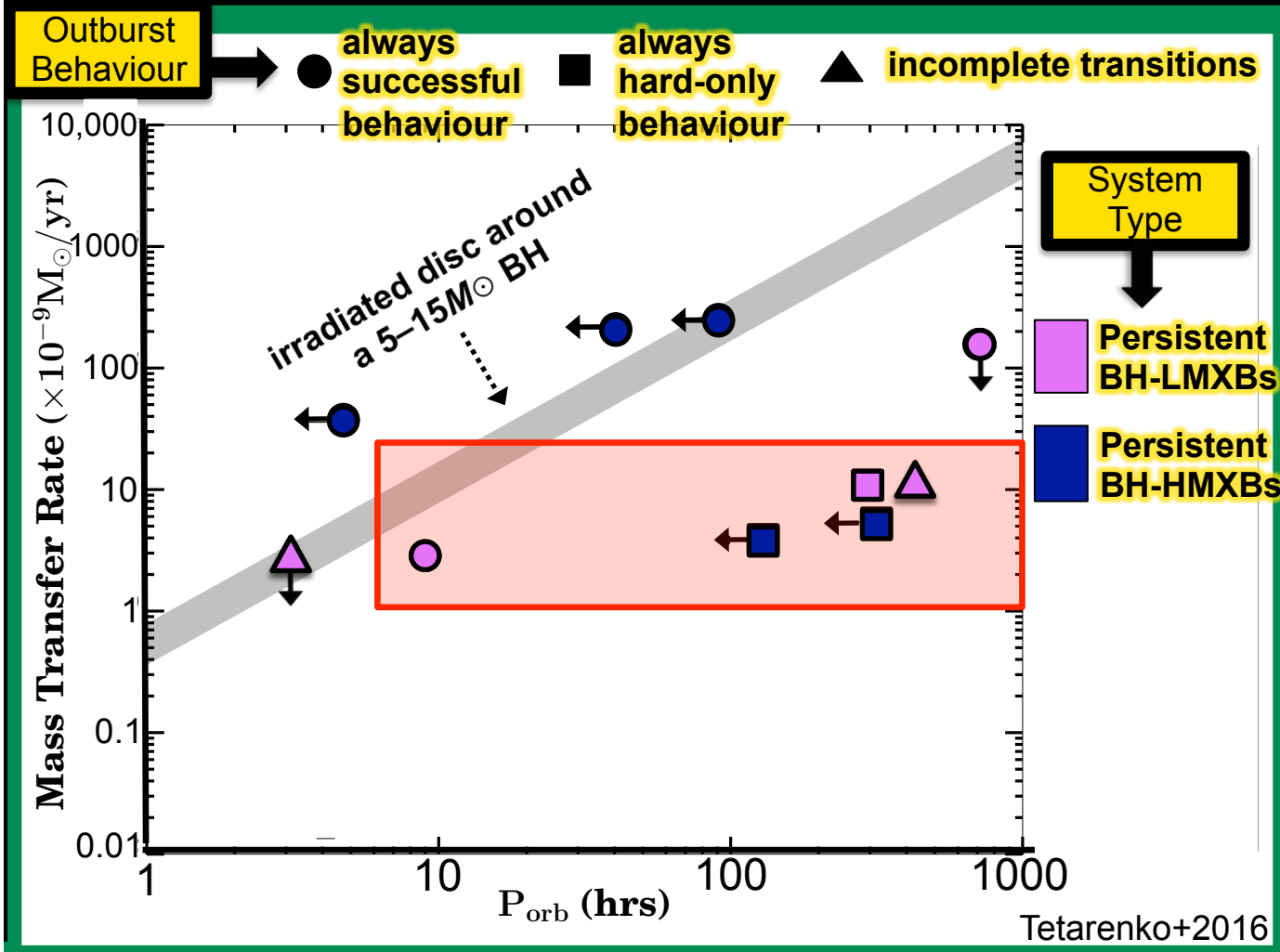

- We observe:

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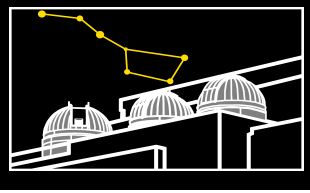
- Possible Explanations:

- change in efficiency

-long P_{orb} persistent systems are long-term transients

- significant loss of matter via outflows



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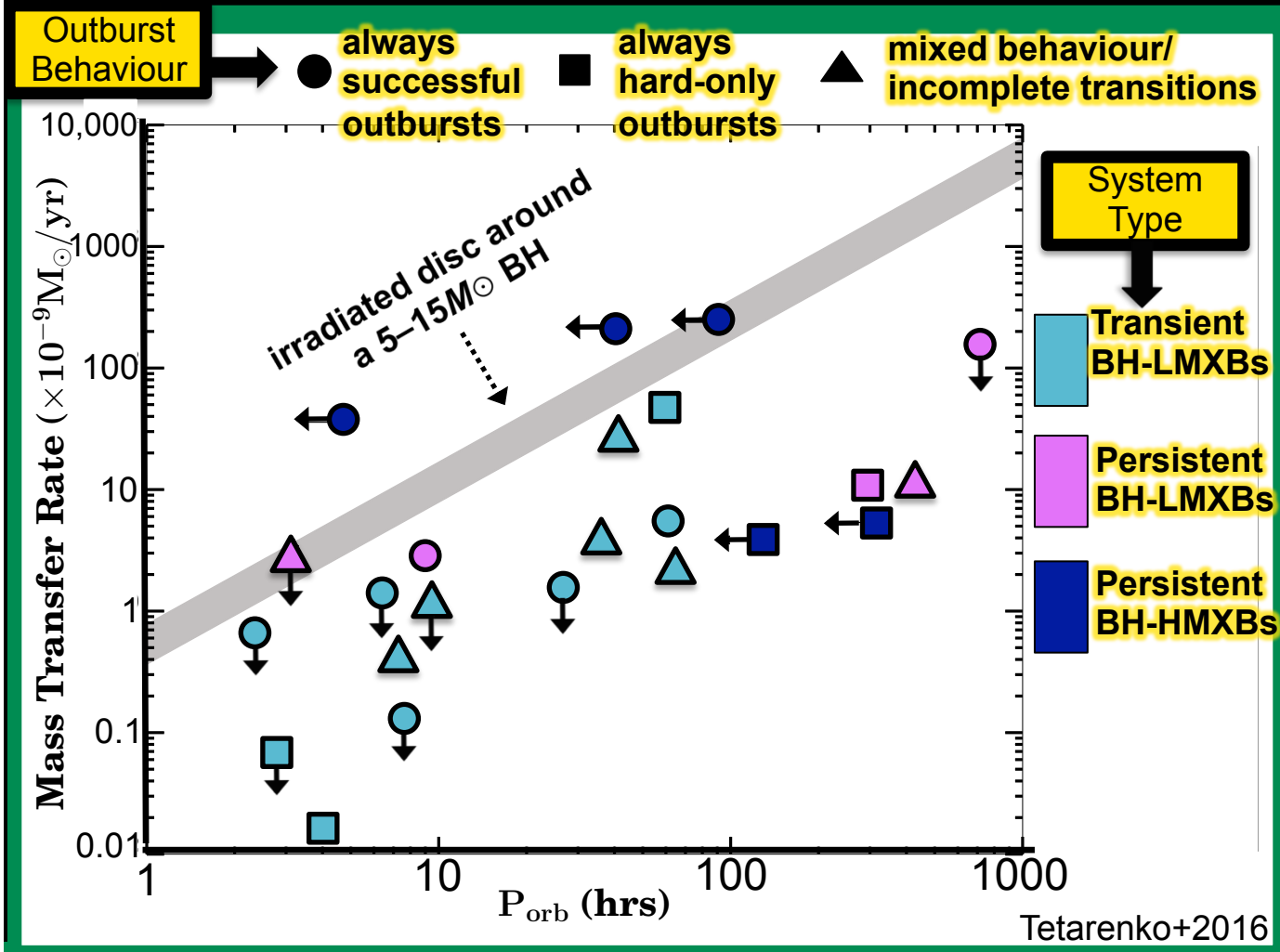

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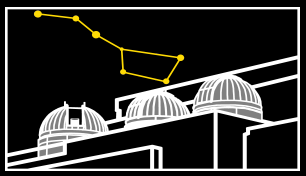

Looking To the Future . . .

WATCHDOG online interface available to the community at:
http://astro.physics.ualberta.ca/WATCHDOG

First Results paper now published in ApJS :
Tetarenko et al. 2016, ApJS, 222,15

Future Plans for WATCHDOG include:

- Infrared Pilot Program: identification and study of binary counterparts in candidate BHXBs
- Discovery, identification, and study of low-luminosity accreting stellar-mass BHXBs
- X-ray Light Curve Modeling: Derivation of key binary parameters in candidate BHXBs

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THANK YOU!!