

Demographics of X-ray binary populations in nearby galaxies

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K. Anastasopoulou, K. Kouroubatzakis, K. Kovlakas

ABINGOS

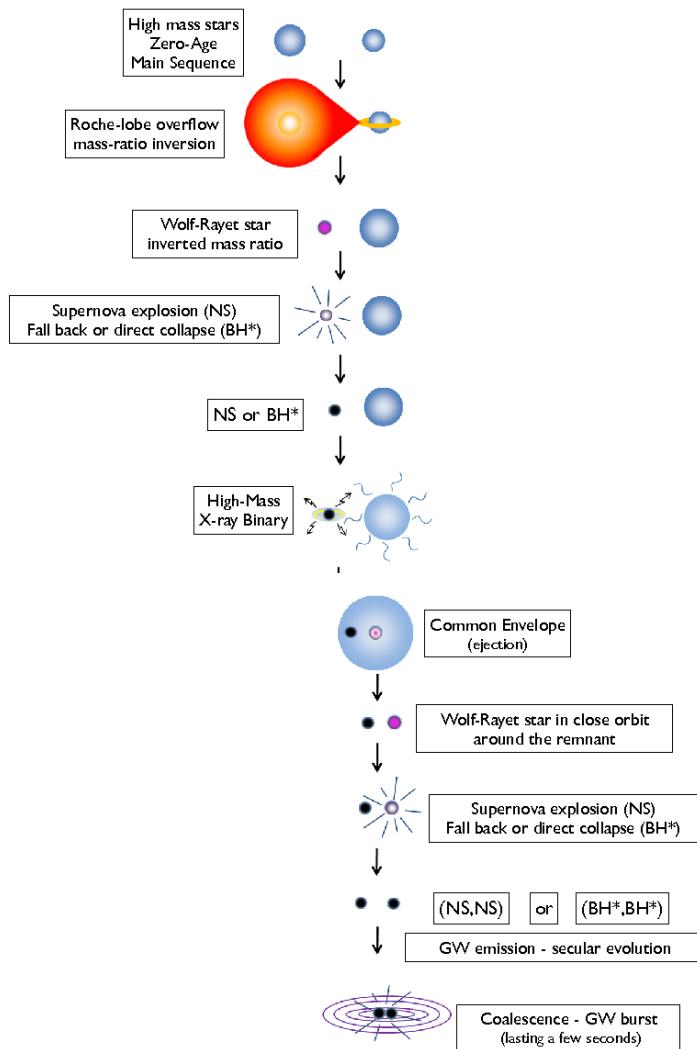
Importance of X-ray binaries

Probes of compact objects

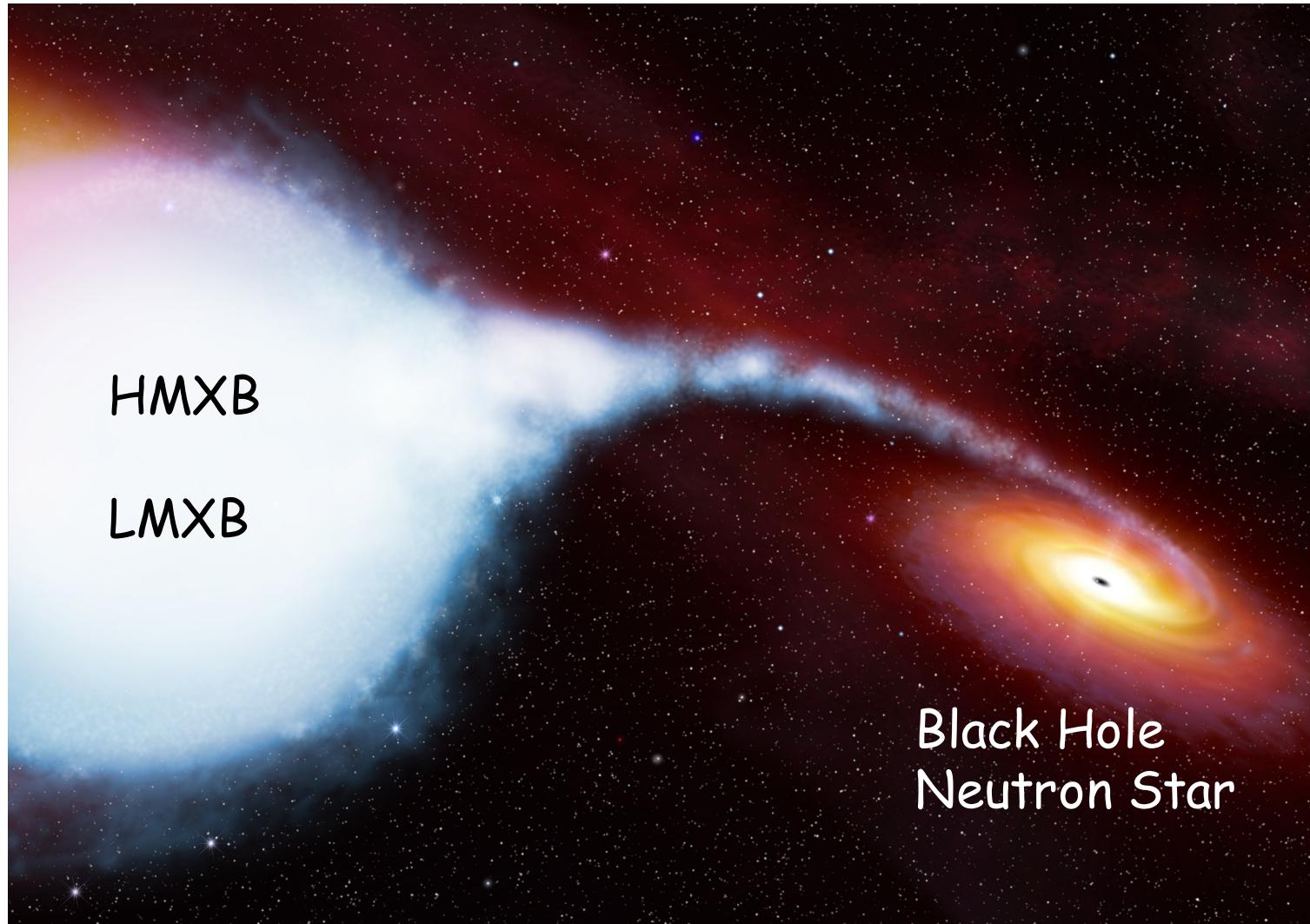
Binary evolution

Gravitational-waves, short GRBs

X-ray output of galaxies



It takes two to party !



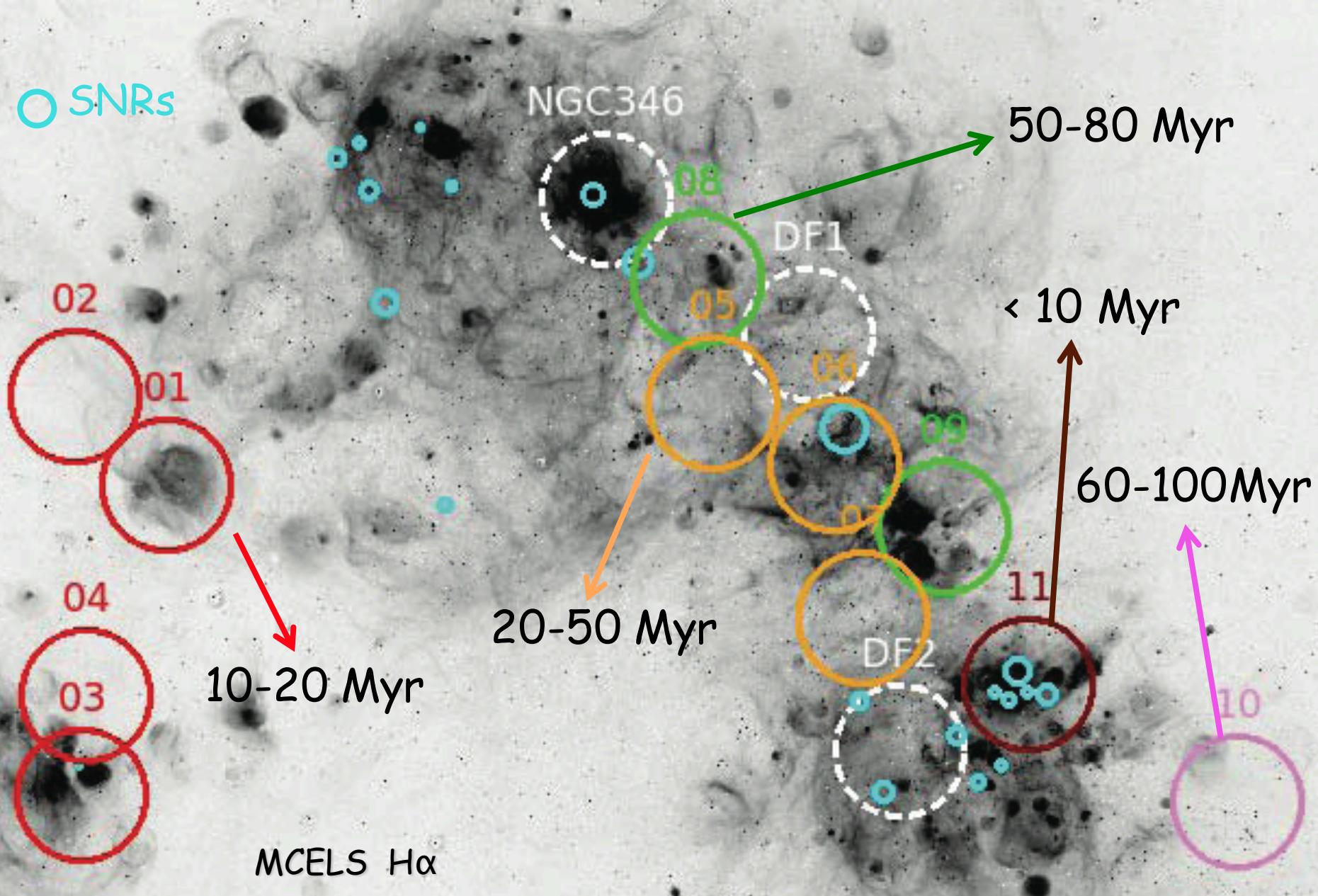
Key questions

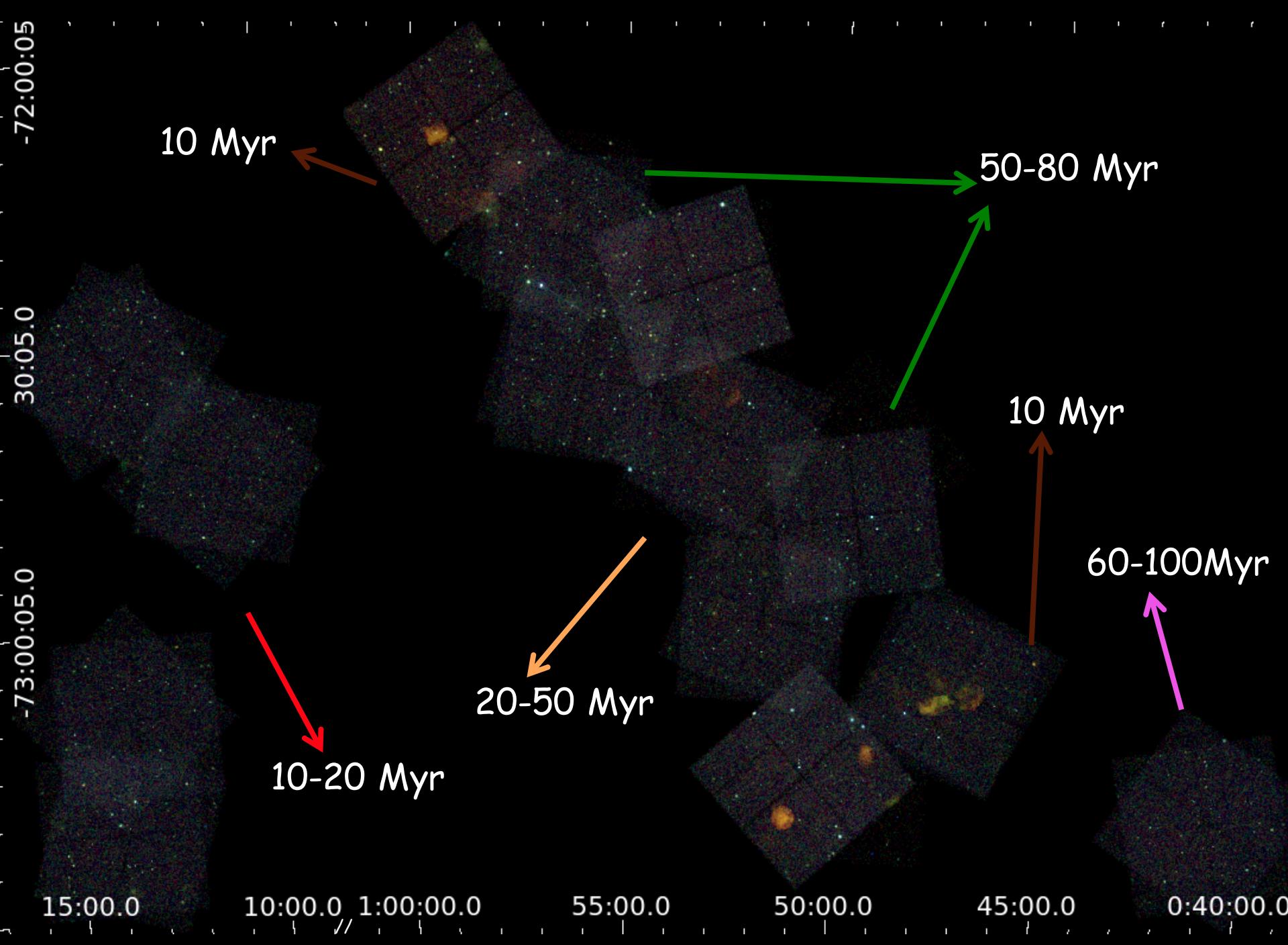
Characterization of X-ray binaries

Formation rate as function of time

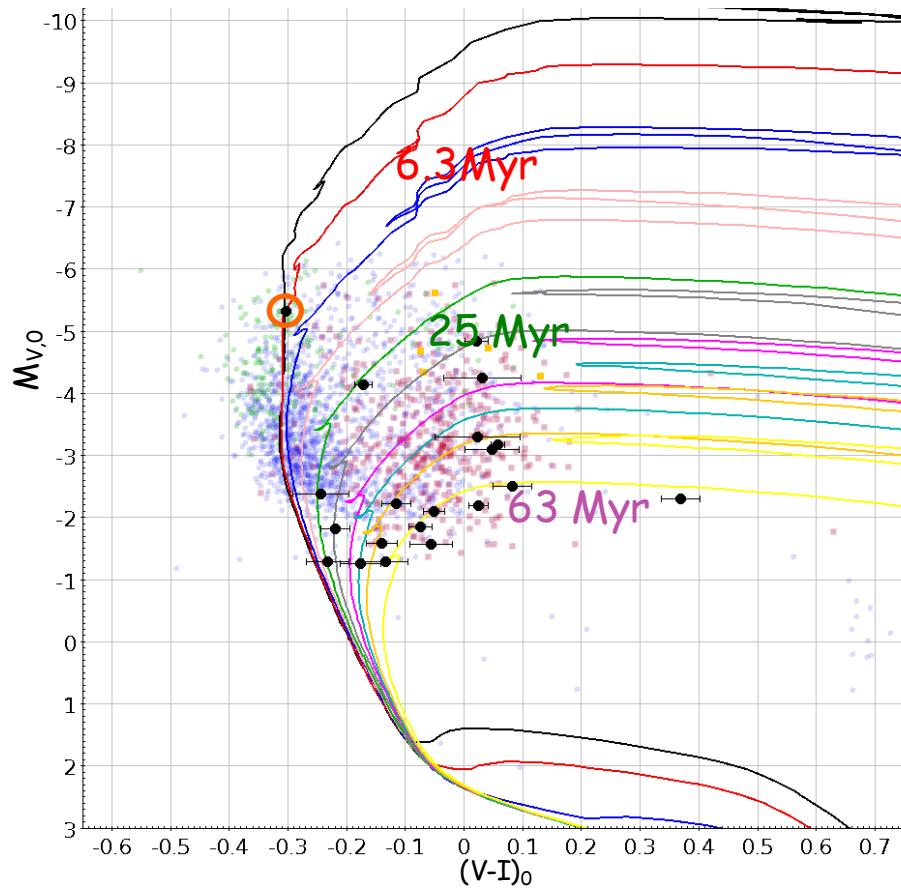
Requires synergy of X-ray and optical/IR observations

The deep Chandra SMC Survey



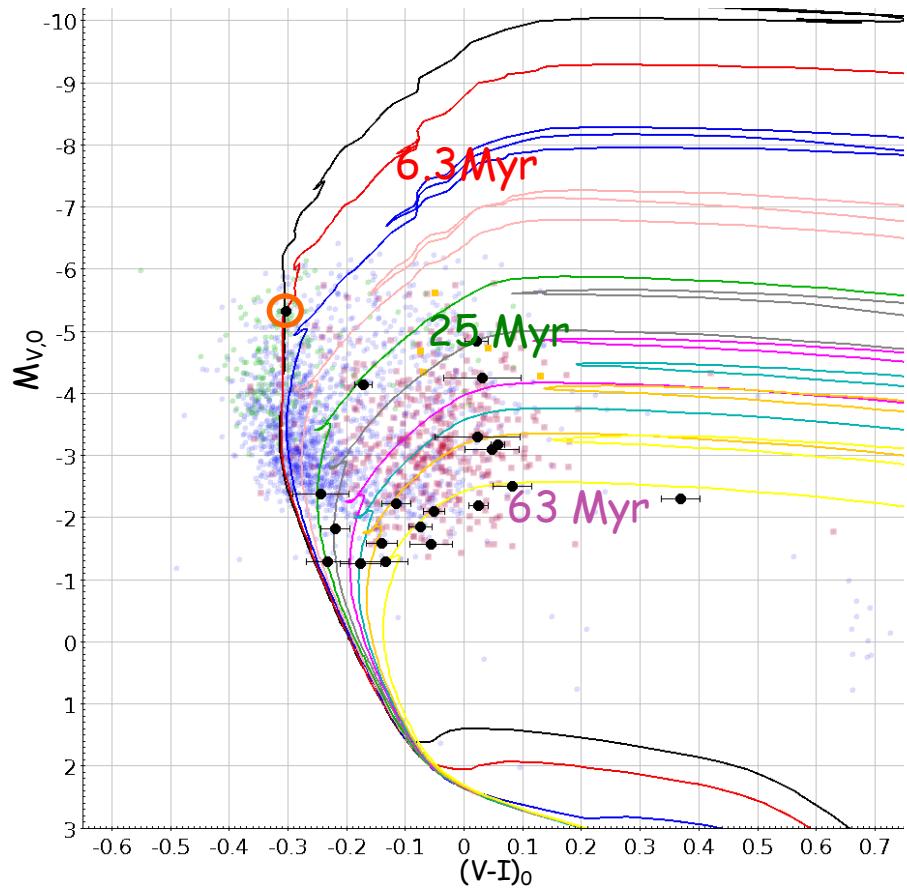


HMXB classification

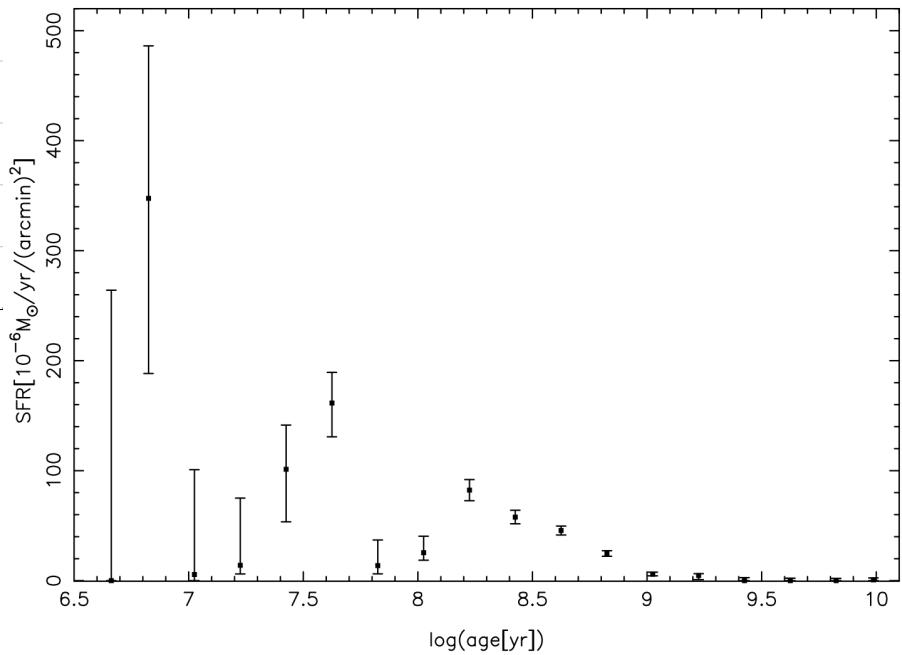


Antoniou et al. 2019
arXiv 1901.01237

HMXB classification

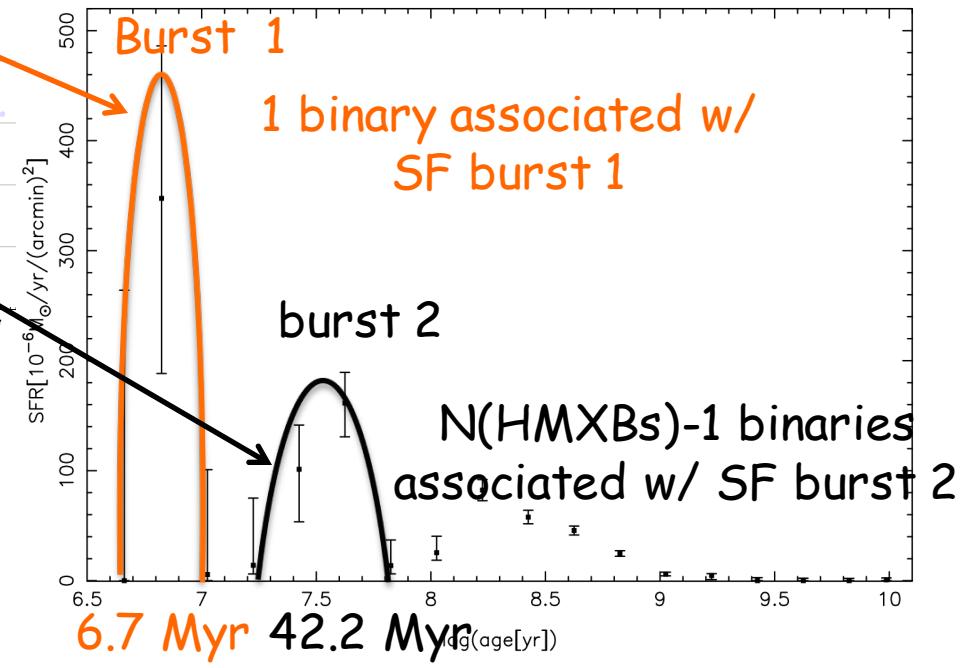
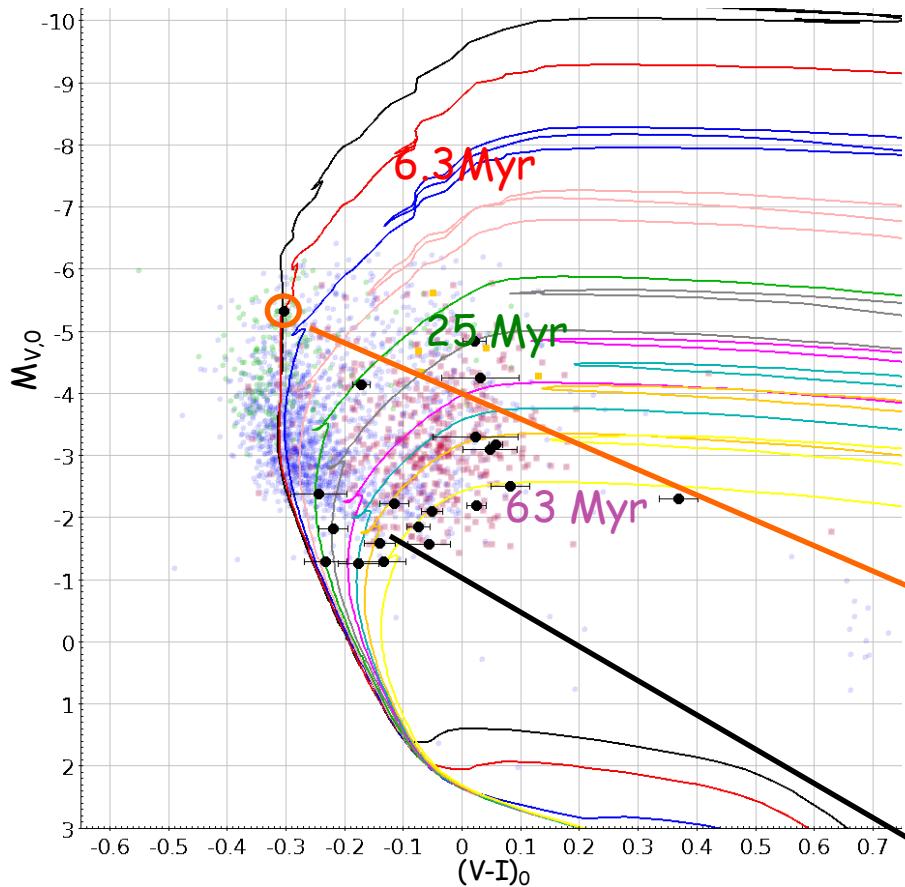


Antoniou et al. 2019
arXiv 1901.01237



Harris & Zaritsky 2004

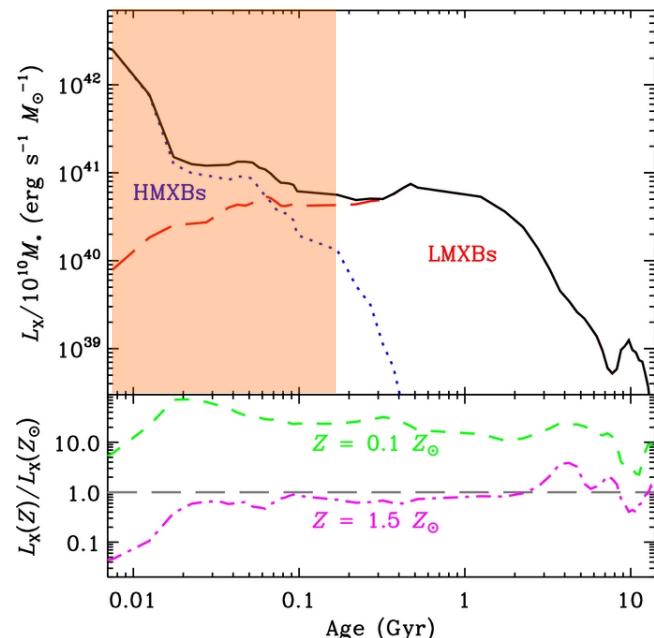
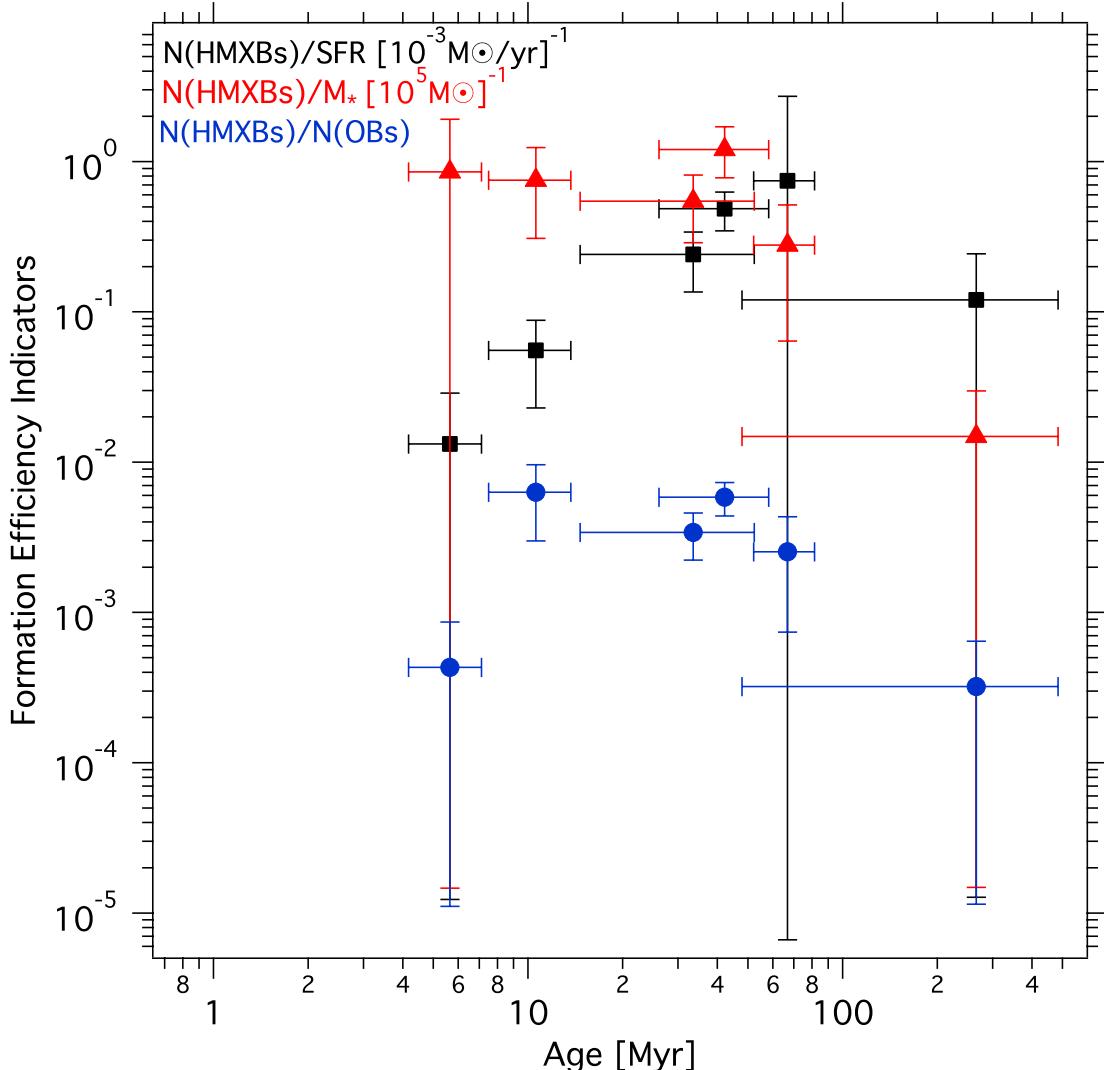
HMXB classification



Antoniou et al. 2019
arXiv 1901.01237

Harris & Zaritsky 2004

HMXB formation efficiency



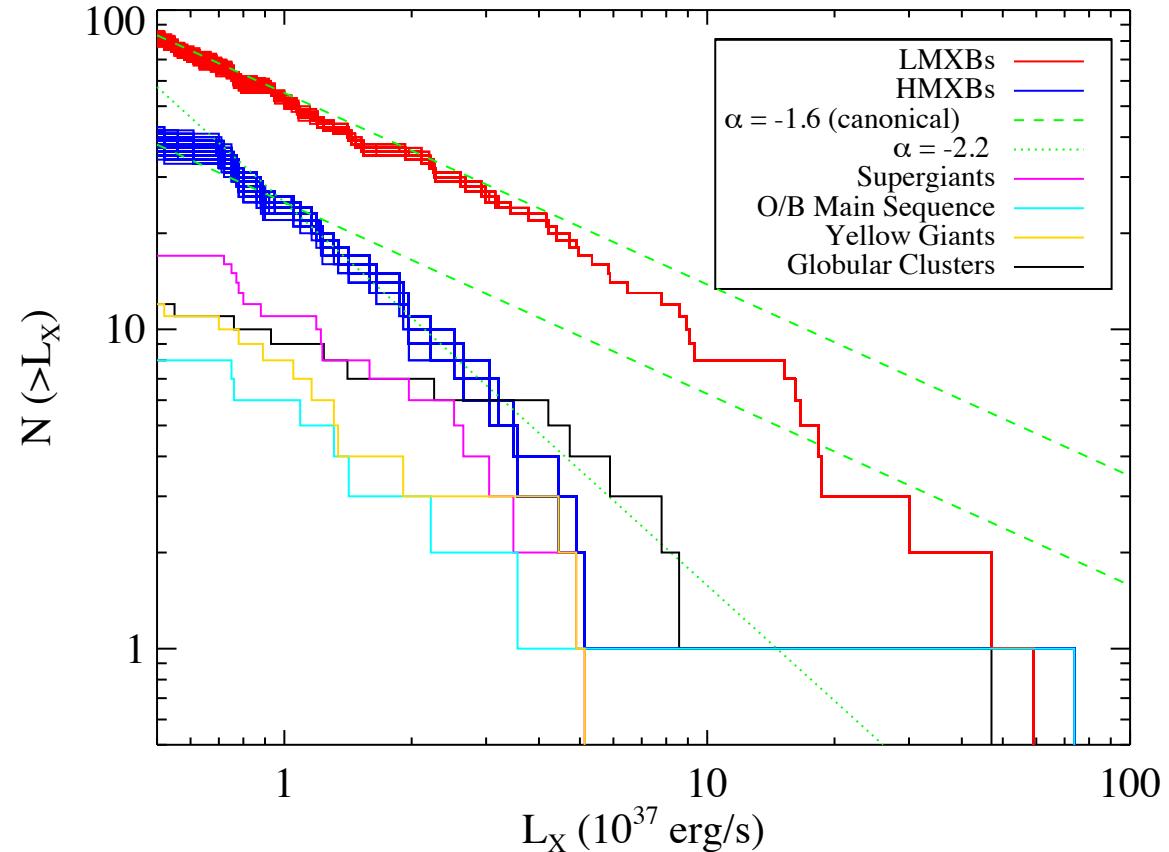
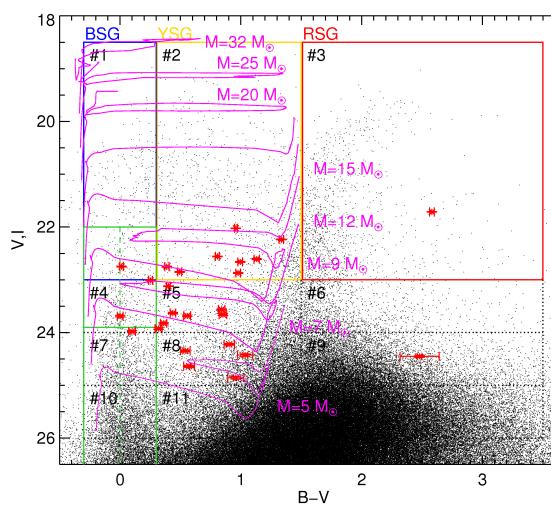
Fragos et al. 2013

Antoniou et al. 2019,
arXiv 1901.01237

ULXs: See also K. Kovlakas' poster

Effects in sub-galactic scales: K. Kouroumpatzakis poster

Dissecting XRB populations: M81



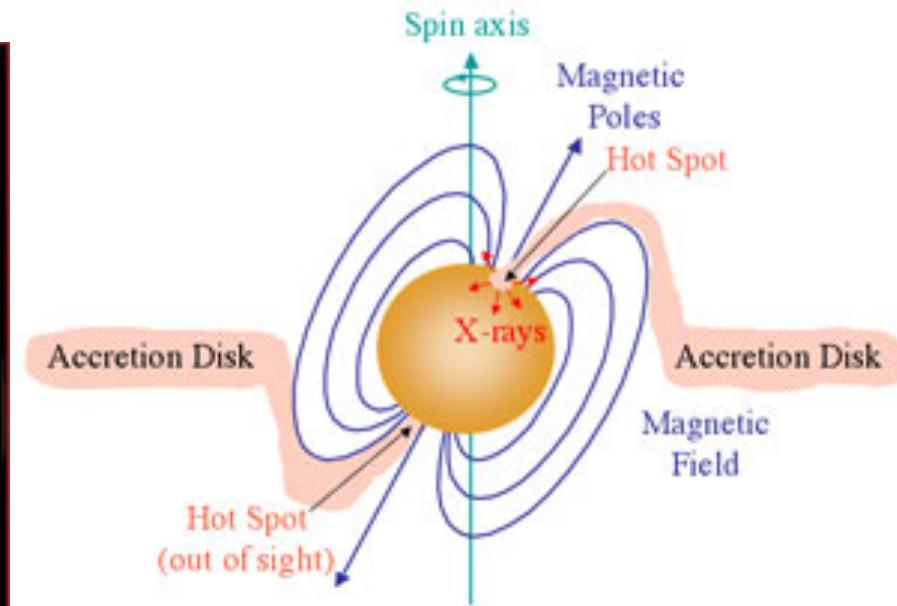
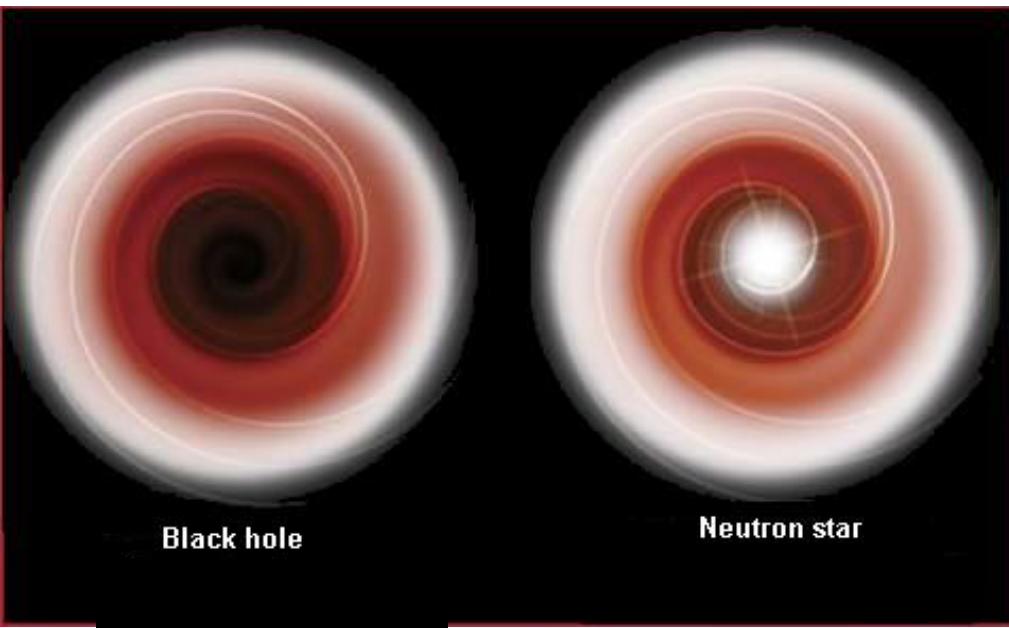
Sell et al. 2019

See also B. Lehmer's talk tomorrow
Integrated emission: K. Anastasopoulou poster

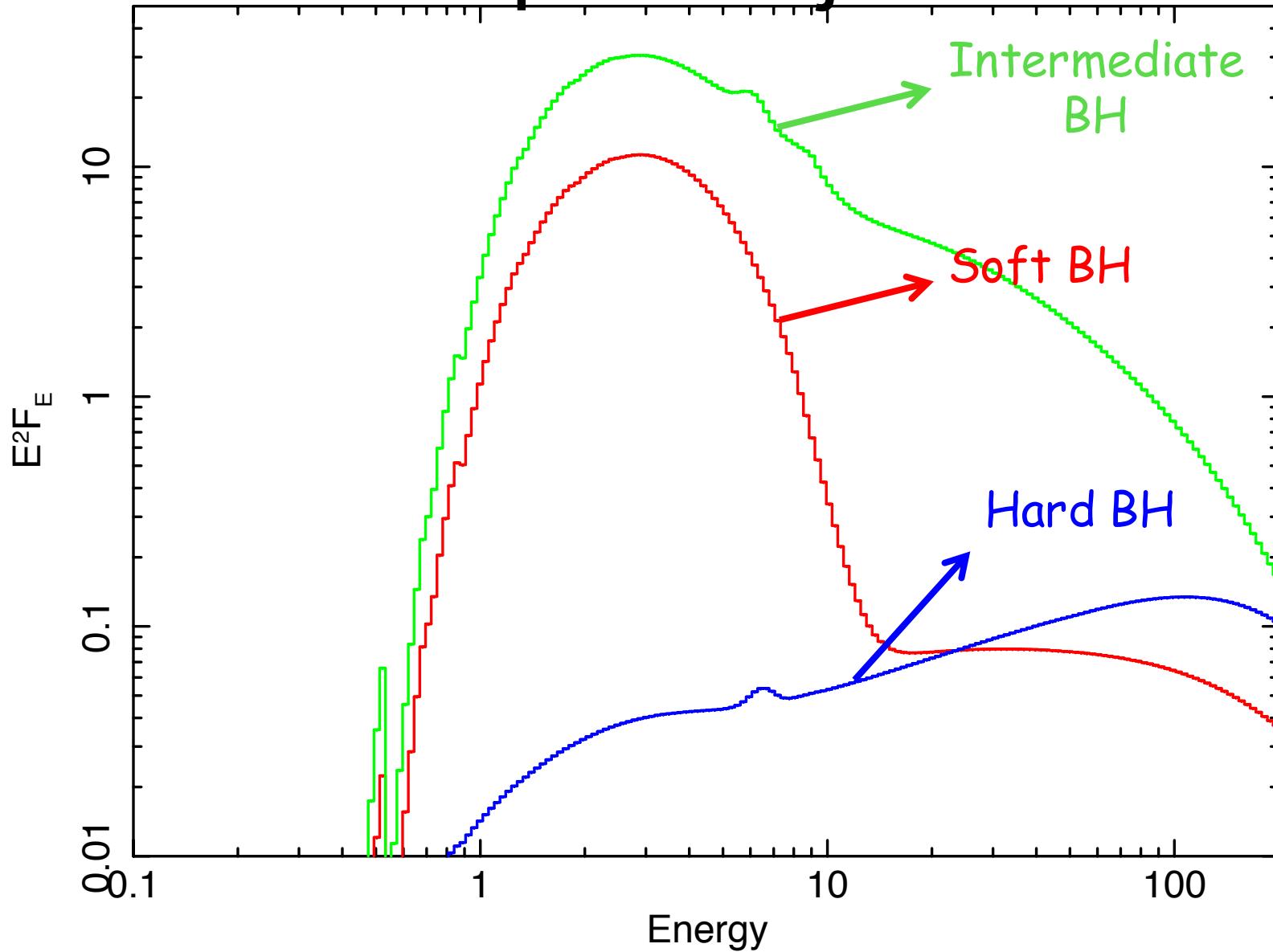
What about the compact objects ?



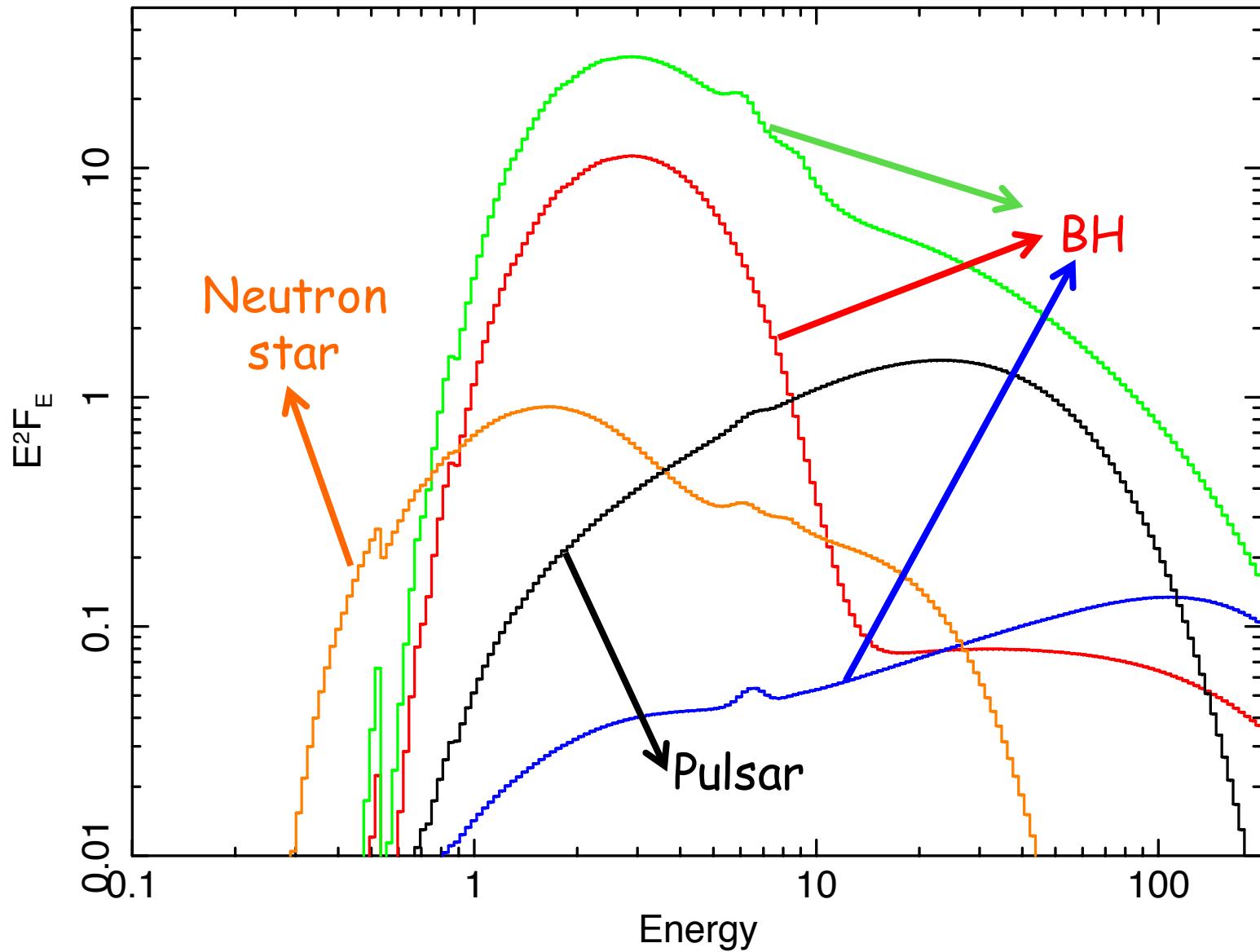
Spectral differences between compact objects



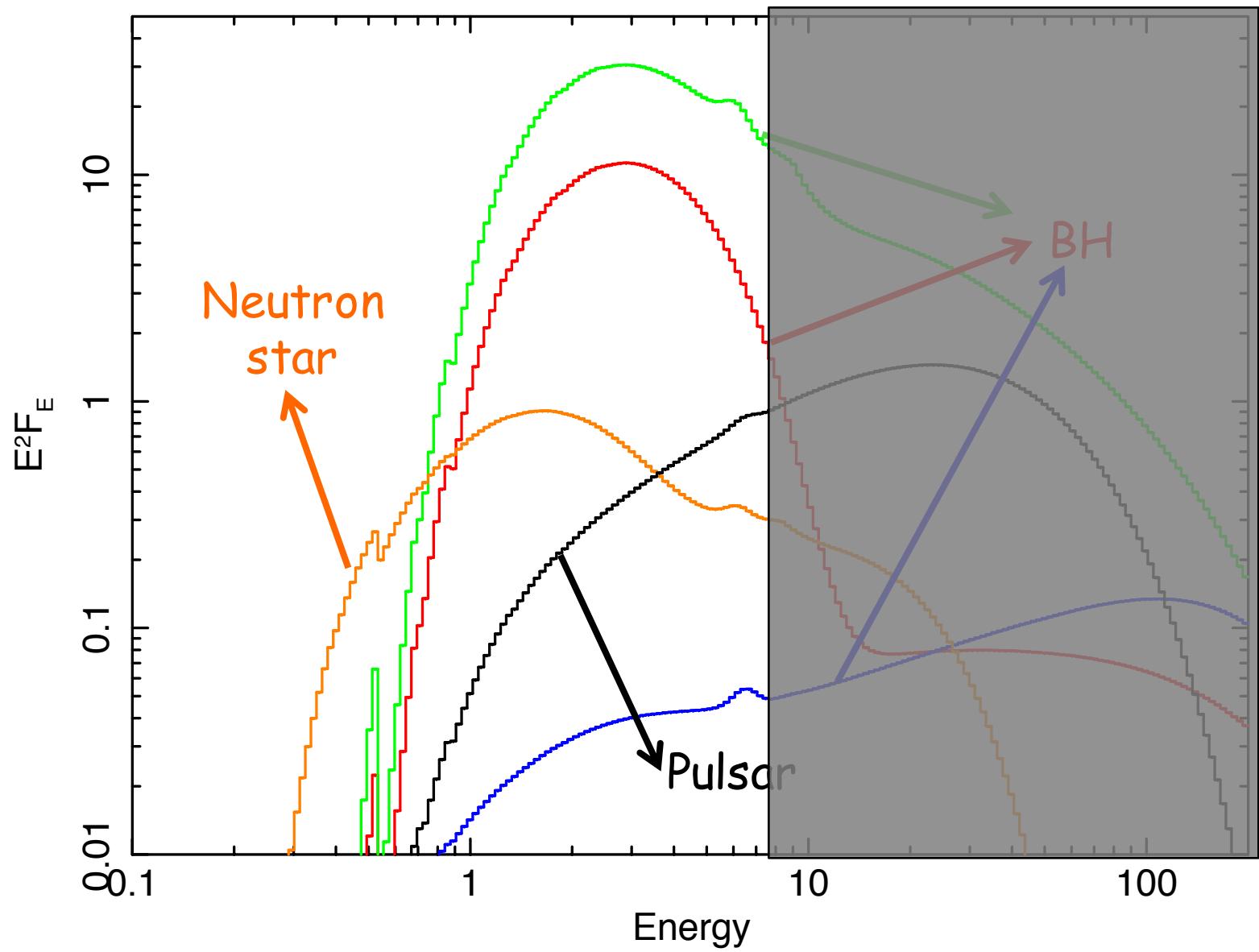
Spectral differences between compact objects



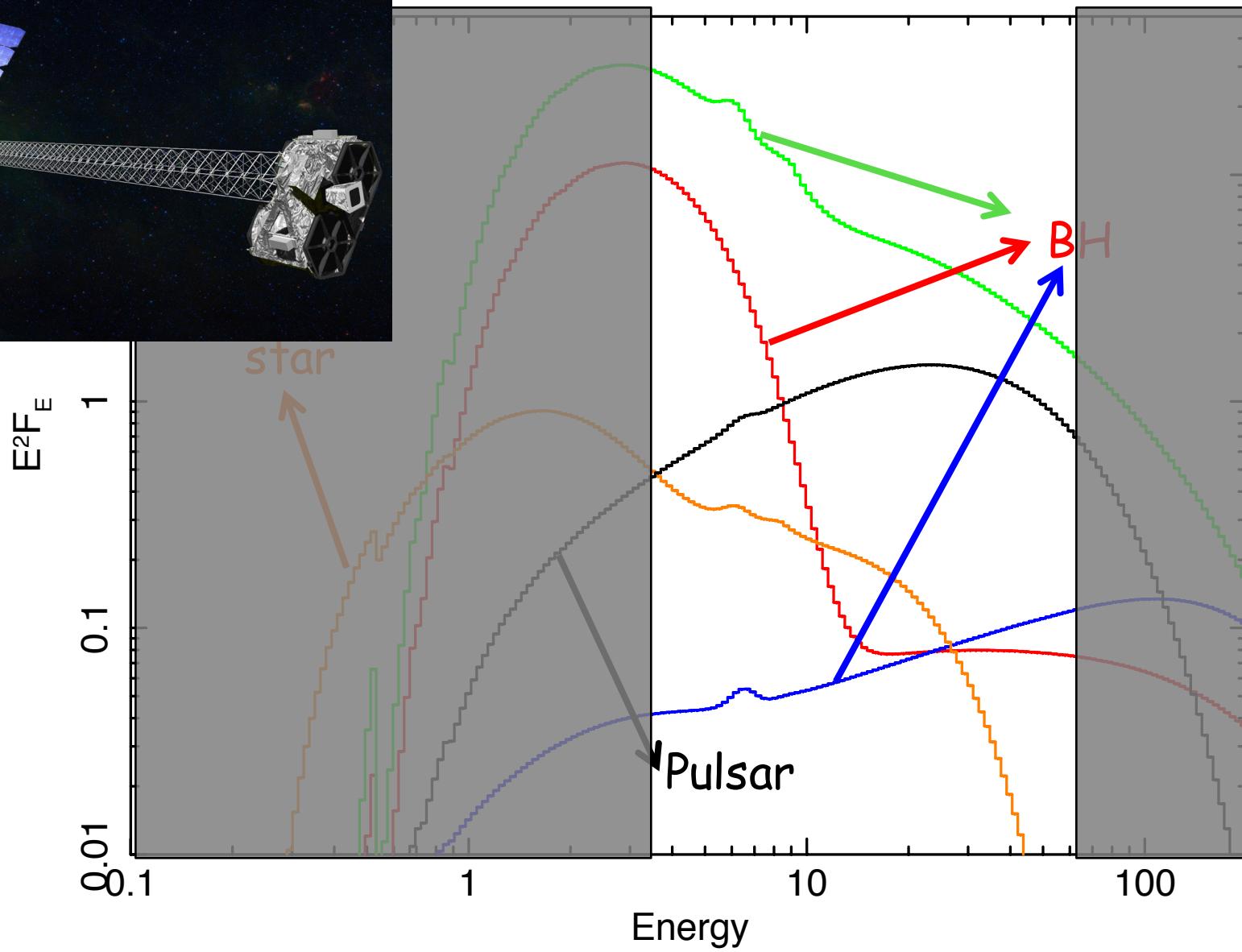
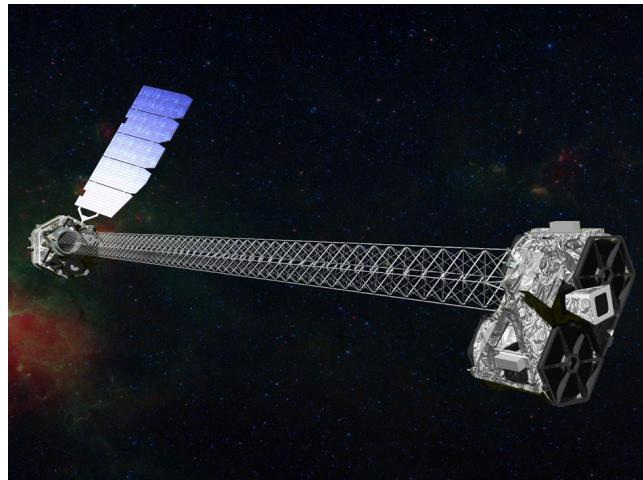
Spectral differences between compact objects



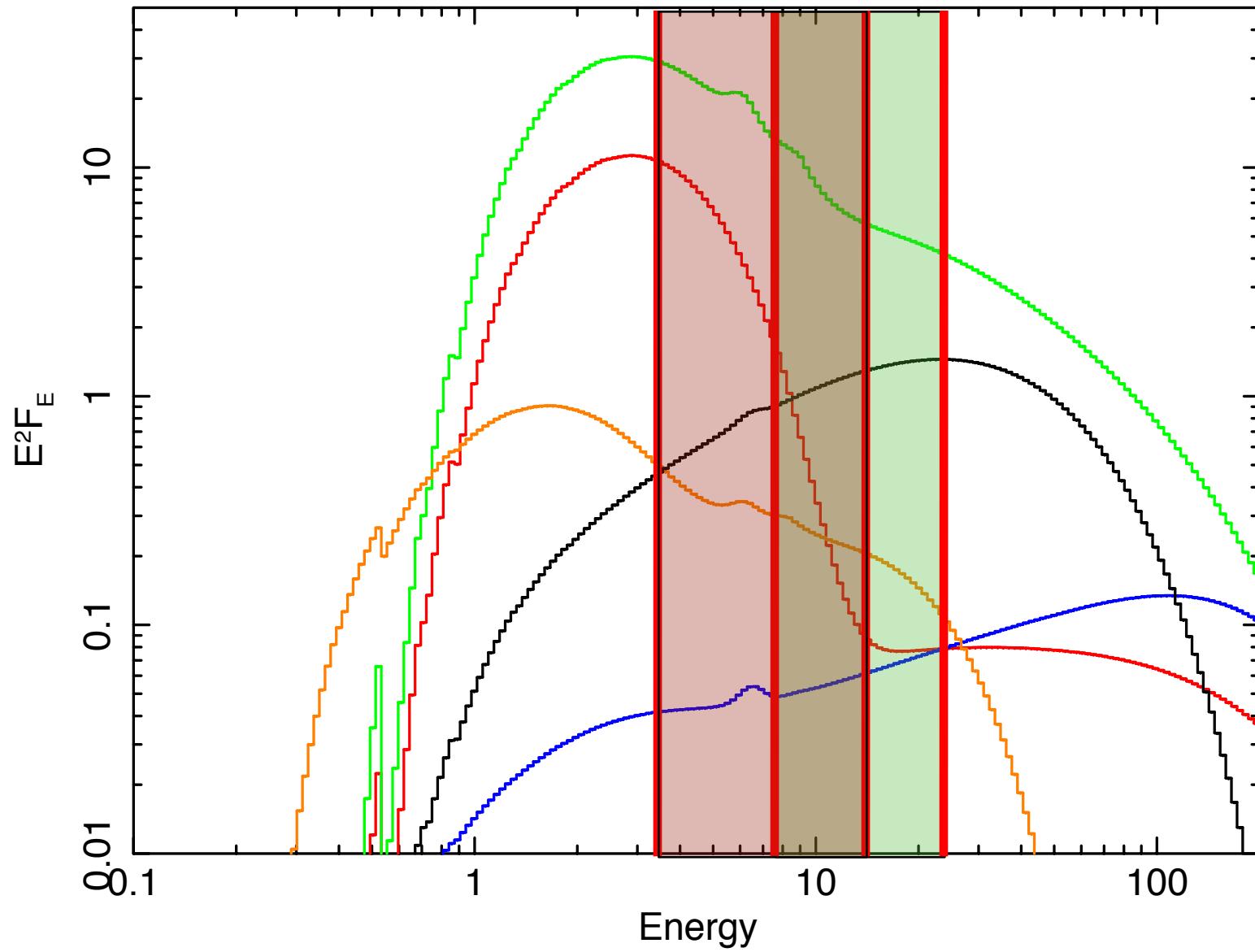
The view of galaxies up to 10 keV



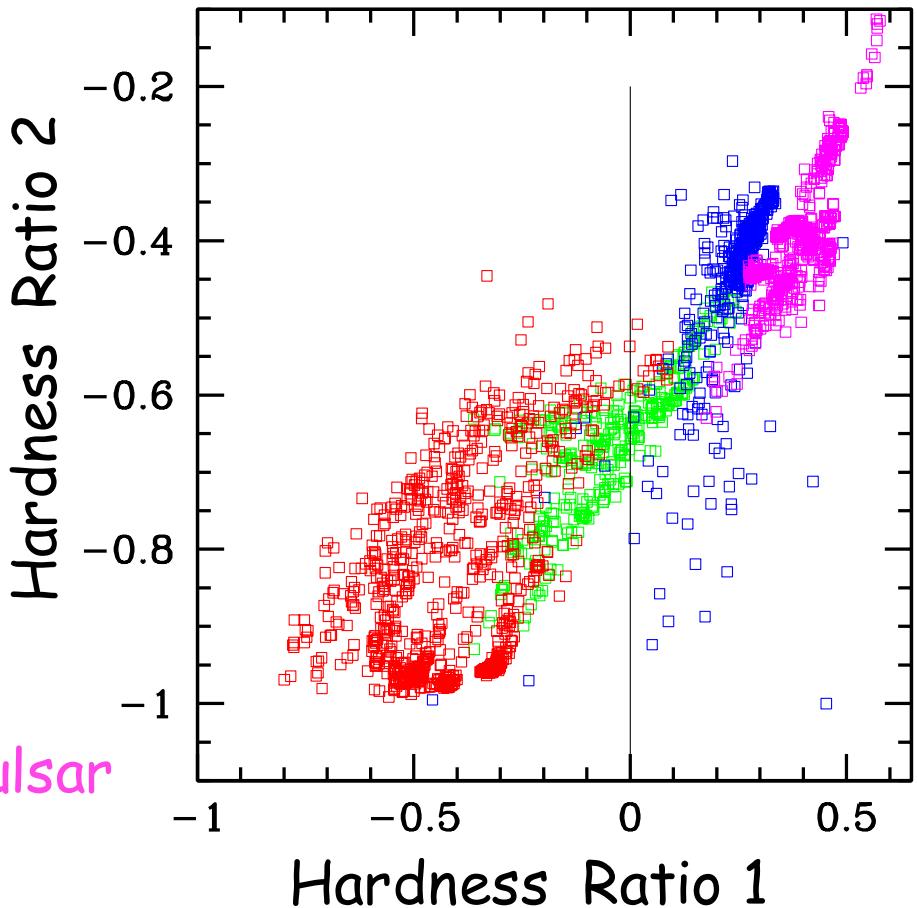
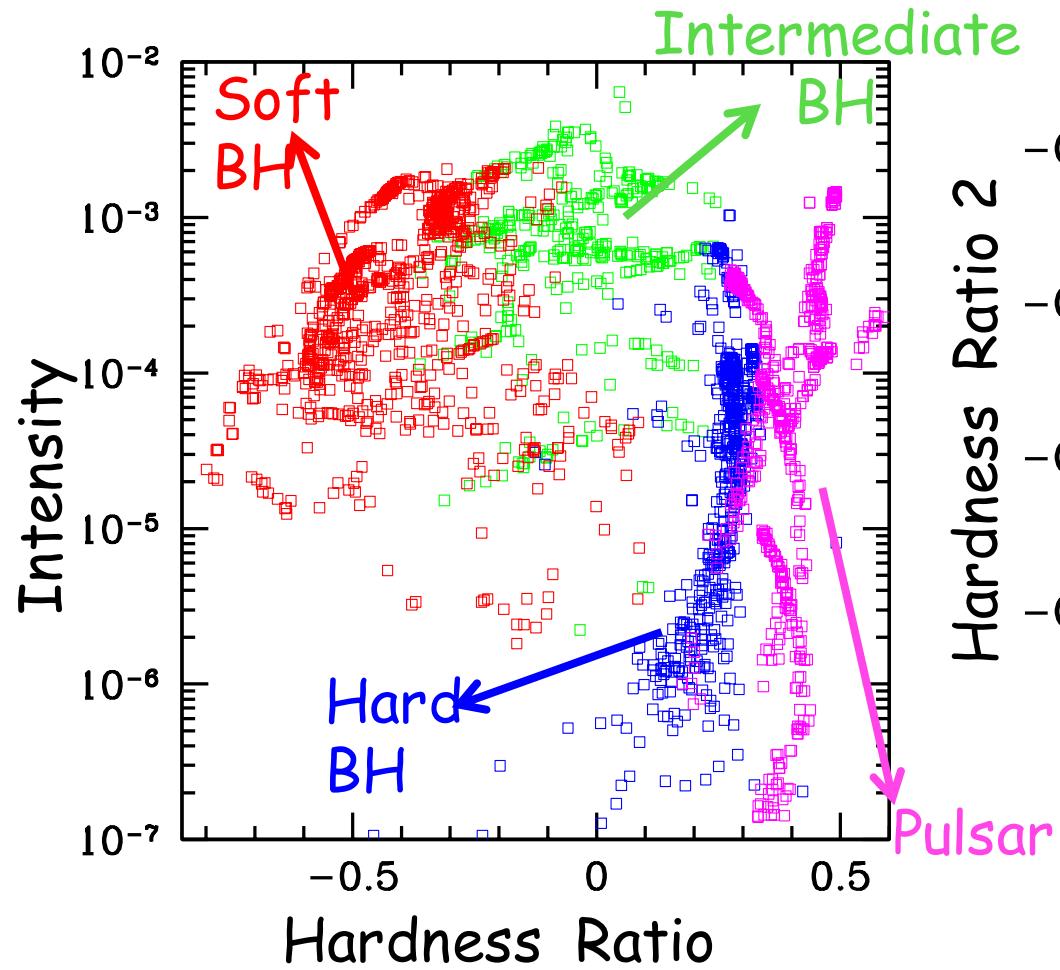
NuSTAR



Compact object classification

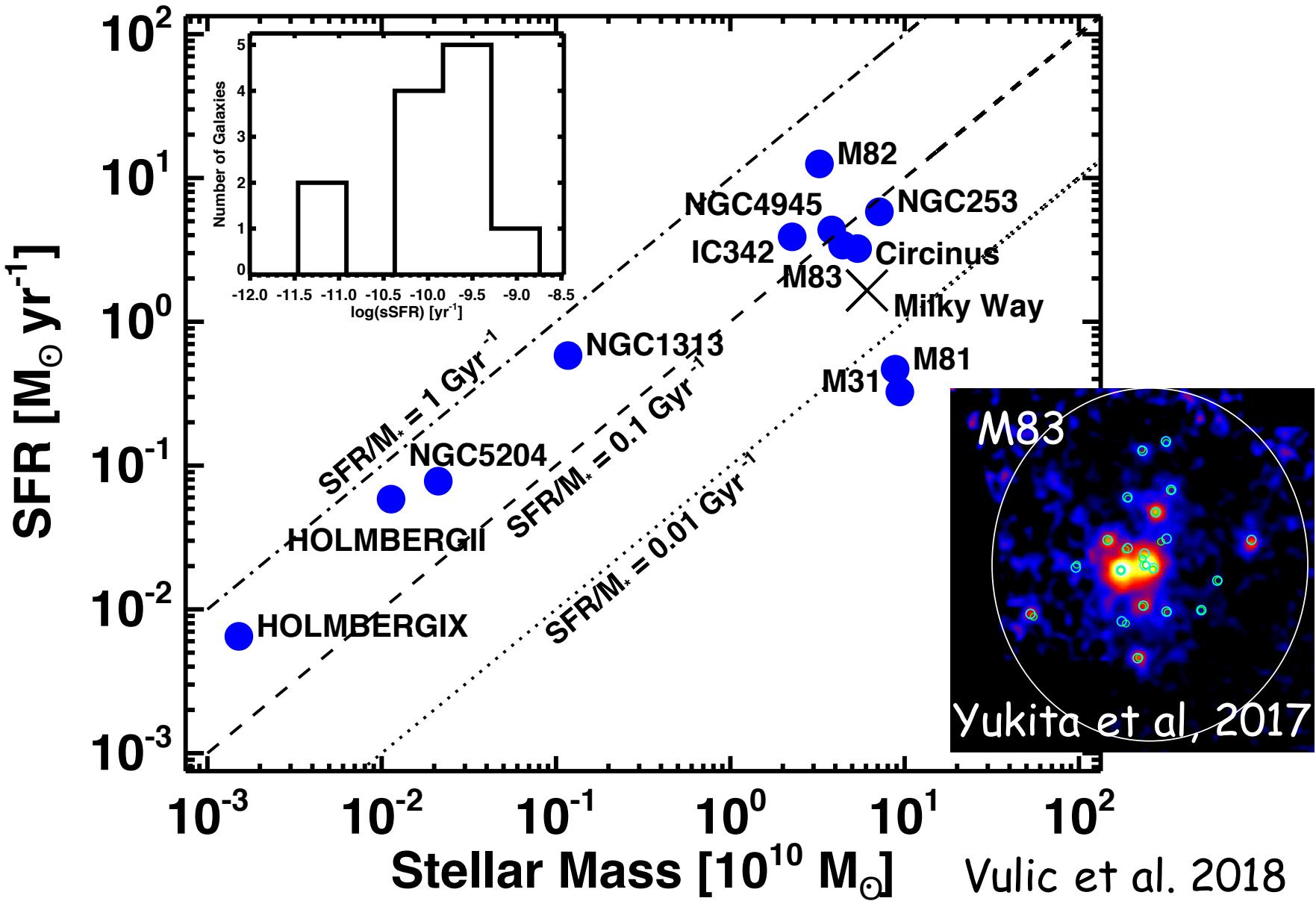


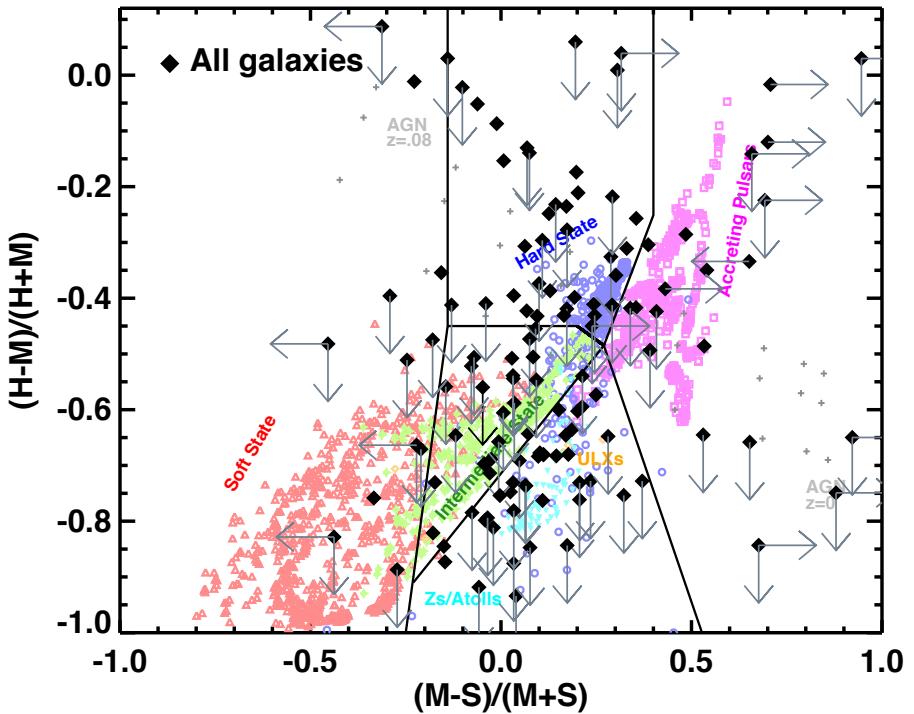
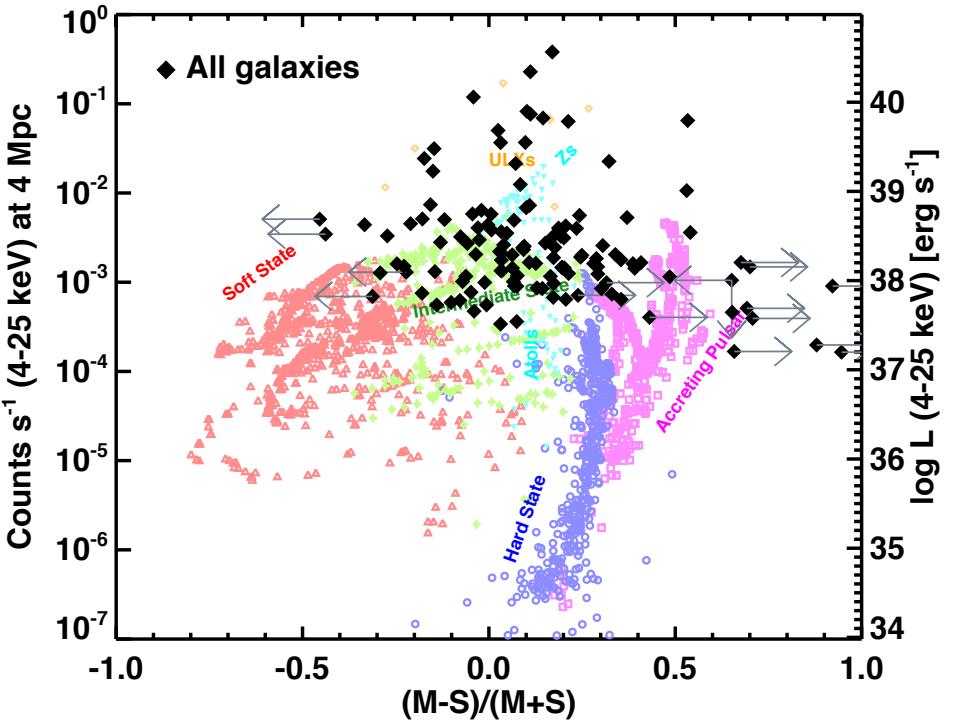
NuSTAR compact object diagnostics



Zezas, Kyanidis, Reig et al. 2019
Maragkakis, Zezas et al. 2019

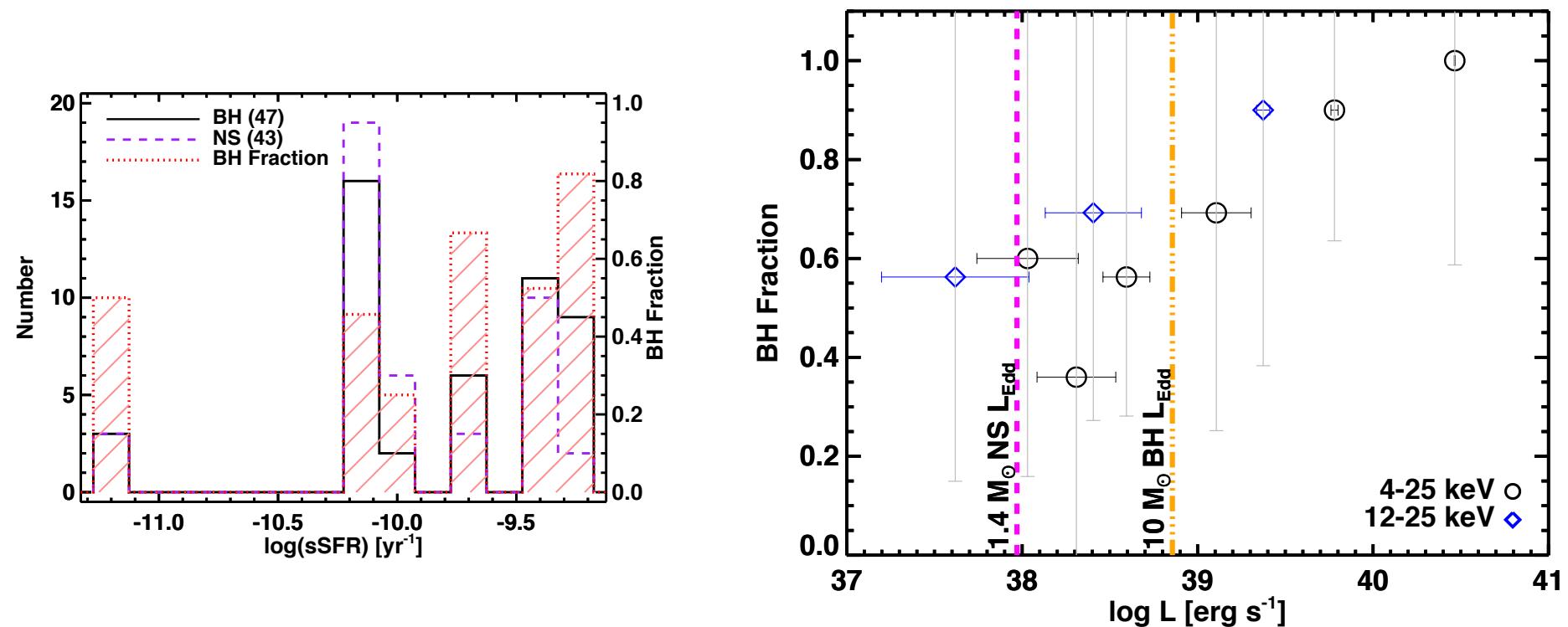
Sample of nearby galaxies



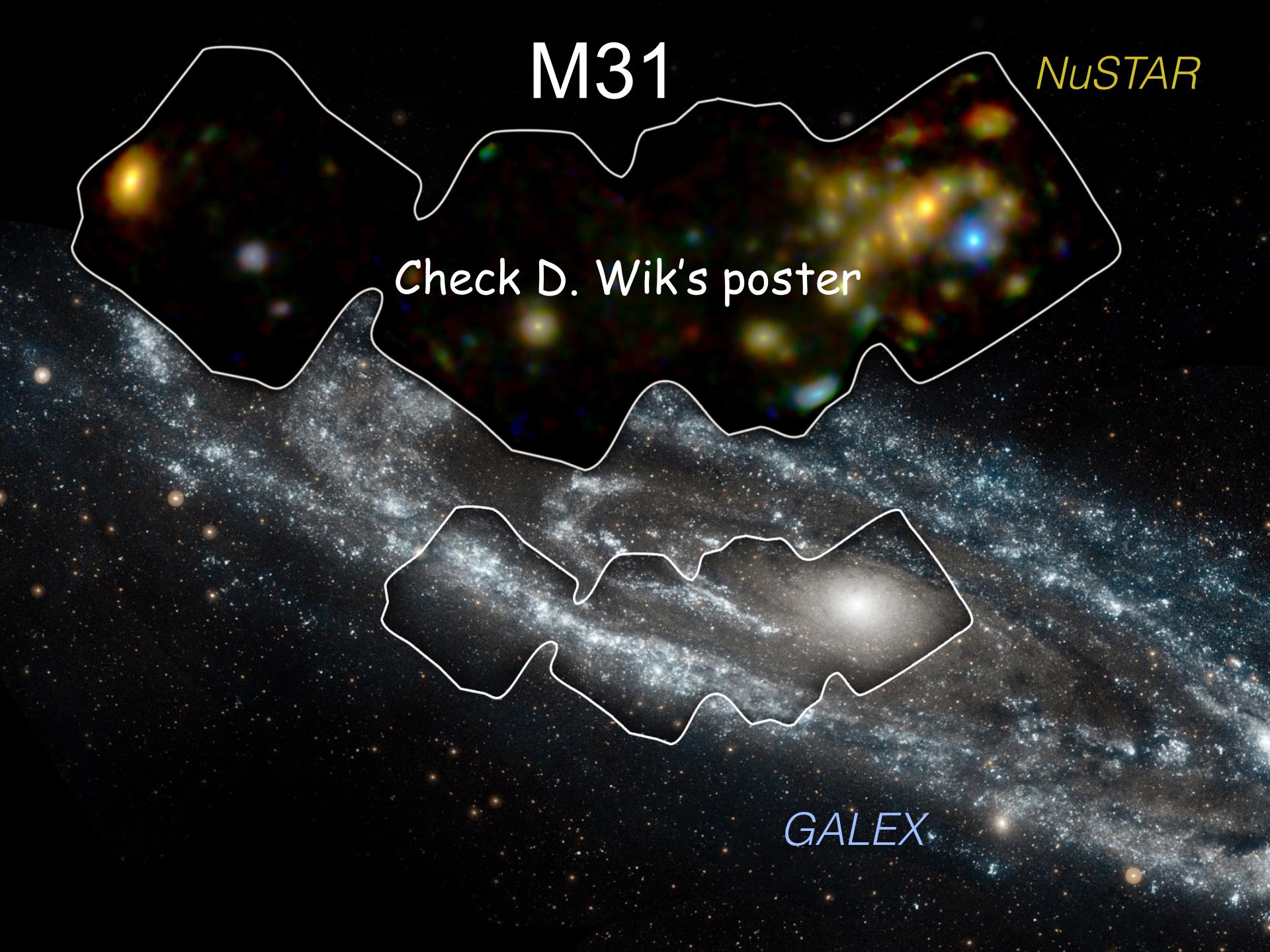


Vulic et al. 2018

Compact Object Demographics



Vulic et al. 2018



M31

NuSTAR

Check D. Wik's poster

GALEX

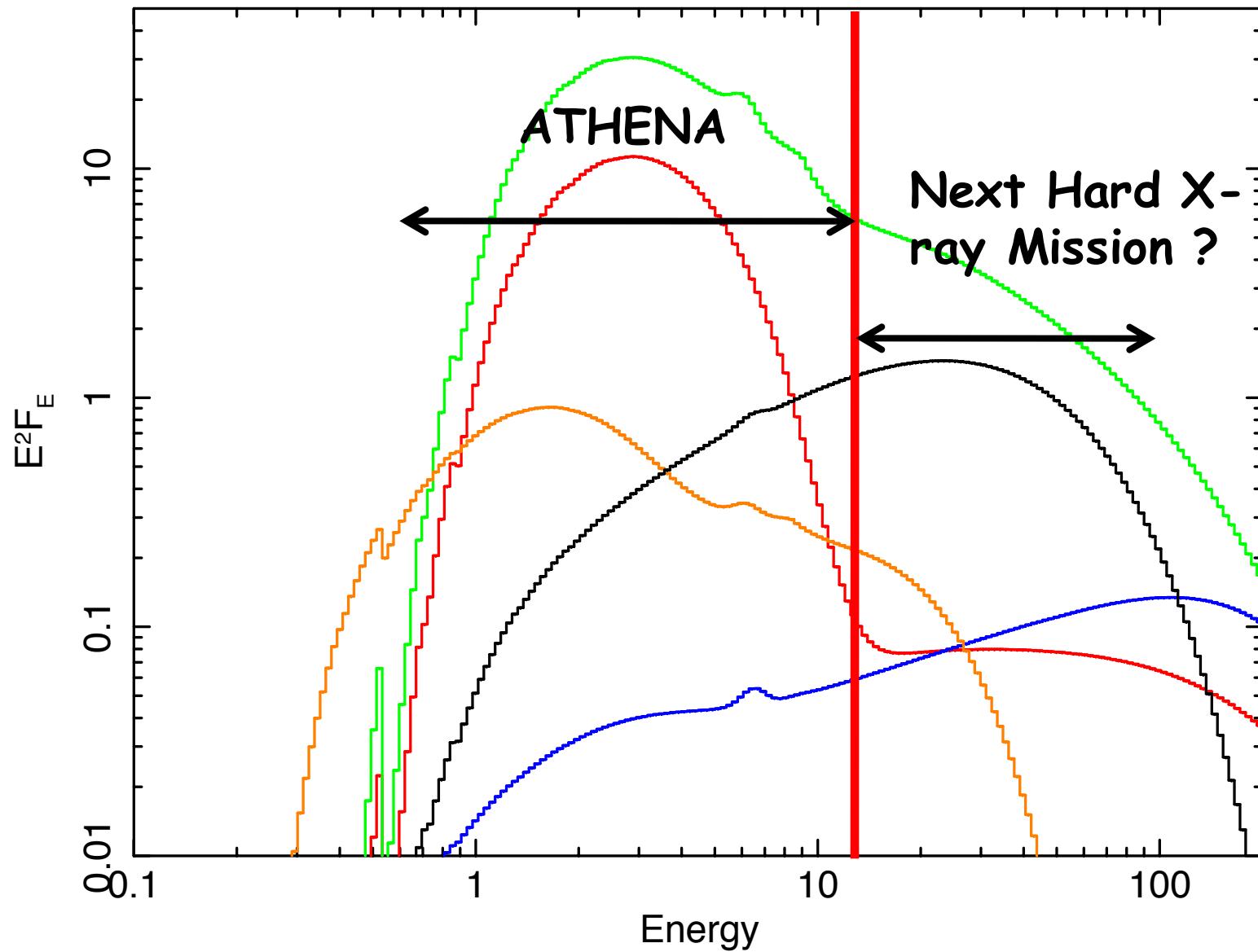
Summary

First direct measurement of XRB formation efficiency

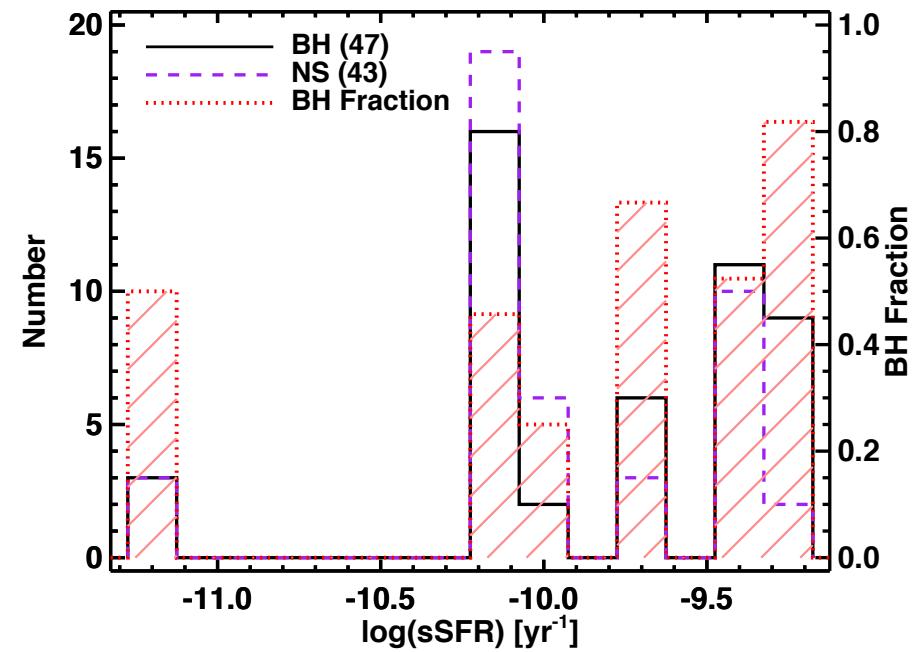
First constraints on compact object demographics in other galaxies

- Synergy of X-ray and multi-wavelength information
 - Characterization of compact objects and donor stars critical for
 - ✓ Measuring XRB formation
 - ✓ Constraining XRB evolution
 - ✓ Effect of star-formation history, metalicity on compact object populations
- Need spatial resolution and energy coverage >10keV

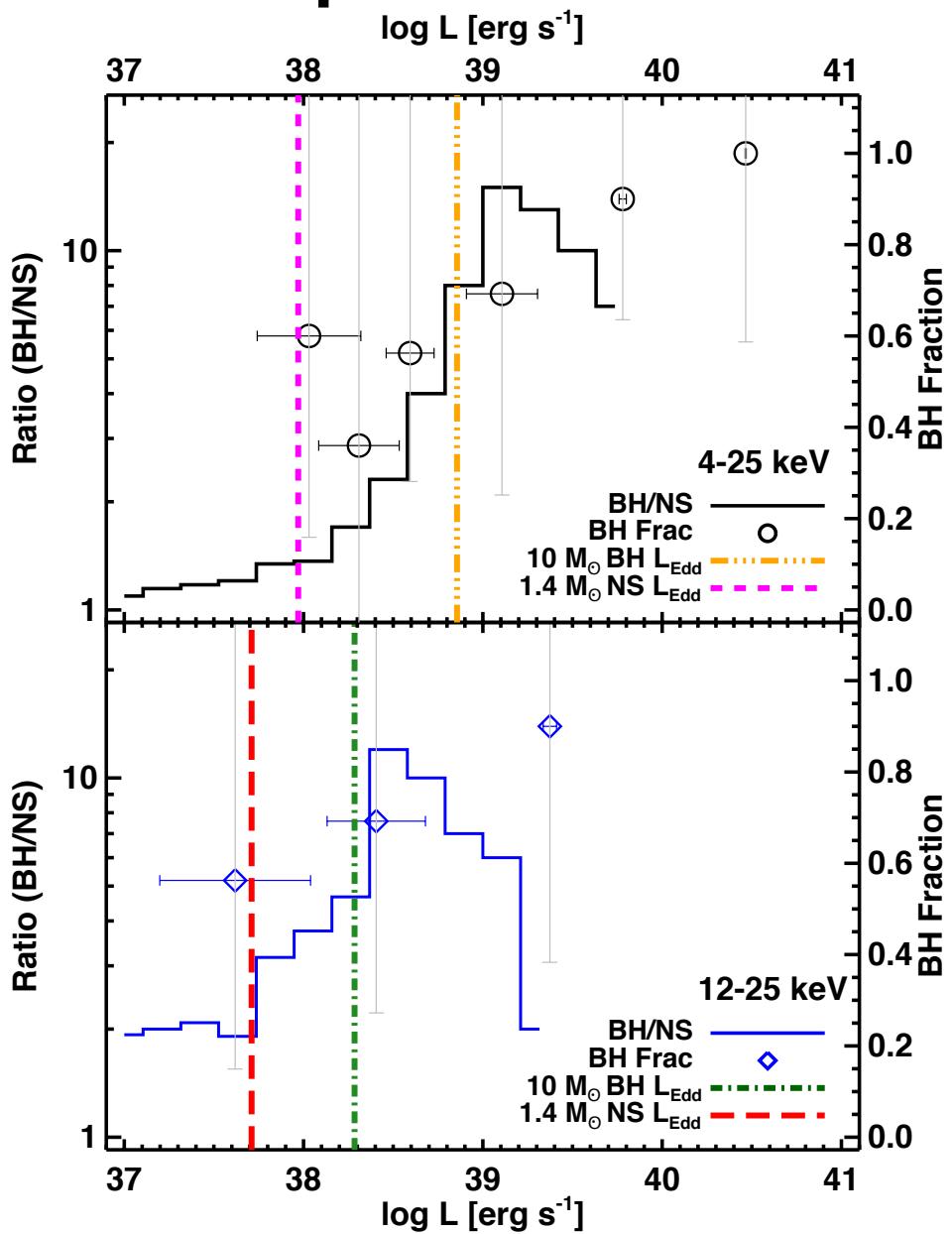
Looking into the future



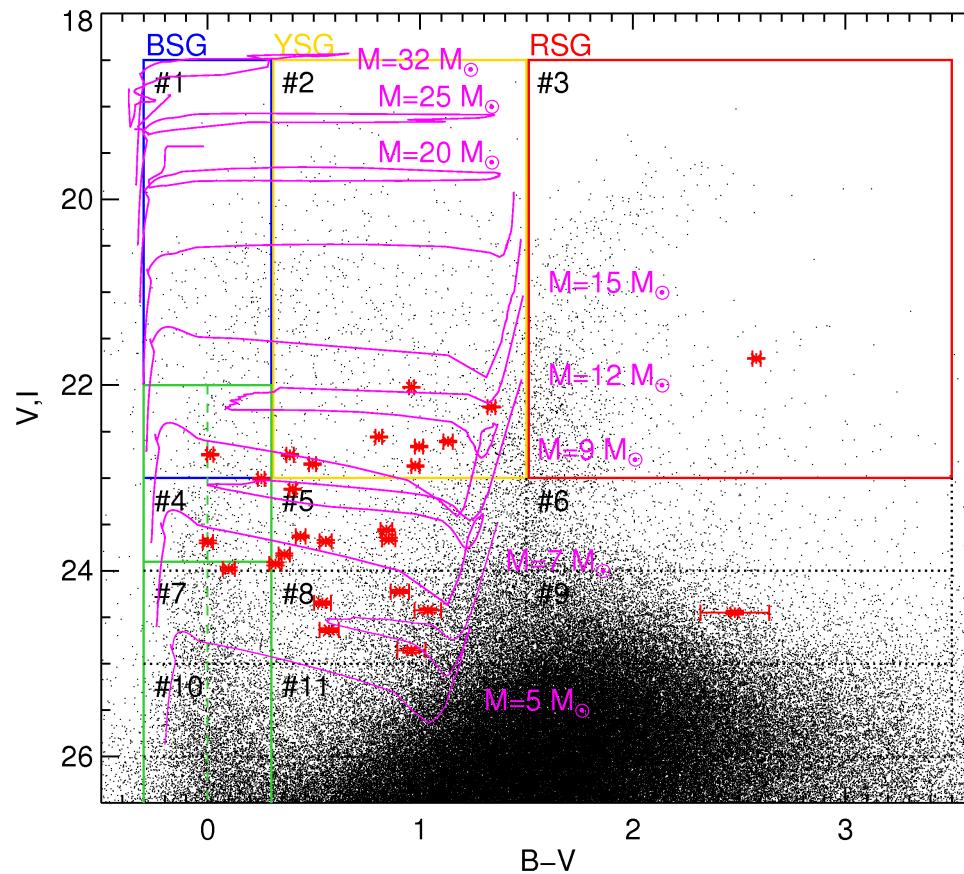
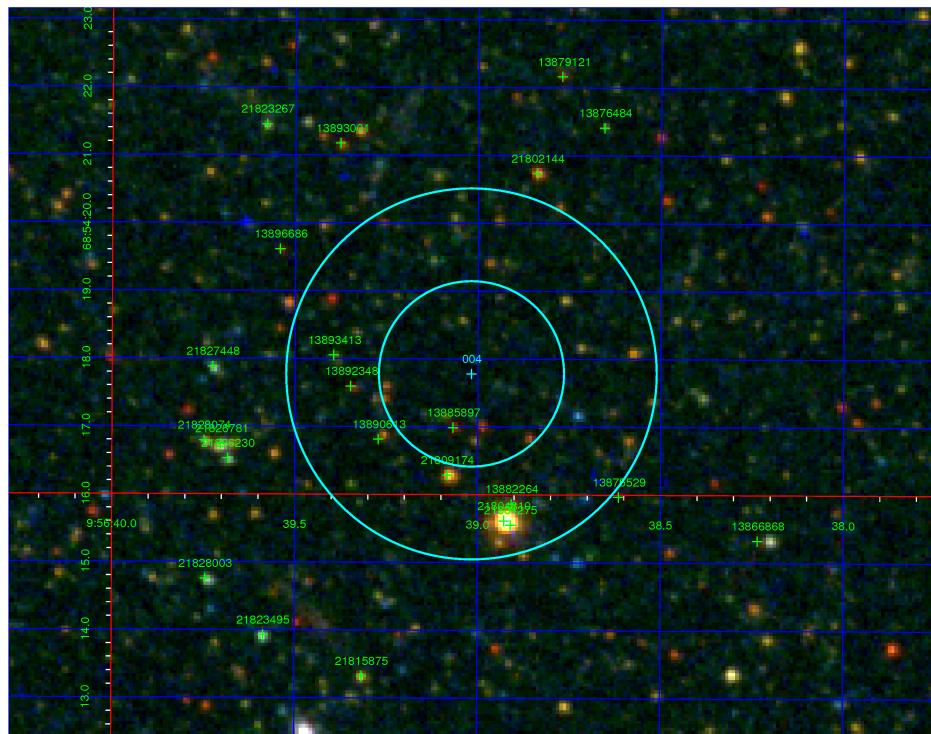
Compact Object Populations



Vulic et al. 2018



Donor star classification



The deep Chandra SMC Survey

A Chandra "X-ray Visionary Program":

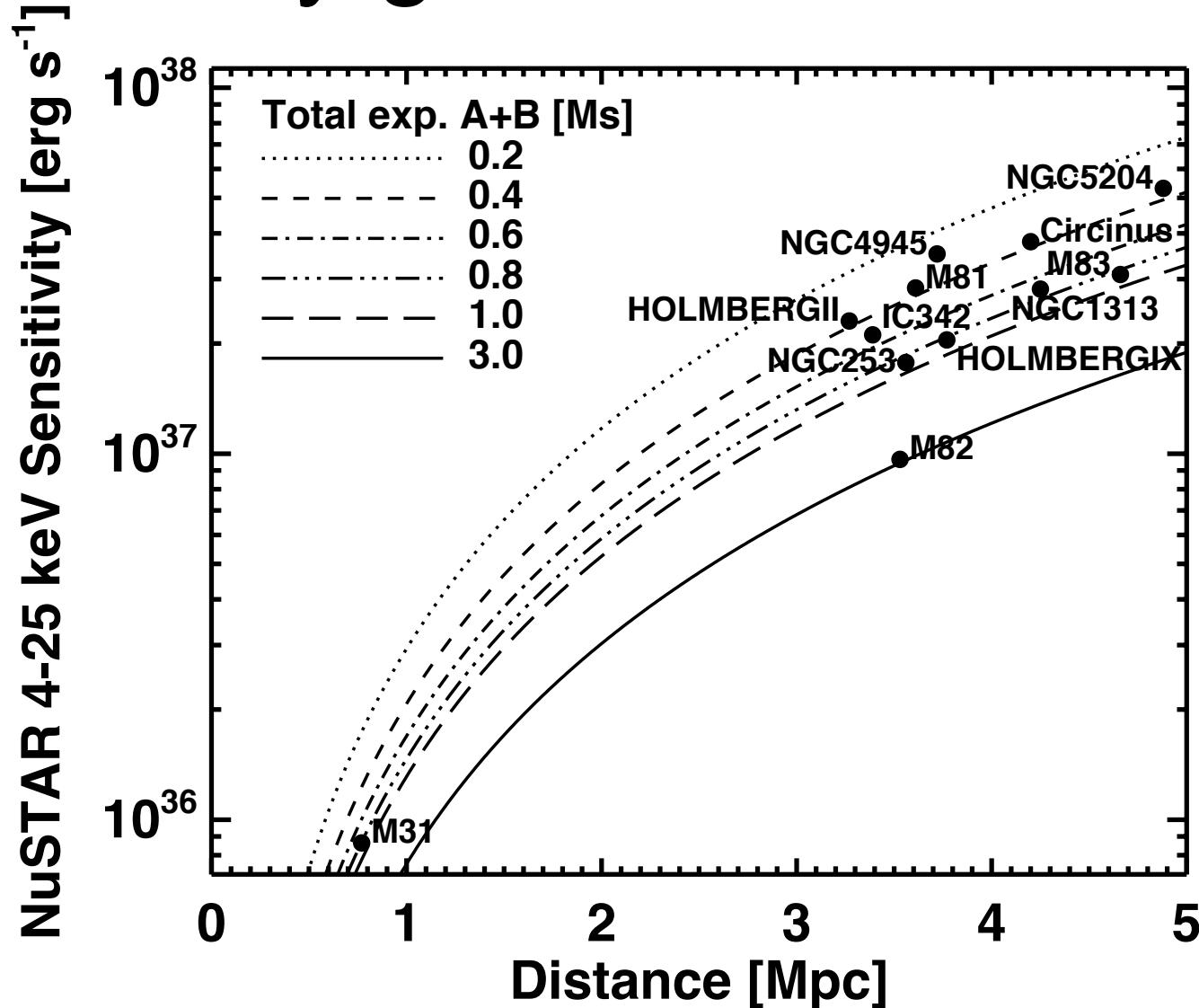
11 +3 Fields in the SMC

2 × 50ksec exposures (1.1 + 0.3 Msec total)

Goals:

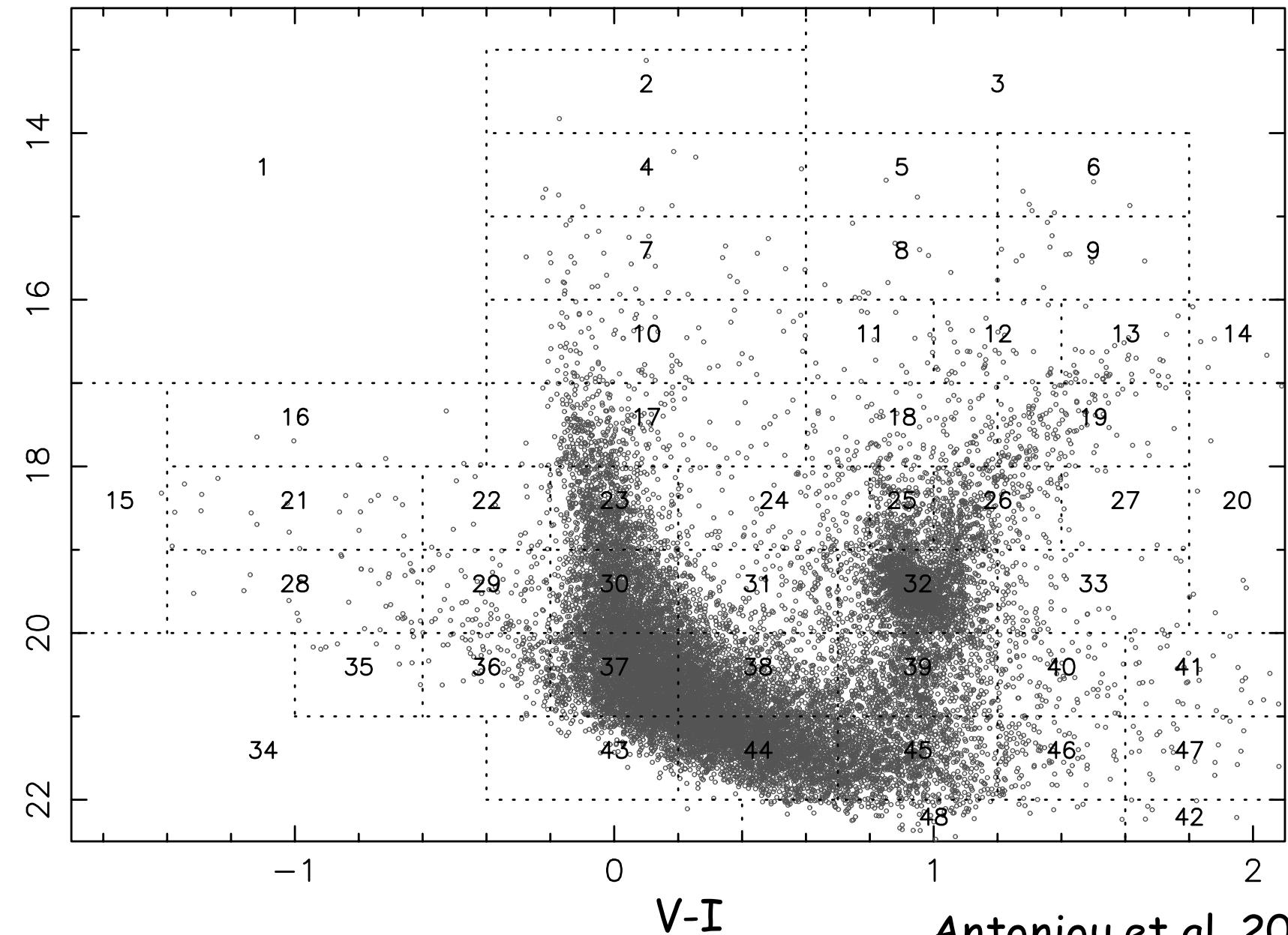
- A deep census of accreting pulsars
- HMXB formation efficiency at different ages
- Long-term variability of accreting pulsars
- Detailed studies of SNRs
- Stars at low metallicity

Nearby galaxies above 10 keV

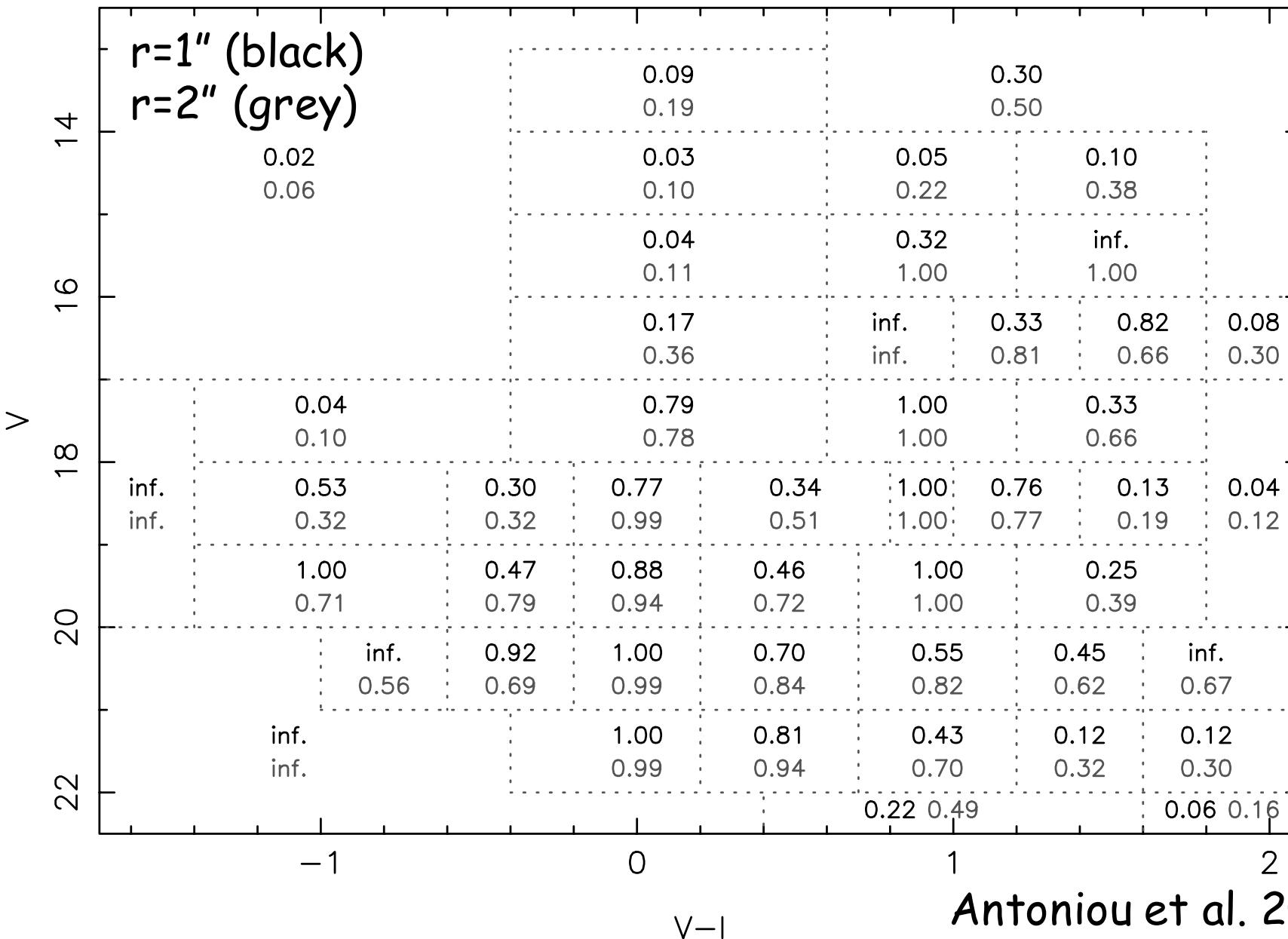


Vulic et al. 2018

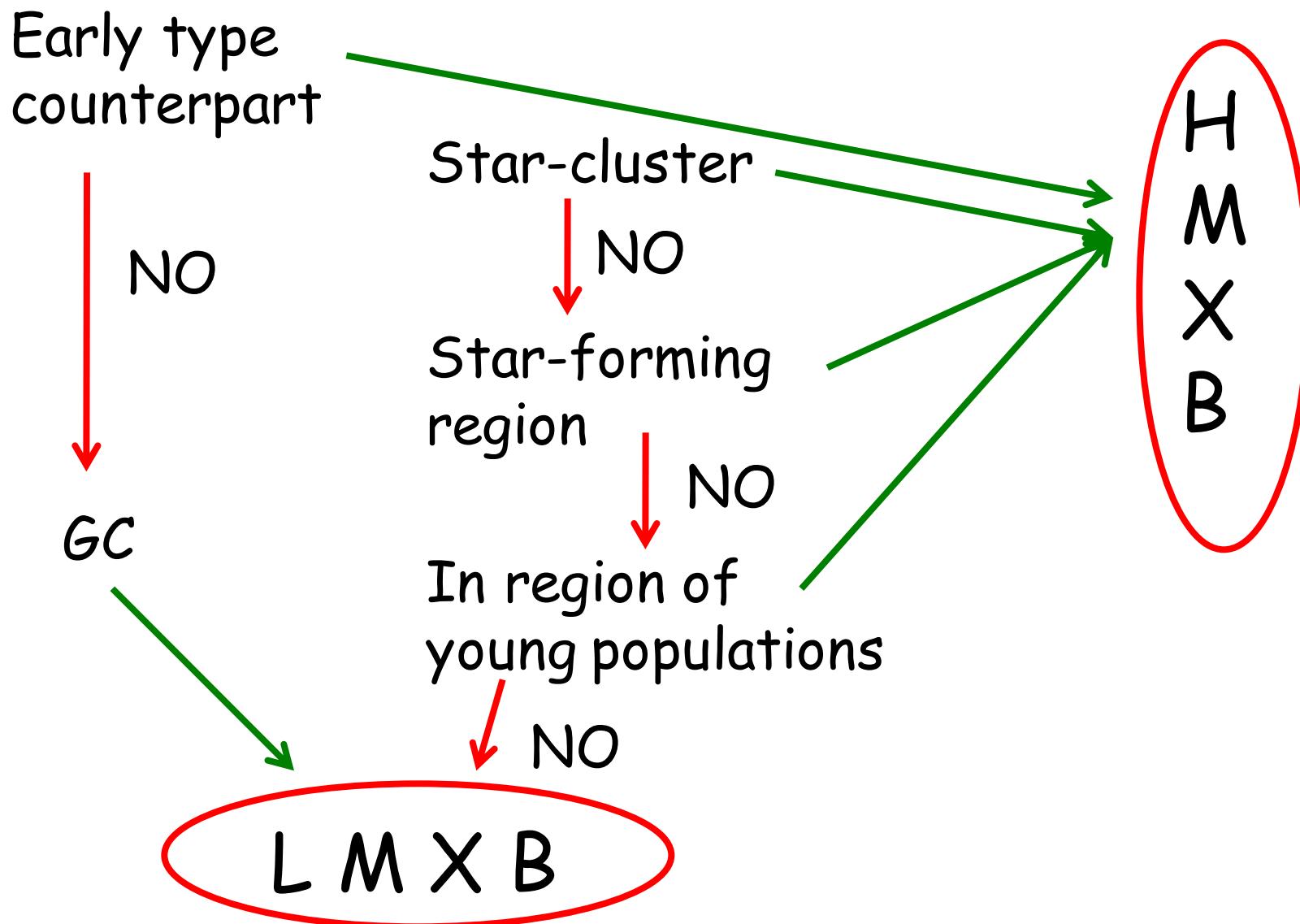
Chance coincidence



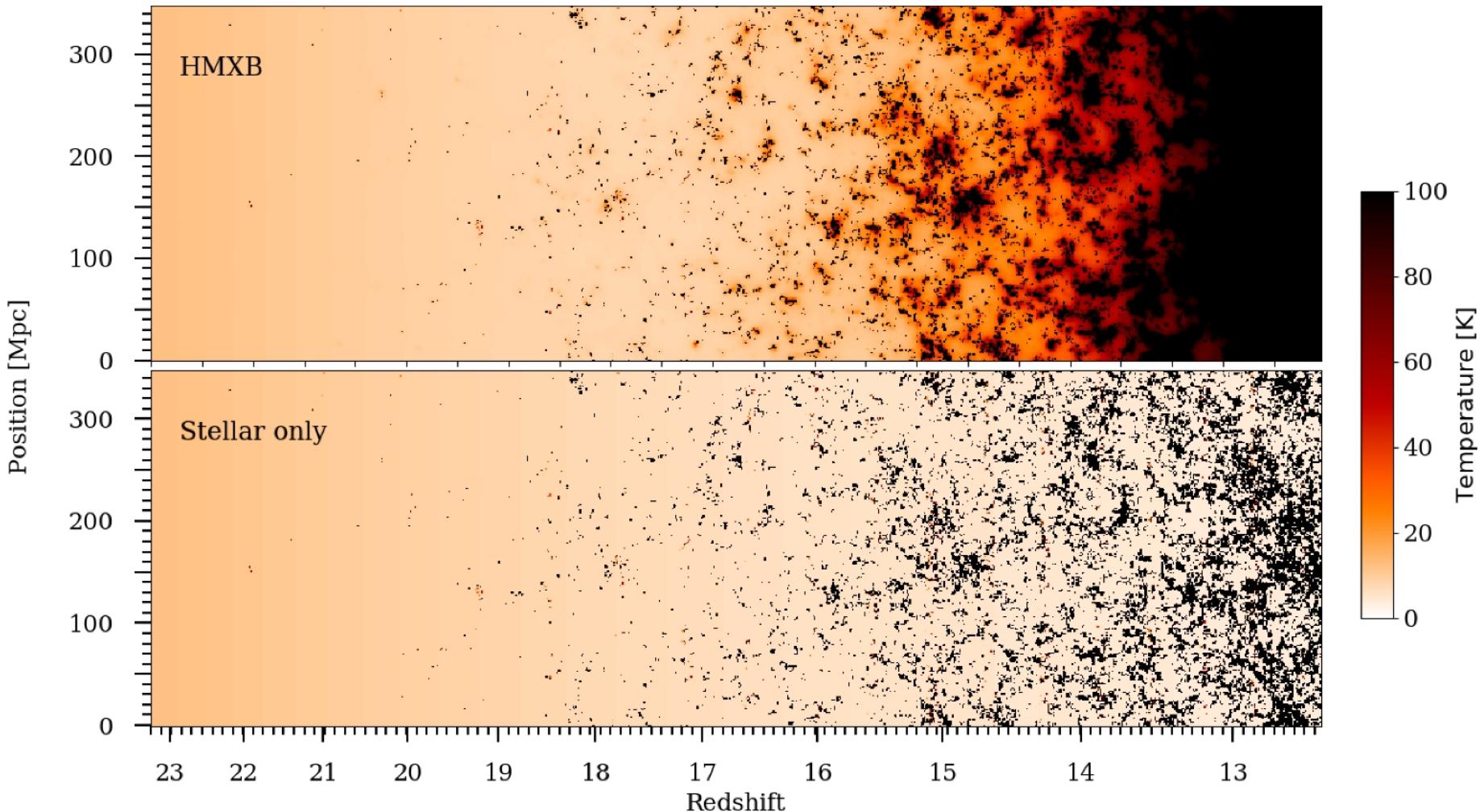
Chance coincidence



X-ray source classification

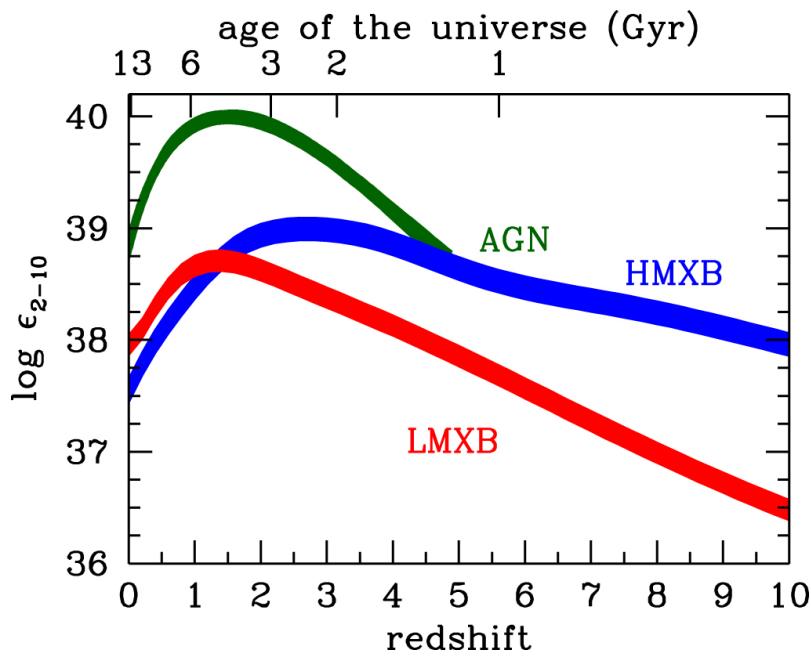


IGM preheating

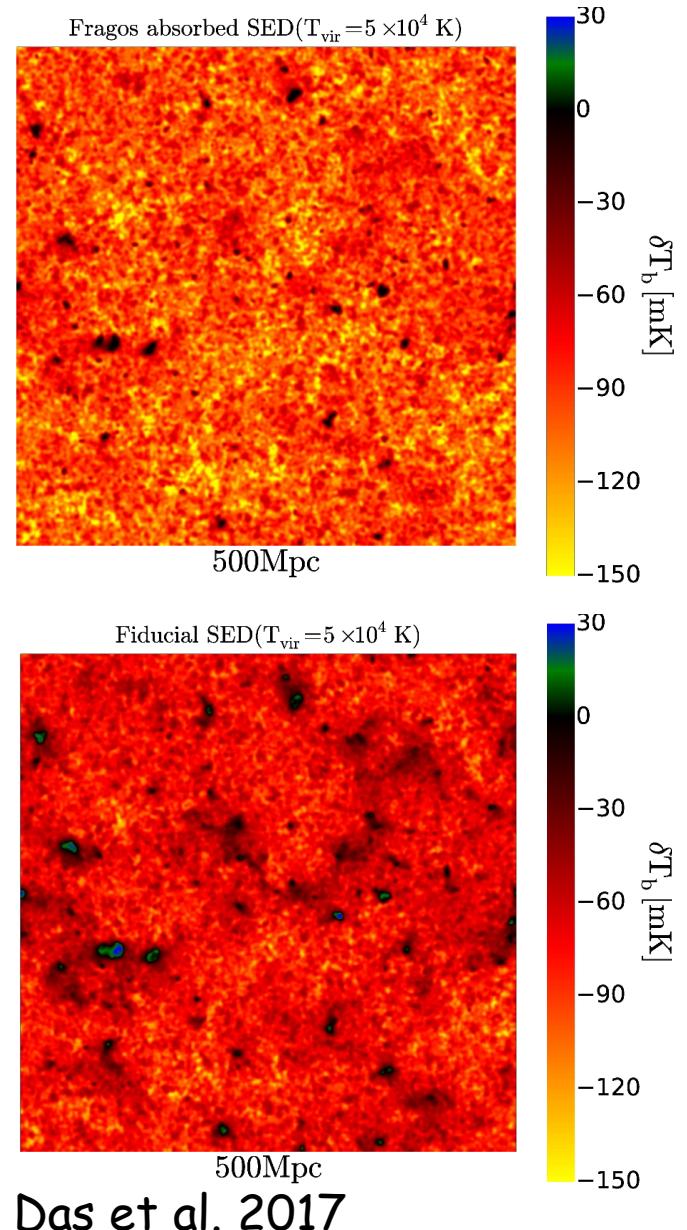


Ross et al. 2017

IGM preheating



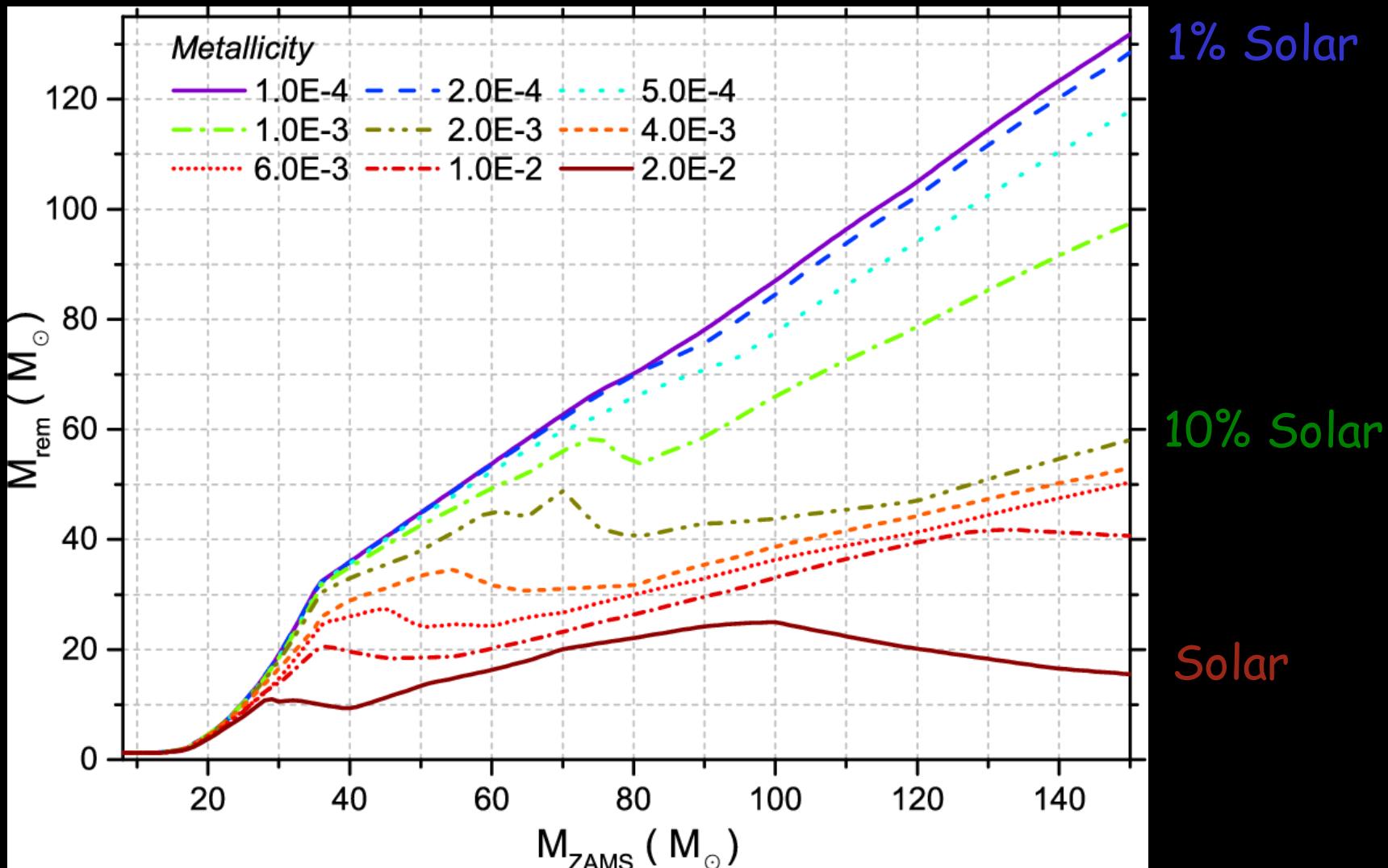
Madau & Fragos 2017



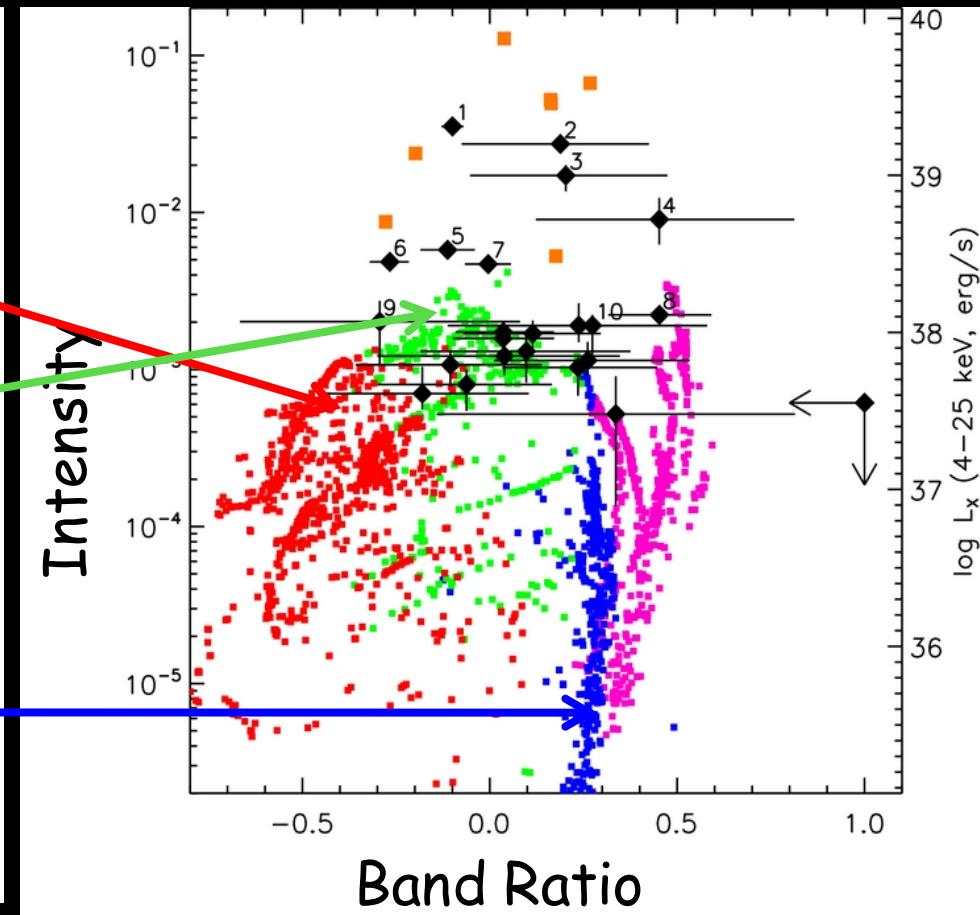
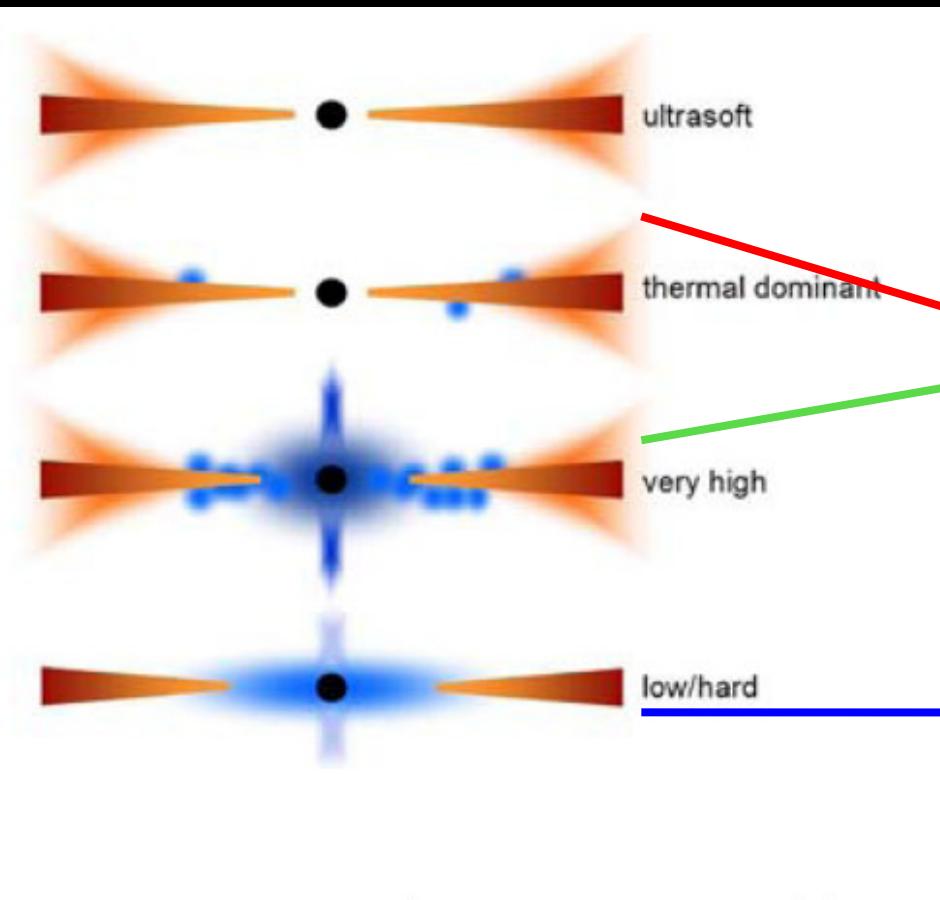


M31: our “twin” galaxy

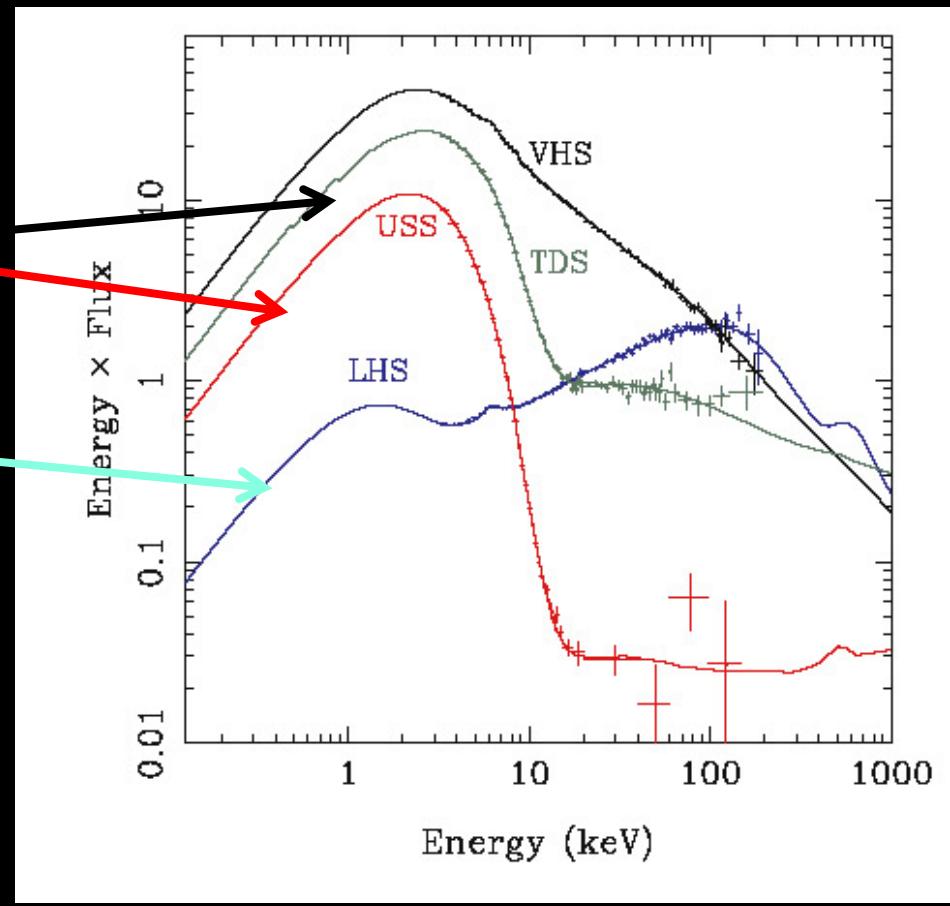
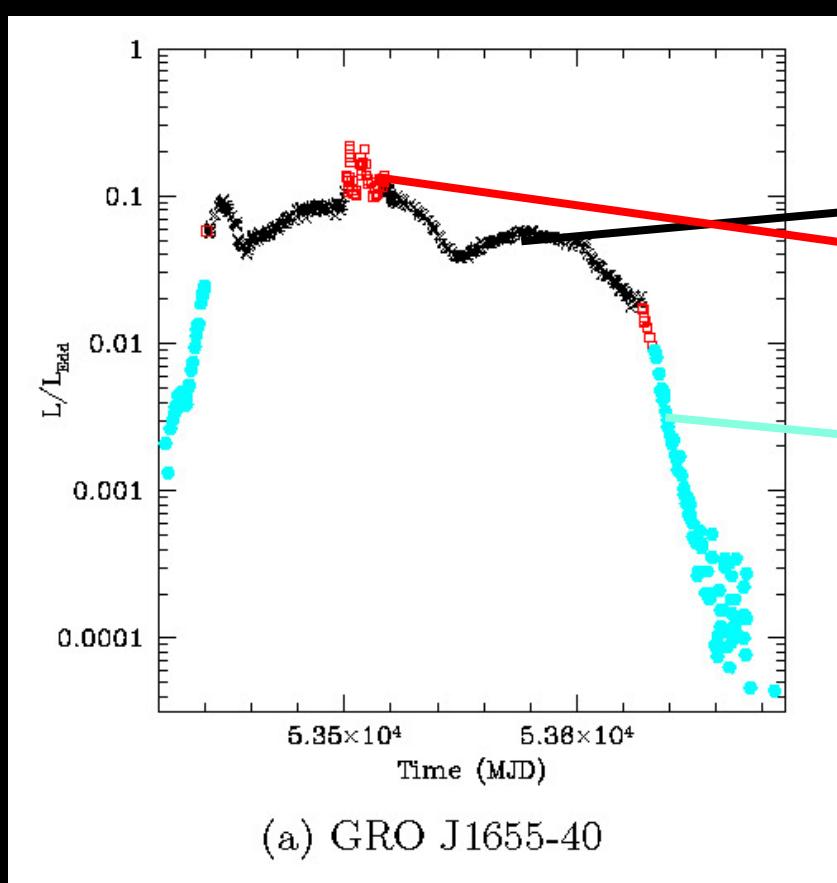
Compact object populations



Accretion Physics

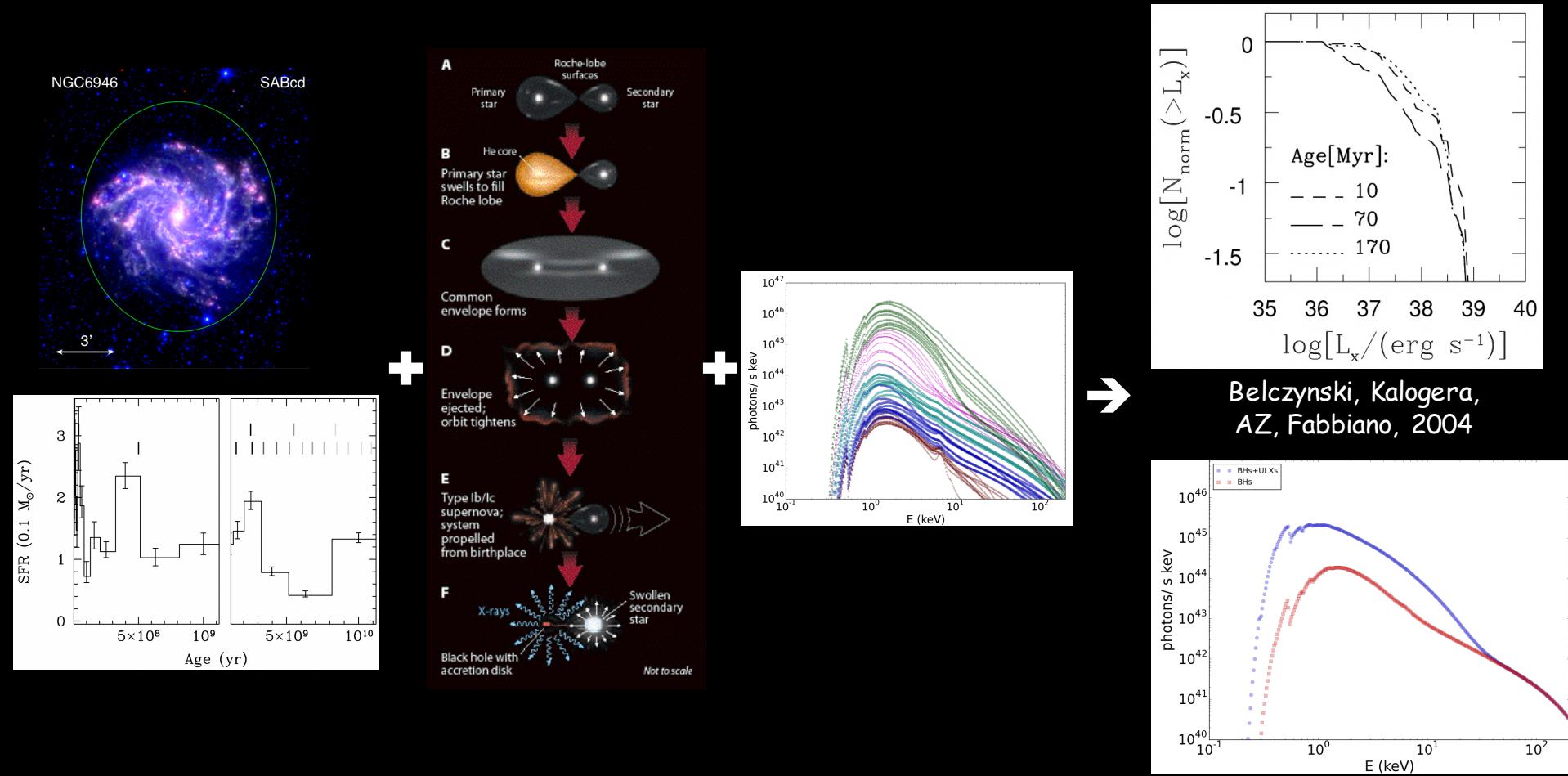


The standard accretion paradigm



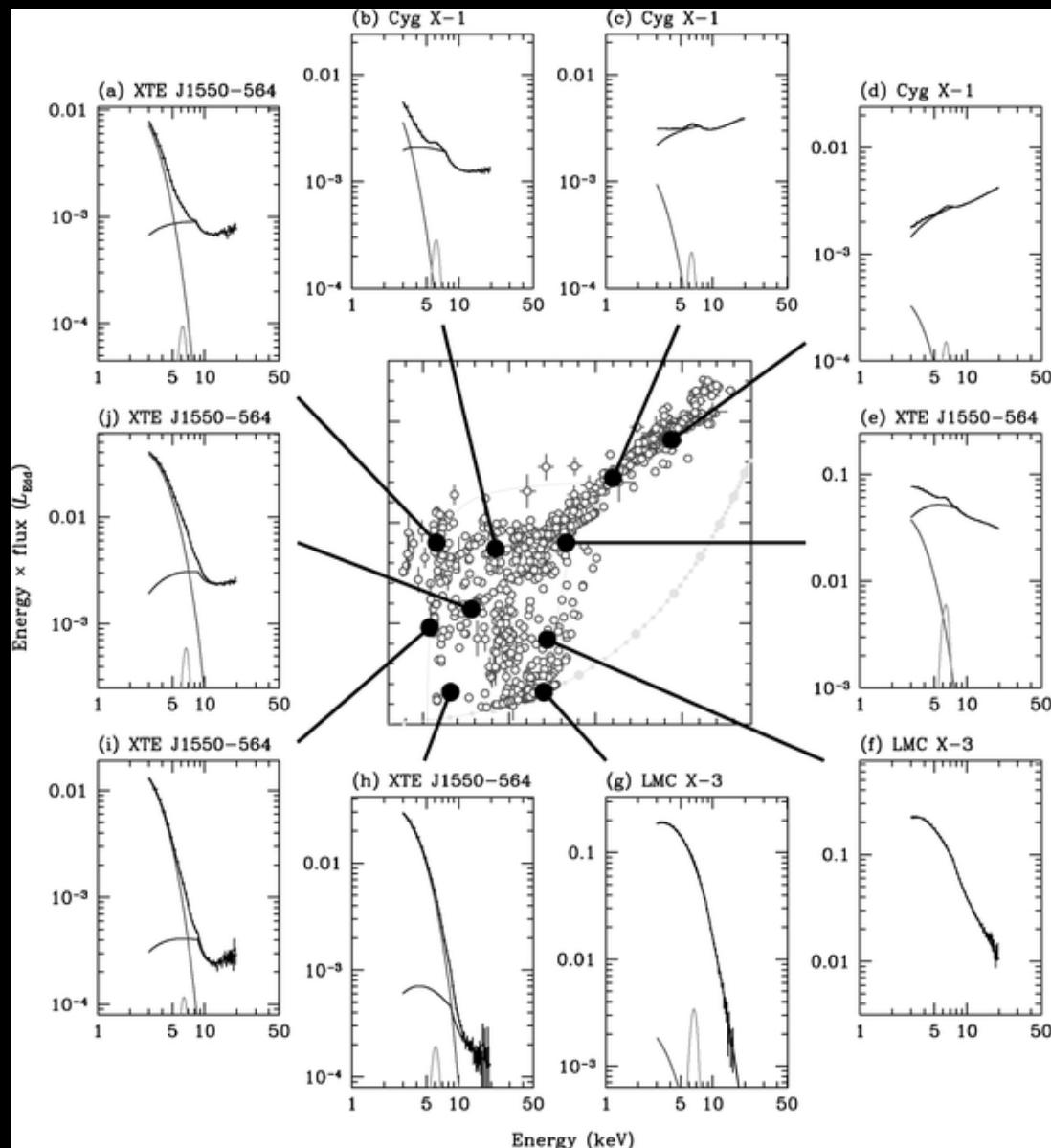
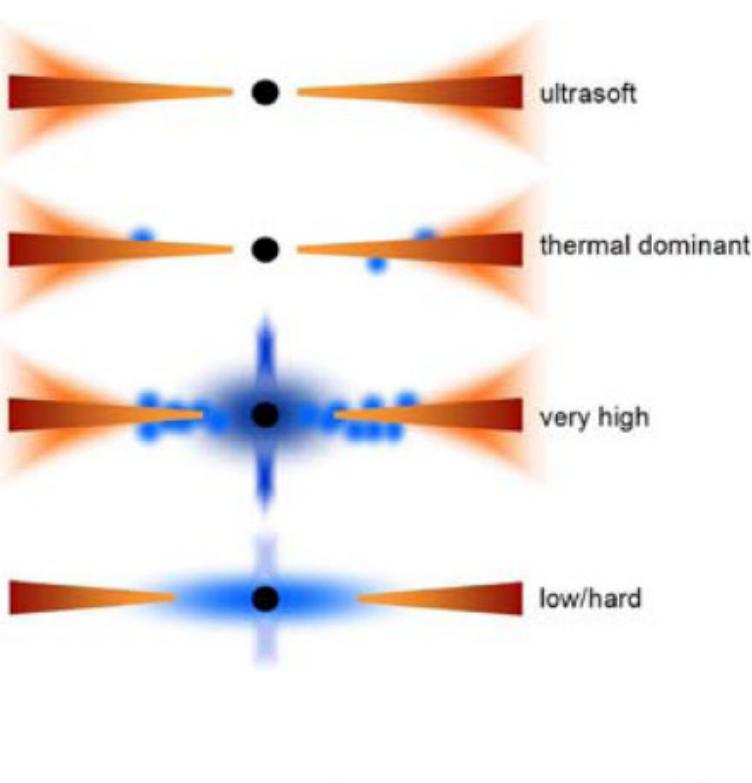
Done, Gierlinski, & Kubota, 2007

Population simulations

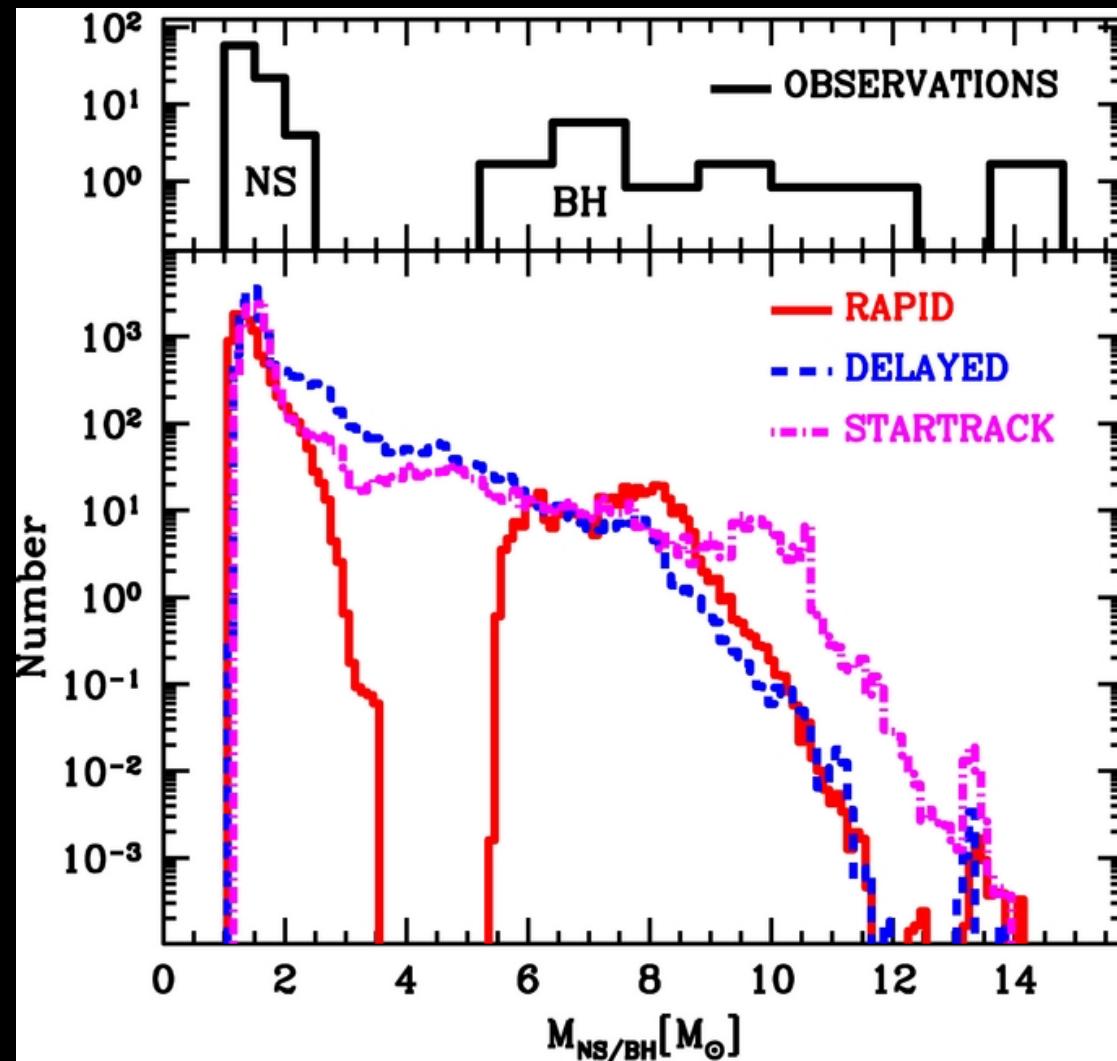


Anastasopoulou,
Zezas et al.

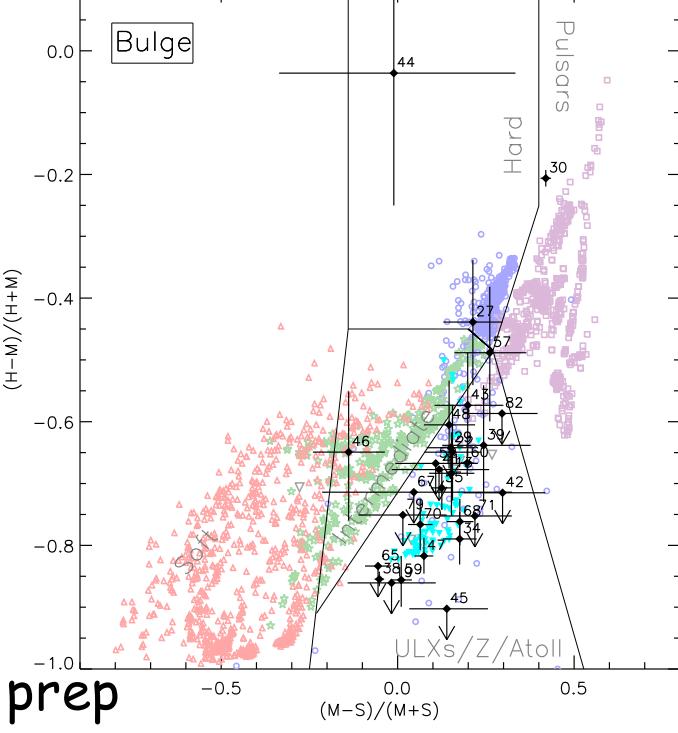
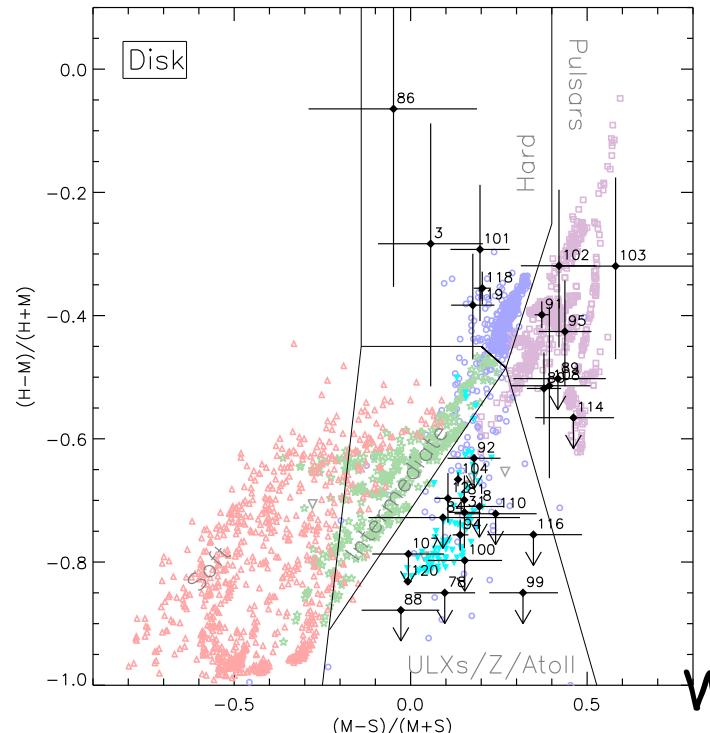
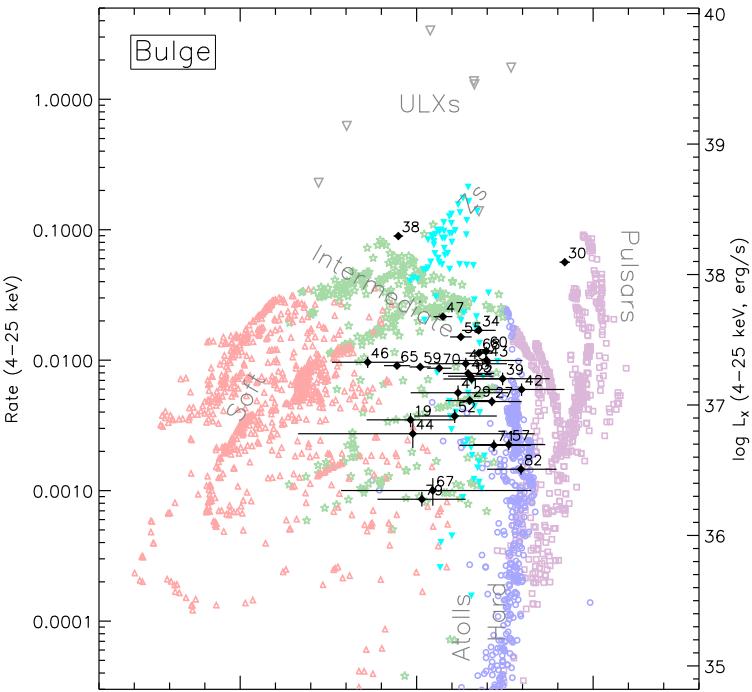
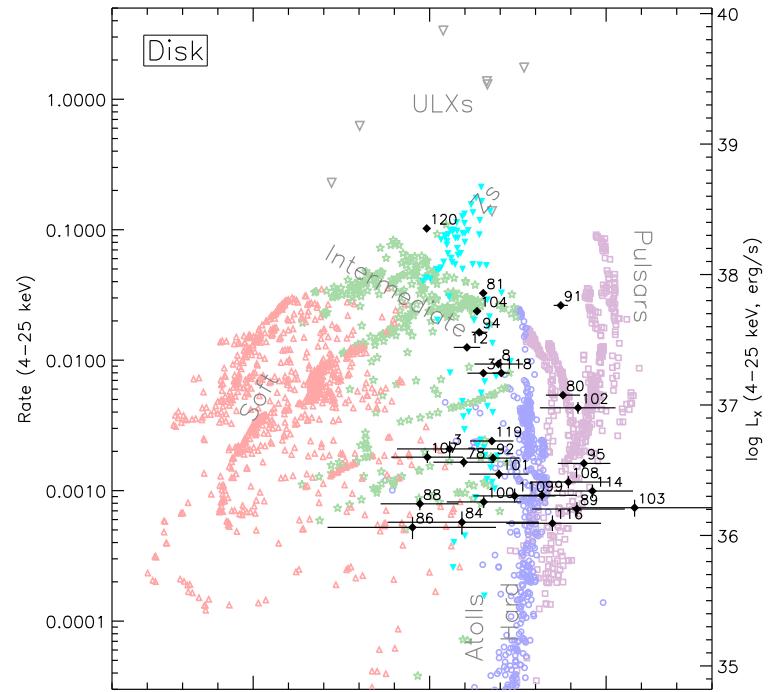
A diagnostic for NuSTAR



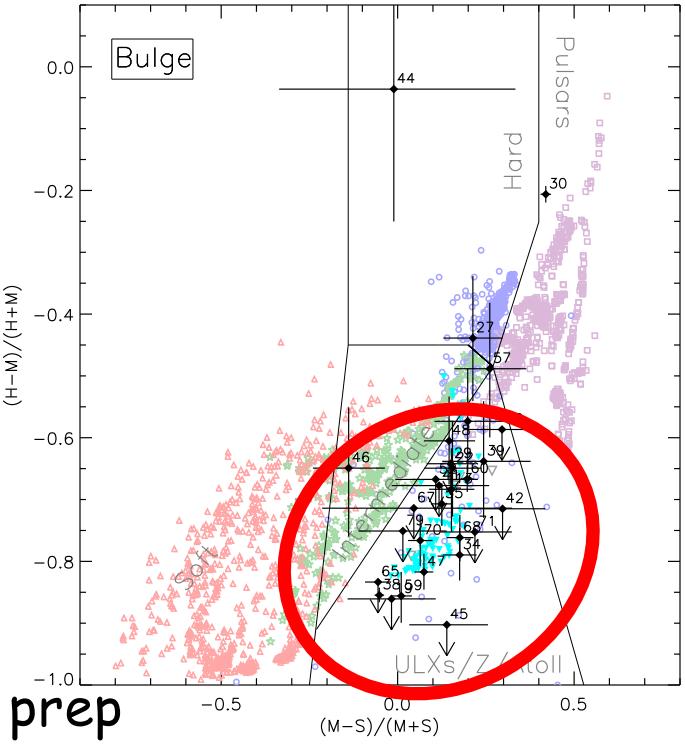
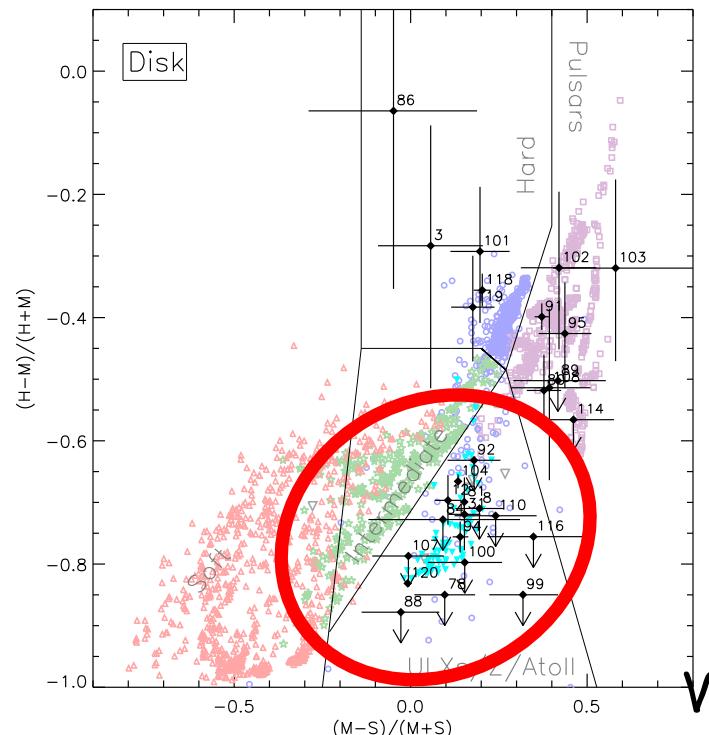
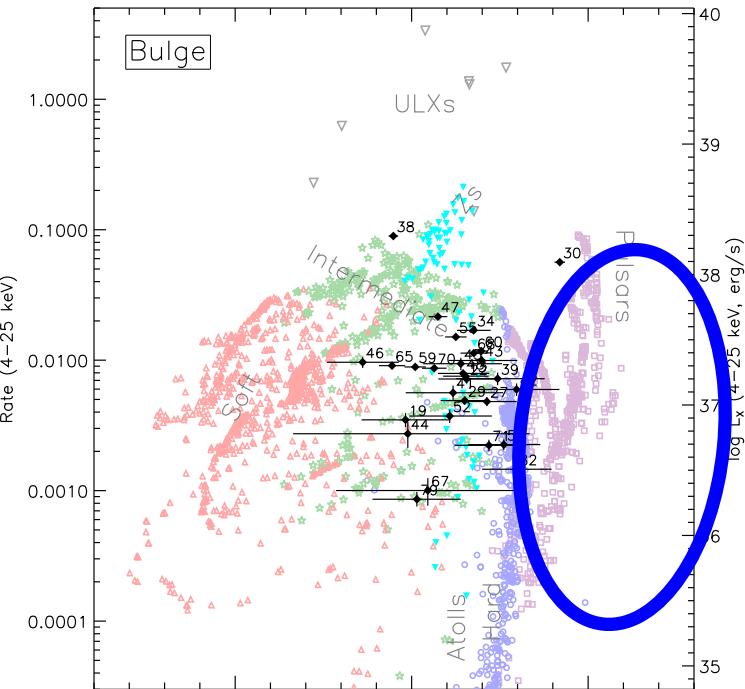
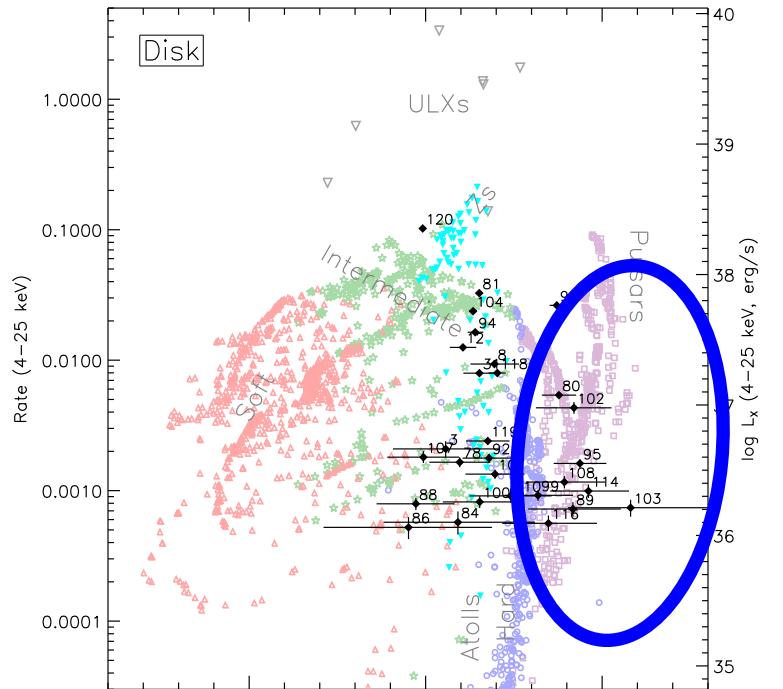
Compact object populations



Belczynski et al, 2012



Wik et al. in prep



Wik, et al in prep

Spatial distribution of compact objects



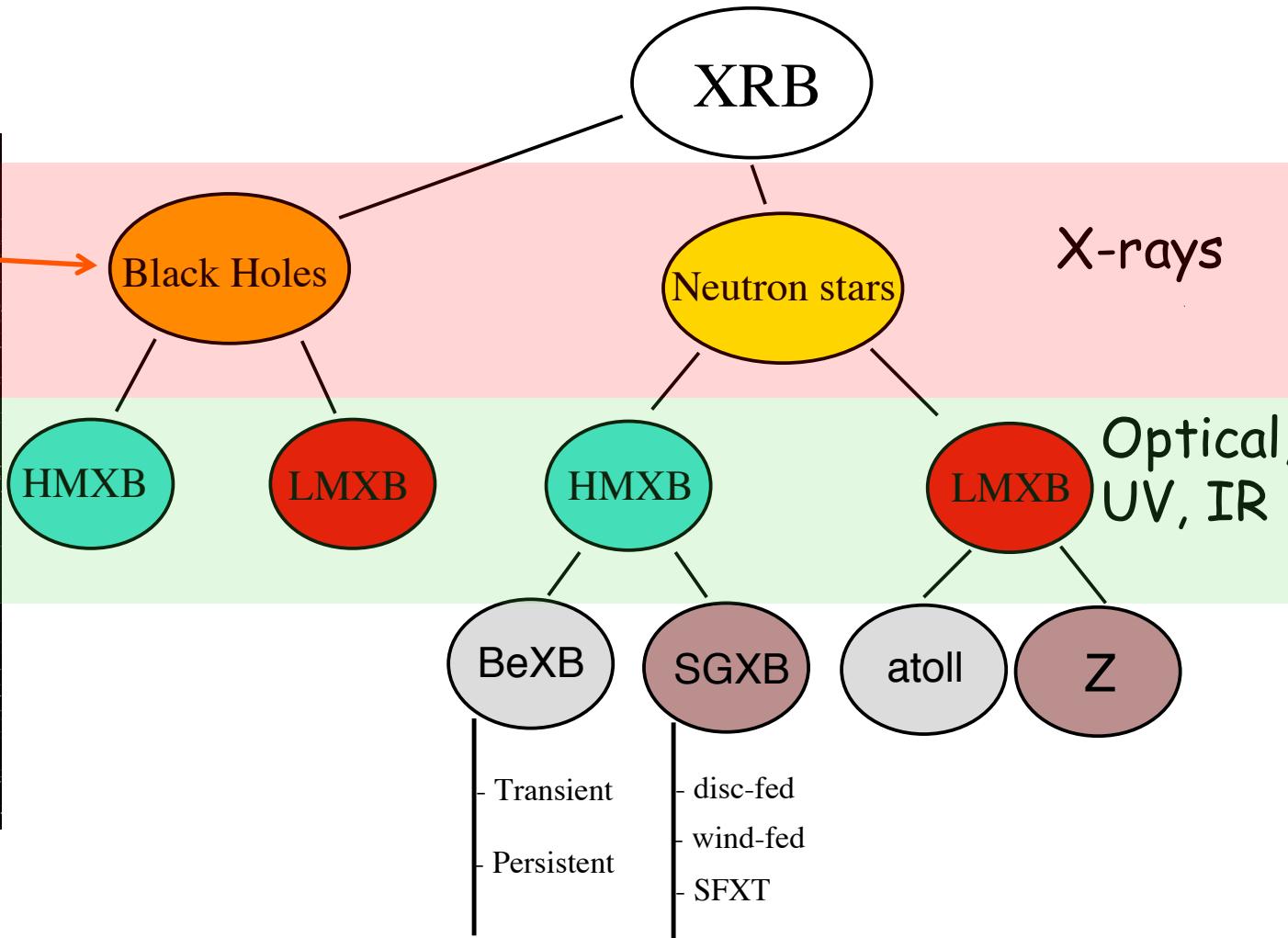
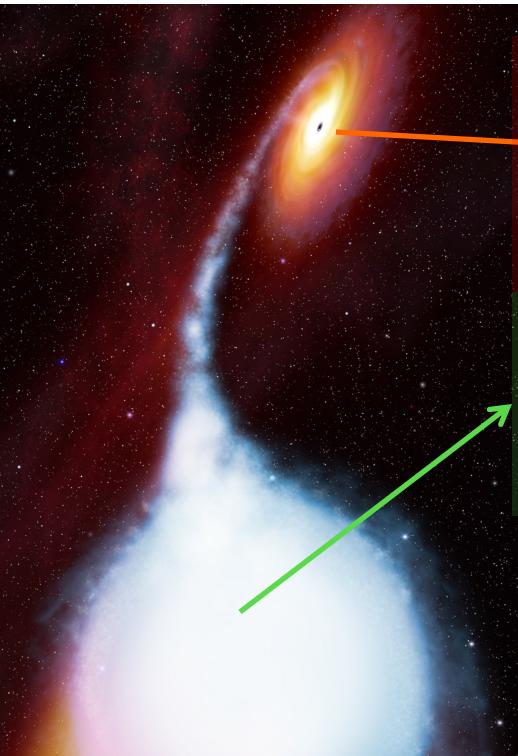
★ Accreting pulsar

★ Black Hole

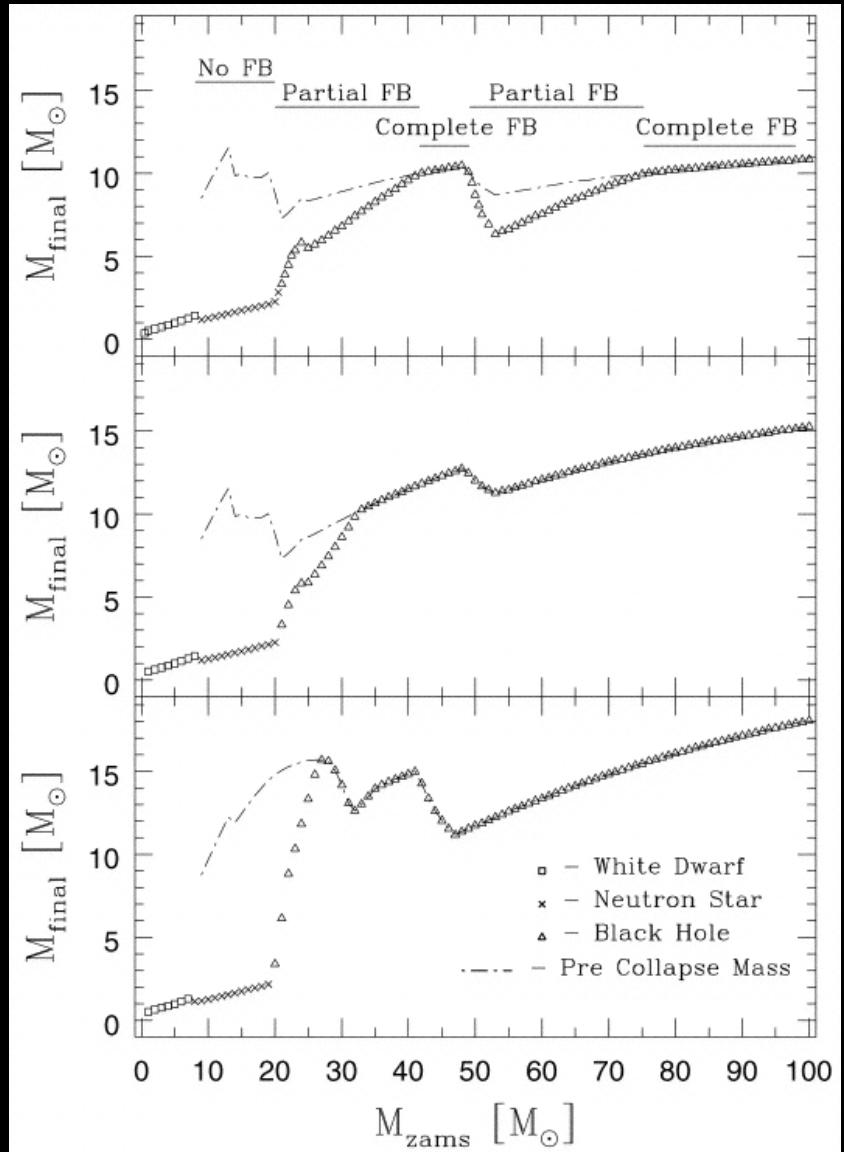
★ Neutron star (low B)

Wik et al, in prep

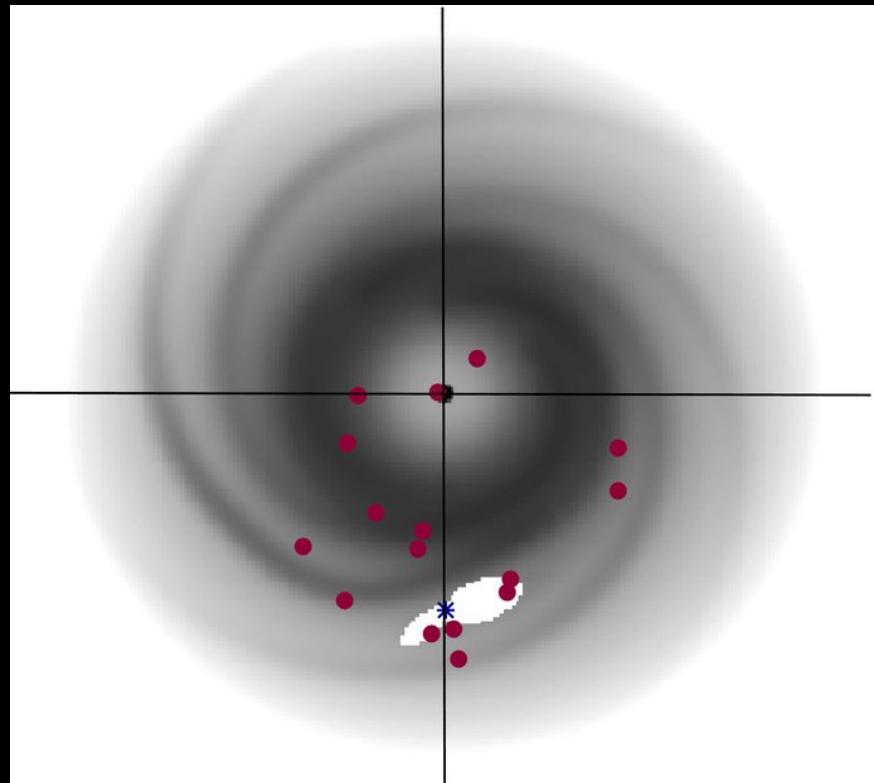
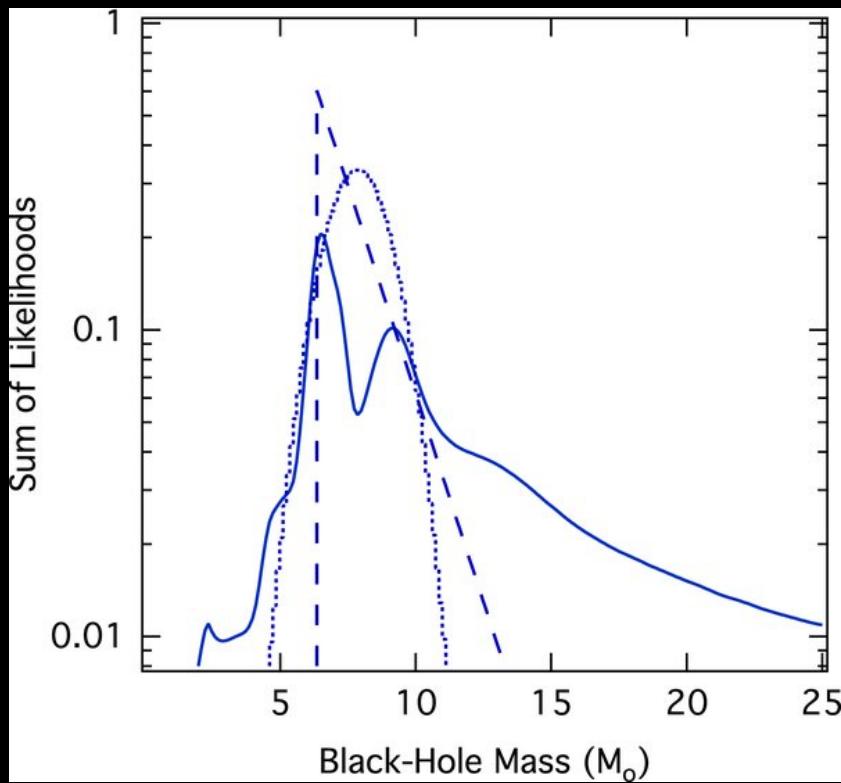
The X-ray binary zoo



Compact object populations

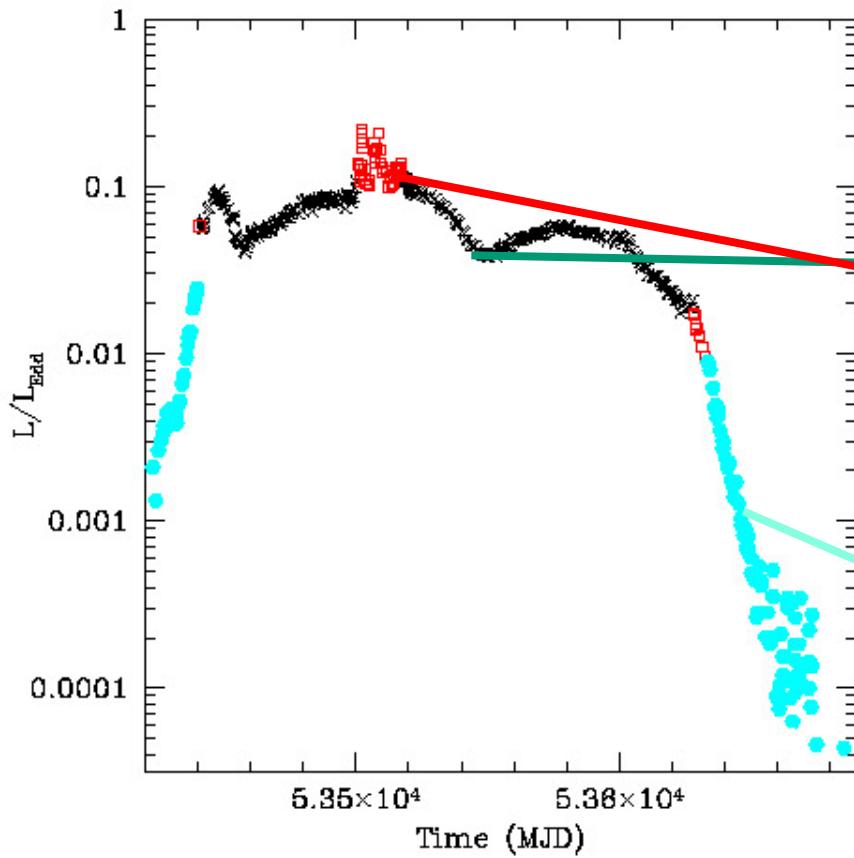


Compact object populations

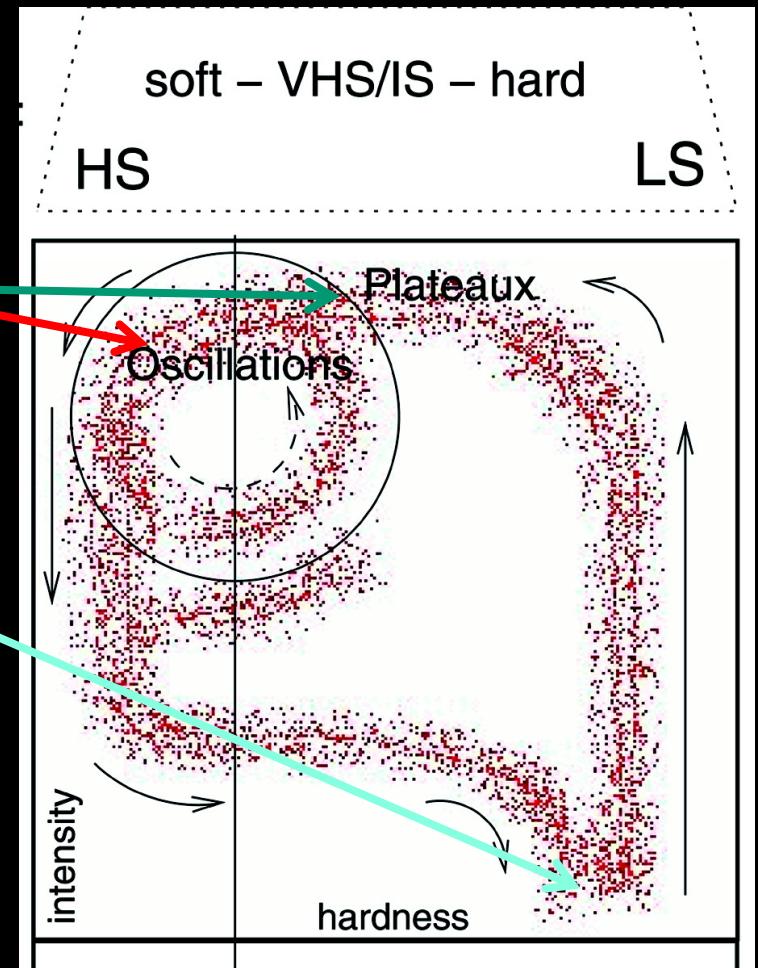


Ozel et al 2010

The standard accretion paradigm

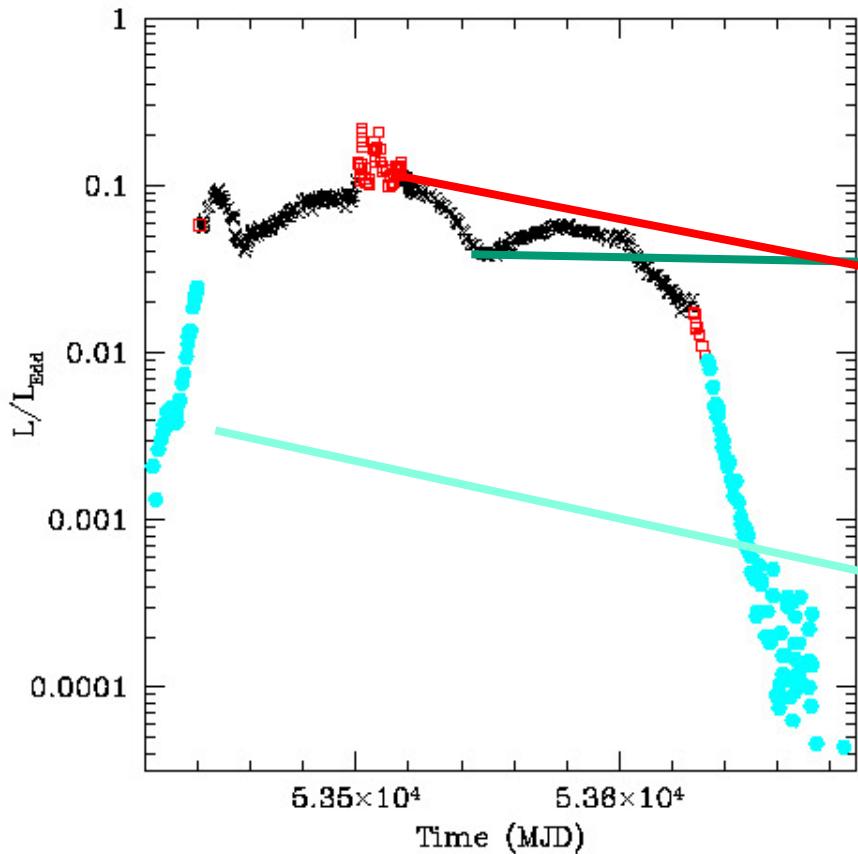


(a) GRO J1655-40

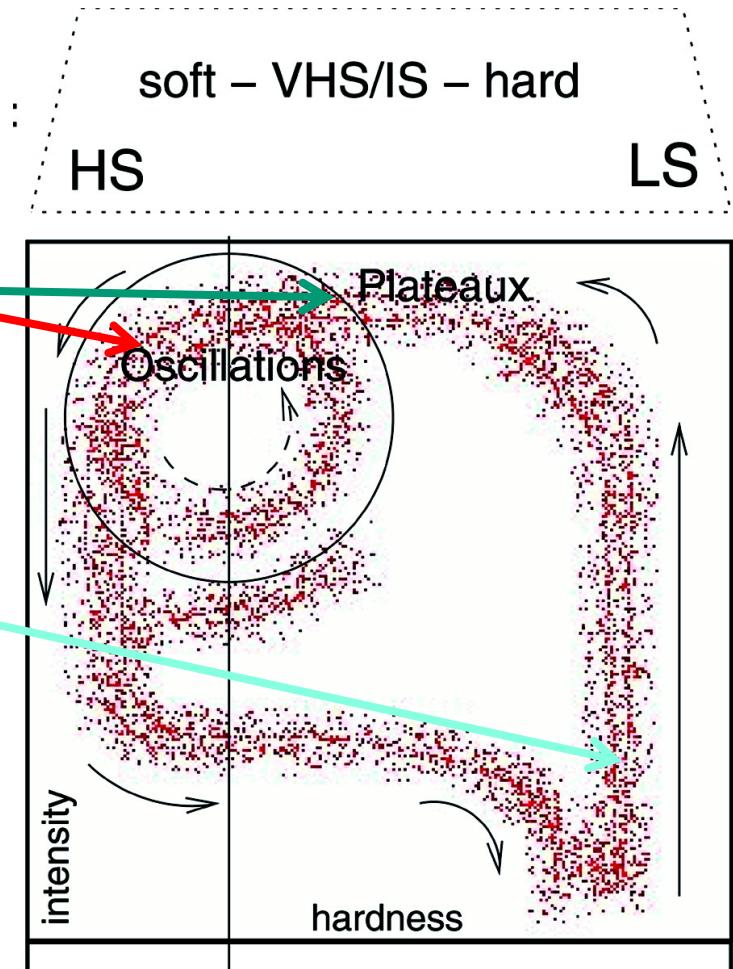


Fender & Belloni, 2004

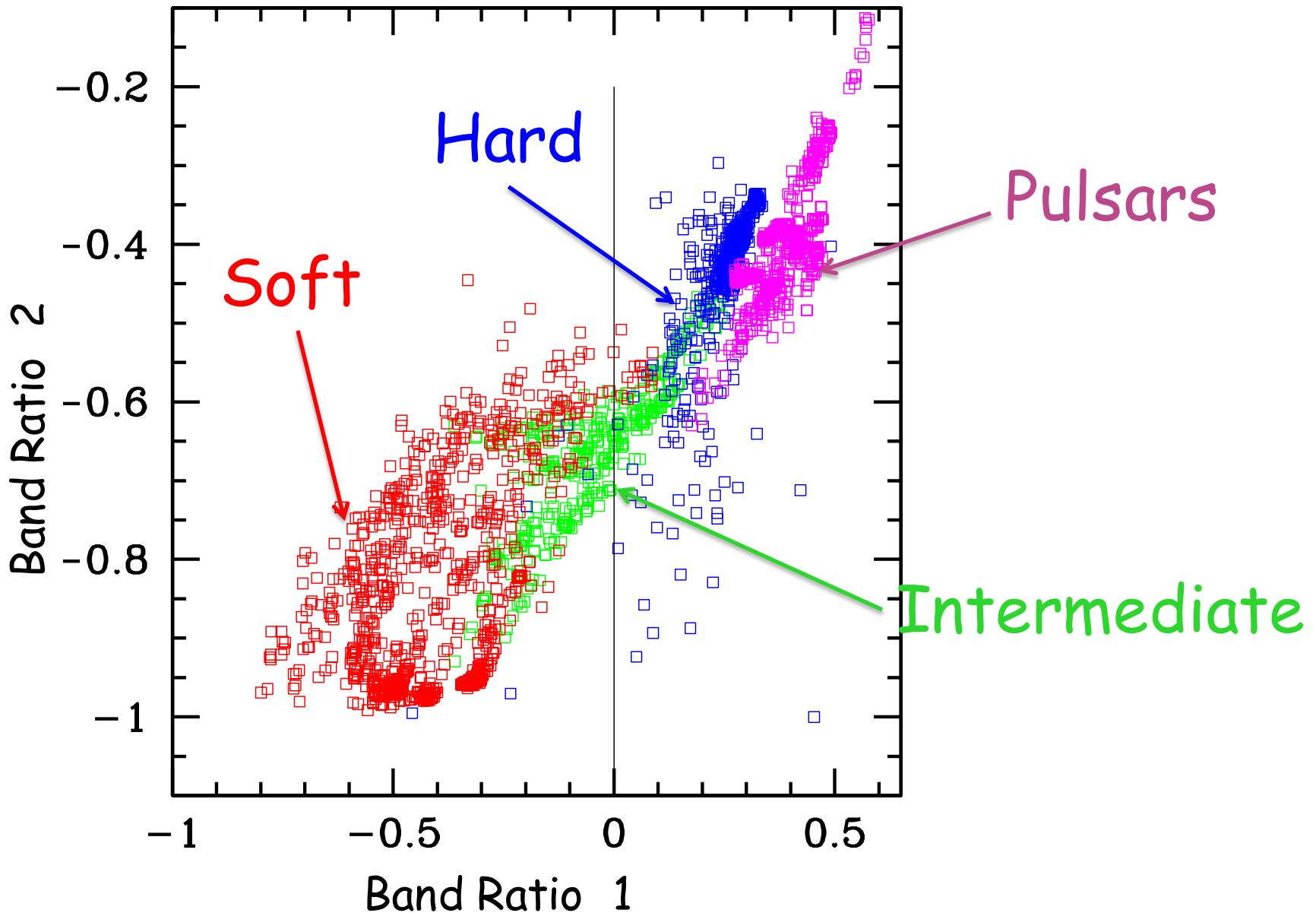
Black-hole accretion states

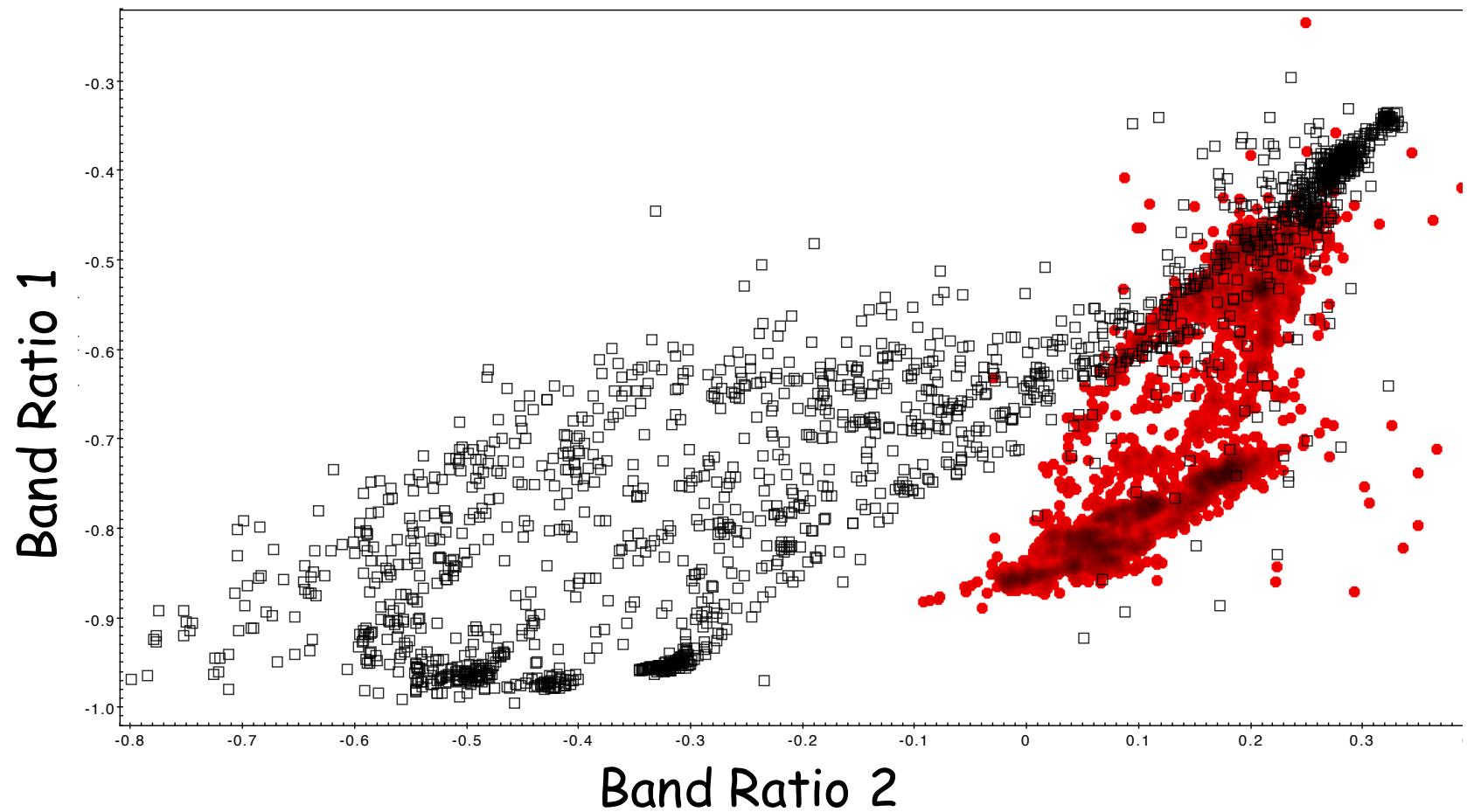


(a) GRO J1655-40



Fender & Belloni, 2004

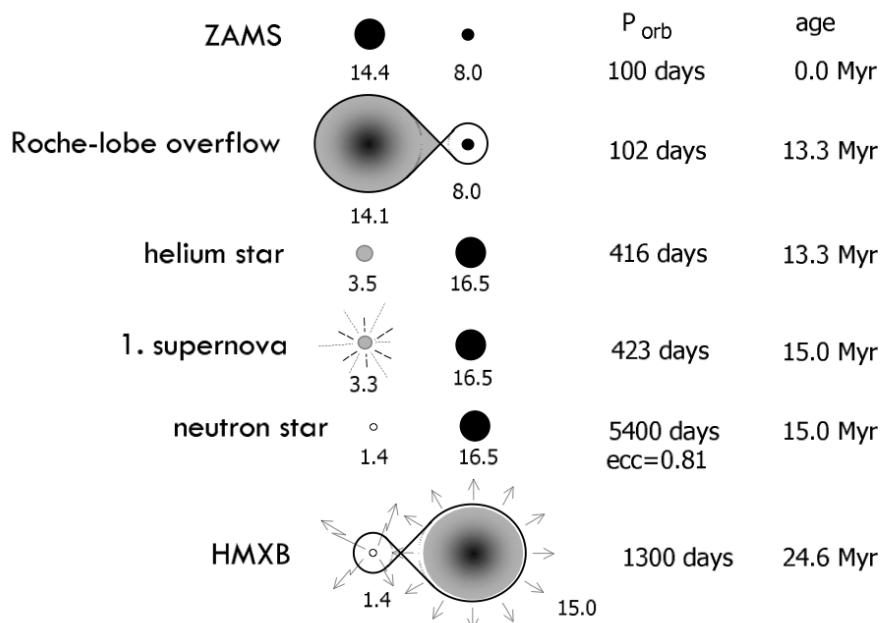




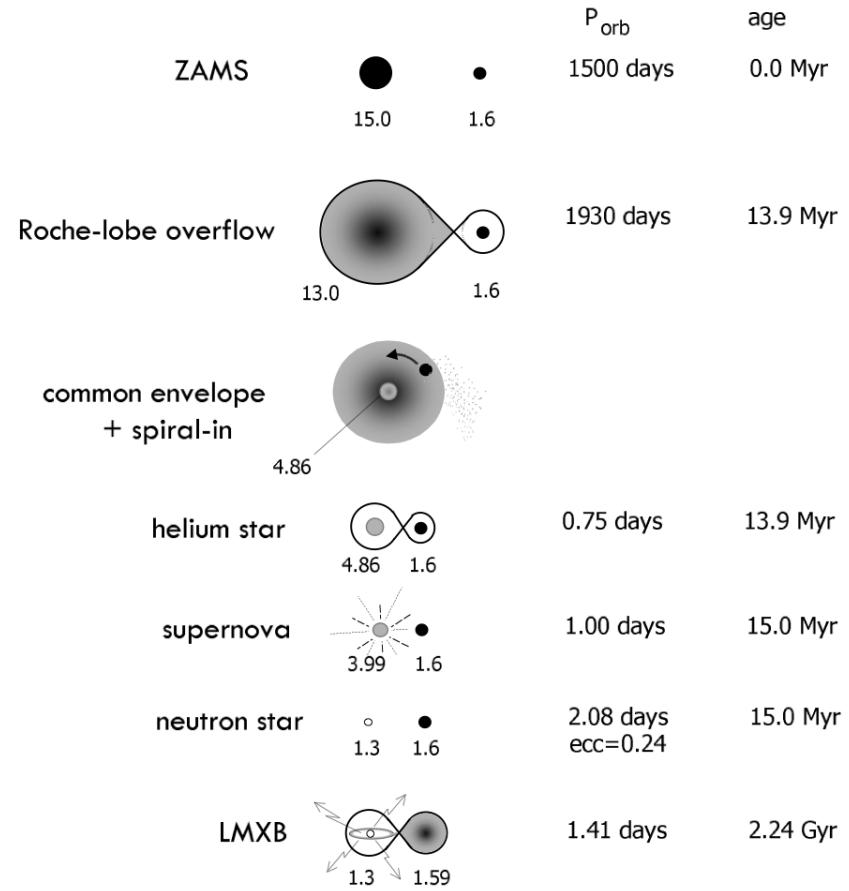
Maragkakis, Zezas et al, 2018

Their (complicated) evolution

High-mass XRBs

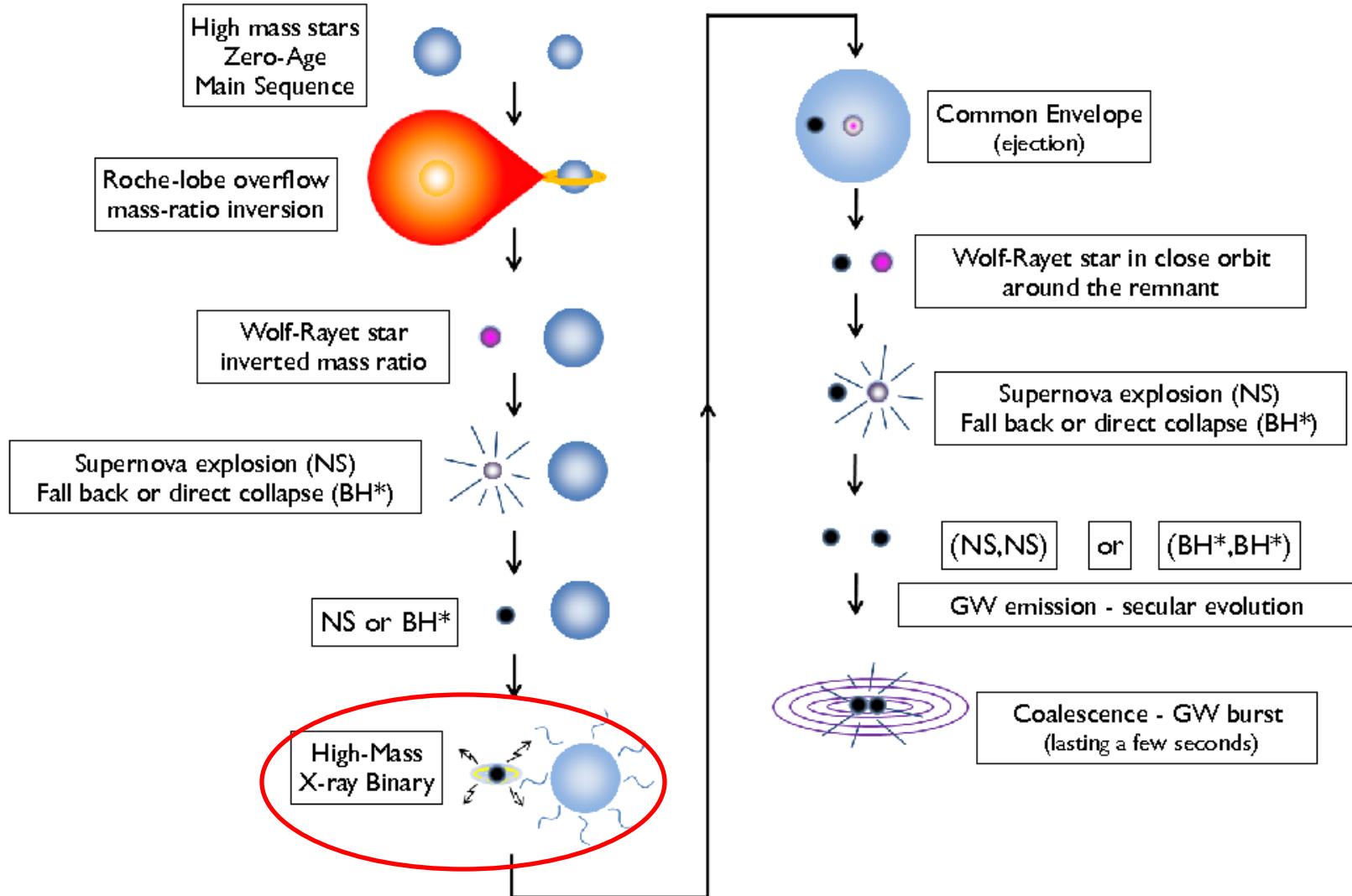


Low-mass XRBs

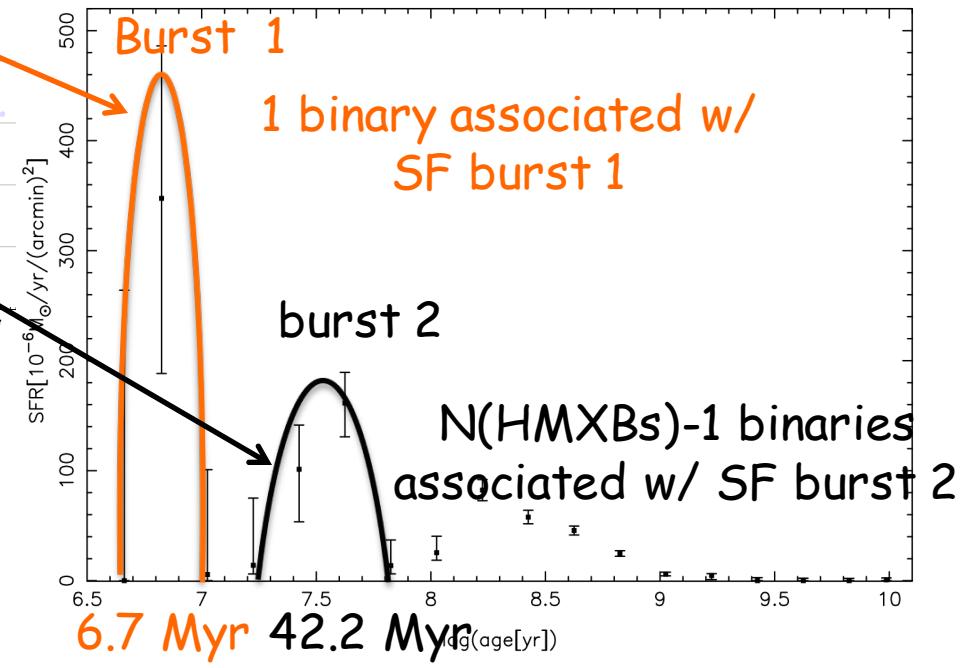
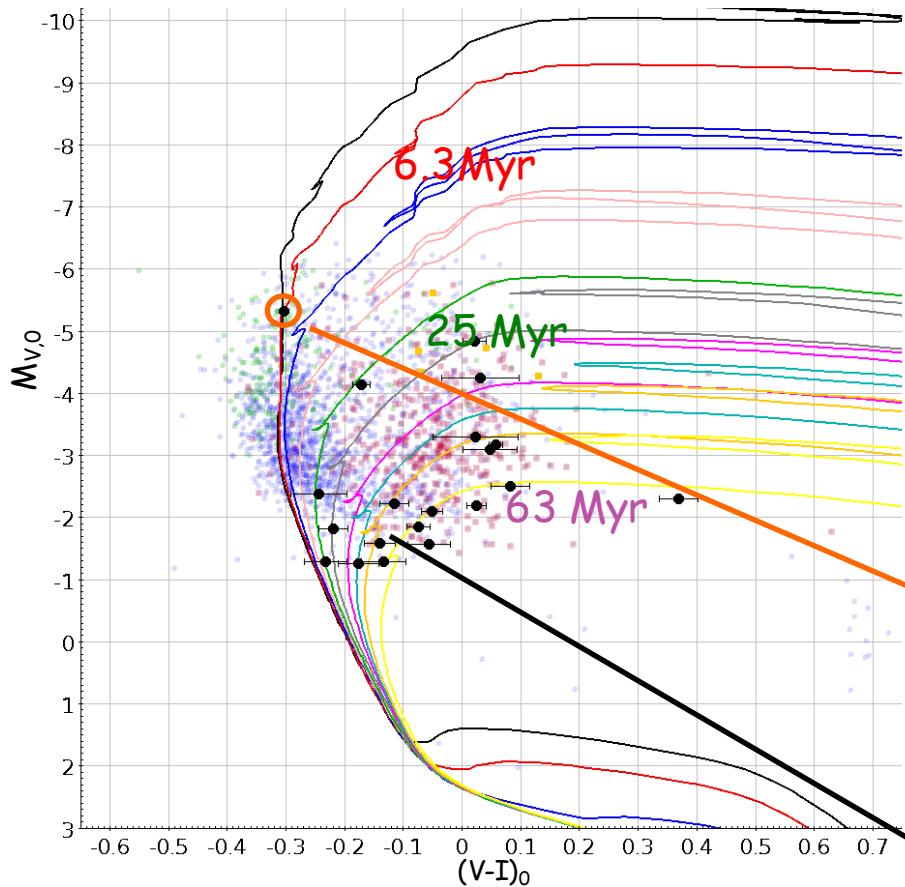


Tauris & van den Heuvel 2006

GW progenitors



HMXB classification



Antoniou et al. 2019
arXiv 1901.01237

Harris & Zaritsky 2004