TIME-DOMAIN ASTRONOMY

Science Case 2: X-Ray Binaries

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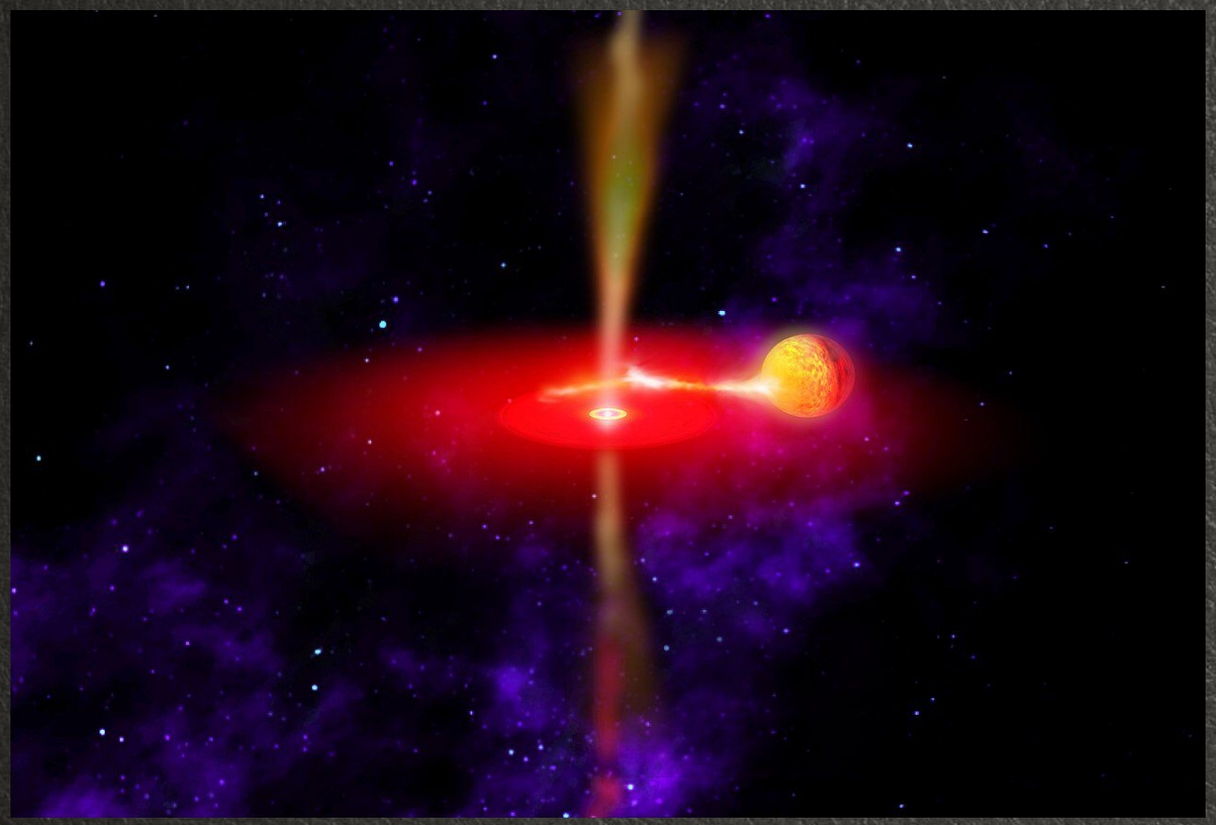
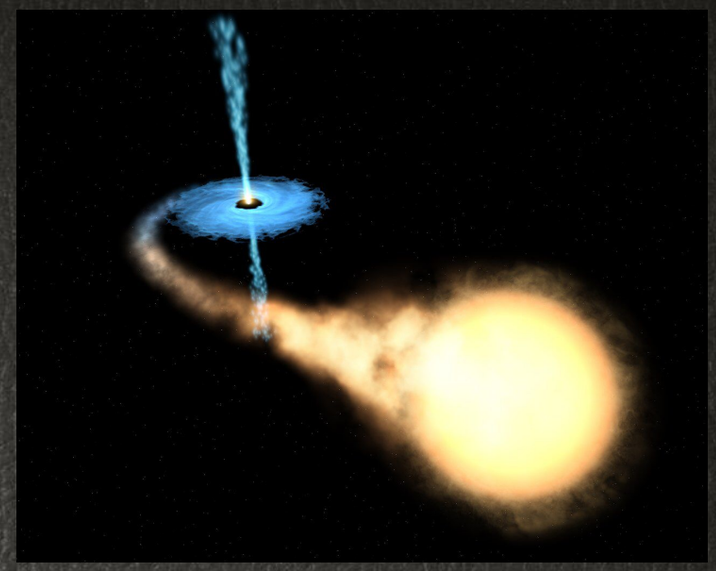
GX339-4 / V821 Ara



GX339-4 according to Wikipedia (artistic view)

- GX-339-4 is a Galactic Low Mass X-ray Binary (LMXB), and candidate black-hole.
- It is a variable source showing occasionally a flaring activity.
- During the outbursts GX 339-4 shows evolution of quasi-periodic oscillations (QPOs).
- A strong, variable relativistic jet, emitting from radio to infrared wavelengths was observed by several studies.

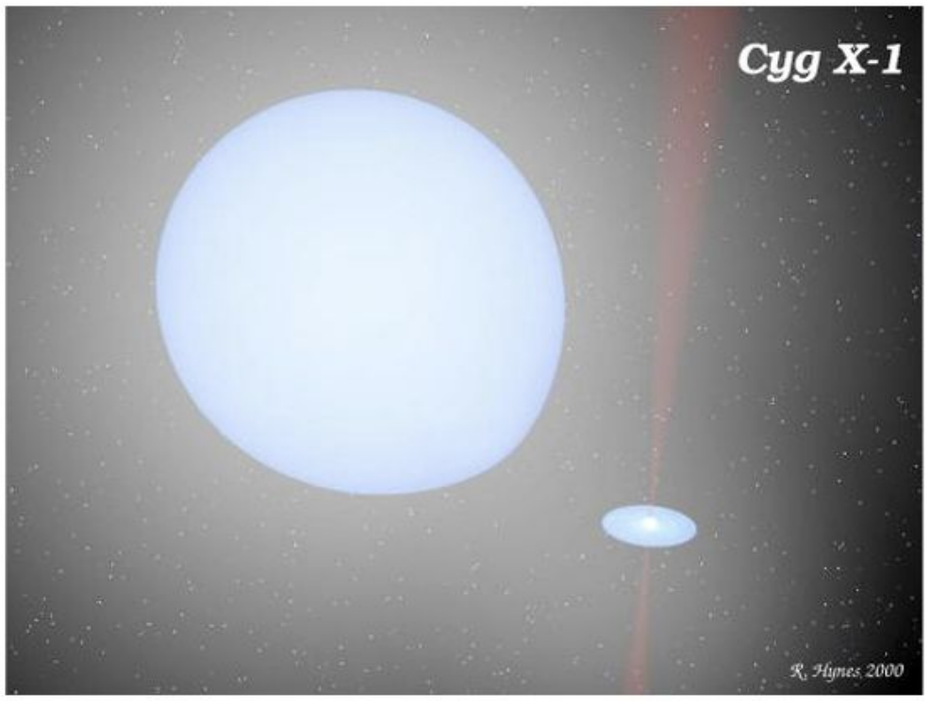
X-ray Binaries (XRBs)



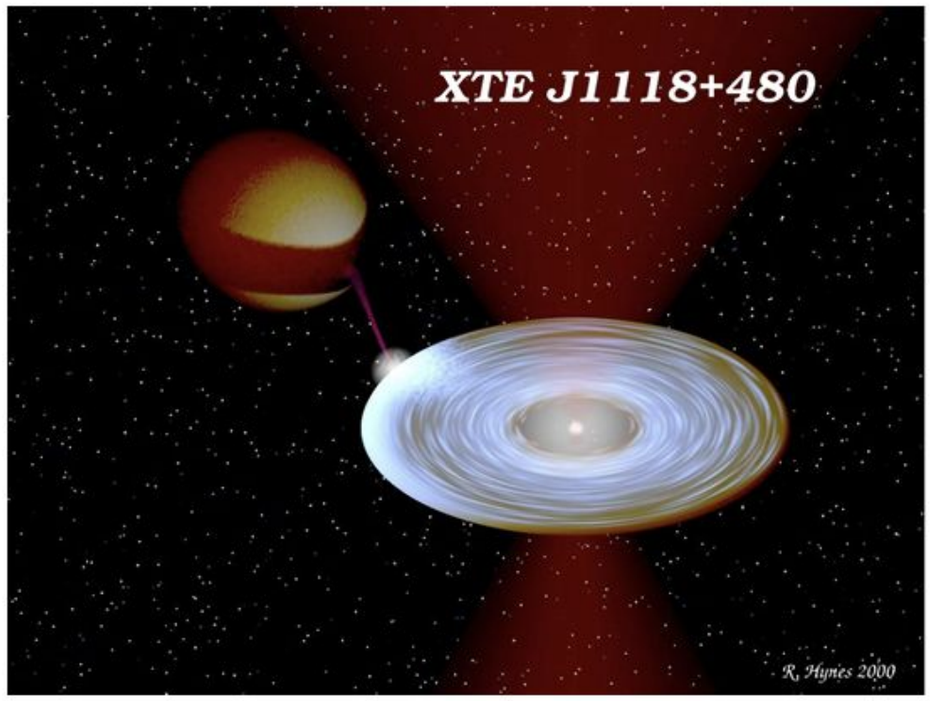
- X-ray binaries are a class of binary stars that are luminous in X-rays.
- The X-rays are produced by matter falling from one component, called the “donor” (usually a relatively normal star), to the other component, called the “accretor”.
- The latter is very compact: a neutron star or a black hole.
- The infalling matter releases gravitational potential energy, up to several tenths of its rest mass, as X-rays.
- $L_X \sim 10^{35\text{-}39}$ erg s^{-1} in the X-ray band.

X-ray Binaries (XRBs)

High mass

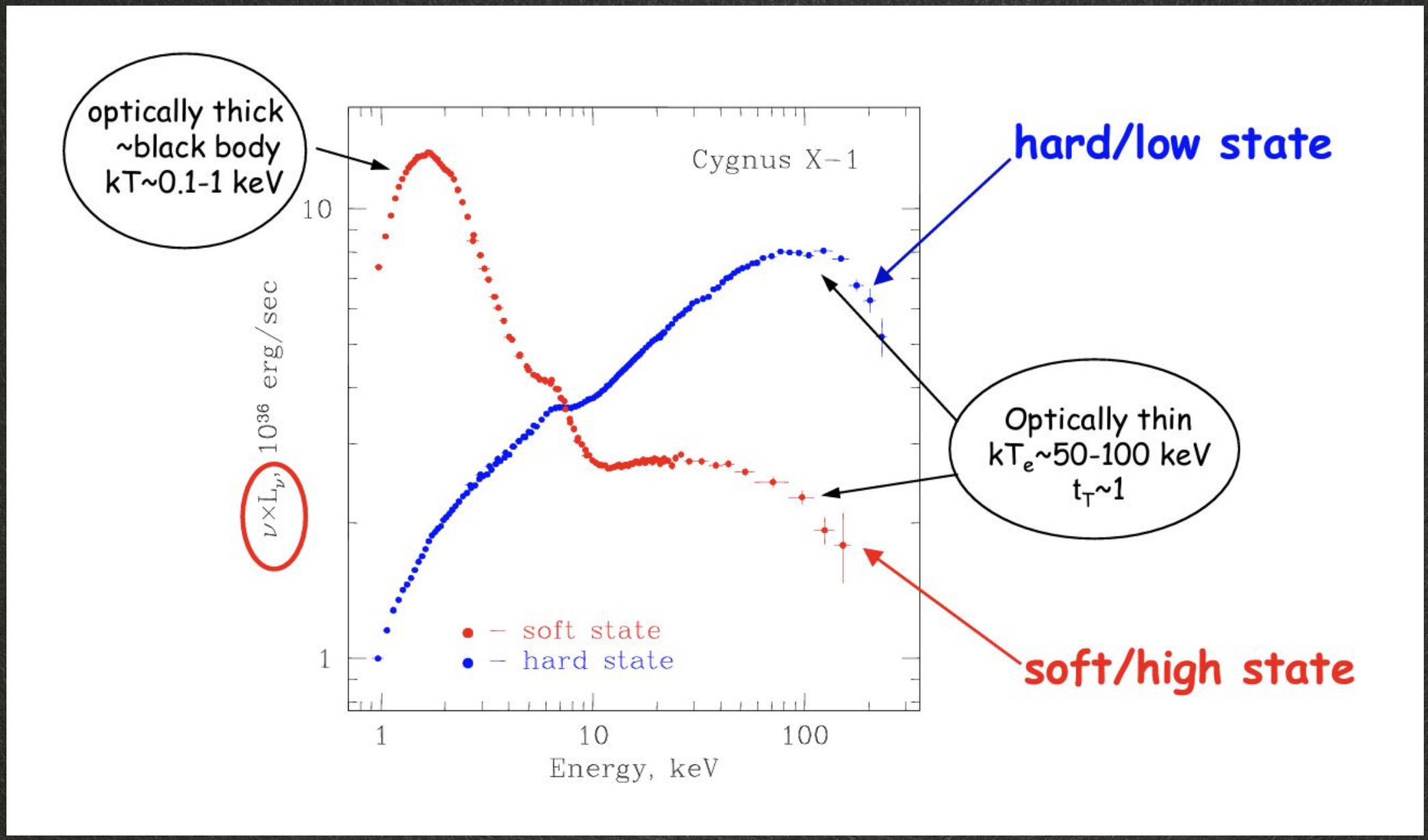


Low mass



- The donor star nature affects the time evolution of the binary.

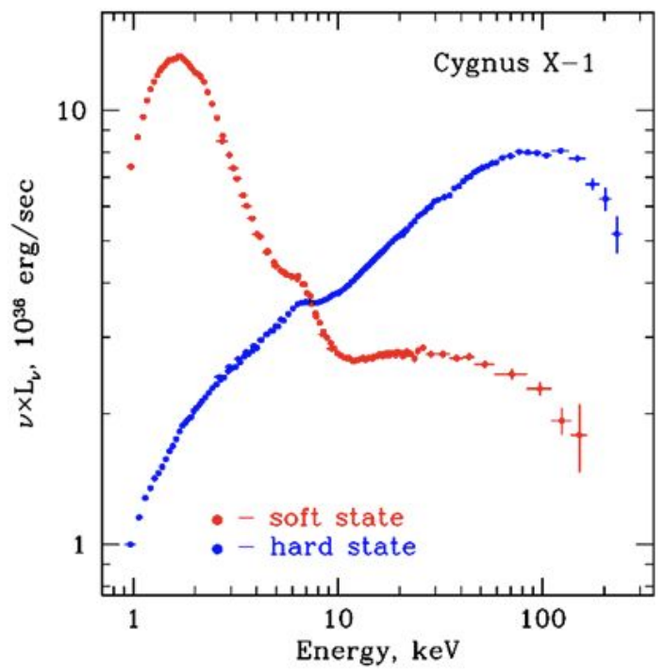
Spectral variability



- Emission can be observed under different “states”.

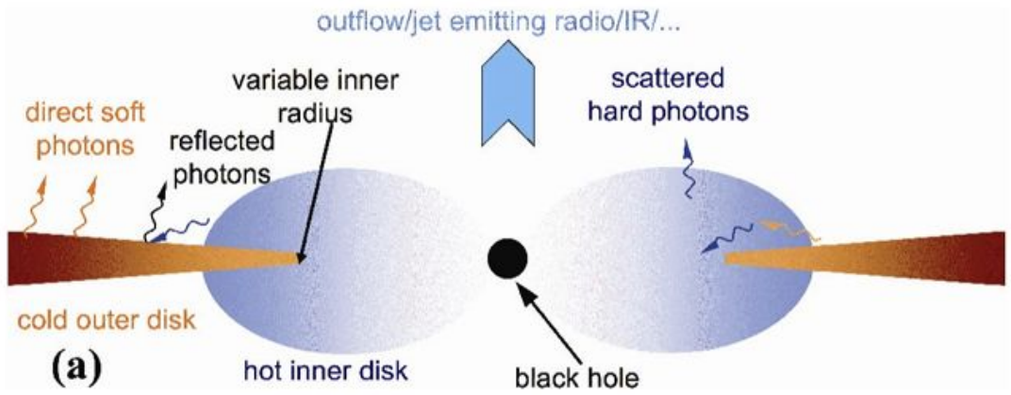
Spectral variability

Geometry



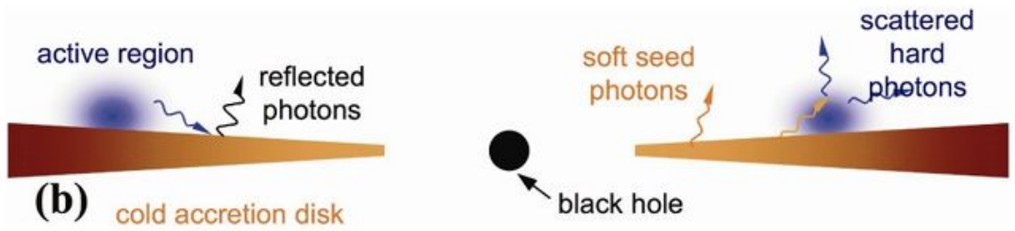
hard state

truncated disk + inner hot flow



soft state

disk extends to last stable orbit

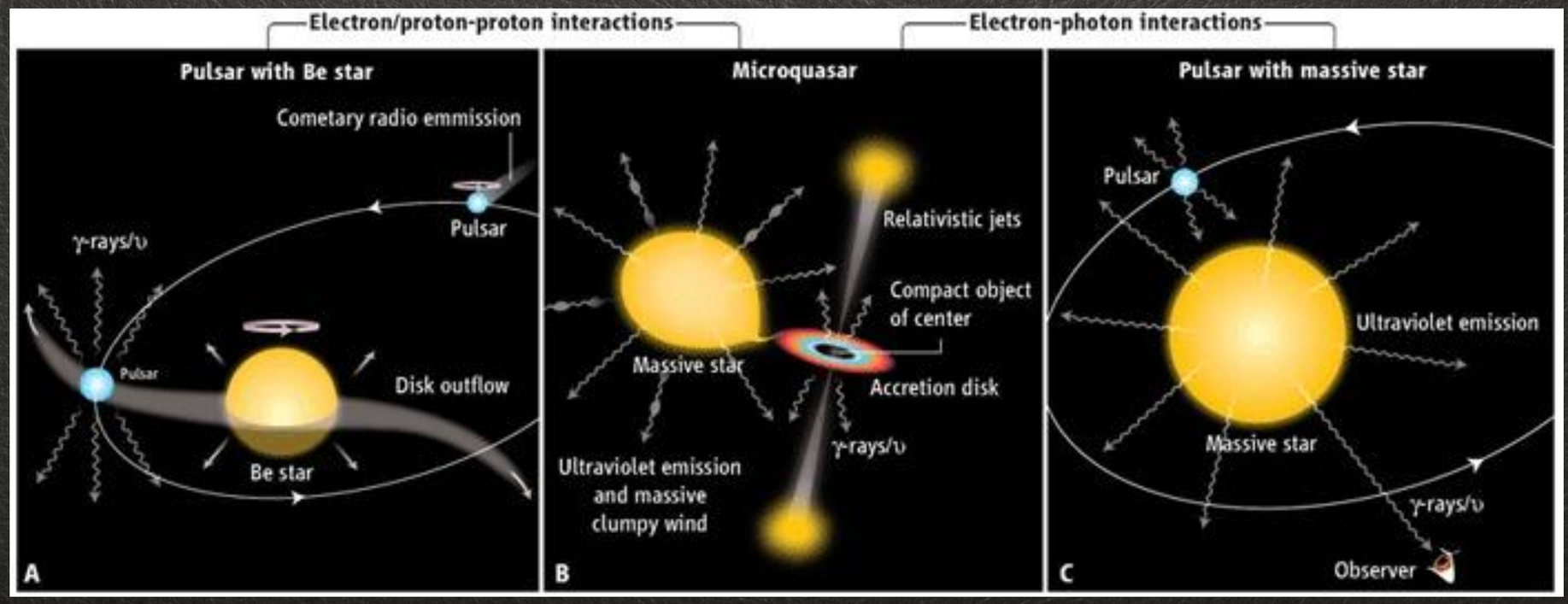


from Zdziarski & Gierlinski, 2004

X-ray Binaries (XRBs)

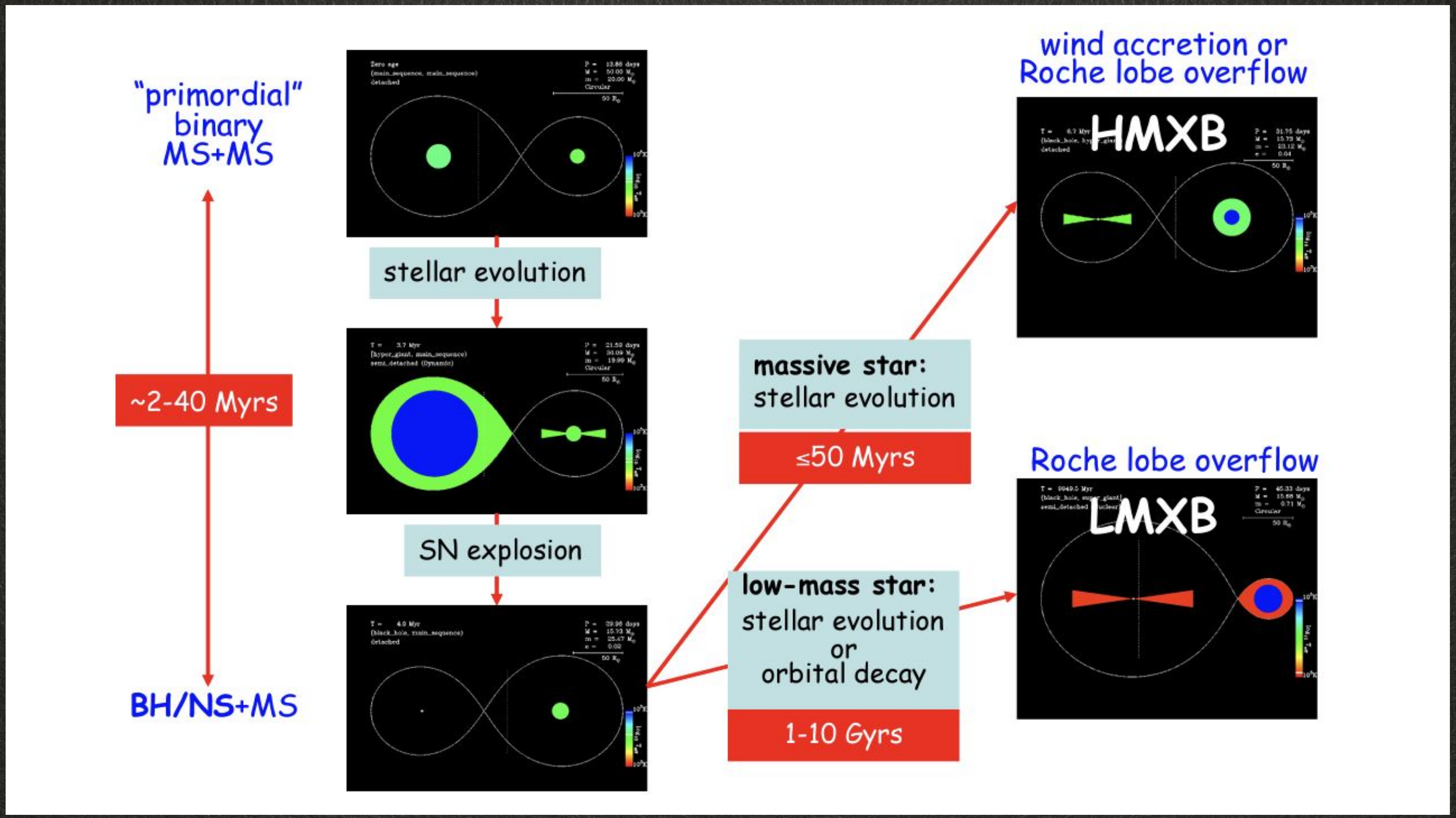
- The lifetime and the mass-transfer rate in an X-ray binary depends on the evolutionary status of the donor star, the mass ratio between the stellar components, and their orbital separation.

- X-ray binaries are further subdivided into several (sometimes overlapping) subclasses. Note that the classification by mass (high, intermediate, low) refers to the optically visible donor, not to the compact X-ray emitting accretor.



X-ray Binaries (XRBs)

- Simple (too simple…) sketch of binary evolution



X-ray Binaries (XRBs)

Evolutionary time scales

HMXB

- t~10-50 Myrs
- ~ duration of star formation event

Star formation tracer

LMXB

- t~1-10 Gyrs
- ~ live time of the host galaxy

Stellar mass tracer

XRB Zoo

- Low-mass X-ray binaries (LMXBs)
  - Soft X-ray transients (SXTs)
  - Symbiotic X-ray binaries
  - Super soft X-ray sources or Super soft sources (SSXs), (SSXB)
- Intermediate-mass X-ray binaries (IMXBs)
  - Ultracompact X-ray binaries (UCXBs)
- High-mass X-ray binaries (HMXBs)
  - Be/X-ray binaries (BeXRBs)
  - Supergiant X-ray binaries (SGXBs)
  - Supergiant Fast X-ray Transients (SFXTs)
- Others
  - X-ray bursters
  - X-ray pulsars
  - Microquasars (radio-jet X-ray binaries that can house either a neutron star or a black hole)

Notebook: GX339QPO

REFERENCES AND DEEPENING

Elisa
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Astronomy & Astrophysics

A transient variable 6 Hz QPO from GX 339-4

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Abstract. We report the results of an observation with the Rossi X-ray Timing Explorer of the black hole candidate GX 339-4 during its 2002/2003 outburst. This observation took place during a spectral transition from the hard to the soft state. A strong (6% rms) transient quasi-periodic oscillation (QPO) appears suddenly in the power density spectrum during this observation. The QPO centroid is ~6 Hz, but it varies significantly between 5 and 7 Hz with a characteristic time scale of ~10 s, correlated with the 2–30 keV count rate. The appearance of the QPO is related to spectral hardening of the flux, due to a change in the relative contribution of the soft and hard spectral components. We compare this peculiar behavior with results from other systems that show similar low frequency QPO peaks, and discuss the results in terms of possible theoretical models for QPO production.

Key words. accretion: accretion disks – black hole physics – stars: oscillations – X-rays: stars