Tracking mass transfer processes: the case of High Mass X-Ray Binary Systems

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What are HMXRBs?

UV sources par excellence

Key WSO-UV science they address:

- Astronomical engines (accretion, outflows)
- ISM
  - Chemical evolution
  - Star formation and binary evolution

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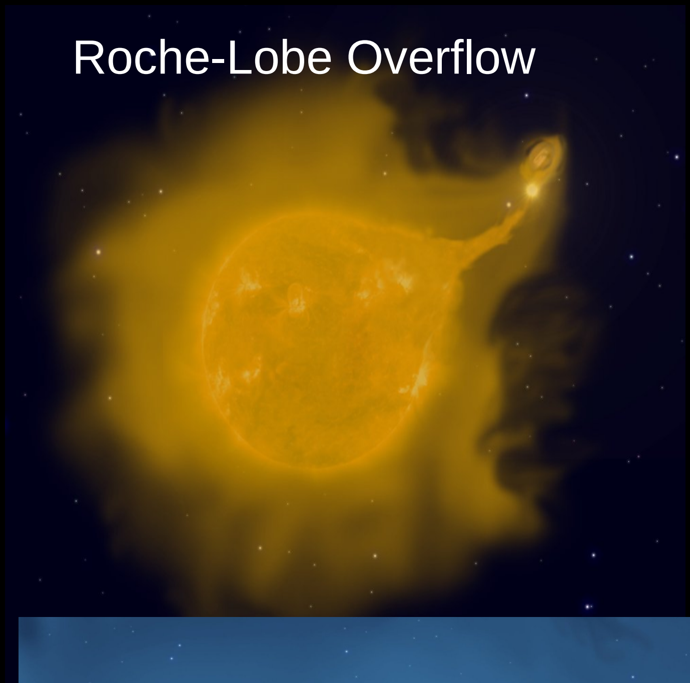
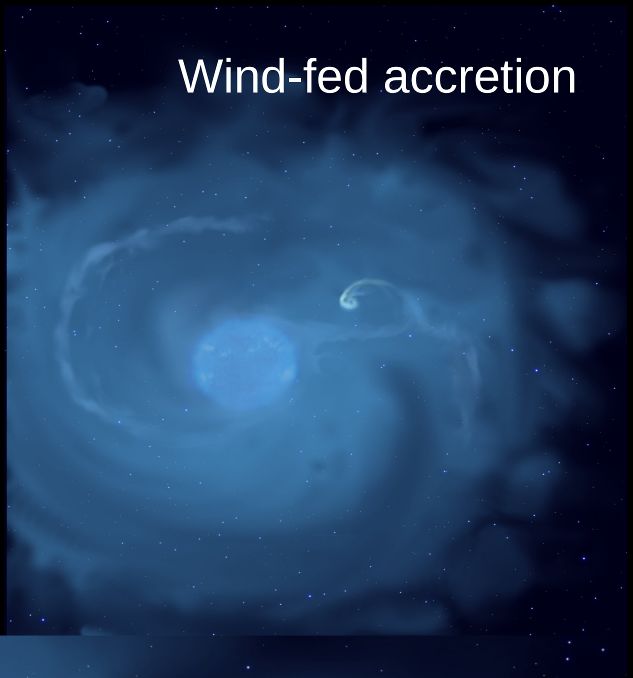
What are HMXRBs?

Stellar binary systems composed by a O-B star and a compact object (NS or BH).

- Systems with a super-giant companion
- Systems with a main-sequence companion
- Weird systems

What are HMXRBs?





What are HMXRBs?

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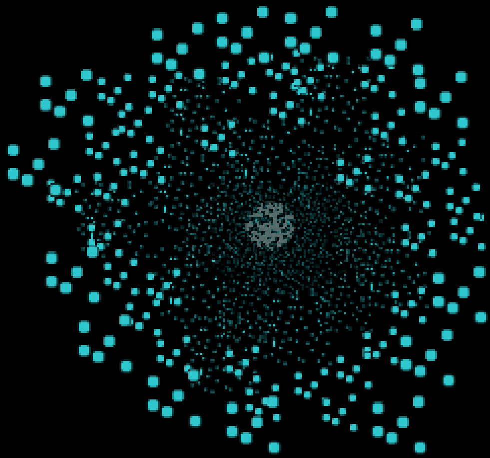
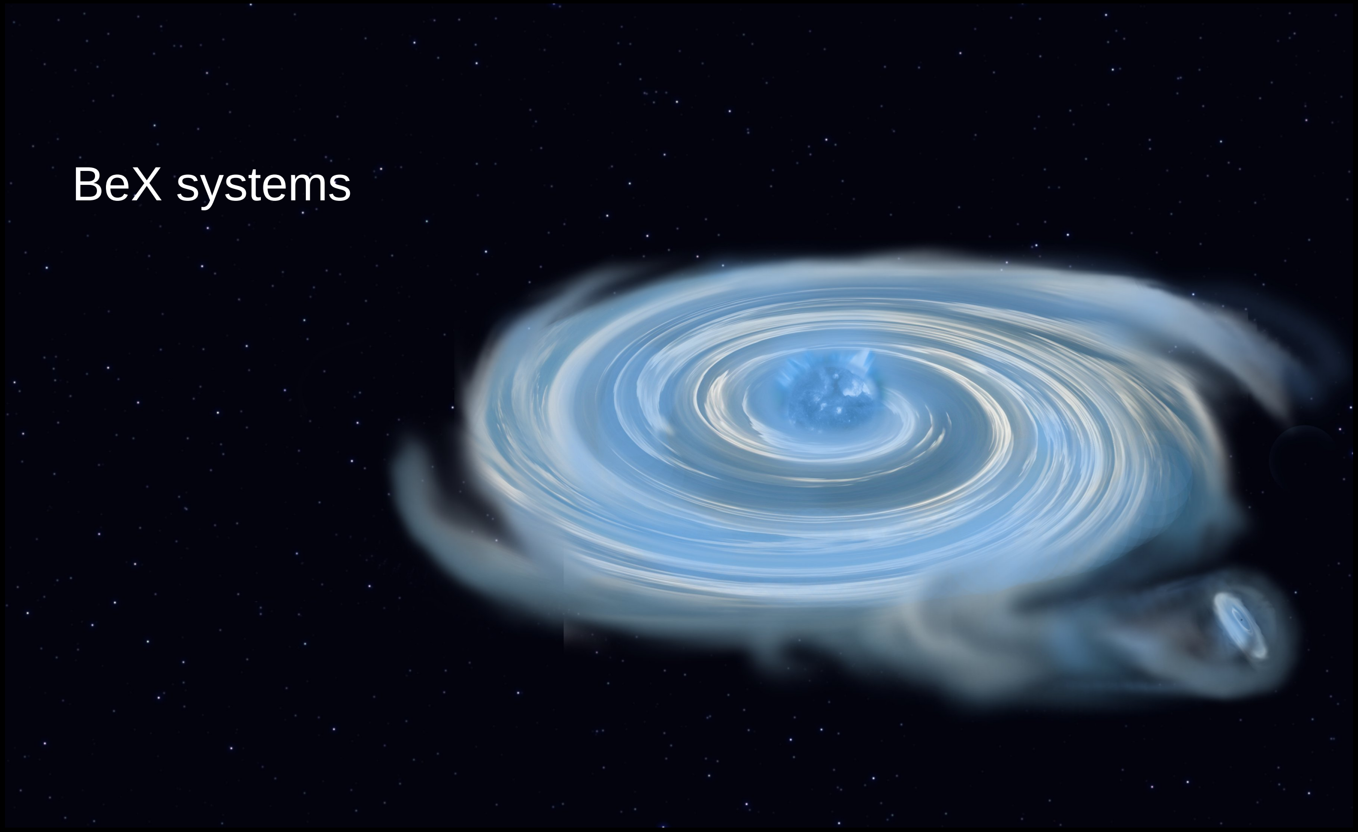
Homogeneous stellar wind
artistic representation



Schematic representation
of a clumpy wind structure

What are those HMXRBs?

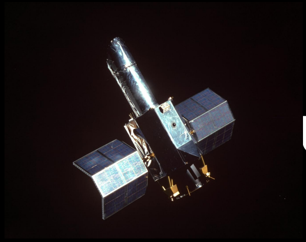
Stellar binary systems composed by a O-B star and a compact object (NS or BH).



Why UV?

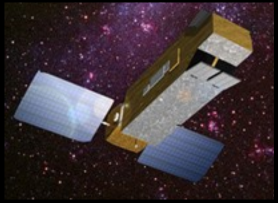
UV data pushed forward our understanding of HMXRB. UV radiation drives the wind of massive stars. Thanks to UV data the mass transfer mechanism in HMXRB was unveiled.

Main UV contribution to our understanding of MHXRBs comes from:



UE → first UV spectroscopic analysis of HMXRBs

HST → first clear evidences of photoionitzation



FUSE → first view of HMXRB in the far UV extreme

Why UV?

The same atomic species driving the wind are sensitive to X-ray radiation (photoionitzation)

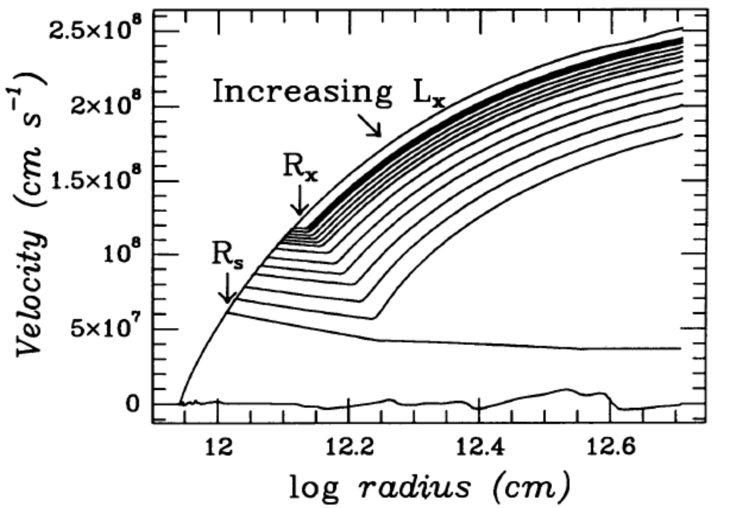


FIG. 1.—Suppression of a radiatively driven wind through photoionization by an orbiting X-ray source. The top line is the velocity of an undisturbed wind, and R_x marks the location of the X-ray source. The solid lines are the velocity of an X-ray–irradiated wind with $L_x = 10^{33}$ ergs s^{-1} for the highest velocity curve and L_x increasing by $10^{0.2}$ for each successively lower curve. If the radiative driving force is suppressed below the radius R_S, corresponding to the critical luminosity $L_{cr} = 10^{35.6}$ ergs s^{-1}, the wind is completely disrupted.

X-ray radiation will modify the wind properties (Hatchet-McCray effect). On the left: plot from *Blondin 1994, ApJ, 435, 756,* showing that, for luminosities higher than 10^{35} erg s^{-1}, wind can even be disrupted.

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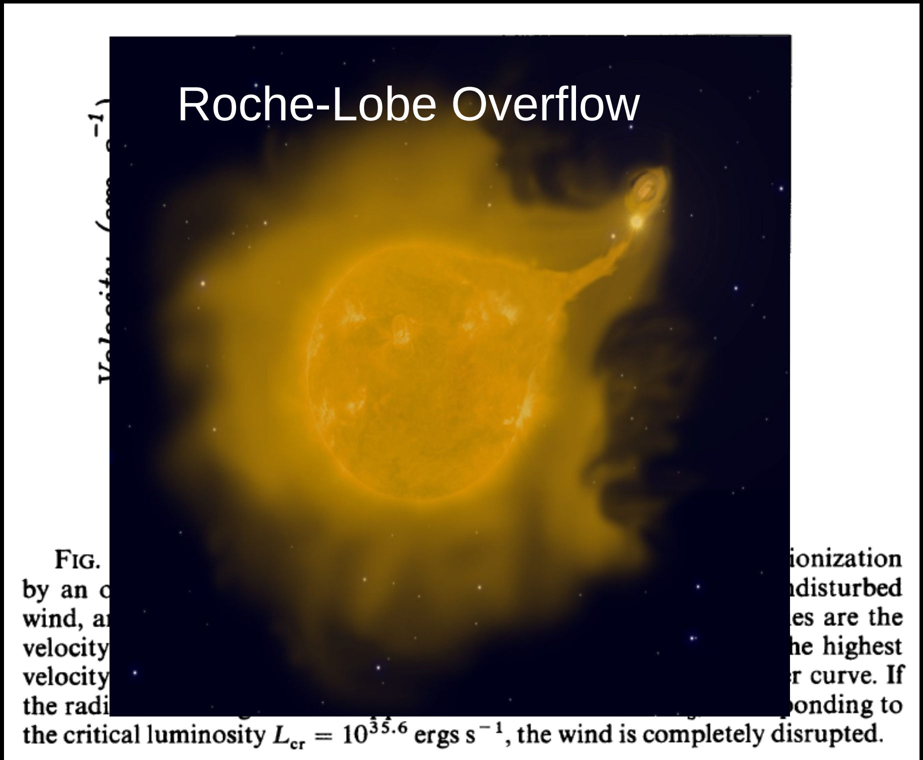

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Why UV?

- *Clark et al. (2002) A&A, 392, 909* → **improvement in spectral classification** of *4U 1700-37* , leading to improvement in mass ratio (discovery of most massive neutron star known, 2.44 $M_\odot$). IUE data.

- *McSWain et al. (2004), ApJ, 600,* 927 → **improvement in spectral classification** of LS 5039 (HST data)

- **Pulsations** of the X-ray pulsar Vela X-1 seen in UV wind lines variations by *Boroson et al. (1996), ApJ, 465, 940* (HST data) and UV differences in different **X-ray states** of Cyg X-1 by *Vrtilek et al. (2008), ApJ, 678, 1248* and *Gies et al. (2008) ApJ, 678, 1237*

What else can be done?

(including some legacy science)

- We are facing the possibility to perform, for the very first time, a continuous and homogeneous follow up of HMXRBs in the UV bands.
- Some unanswered questions about wind structure in close binary systems can only be solved with UV data
  - Are classical wind-fed systems and SFXTs explained with the same physical scenario?
  - To which extent is accretion directly related to mass-loss and mass loss affected by accretion?
  - Can we separate accretion disk contribution to UV continuum in eclipsing systems?

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- Spectral classification: The lack of good spectral classification hinders in some cases the comparison between systems or with models, and makes statistical analysis very difficult.
- Analysis of the local neighborhood can help to determine how much absorption is intrinsic to the source (UV bump).
- Decoupling of intrinsic stellar properties from disc contributions in BeX systems

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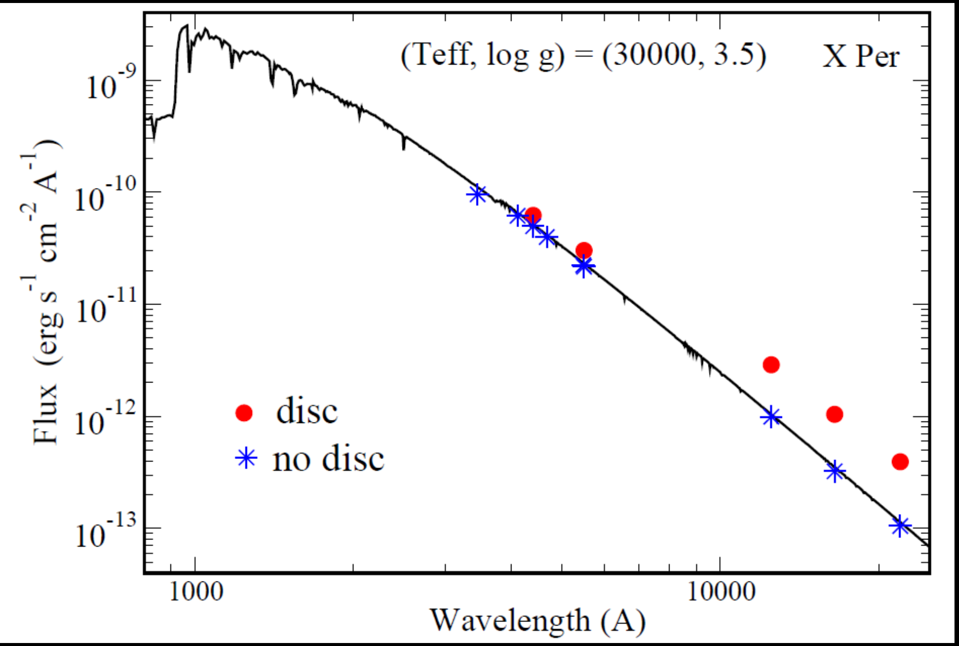
Reig, 2011, Ap&SS, 332, 1



- Decoupling of intrinsic stellar properties from disc contributions in BeX systems

What else can be done?

(including some legacy science)

- Detailed spectral analysis of early type stars in a wide range of types and luminosity classes and very diverse orbital geometrical configuration.

- Combination of broad/continuum filters and narrow filters distributed along NUV and FUV for a complete characterization of these systems in the UV, identifying meaningful colors or indexes, their relation to extinction, etc

Thanks!