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X-raying stellar winds in high mass X-ray binaries

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In high mass X-ray binaries (HMXBs), the black hole or neutron star accretes matter from the wind of a massive supergiant companion: the stellar wind drives changes in the accretion and thus the system's X-ray emission. But the interaction of this emission with the wind material can also be used to study the wind itself, in particular its geometry, porosity (or clumpiness), mass-loss rate and interaction with the compact object. HMXBs are our unique chance to probe individual clumps as opposed to the wind as a whole. They are, at the same time, among the best tools to study accretion processes, often using the same observation.
Our recent and ongoing high resolution studies of two of the brightest HMXBs, have opened a new window onto the wind structure. In Cygnus X-1, absorption-strength resolved spectroscopy reveals the onion-like structure of the wind clumps, with a highly ionized exterior and a colder, less ionized interior. In Vela X-1, our analysis implies a co-existence of cold and hot gas in a highly variable, structured accretion flow close to the neutron star, similar to what is seen in recent simulation of clumpy wind accretion in HMXBs. An observation during a flare in this source further allows us to probe the reaction of the wind structure to changes in X-ray irradiation.
But we are currently limited by both resolution and sensitivity of today's instruments. Only XRISM and Athena will enable us to observe individual wind clumps in bright sources such as Cyg X-1 And Vela X-1 and thus constrain clump origin in wind or structured accretion flow. First high quality high resolution observations of fainter sources will finally provide us with a sample of HMXBs that will allow to compare wind properties in massive stars of different stellar (sub-)types and, based on the different distances of compact object and donor star, at different radii, constraining theories of clumpy wind formation and evolution.

Topic

Compact and diffuse sources in galaxies and in the Galactic Center

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