# Gone with the stellar winds


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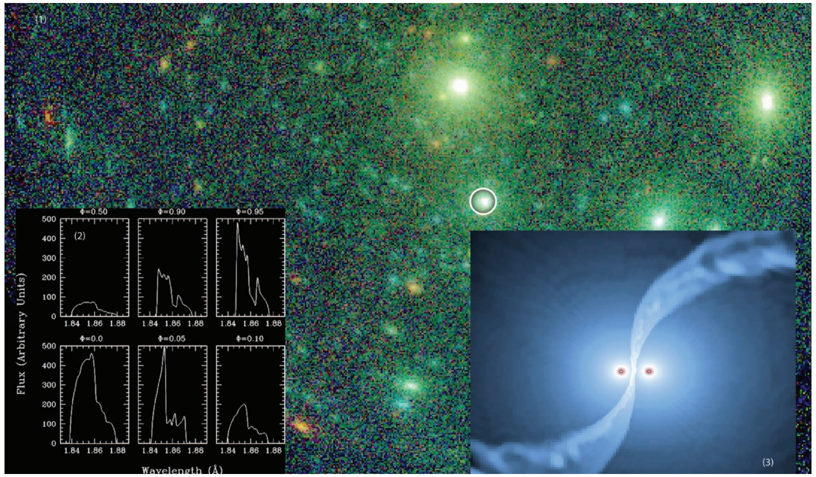


Many massive stars, such as Cygnus OB2 #9 (observed here with XMM-*Newton*) are binary systems hosting a wind interaction zone. *Athena*/X-IFU will resolve the X-ray spectral lines at key orbital phases, hence unveiling their variability, thus providing a powerful diagnostic of the dynamics of stellar winds. Credit: (1) Rauw G. 2011, A&A 536, A31 (2) Rauw et al. 2016, New Astronomy, 43, 70 (3) Parkin et al. 2014, A&A 570, A10.

Among the stellar populations of our Galaxy, stars with masses above 10 solar masses are key players as far as feedback of chemical elements and kinetic energy into the interstellar medium is concerned. This feedback is not restricted to the supernova explosions at the end of their lifes, but proceeds over their entire existence via their powerful stellar winds that carry typically a billion times the energy of the Solar wind. These stellar winds are driven by the huge ultraviolet radiation pressure that those hot and luminous stars produce. The ensuing mass-loss has a profound impact on the evolution of the star, as well as on the mass and nature of its evolution endpoint. Many aspects of these winds are still not fully understood.

Many massive stars reside in binary systems, mostly in association with another massive star. In such systems, the stellar winds of both stars collide in between the two stars, resulting in a shock cone wrapped around the star with the weaker wind. The exact location and the properties of this collision zone depend on the relative strengths of the winds of both stars. At the shocks, the huge kinetic energy of the winds is partially converted into heat, resulting in plasma at a temperature of over 10 million degrees that emits copious amounts of X-rays. Because the orientation of the shock cone as seen by an external observer changes as the stars revolve around each other, the profiles of lines formed in the wind interaction zone display phase-locked variations. Moreover, in eccentric binaries, the amount of material in the wind interaction zone changes with orbital separation, leading to a phase-locked modulation of the X-ray line intensity. Measuring the X-ray spectra of colliding wind binaries at various orbital phases thus provides a powerful tool to sound the properties of the stellar winds of massive stars.

*Athena*'s high-resolution spectrometer X-ray Integral Field Unit (X-IFU) will resolve the spectral lines of colliding wind binaries, notably those of highly-ionized iron at energies near 6.7 keV. These lines are formed at the hottest core of the wind interaction zone thereby offering a unique probe of the physical conditions inside this region. Current X-ray telescopes lack the sensitivity and resolving power to fully exploit these diagnostics. Observing massive binary systems with *Athena* X-IFU at several, carefully-selected, orbital phases will unveil the phase-dependent morphology of these lines in great detail. Comparison of the observed line profiles with theoretical predictions will provide unprecedented insight into the dynamics and physics of stellar winds.