論文題目要旨

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論文題目：Observational Study of Stellar Wind Dynamics in the High-mass X-ray binary Cyg X-3 through High-Resolution X-ray Spectroscopy with XRISM

論文要旨：

Cygnus X-3, hosting a Wolf-Rayet (WR) star whose dense wind produces various spectral lines due to photoionization by X-rays from a compact object, provides an ideal laboratory for studying wind dynamics and density structure. We measured the orbital modulations of the Fe, Ca, Ar, and S Lyα lines observed with the X-ray microcalorimeter (Resolve) onboard the XRISM, taking account of both emission and absorption lines of the Lyα complexes. The modulations of Doppler shifts of the Fe, Ca, Ar, and S Lyα lines showed amplitudes of 500 km s^{-1} and phase offsets of 0.04, 0.09, 0.11, and 0.17, respectively, in units of a orbital period (4.8 hours) relative to the orbital motion of the compact object. This result indicated that H-like Fe most closely follows the compact object's motion. The line widths ranged from 400 to 1000 km s^{-1}. The intensities of both emission and absorption lines reached their minima around orbital phase 0.0 and their maxima around phase 0.5. The absorption peaks, however, did not align exactly with phase 0.5, suggesting the inhomogeneous structures such as an accretion wake and/or a bow shock. We compared the observed modulations with calculations based on a stellar wind model, accelerated by ultraviolet radiation from the WR star. One of the calculations qualitatively reproduced the observed trend that H-like Fe ions were concentrated near the compact object, whereas H-like S was distributed across the binary system, with H-like Ca and Ar showing intermediate spatial distributions. From this comparison, we estimated that a mass-loss rate of the stellar wind was approximately 5×10^{-6}–1×10^{-5} $M_\odot$ yr^{-1}. We further examined the differences between the spectra obtained under the assumption of the CAK model and the observed spectra. We found that the Fe Lyα lines exhibit smaller line widths and weaker intensities compared with the observations. In contrast, the Lyα lines of Ca, Ar, and S are reproduced reasonably well compared to the Fe Lyα lines. These results suggest that, for the Fe Lyα lines, not only the Doppler shifts but also the line widths and intensities are more strongly influenced by the compact object than those of other lines.