

First look at Vela X-1 with XRISM

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The spectral and timing behaviour of neutron star high-mass X-ray binaries (HMXBs) offers a unique opportunity to investigate accretion onto compact objects and the wind structures of massive stars. In particular, understanding the X-ray emission from neutron stars is a critical topic of research for current and future astrophysical studies, as highlighted by its prominence in the science cases of the upcoming NewAthena mission. In our study, we focus on an observation of the key source Vela X-1, which was obtained during the first cycle of the Guest Observer programme of XRISM when the neutron star was in inferior conjunction. We also present results obtained simultaneously with the XMM-Newton and NuSTAR observatories. This exceptional dataset enables high-resolution broadband spectroscopy of Vela X-1, covering the energy range from 0.5 to 79 keV. The Resolve spectrometer onboard XRISM reveals for the first time the doublet of the emission lines of $\text{FeK}\alpha_1$ and $\text{FeK}\alpha_2$ as well as $\text{NiK}\alpha$. Additionally, we investigate the clumpy structure of the material being accreted by the neutron star with an in-depth view into the accretion and photoionisation wakes, and provide valuable data for cross-calibration studies among three of the most modern and widely used X-ray telescopes. The analysis was performed with the jaxspec X-ray spectral fitting library, which allowed the fit parameters to remain free to vary by employing variational inference with a multivariate Gaussian guide for the posteriors –an approach not possible with classical frameworks.

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