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High-precision optical polarimetry of black hole X-ray binaries

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Stellar-mass black holes in low-mass X-ray binaries are natural laboratories for studying the interaction of matter and radiation under extreme physical conditions. These systems spend most of their lifecycle residing in the inactive (quiescent) state, sometimes suddenly bursting out, increasing their brightness by several orders of magnitude over the entire spectrum. Their optical and infrared emission is a product of a complex interplay between the jet, wind, accretion disc, and hot accretion flow components.

The study of the contributions of various components and their properties to the observed spectrum is crucial for the understanding of the mechanisms leading to outbursts. One of the effective, and often overlooked, ways of such study is optical polarimetry since the polarization carries information about the geometrical properties of the emitting/scattering media, which may otherwise be inaccessible to an observer.

We present the results of multiwavelength (BVR) polarimetric studies of a sample of eight black hole X-ray binaries during outbursts and those residing in the quiescent (or near-quiescent) state. We surveyed both long- and short-period systems located at different Galactic latitudes. Careful analysis of the interstellar polarization in the direction of the sources allowed us to estimate the intrinsic polarization of all binaries. Intrinsic polarization is found to be small (<0.2%) for sources in bright soft states. It was found to be significant in the rising hard state of MAXI J1820+070 at the level of 0.5% and negligible in the decaying hard state. Four out of five sources observed during quiescence show no evidence of significant intrinsic polarization. The only exception is MAXI J1820+070, which showed substantial (>5%) intrinsic quiescent state polarization with a blue spectrum. The absence of intrinsic polarization at the optical wavelengths puts constraints on the potential contribution of non-stellar (jet, hot flow, accretion disc) components to the total spectra of quiescent black hole X-ray binaries.

Primary authors: VELEDINA, Alexandra; Mr KRAVTSOV, Vadim (University of Turku); Dr BERDYUGIN, Andrei (University of Turku); POUTANEN, Juri (University of Turku)

Presenter: Mr KRAVTSOV, Vadim (University of Turku)

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