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X-ray spectroscopy of highly magnetic cataclysmic variables during the eROSITA pointed phase

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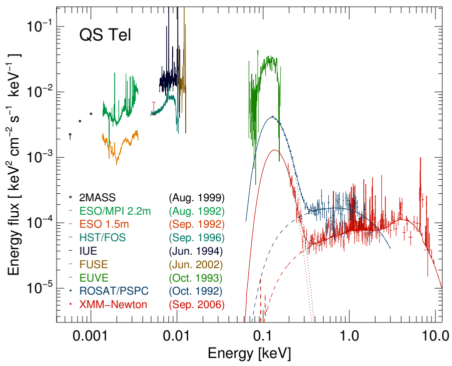
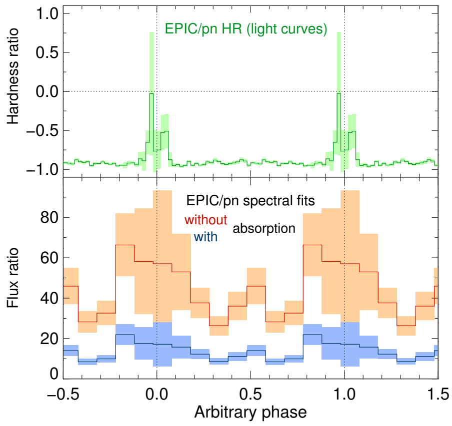
Motivation

Accretion onto magnetic white dwarfs involves plasma under extreme physical conditions, in particular very high temperatures. With X-ray observations, it has become possible to study the accretion processes and the correlated system properties directly. The X-ray emission of polars consists of two main components: the harder emission from the cooling accretion column above the white dwarf and the softer emission from the heated accretion region on the white-dwarf surface. Several systems show an excess of soft over hard X-ray flux by factors up to 1 000, which is interpreted as a sign of inhomogeneous, “blobby” accretion. Model calculations and recent spectral analyses indicate that the emission regions exhibit a complex structure and a wide range of temperatures and densities, which affect the spectral continuum and emission lines. The X-ray luminosity of accreting white dwarfs, however, is comparably low ($L_X \sim 10^{31} - 10^{34}$ erg s^{-1}) and greatly variable. Highly resolved X-ray spectra, as taken by Chandra/LETG or XMM-Newton/RGS, thus have been available only for few systems so far. Pointed eROSITA observations with exposure times on the order of one to two binary orbits, i.e. 10—60 ks, will provide us with spectra of a large number of cataclysmic variables in the relevant energy range. They will enable us to better distinguish between different models for the temperature and density structures and push our knowledge about the physical properties of the X-ray emission regions of polars.



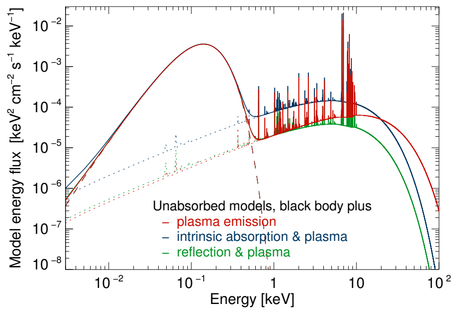
Long-term spectral energy distribution of the X-ray soft polar QS Tel, comprising our XMM-Newton observations and archival data. An absorbed black-body model represents the emission from the heated photosphere of the white dwarf, and a partially absorbed plasma model the emission from the accretion column in the spectral fit.

Soft-to-hard model flux ratios



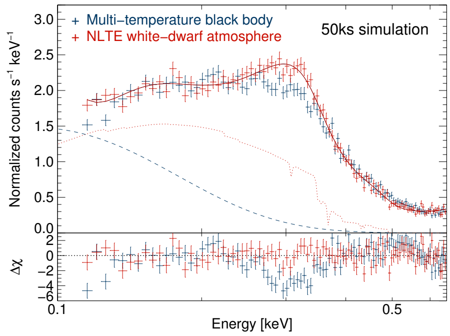
Phase-resolved hardness and bolometric model flux ratios of RS Cae. *Upper panel:* Hardness ratios, derived from the EPIC/pn light curves at energies above and below 0.5 keV, folded to 50 phase bins. *Lower panel:* Flux ratios, derived from fits to the EPIC/pn spectra of RS Cae for ten phase bins.

A systematic study of the model flux and luminosity ratios between the X-ray soft and hard spectral components will test the pictures of the energy balance in polars and the fraction of soft X-ray dominated systems. The soft-to-hard flux ratios that we derive from XMM-Newton EPIC data strongly depend on the choice of the spectral model. Currently, the analytical potential is limited: In the ROSAT survey, objects with high soft X-ray luminosities have been discovered, i. e. polars during high states of accretion and soft X-ray dominated polars; and detailed spectral analyses are restricted to X-ray luminous systems. The eROSITA survey and pointed observations will significantly increase the total number of known systems and the number of systems for that reliable soft-to-hard ratios can be derived.



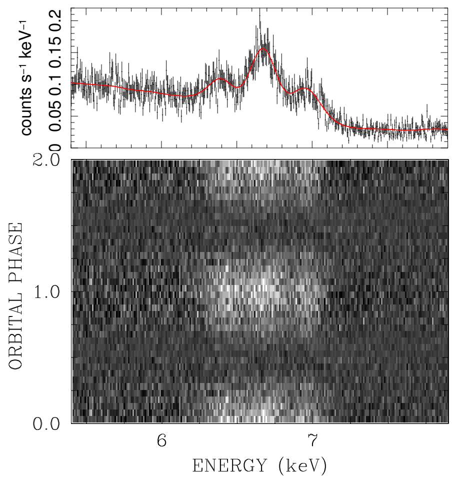
Model dependence of the measured flux ratios: Unabsorbed model fluxes of three black-body plus plasma fits to the XMM-Newton spectra of RS Cae.

Soft X-ray spectra with eROSITA



A pointed 50 ks observation with eROSITA, based on the best fits to EPIC spectra of AI Tri. We will be able to distinguish between black-body (blue) and non-LTE atmosphere models (red). Dashed / dotted: unfolded models (arbitrary flux units).

The iron complex with eROSITA



Phase-resolved spectroscopy of AM Her: tracing the iron lines. *Top:* 100 ks eROSITA spectrum. The accretion-column model consists of a reflection and multi-T plasma components. *Bottom:* XMM-Newton EPIC/pn spectra in 20 phase bins.

Prospectives

◇ Insights into the structure of accretion column and region, comparison of diverse single- and multi-temperature model approaches.
◇ Phase-resolved analyses of the contribution of different spectral components and the energy balance of X-ray soft and hard systems.
◇ More accurately determining mass accretion rates during high and low states.
◇ Comprehensive statistical studies of the system properties of a largely extended sample.

First eROSITA International Conference, Garmisch-Partenkirchen, 2011