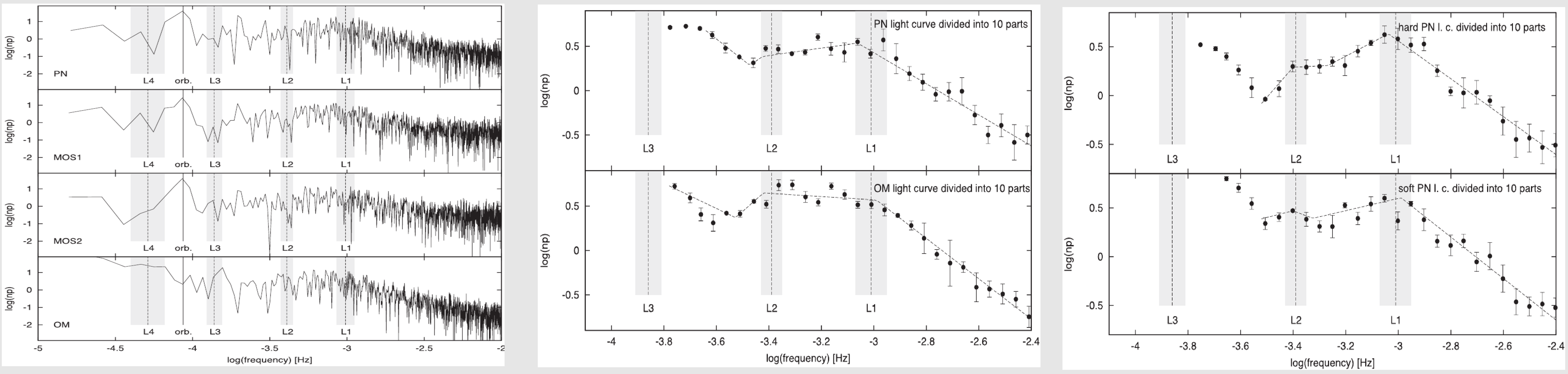
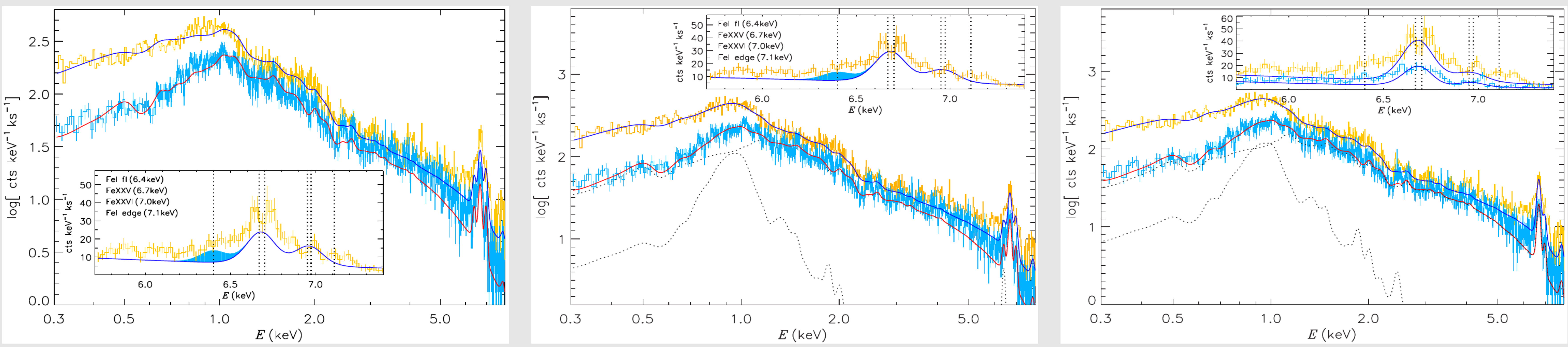
XMM-Newton observation of nova like system MV Lyr and search for source of the fast variability detected in Kepler data

Andrej Dobrotka (Slovak University of Technology, Slovakia), **Jan-Uwe Ness** (ESAC, Spain), **Shin Mineshige** (Kyoto University, Japan), **Achille Nucita** (University of Salento, INFN, Italy)

Abstract: Nova like system MV Lyr is present in the Kepler field yielding a high cadence long lasting light curve ideal for detailed study of the fast variability. Scaringi et al. (2012) detected four frequency components in the power density spectra (PDS), and the modelling of the highest component suggests an expanded hot geometrically thick optically thin X-ray corona as a source (Scaringi 2014). In such case the X-rays are reprocessed into optical radiation by the underlying geometrically thin disc. Such interpretation requires a direct X-ray observation to confirm the model or to suggest another way of research. We present analysis of our XMM-Newton data of MV Lyr where we detected the searched frequency component in both the X-ray and UV light curves. Furthermore, the X-ray spectra are described by either a two temperature collisional plasma or a cooling flow model. The latter yields a considerably lower mass accretion rate than expected in the bright state, suggesting an evaporated medium with low density and high temperature. Therefore, we confirm the model where a geometrically thick X-ray corona is surrounding the central region of a standard geometrically thin accretion disc (sandwiched model).

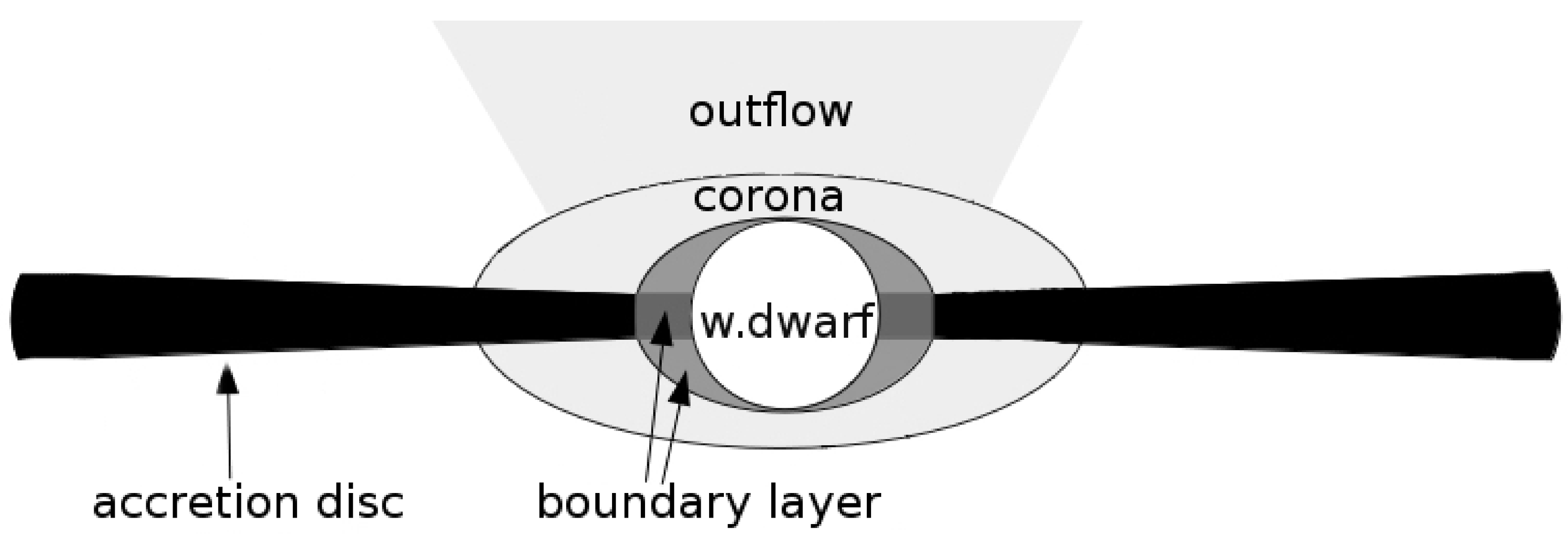


Timing analysis: Periodograms (left panel) of all instruments show a break frequency around a value log(f/Hz) = -3 marked as L1 (from Scaringi et al. 2012, four components L1 – L4 detected in Kepler data). PDS estimates (light curve divided into several parts, periodogram is calculated for every sample, all periodograms are averaged and binned into equally spaced bins) show also L2 component mostly visible in UV (middle panel). Decomposition of the X-ray data into soft and hard band (based on our spectral modeling) revealed that the L2 component is strong in hard band (right panel). The orbital signal is present in X-rays but absent in UV (left panel).



Spectral analysis: The RGS spectrum displays emission lines plus continuum, confirming model approaches to be based on thermal plasma models. The EPIC (MOS1+2 in light blue, PN in orange) spectra are consistent with either a cooling flow model (left panel) or a 2-T collisional plasma plus Fe emission lines (middle panel) in which the hotter component may be partially absorbed (right panel) which would then originate in a central corona or a partially obscured boundary layer, respectively. The cooling flow model yields a mass accretion rate typical for dwarf novae in quiescence, suggesting an evaporated plasma with a low density, thus consistent with the corona.

Conclusion: The low accretion rate derived from the cooling flow model is not in agreement with the high state of MV Lyr which would suggest mass accretion rate as in dwarf novae in outburst. However, Balman et al. (2014) pointed out a dilemma in radiation from nova like systems, i.e. the optical and UV accretion rates and luminosities resembling those of dwarf novae in outburst, while their X-ray analysis during the same brightness state with resulting accretion rates and luminosities resemble those in quiescent dwarf novae. The sandwiched model offers a connection between these antagonistic aspects, i.e. the existence of both, the standard disc with an optically thick boundary layer (resembling dwarf novae in outburst, proposed by Godon & Sion (2011), together with a corona with an optically thin hot boundary layer (resembling quiescent dwarf novae, proposed by Balman et al. (2014). Concerning the PDS components, the basic idea is that every characteristic break frequency is a finger-print of a specific accretion structure. Following the recent work we can confirm the connection of L1 and the corona.



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