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About the dependency of the spin maxima on orbital phase in the intermediate polar MU Cam

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Abstract. Long term monitoring of intermediate polars is performed as part of the Inter-Longitude Astronomy campaign. High-quality and long time series observations allow us to investigate fine effects on complex light curves. In the case of MU Cam we have investigated the periodic modulation of the spin phases with the orbital phase. This dependency was already described by Kim et al. (2005). As an explanation they proposed inhomogeneous accretion flow from the secondary. However, based on our new data, we propose as a simple explanation the influence of orbital sidebands in the periodic signal produced by the intermediate polar. This explanation is supported by the fact that the changes in spin maxima phase are observed mainly when the sideband frequency is dominant in the periodogram.

Key words: stars: individual: MU Cam – stars: novae, cataclysmic variables – accretion, accretion discs

1. Observations and data analysis

MU Cam (1RXS J062518.2+733433) was classified as an intermediate polar by Staude et al. (2003) and Araujo-Betancor et al. (2003). They determined spin and orbital periods of the system.

Our observations of MU Cam were taken as part of the Inter-Longitude Astronomy Campaign (Andronov et al., 2003). The goal of the campaign is the monitoring of selected intermediate polars for spin period changes. In this work we analyze data from the Astronomical Observatory on Kolonica Saddle and from M.R. Štefanik Observatory in Hlohovec. We used the Vihorlat National Telescope VNT 1000/9000 mm and Cassegrain 600/2500 mm. Ensemble photometry was performed using C-Munipack, CoLiTecVS (Kudzej et al., 2019) and MCV (Kim et al., 2004) software packages.

We have constructed the O-C diagram of spin pulse maxima based on the ephemeris $BJD_{max} = 2452682.4181 + 0.01374116815 \times E$. Residuals from the quadratic fit $BJD_{max} = 2452682.4181 + 0.0137412342412802 \times E - 1.52 \times 10^{-12} \times E^2$ show unexpected scatter. As a possible source of these deviations we have investigated the dependency of spin maxima timings on orbital phase.

Mean spin maxima were determined for 10 phase intervals: 0.0-0.1; 0.1-0.2, etc. Only long time series were used to achieve higher precision. The amplitude and shape are changing, but there is no unambiguous dependency on orbital phase.

Periodogram analysis reveals two correlations:

1. High amplitude O-C variations of spin maxima – strong sideband signal. Low amplitude – low or no sideband signal.
2. Orbital sideband appears mainly in low states of the long term light curve.

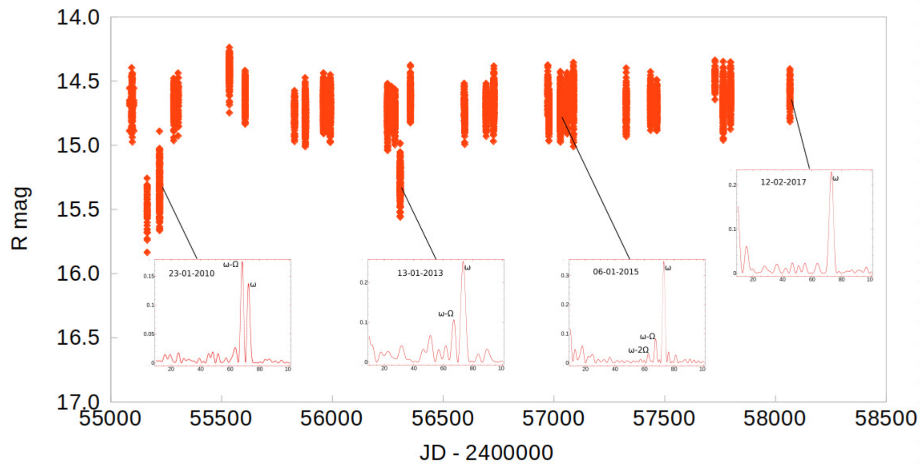

Figure 1. Selected periodograms depicted on the long-term light curve.

2. Conclusions

We performed photometric observations of MU Cam, analysed the new and previously published data, and obtained the following results:

– Spin maxima phase changes are caused by the interaction with the orbital sideband frequencies.

– The presence of orbital sidebands is more prominent in low states.

– The origin of orbital sidebands can be direct accretion from the stream or/and reprocessing of X-rays at some part of the system which rotates with the orbital period.

– The low states in intermediate polars are connected with lower mass transfer in the system. In that situation the disc-fed accretion should be lower. The disc can completely disappear as was demonstrated by Hameury & Lasota (2017) for the FO Aqr case.

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