

# LMC X–4: Different Types of Long-Term Variability

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**Abstract.** This talk presented a summary of our study of different types of long-term variability in the high-mass X-ray binary LMC X-4, by taking advantage of more than 43 years of measurements in the X-ray domain. In particular, we investigated the 30-day cycle of modulation of the X-ray emission from the source (super-orbital or precessional variability), and refined the orbital period and its first derivative. We showed that the precession period in the time-interval 1991–2015 is near its equilibrium value of  $P_{sup} = 30.370$  days, while the observed historical changes in the phase of this variability can be interpreted in terms of the ‘red noise’ model. We obtained an analytical law from which the precession phase can be determined to within 5% throughout the entire time-interval under consideration. Our analysis revealed for the first time that the source is displaying near-periodic variations of its spin period, on a time-scale of roughly 6.8 years, thus making LMC X-4 one of the (few) known binary systems that show remarkable long-term spin–torque reversals.

**Keywords.** X-rays: binaries, individual (LMC X-4)

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Our results have been published in three papers so far:

Molkov, S. V., Lutovinov, A. A., & Falanga, M. 2015, *Astron. Let.*, 41, 562

Molkov, S., Lutovinov, A., Falanga, M., Tsygankov, S., & Bozzo, E. 2017 *MNRAS*, 464, 2039

Shtykovsky, A. E., Lutovinov, A. A., Arefiev, V. A., Molkov, S. V., Tsygankov, S. S., & Revnivtsev, M. G. 2017, *Astron. Let.*, 43, 175