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The accreting millisecond pulsar SAX J1808.4 3658 during its 2022 outburst

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Accreting millisecond pulsars (AMSPs) are rapidly rotating neutron stars hosted in a tight binary system with a low-mass companion. Their millisecond periods result from a Gyr-long phase in which old radio pulsars are spun up by accreting matter from a donor via a Roche lobe overflow. SAX J1808.4-3658 was the first AMSP discovered in 1998. Since then, the source has undergone ten ~ 1-month-long outbursts with ~ 2-3 years recurrence, making it the most thoroughly investigated of its type. When the onset of a new outburst was detected in August 2022, we performed a multiwavelength campaign with three X-ray telescopes - XMM-Newton, NuSTAR, and NICER -, the fast optical photometer TNG/SiFAP2, and the HST. I will present a coherent timing analysis of X-ray pulsations during this latest outburst, confirming the long-term spin-down rate compatible with the expected energy losses from a rotating magnetic dipole of 108 G. This may indicate that a radio pulsar is active in the system during quiescence. For the first time in the last twenty years, we found hints of an orbital decay. I will discuss this evolution in terms of a gravitational coupling between the orbit and variations in the mass quadrupole of the companion star.

Presenter: ILLIANO, Giulia

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