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Discovery of an optical millisecond pulsar with a Silicon Fast Astronomical Photometer

The recent advent of solid-state detectors originally developed for high energy physics is revolutionizing astrophysical measurements. An ultra-fast photometer based on the Silicon Photo Multiplier technology (SiFAP, Silicon Fast Astronomical Photometer, Ambrosino et al., 2013, 2016) and capable of the single-photon detection in the Optical band (320-900 nm) with a time resolution down to 8 ns was developed at the Department of Physics of Sapienza Università di Roma since 2009 to study astrophysical faint variable sources. Currently mounted at the 3.6m INAF Galileo Telescope, SiFAP recently proved its capabilities by detecting for the first time optical pulsations from a 1.7 millisecond transitional pulsar in a binary system, PSR J1023+0038 (Ambrosino, Papitto et al., 2017, Nature Astronomy). Millisecond pulsars are neutron stars that attain their very quick rotation during a Gyr long, X-ray bright phase of accretion of matter from a low mass companion star. Some of them swing between an accretion-powered X-ray pulsar regime and a rotationally powered radio pulsar state on a time scale of a few weeks and are dubbed transitional (Papitto et al., Nature, 2013). The SiFAP detection of optical pulses occurred when the pulsar was surrounded by an accretion disk but was most likely powered by the rotation of its, an unexpected outcome of the disk-magnetosphere interaction highlighted by our observations (Papitto, Ambrosino et al. 2019, ApJ). I will present the working principle of SiFAP and its results obtained from observations of the transitional millisecond pulsar PSR J1023+0038 as well as the Crab Pulsar, Hz Her/Her X-1, Aql X-1. I will also show future prospects and technological improvements of SiFAP.

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