Astronomers explore properties of the high-magnetic field pulsar PSR J1119−6127

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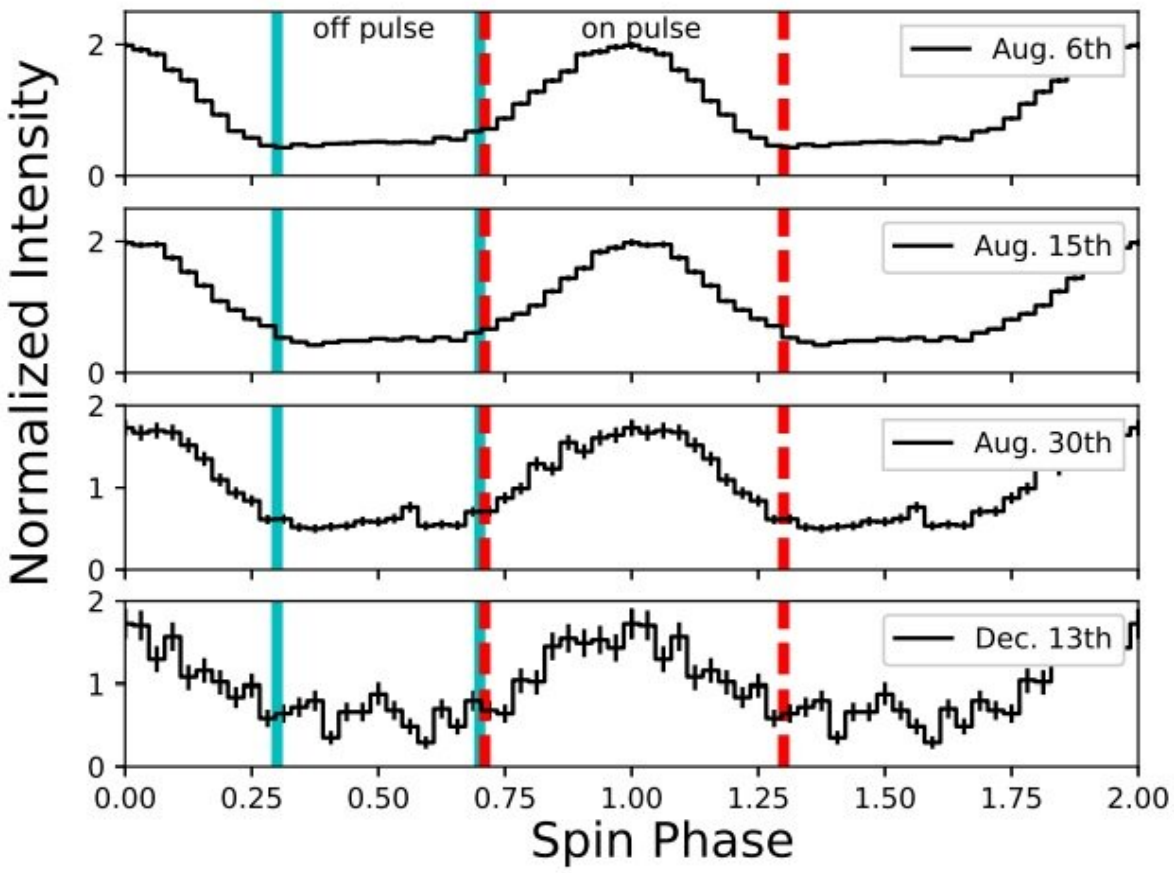

X-ray folded light curves of PSR J1119−6127 in the 0.5–10.0 keV energy band from XMM-Newton. Credit: Wang et al., 2020.

Using various space observatories, astronomers have conducted multi-

wavelength study of a high-magnetic-field pulsar known as PSR J1119−6127, which underwent an outburst in 2016. The results shed more light on the properties of this pulsar during the post-outburst period. The study is detailed in a paper published August 28 on arXiv.org.

Pulsars are highly magnetized, rotating neutron stars emitting a beam of electromagnetic radiation. They are usually detected in the form of short bursts of radio emission, however, some of them are also observed using optical, X-ray and gamma-ray telescopes.

PSR J1119−6127 was discovered in 2000 by the Parkes multibeam pulsar survey, likely associated with the supernova remnant G292.2-0.5 at a distance of about 27,400 light years. The pulsar has a spin period of 0.407 seconds, a characteristic age of some 1,600 years and spin-down power of approximately 2.3 undecillion erg/s.

In late July 2016, NASA's Fermi and Swift spacecraft detected magnetar-like X-ray outbursts of PSR J1119−6127 and also 13 short X-ray bursts. The total energy that was released during this event was estimated to be at a level of around 1.0 tredecillion erg. To better understand the evolution of PSR J1119−6127 after the 2016 outburst, several teams of researchers started to monitor this pulsar.

One such team, led by Huihui Wang of the Huazhong University of Science and Technology in Wuhan, China, carried out a multi-wavelength (from radio to gamma-ray band) study of PSR J1119−6127. For this purpose, they used data from Fermi, Swift, ESA's X-ray Multi-Mirror Mission (XMM-Newton) and NASA's Nuclear Spectroscopic Telescope Array (NuSTAR).

"In this study, we have performed a multi-wavelength study for PSR J1119−6127 after its 2016 magnetar-like outburst," the astronomers

wrote in the paper.

Before the 2016 outburst, the X-ray pulse peak of PSR J1119−6127 was aligned with its radio pulse peak. The study found no substantial shift between these peaks after the outburst. It was noted that the observed X-ray spectra of both on-pulse and off-pulse phases are well described by two blackbody components plus a power-law model.

In general, the radio and X-ray emission properties, as well as the spindown properties of PSR J1119−6127 after the 2016 outburst were found to be similar to those of the magnetar XTE J1810−197, which underwent an X-ray outburst in 2003. Wang's study revealed that the evolution of the timing solution, radio emission and X-ray emission properties of PSR J1119−6127 after its latest outburst are very similar to those of XTE J1810−197. However, the recovery time scale and released total energy are one or two orders of magnitude smaller in PSR J1119−6127.

When it comes to the GeV gamma-ray emission from PSR J1119−6127, the results indicate that it is slightly suppressed around the 2016 outburst. The GeV spectral characteristics after January 2017 (post-relaxation epoch) are consistent with that of the pre-outburst period. Moreover, the phase difference between the gamma-ray peak and radio peak in the post-relaxation stage is about 0.4, which is consistent with the measurement before the 2016 X-ray outburst.

Taking into account all the collected data, the astronomers concluded that the 2016 X-ray outburst probably caused a reconfiguration of the global magnetosphere of PSR J1119−6127and changed the structure of the open field line regions. They added that this reconfiguration continued for about a half-year after the outburst.

More information: Wang et al., A multi-wavelength study of PSR

J1119−6127 after 2016 outburst, arXiv:2008.12585 [astro-ph.HE]
arxiv.org/abs/2008.12585