Average and single-pulse emission of PSR B1744–24A

Pulsars are one of the most exotic type of stars ever to be identified: they are born in supernova explosions, when a dying star leaves behind its rapidly spinning core, compressed to super-nuclear densities. Astonishingly small by astronomical scales (10-20 km), pulsars harbour ultra-strong magnetic fields and most of the time the only way to see them is to catch the narrow beam of electromagnetic radiation created by relativistic plasma in the pulsar's magnetosphere. When this beam sweeps past the Earth, like the light from a lighthouse, a pulse is detected. The thorough investigation of these pulses provides a wealth of astrophysical information and can even be used to test fundamental physical theories.

PSR B1744–24A (also known as Ter5A) was the first pulsar discovered in globular cluster Terzan 5, a gravitationally bound agglomeration of stars that orbits Galactic core as a satellite. Similarly to many other pulsars, Ter5A at most times is too faint to be detected via individual pulses. However, the periodicity in incoming signal can be assessed by indirect methods and once the spin period of a pulsar is identified, so-called “average pulse” can be accumulated by folding the data stream synchronously with the spin period. The case of Ter5A is further complicated by the fact that the pulsar belongs to a tight binary system and the appearance of the average pulse is sometimes affected by the propagation through the cloud of plasma which surrounds the pulsar's companion. The center part of the plot shows the evolution of the average pulse at radio wavelengths throughout one orbit. At the orbital phases 0.0 – 0.1 and 0.9 – 1.0 the pulsar is eclipsed by its companion and close to eclipses the propagation through the outer layers of companion star smears and delays observed pulses.

Ter5A emission poses few questions which still await their answers. One of them is the behaviour of linear polarization. In the middle of orbital period, where pulsar is in front of the companion and the pulsar radiation travels uninterrupted, the pulsar radio emission has moderate, but distinct level of linear polarization (see the inset on the right side with average pulses from selected orbital phases). Interestingly enough, this linearly polarized emission vanished in the vicinity of eclipses, but well before the shape of profile or level of circular polarization changes. Even more puzzling, there have been spotted bursts of strong pulses (shown on the left) which frame the disappearance of linear polarization. These pulses are so strong that we can detect them in original data, without any averaging. However, the fraction of such super-pulses is tiny and they do not influence the average intensity or pulse shape. It is currently unclear what makes these pulses so bright and how they are connected to the disappearance of the linear polarization in the average emission. We hope that investigating this will shed some light on the interaction of pulsar emission with companion's plasma and the conditions in the binary system.