ABSTRACT

Spectral analysis of the polarisation of drifting subpulses

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Pulsars are among the most extreme objects in the Universe. Each one is born during a supernova – a dramatic explosion that happens when a bright star is many times bigger than our Sun and runs out of fuel. The heavy core of the star collapses under its own weight into something denser than the nucleus of an atom. Each pulsar has a magnetic field that is millions of times stronger than any that can be produced here on the Earth. Like a cosmic lighthouse, this magnetic field generates beams that sweep across the Galaxy with each rotation of the star (Gold, 1968); however, the underlying physics of the pulsar emission mechanism remains poorly understood after decades of study. Unlike the steady beam of a lighthouse, a pulsar's beam crackles and pops with lightning-like discharges of energy (Ruderman & Sutherland, 1975). By studying this highly dynamic signal, we learn about what generates the radio waves and what happens as they travel through the turbulent plasma in the pulsar's strong magnetic field. A relatively rare number of pulsars exhibit quasi-periodic variations in the polarization state of their emission (Primak et al., 2022). To provide new insight into the origin of this behaviour, I have developed a novel statistical method of studying quasi-periodic polarization fluctuations. I apply this technique to the first-discovered pulsar, and compare and contrast the results with previous work. The method can be applied to a wide range of radio pulsars and used to estimate the fraction of pulsars that exhibit quasi-periodic polarization fluctuations. In doing so, this experiment will provide new experimental constraints on theories of radio emission and propagation in the pulsar magnetosphere, and facilitate a deeper understanding of the physics of relativistic plasmas in strong magnetic fields.

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