Pulsar in Ter5 A binary system: timing and single-pulse study

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Abstract. Millisecond pulsar B1744−24A (Ter5A) in globular cluster Terzan 5 belongs to the one of the few “windy” binary systems, with unbound material escaping from the companion star and interacting with the pulsar’s magnetosphere. In this work we used two decades of timing data to trace the evolution of the pulsar’s spin and orbital parameters. Also, Ter5A appears to emit strong wide single pulses, with energies 30 or more times the mean pulse energy, with widths comparable to that of the average profile. These pulses occur preferentially shortly before and after the pulsar is obscured by the unbound material from the companion star.

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Timing

The pulsar was observed from 1990−2010 with the VLA, Parkes, the 140-ft and 100-m Green Bank telescopes. A timing solution was obtained with *tempo2*. We used the T2 orbital model with longitude of periastron and orbital eccentricity set to zero. Binary parameters were mapped by dividing data in subsets of appropriate length and obtaining timing solutions separately for each subset.

We note that the observed pulsar spin frequency must be fit with high-order polynomials (see Fig. 1a), otherwise phase wraps are inevitable. It is not clear yet whether this behavior is intrinsic to pulsar or is due to external effects (for example, gravitational torques from the cluster). Secondly, the dispersion measure increased gradually over 20 years with dDM/dt = 0.005 pc/cm³/yr (see Fig. 1c). We could not detect any change in the projected semimajor axis of the orbit, however the measurements of the epoch of the periastron (antiderivative of orbital period) indicate that the orbital period gradually decreases with time, at the same time undergoing ~8-year quasi-periodic oscillations (see Fig. 1b). The remaining phase offsets (see Fig. 1d) seem to have systematic variations with ~4-year period. Possible interpretations of these oscillations include additional low-mass bodies in the system or torques on pulsar due to infalling matter [1]. After fitting out all possible parameters, the residuals have ~ 600 µs scatter, mostly due to increasing DM in the vicinity of eclipses.
Single pulses

Single pulses were extracted from the recent 8-hour observations of Terzan 5 at 2 GHz with the GBT. Fig. 2 shows the observed average pulse energy as a function of orbital phase. When the average energy drops to zero, the pulsar is obscured by unbound material. Most of the time single pulses are too weak to detect, but right before and after the pulsar is obscured, there appear short bursts of strong pulses. The energy of these pulses can easily exceed 30 times the average energy. However, unlike the most studied example of abnormal single-pulse behavior, Giant Pulses, these strong pulses are a few milliseconds in width.

REFERENCES