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Rotational and Orbital Fluctuations of Eclipsing Binary Pulsar PSR B1744-24A

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Eclipsing binary pulsars systems highlight an important stage in the evolution of isolated millisecond pulsars. In these systems, the pulsar's companion is losing mass due to Roche lobe overflow and/or a stellar wind induced by intercepted energy from the pulsar flux. Eventual evaporation of the companions could yield isolated millisecond puslars. PSR B1744-24A was the second eclipsing millisecond pulsar to be discovered (Lyne *et al.* 1990). It is in a 1.8 hr orbit with a $\sim 0.1\,M_\odot$ companion. Its eclipses show some variability, and the pulsar is undetectable at about 25% of observing epochs, presumably because it is completely enveloped by the companion's outflow (Nice & Thorsett 1992).

We have observed PSR B1744-24A over more than five years using the VLA, at 1665 MHz, and the Green Bank 140 foot telescope, at 800, 1330, and 1660 MHz.[1] Observations are made at intervals of two or three months. Pulse arrival times are measured and analyzed using standard procedures.

We find that the orbital period P_b changes over time. The orbital period derivative, $\dot{P}_b = (-2.1\pm0.3)\times10^{-12}$, implies an orbital decay time of 100 Myr, an order of magnitude shorter than that expected from general relativity. However, given the apparently stochastic orbital phase shifts of PSR B1957+20 (Arzoumanian *et al.* 1994), the long term orbital evolution of PSR B1744-24A may not be simple.

After removing the orbital time-of-flight delays and a standard pulsar rotation model (including a negative rotation period derivative, induced by the cluster gravitational potential), systematic residual pulse arrival time variations remain. These residuals have an amplitude of $500\,\mu$s and a red spectrum, and are independent of frequency (Fig. 1), ruling out dispersion measure variations as an origin. The cubic term of the residuals, $\ddot{P}/P = 3\times10^{-26}\,\mathrm{s}^{-2}$, is much larger than the jerk expected from the cluster, of order $9\times10^{-29}\,\mathrm{s}^{-2}$ (Phinney 1993). The residuals must reflect either torques on the pulsar itself (perhaps induced by interaction with the companion outflow during those times when the pulsar is undetectable) or acceleration of the entire binary system, perhaps by additional orbital companions or a distant "excretion" disk (Banit *et al.* 1993).

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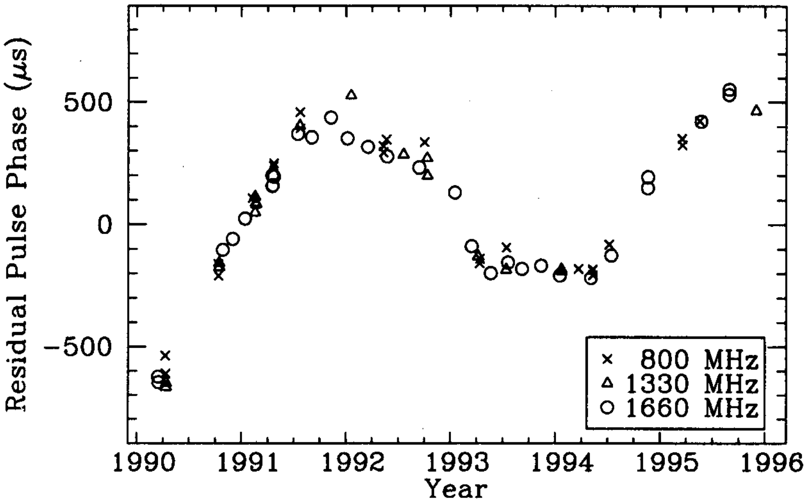

Figure 1. Residual pulse arrival times after removing all orbital effects and a standard pulsar rotation model.

References

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Table 1. Timing Parameters of PSR 1744-24A

Right Ascension (J2000)	$17^h48^m02\overset{s}{.}2535(6)$
Declination (J2000)	$-24°46'37\overset{''}{.}1(2)$
Period (ms)	11.56314838880(1)
Period Derivative	$-2.54(7) \times 10^{-20}$
Period Second Derivative (s^{-1})	$3.1(6) \times 10^{-28}$
Epoch (MJD)	48670.0
Orbital Period (s)	6535.824407(8)
Orbital Period Derivative	$-2.1(3) \times 10^{-12}$
Projected Semi-Major Axis (light s)	0.11964(1)
Time of Ascending Node (MJD)	48633.9634359(7)

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