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# A Search for Radio Pulsars at High Galactic Latitude

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**Abstract.** We have completed a search for radio pulsars using the Parkes 64 m telescope, covering ~4500 $\deg^2$ between 15° and 30° from the Galactic plane. Each pointing was observed for 265 s with the 13-beam multibeam system at a frequency of 1374 MHz. The signal from each beam was processed by a 96-channel filterbank and sampled every 125 $\mu$s, with a bandwidth of 288 MHz. This strategy affords rapid sky coverage and good sensitivity to pulsars with periods as short as 1 ms, whose existence would constrain the neutron star equation of state. Data were analyzed using the workstation cluster at the Swinburne Centre for Astrophysics and Supercomputing. This effort has yielded 26 new pulsars, including seven recycled pulsars. Taken together with the previous Swinburne Intermediate Latitude Pulsar Survey, a total of 95 new pulsars were found over nearly 7500 $\deg^2$ of sky between 5° and 30° from the plane of the Galaxy. This large sample of newly discovered objects contains no young pulsars.

## 1. Introduction

Pulsar spin periods have the potential to provide the cleanest constraint on the neutron star equation of state. Unfortunately, the shortest known pulsar spin period ($P = 1.558$ ms) rules out only the hardest equations of state. This survey was primarily motivated by the desire to find a pulsar that spins more rapidly than any presently known. Though this goal was not achieved, several millisecond pulsars were discovered which promise to be very useful for precision timing experiments.

We have searched ~4500 $\deg^2$ in the region $15° < |b| < 30°$, $-100° < l < 50°$ using the 13-beam Parkes multibeam system at 1374 MHz. Sampling the $2 \times 96 \times 3$ MHz filterbanks every 125 $\mu$s provides good sensitivity to pulsars with short spin periods.

This effort follows the successful observing and analysis strategy employed by the Swinburne Intermediate Latitude Pulsar Survey (Edwards et al. 2001). This previous survey of ~3000 $\deg^2$ in the region $5° < |b| < 15°$ found 69 new pulsars, including eight recycled pulsars. Together, these two surveys provide a uniform picture of the pulsar population over a very large area of the sky.

## 2. Swinburne High Latitude Survey Discoveries

This survey has uncovered 26 new pulsars, including seven recycled pulsars (Table 1). This is a much higher fraction of recycled pulsars than in the pulsar population as a whole. While we have not yet obtained age estimates for most of the other pulsars discovered in the survey, we have no reason to believe that any of them are young. This is not surprising given the time required for neutron stars to migrate away from the Galactic plane.

Table 1. Recycled pulsars discovered in survey. All binaries have low-eccentricity orbits.

| Name (PSR) | $P$ (ms) | DM (pc cm$^{-3}$) | $d$ (kpc) | $P_b$ (d) | $a\ \sin(i)$ (lt sec) | $M_{2\ min}$ ($M_\odot$) | $\tau_c$ (Gyr) |
|---|---|---|---|---|---|---|---|
| J1909−3744 | 2.95 | 10.4 | 0.8 | 1.53 | 1.90 | 0.20 | 7.3 |
| J1933−62 | 3.54 | 11.7 | 0.6 | ~13 | ~12 | ~0.3 | |
| J1600−3053 | 3.60 | 52.3 | 2.7 | 14.35 | 8.80 | 0.20 | 6.0 |
| J1741+13 | 3.74 | 24.0 | 1.4 | >4 | >1 | >0.06 | |
| J2010−1323 | 5.22 | 22.1 | 1.3 | — | — | — | |
| J1738+0333 | 5.85 | 33.5 | 1.9 | 0.35 | 0.34 | 0.09 | 4.0 |
| J1528−3146 | 60.82 | 19.7 | 1.1 | 3.18 | 11.45 | 0.94 | 4.8 |

The millisecond pulsars PSR J1600−3053 and PSR J1909−3744 have great potential for high-precision timing experiments because they are bright and have unusually narrow pulse profiles. Initial results with the Caltech-Parkes-Swinburne Recorder II (CPSR2) coherent dedispersion system indicate that these pulsars may rival the timing precision achieved with PSR J0437−4715 (van Straten et al. 2001). PSR J1738+0333 is relatively faint, but has good prospects for precision timing with the Arecibo telescope.

PSR J1528−3146, with its massive white dwarf companion, is in the small but growing class of intermediate mass binary pulsars (Camilo et al. 2001; Edwards & Bailes 2001).

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