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The Parkes Pulsar Timing Array Project

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Abstract. The Parkes Pulsar Timing Array project is timing 20 millisecond pulsars with the aims of detecting gravitational waves, establishing a time scale based on pulsar periods and improving solar-system ephemerides.

Keywords. pulsars: general — time — reference systems — gravitational waves

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The Parkes Pulsar Timing Array (PPTA) project is timing 20 millisecond pulsars using the Parkes 64-m radio telescope with observations at three frequencies, 685 MHz, 1.4 GHz and 3 GHz, at 2 – 3 weekly intervals. Principal collaborators in the project are based at Swinburne University of Technology, the University of Texas at Brownsville, the University of California, San Diego, and at the CSIRO Australia Telescope National Facility. The main goals of the project are to detect gravitational waves, to establish "pulsar time" as a long-term standard of time and to improve the currently used solar-system ephemerides. Data acquisition commenced in mid-2004. Since then, data recording and analysis systems have been improved so that we are now reaching our goal of 100 ns rms timing residuals on several pulsars. Currently, nearly half of the sample has rms residuals of less than 500 ns and almost all are less than 2 μs. More complete descriptions of the project are given by Manchester (2008) and Hobbs *et al.* (2009).

Early results from the project (Jenet *et al.* 2006) put a limit of $\sim 2\times10^{-8}$ on the energy density of a graviational-wave background in the Galaxy relative to the closure density of the Universe. They also limited the tension of cosmic strings in the early Universe and the equation of state in the inflation era. Saito & Yokoyama (2009) also show that PTA observations put strong limits on the formation of intermediate-mass black holes at the end of the epoch of inflation.

Pulsars have a frequency stability comparable to the best atomic clocks over intervals a year or more. By combining results from the many pulsars observed in the PPTA and other PTA projects, it should be possible to establish a pulsar timescale which has better stability than the current international timescales. With continued observations it will also be possible to improve on the best current measurements of planetary masses and possibly to detect previously unknown trans-Neptunian objects.

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