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High Cadence Radio Pulsar Observations with CHIME/Pulsar

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Radio pulsars are rapidly rotating, highly magnetised neutron stars that emits beamed radio emission from the magnetic poles, which arrive at Earth in pulses as the neutron star rotates. This allows us to study various properties of radio pulsars through the technique of pulsar timing – measurement of the arrival times of the pulses at different epochs. Through pulsar timing, we are able to model the rotational properties of radio pulsars, and from them, infer the physical properties. The technique also allows us to model the orbital properties of radio pulsars in binary systems, and for cases of relativistic binaries, as tests of general relativity and nuclear astrophysics.

The Canadian Hydrogen Intensity Mapping Experiment (CHIME) is a transit radio inteferometer operating at frequencies of 400-800 MHz. The telescope has an instantaneous field of view (FoV) of 120° North-South and 1.3-2.5° East-West. While CHIME is primarily designed to study dark energy through the measurement of the evolution of baryon acoustic oscillations, the telescope is capable of producing 10 simultaneous, independent tied-array beams to observe different parts of the sky. The CHIME/Pulsar system [1] utilises the capability to monitor radio pulsars regularly in the Northern Sky, observing up to 500 individual sources per sidereal day. The CHIME/Pulsar system is able to record coherently dedispersed, high time resolution data in real time in either 'fold mode' of 3-D archive files folded to the period of the radio pulsars or 'filterbank mode' of 2-D dynamic spectra of frequency against time. The scheduling of sources is done by an automated, probabilistic scheduler that takes into account the priority of a given radio pulsar, with observing cadence as short as one day. The scheduling system allowed us to observe 75 per cent of the 1200 known sources in the Northern Sky with a cadence of 2 weeks or less.

CHIME/Pulsar is engaging in a variety of radio pulsar science projects. One of the primary initiatives is the long-term, daily timing of a selection of millisecond pulsars as part of the North American Nanohertz Observatory for Gravitational Waves project [2] to search for gravitational waves by modelling changes in pulse arrival times of the ensemble of pulsars. CHIME/Pulsar is also performing follow-up observations of radio pulsars discovered by various large scale pulsar surveys around the world, as well as single pulses deemed to have originated from within our Galaxy by the CHIME/Fast Radio Burst project [3]. The regular monitoring of other pulsars within the FoV of CHIME has also resulted in new and improved measurements of Faraday rotation measure of pulsars [4] and discovery of a new group of pulsars showing variable radio emission processes [5]. Future science projects with CHIME/Pulsar include a large scale pulsar survey using the 'filterbank mode' capability, study of the interstellar medium through dispersion measure and scintillation modelling, as well as detection and modelling of pulsar glitches.

References

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