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The Indian Pulsar Timing Array (InPTA)

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The Indian Pulsar Timing Array is an experiment aimed at detection of Gravitational waves (GWs) in the sub-microHertz frequency range by observing an ensemble of millisecond pulsars (MSPs). GWs from both the stochastic GW background as well as the individual sources like supermassive black hole binaries (SMBHBs) leave an imprint on the time-of-arrival (TOA) of the pulsed emission from MSPs, which could be detected with high precision due to the clock-like stability of these pulsars. InPTA aims to contribute its data and its analysis results to an international effort, called the International Pulsar Timing Array (IPTA), where three other experiments also contribute data.

InPTA uses the upgraded Giant Meterwave Radio Telescope (uGMRT) and the Ooty Radio Telescope (ORT) to observe a carefully chosen sample of 20 MSPs at a bi-weekly cadence, more frequently than other international experiments. InPTA has been now operational for last three years, with high signal-to-noise detection of these weak radio sources. It has provided a useful baseline for obtaining good timing solutions for these pulsars. At present we are able to achieve TOAs with microsecond uncertainties and efforts are underway to achieve TOAs with 100 nanosecond uncertainties. The seamless frequency coverage from 300 MHz to 1500 MHz available at uGMRT alongwith wideband digital backends provide an unique simultaneous multi-frequency data set enabling very accurate characterization of dispersion measure (DM) variations seen in some of the MSPs. In this presentation, some results on these variations from our experiments will be showcased apart from timing residuals and solutions for the pulsars in our ensemble. Another year of observations will provide sufficient baseline for advanced statistical GW analysis similar to the other international experiments and the first limits on the stochastic GW background are expected in next six months. The data set is also useful in studying changes in the interstellar medium and pulse emission and investigations are ongoing in two of our pulsars. Some preliminary results will be presented in this talk.

Additionally, we are pursuing several IPTA relevant efforts such as developing prescriptions to search for nano-Hz GWs from SMBH binaries in eccentric and hyperbolic orbits. This involves developing accurate and efficient prescriptions that incorporate various general relativistic effects while modeling timing residuals due to SMBHBs in eccentric and hyperbolic orbits. Further, efforts are ongoing to characterize effects of diffractive interstellar scintillation. These efforts will also be described briefly in this presentation.