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Exploring the Universe with Pulsar Timing Arrays

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It is an exciting time for pulsar timing arrays, as their upper limits on gravitational radiation are carving into the expected strength of gravitational waves from several source populations in the Universe. Cosmic strings, inflationary gravitational waves, and binary supermassive black holes are all expected contributors to the nanohertz to microhertz band probed by pulsar timing arrays: they might be discovered as bursting sources, as continuously oscillating signals, or as an ensemble population in a stochastic background. This presentation will discuss the predicted intensity and form of these sources, and how the upper limits set by pulsar timing arrays are being used to set unique constraints on source properties, and to measure galaxy evolution in the nearby Universe. Looking to the future, we will explore how pulsar timing arrays can characterize their target source populations, and we will present the prospects for multi-messenger detection.