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High-Precision Pulsar Timing and the Search for Nanohertz Gravitational Waves

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The NANOGrav collaboration makes high-precision radio telescope observations of an array of millisecond pulsars with the goal of detecting gravitational waves in the nanohertz band, i.e., gravitational waves with periods of several years. Gravitational waves will be detected via small perturbations in measured pulse arrival times correlated across the pulsars in the array. We use the Green Bank Telescope and Arecibo Observatory to observe 49 millisecond pulsars at intervals of three to four weeks. Arrival time measurement accuracy for individual pulsars ranges from 50 ns to 1 μ s (daily post-fit RMS). Observations are made over wide bands with two receivers at each telescope to aid in mitigating interstellar dispersion. In this talk we will present an overview of the pulsar timing array technique for detecting gravitational waves; summarize the NANOGrav observing program; describe our most recent data release, the NANOGrav nine-year data set; discuss upper limits on gravitational wave from our data, along with astrophysical implications; and describe some ancillary astrophysics that is being accomplished with the NANOGrav data.