SES19-2019-000197

Abstract for an Invited Paper
for the SES19 Meeting of
the American Physical Society

Relativistic Shapiro delay measurements of a 2.14-solar-mass millisecond pulsar

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Millisecond pulsar (MSP) timing the process of accounting for every rotation of a rapidly spinning neutron star over long time spans is a powerful tool for probing realms of physics that are otherwise inaccessible to Earth-based scientists. The neutron star interior equation of state (EoS) is one example of a puzzle in fundamental physics that has been somewhat elucidated by MSP timing. Measuring relativistic Shapiro delay, which is observable in a small subset of MSP binaries, facilitates the unique determination of the masses of both a pulsar and its companion. By combining orbital-phase-specific observations of Shapiro delay using the Green Bank Telescope with data from the North American Nanohertz Observatory for Gravitational Waves (NANOGrav) 12.5-year data set, we have measured the mass of PSR J0740+6620 to be 2.14 (+0.10, −0.09) solar masses (68% credibility interval); it is therefore likely to be the most massive neutron star yet observed. Our measurements serve as a strong constraint on the neutron star interior EoS.