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Testing Fundamental Physics with Radio Pulsars

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Millisecond spin-period radio pulsars provide us with unique astronomical "laboratories" for exploring fundamental physics in a variety of ways – from the physics of matter at super-nuclear density, to experimental tests of gravity, to the possible direct detection of gravitational radiation. In this talk, I will focus on our recent discovery of a two solar mass pulsar, currently the highest well-measured neutron star mass. In addition to several astrophysical implications, this measurement places constraints on theories of neutron star composition via the nuclear matter equation of state (EOS). Neutron stars are composed of the densest known stable form of matter, expected to be at least several times as dense as an atomic nucleus. The EOS of this material, and in particular the maximum stable mass before collapse to a black hole is inevitable, depends on the composition of the star's interior. Our new measurement either rules out or strongly constrains many proposed EOS that include "exotic" forms of matter such as hyperons, kaon condensates, or free quarks.