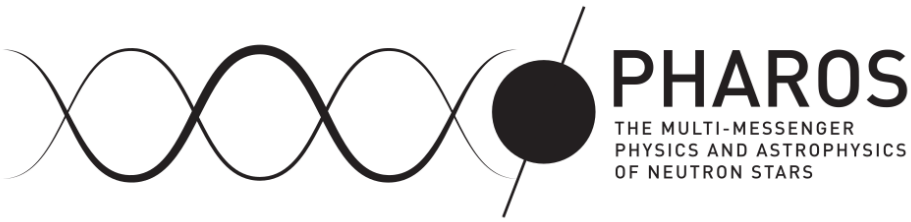

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A 2.3 Solar-mass neutron star

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The macroscopic properties of neutron stars depend on how sub-atomic particles interact in their interiors. These interactions, encoded in the equation of state, are specially uncertain in the central regions, where densities exceed that of an atomic nucleus. The maximum mass of a neutron star can discriminate between proposed equations of state. New millisecond pulsars in compact binaries provide a good opportunity to search for the most massive neutron stars. We present observations and detailed modeling of an extremely irradiated companion to a millisecond pulsar, using the largest optical telescope on Earth. We develop and apply a new method to measure the velocity of both sides of the companion star, and find that the binary hosts one of the most massive neutron stars known to date, with a mass of 2.27[+0.17-0.15] MSun. A 2.3 Solar-mass neutron star would rule out most currently proposed equations of state, casting doubt on the existence of exotic forms of matter in the core.

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