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Can the inverse method unravel the matter at the neutron star interior?

The quest to understand the properties of matter at high density has intrigued physicists for more than a few decades. The problem is complicated, as having a proper theory describing it is challenging. Also, earth-based experiments to probe them have yet to materialize. One of the naturally occurring laboratories where such matter exists is the cores of a neutron star. Recent precise mass and radius measurement of several pulsars, along with gravitational wave detection of binary mergers, has thrown some light towards constraining matter properties that can reside inside neutron stars. Usually, a neutron star problem is addressed as follows: assuming an EoS, we solve the tollman-oppenheimer-volkoff equation to obtain its mass and radius. Recently, physicists have been trying to address the problem inversely. Having some measurement or observation from a neutron star, one can invert the problem and deduce various parameters of the neutron star like the mass, radius, moment of Inertia and tidal deformability. It has been seen that few parameters of neutron stars are seen to be insensitive towards the microscopic description of matter and follow universal relations with each other. Therefore, one can expect to deduce some gross matter properties or constrain them effectively, thereby unravelling the properties of matter at the neutron star's core.

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