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Unified equations of state of cold dense matter in nonaccreted neutron stars

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The interior of a neutron star is expected to contain at least three distinct regions: (i) an outer crust made of exotic nuclei coexisting with a degenerate electron gas, (ii) an inner crust where neutron-proton clusters are immersed in a sea of free neutrons in addition to electrons, and (iii) a liquid core made of neutrons, protons, and leptons. In this contribution, we will present our latest series of unified equations of state of cold dense matter in neutron stars, allowing for the existence of a liquid-crystal mantle of nuclear pastas. Based on the nuclear energy-density functional theory, these equations of state provide a thermodynamically consistent treatment of all regions of the star and were calculated using functionals that were precision fitted to experimental and theoretical nuclear data. These equations of state were specifically developed to assess the role of nuclear uncertainties on neutron-star properties. We will also present recent results for the neutron-proton entrainment parameters in neutron-star cores, which we have calculated consistently with our unified equations of state within the same microscopic framework and using the same functionals.

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