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Nucleon Finite Volume Effect and Nuclear Matter Properties in a Relativistic Mean-Field Theory

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Abstract: Effects of excluded volume of nucleons on nuclear matter are studied, and the nuclear properties that follow from different relativistic mean-field model parametrizations are compared. We show that, for all tested parametrizations, the resulting volume energy a_1 and the symmetry energy J are around the acceptable values of 16 MeV and 30 MeV, and the density symmetry L is around 100 MeV. On the other hand, models that consider only linear terms lead to incompressibility K_0 much higher than expected. For most parameter sets there exists a critical point (ρ_c,δ_c), where the minimum and the maximum of the equation of state are coincident and the incompressibility equals zero. This critical point depends on the excluded volume parameter r. If this parameter is larger than 0.5 fm, there is no critical point and the pure neutron matter is predicted to be bound. The maximum value for neutron star mass is $1.85M_{\odot}$, which is in agreement with the mass of the heaviest observed neutron star 4U0900-40 and corresponds to r=0.72 fm. We also show that the light neutron star mass ($1.2M_{\odot}$) is obtained for $r\approx 0.9$ fm.

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