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Quantum van der Waals quarkyonic matter at non-zero isospin asymmetry

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Quarkyonic matter is a possible realization of dense QCD matter, corresponding to a mixture of hadrons and quarks with a mixed phase in momentum space. Recently, the quantum van der Waals theory of quarkyonic matter was developed [Phys. Rev. C 108 (2023) 045202], indicating that quarkyonic regime in symmetric nuclear matter may occur at densities as low as twice the saturation density, achievable in heavy-ion collisions. Here, we extend the framework to non-zero isospin asymmetries by utilizing the two-component van der Waals equation and separate Fermi surfaces for u and d quarks. We utilize constraints on the symmetry energy and its slope, as well as the neutron stars mass-radius relation to fix the isospin dependence of the van der Waals interaction parameters. We also outline the extension to finite temperatures, which will allow direct applications of the proposed framework to heavy-ion collisions.

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