



Iranian Journal of Physics Research, Vol. 26, No. 2, 2026
DOI: 10.47176/ijpr.26.2.22295

The thickness of the neutron star's shell

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(Received 18 February 2026 ; in final form 15 July 2026)

Abstract

In this paper, the structure of neutron star crusts is investigated within the framework of a holographic model based on the gauge-gravity duality. The focus of this study is the description of dense nuclear matter in the transition region between the uniform phase and the vacuum. A key objective is the analysis of inhomogeneous phases in the form of various geometric configurations in the mixed region. For this purpose, the Witten-Sakai-Sugimoto model is employed as an effective QCD model at low energies. By calculating the free energy and comparing the thermodynamic stability of different geometric configurations, the region in which the mixed phase emerges along with its corresponding structures, is determined. The results indicate that rod-like structures remain stable over a broader range of chemical potentials and play a more significant role in determining the crust thickness. Furthermore, the dependence of free energy on the surface tension coefficient reveals that this parameter acts as a controlling factor in the stability of inhomogeneous phases, and its increase leads to a reduction in the preferred region for geometric configurations. These findings provide a coherent picture of the role of geometric structures in determining the thermodynamic properties of neutron star crusts within the holographic framework.

Keywords: Neutron star, Crust, Mixed phase, Witten-Sakai-Sugimoto model

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