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Implication of Quarkyonic duality to the hyperon puzzle

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Duality between quarks and baryons is the fundamental properties of QCD. We have recently shown in Ref. [1] that the duality is closely tied to Quarkyonic nature of matter at high baryon density. We have formulated a dual model for dense QCD, which allows a thermodynamic description both in terms of baryons or quarks, with the quark confinement relation that sets the transformation between both descriptions.

The nontrivial robust consequence of the duality is that when we persist with the baryonic picture in the region where the quark description is more natural, the shell structure, which is the notable feature of Quarkyonic matter, appears in the pure baryonic distribution owing to the Pauli exclusions among quarks. This Quarkyonic shell structure is dual to a description in terms of quarks with a filled Fermi sea of quarks with a finite Fermi surface.

In this talk, we discuss the implication of this Quarkyonic duality to the hyperon puzzle [2]. We illustrate the combined effect of the duality and the strangeness by extending the model to three flavors. We find that the threshold density for the hyperons are shifted to higher density compared to the conventional treatment, and the softening of the equation of state becomes milder.

References:

- [1] Y. Fujimoto, T. Kojo, L. McLerran, Phys. Rev. Lett. 132, 112701 (2024), [2306.04304].
- [2] Y. Fujimoto, T. Kojo, L. McLerran, In preparation.

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