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QCD θ-vacua from the chiral limit to the quenched limit

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We investigate the dependence of the QCD vacuum structure on the θ-angle and quark mass, using the Di-Vecchia−Veneziano model. Although the Di-Vecchia−Veneziano model is a chiral effective model, it contains the topological properties of the pure Yang−Mills theory. It is shown that within this model, the ground state energies for all θ are continuous functions of quark mass from the chiral limit to the quenched limit, even including the first order phase transition at $\theta = \pi$. Based on this effective model, we discuss (i) how the ground state depends on quark mass, and (ii) why the phase transition at $\theta = \pi$ is present in both the chiral and the quenched limit. In order to analyze the relation between quark mass and the θ-vacua, we calculate the chiral condensate as a function of quark mass. Also, considering the presence of the innate metastable states included in the QCD θ-vacuum, we also give a unified understanding of the phase transitions at $\theta = \pi$ in the chiral and quenched limit.

On behalf of collaboration:

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