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Chiral effective theory of diquarks and application to heavy hadron spectrum

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Light quarks form diquark clusters in hadrons and hadronic matter. We construct a chiral effective theory of spin 0 (scalar-pseudo-scalar) and 1 (axial-vector and vector) diquarks. The masses of the diquarks contain chiral invariant and non-invariant terms. The latter is given in terms of chiral condensate and thus variant in finite temperature and/or density. The parameters of the effective theory can be determined by the lattice data for diquarks as well as the masses of the single-heavy baryons (such as Λ_Q, Σ_Q and so on with $Q = c$ or b). We find the mass terms of the scalar-pseudo-scalar diquarks contain a special $U_A(1)$ anomaly term, which induces an inverse mass hierarchy for the pseudo-scalar diquarks. The heavy baryon is modeled by a bound state of a heavy quark Q and a diquark. We find that the inverse mass hierarchy results in qualitative difference of the mass spectra of Λ_Q and Ξ_Q. The dependences of the scalar and axial-vector diquarks on the chiral order parameter are largely different. As a result, reduced chiral condensate may result in the inversion of the scalar and axial-vector diquarks, which may be observed as a change of the heavy baryon spectrum in dense matter. We apply the same model to the heavy tetraquark T_{QQ} and obtain its spectrum.

Reference
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