
Contribution ID: **389** Type: **Oral Presentation**

# Perturbative Corrections to Heavy Quark-Diquark Symmetry Predictions for Doubly Heavy Baryon Hyperfine Splittings

*Wednesday 31 July 2019 16:20 (20 minutes)*

Doubly heavy baryons $(QQq)$ and singly heavy antimesons $\left(\bar{Q}q\right)$ are related by the heavy quark-diquark (HQDQ) symmetry because in the $m_Q \to \infty$ limit, the light degrees of freedom in both the hadrons are expected to be in identical configurations. Hyperfine splittings of the ground states in both systems are nonvanishing at $O(1/m_Q)$ in the heavy quark mass expansion and HQDQ symmetry relates the hyperfine splittings in the two sectors. In this paper, working within the framework of Non-Relativistic QCD (NRQCD), we point out the existence of an operator that couples four heavy quark fields to the chromomagnetic field with a coefficient that is enhanced by a factor from Coulomb exchange. This operator gives a correction to doubly heavy baryon hyperfine splittings that scales as $1/m_Q^2 \times \alpha_S/r$, where $r$ is the separation between the heavy quarks in the diquark. This correction can be calculated analytically in the extreme heavy quark limit in which the potential between the quarks in the diquark is Coulombic. In this limit, the correction is $O(\alpha_s^2/m_Q)$ and comes with a small coefficient. For values of $\alpha_s$ relevant to doubly charm and doubly bottom systems, the correction to the hyperfine splittings in doubly heavy baryons is only a few percent or smaller. We also argue that nonperturbative corrections to the prediction for the hyperfine splittings are suppressed by $\Lambda_{\rm QCD}^2/m_Q^2$ rather than $\Lambda_{\rm QCD}/m_Q$. Corrections should be $\approx 10\%$ in the charm sector and smaller in heavier systems.

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**Session Classification:** Quark & Lepton Flavor

**Track Classification:** Quark & Lepton Flavor