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Diquarks on the Lattice

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Diquarks are often used as QCD effective degrees of freedom to describe nucleons and other baryons as well as exotic hadrons. Phenomenologically the splittings of the four possible diquark operators, grouped into three channels dubbed “good”, “bad” and “not-even-bad”, can be estimated from the experimentally observed spectrum in principle. Yet, despite the concept of diquarks being very old and successful in describing many of these low lying QCD states they have remained elusive.
One issue for ab initio, lattice calculations has been their colored nature in the past. Here we present a study that resolves this issue and report on the properties of diquarks in a gauge-invariant formalism with quark masses down to almost physical pion masses in full QCD. We broadly confirm the diquark-diquark as well as diquark-quark mass splittings. Going further we find attractive quark-quark spatial correlations only in the good scalar channel with $\bar{3}_F$, $\bar{3}_c$, $J^P = 0^+$ quantum numbers and we observe that the good diquark shape is spherical. From the spatial correlations in the good diquark channel we extract a diquark size of ~ 0.6 fm. Our results provide quantitative support for modelling the low-lying baryon spectrum using good light diquark effective degrees of freedom.

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