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Abelian Decomposition of QCD and Two Types of Gluons

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We review the Abelian decomposition of QCD and discuss the physical implications of the decomposition. The Abelian decomposition decomposes the gluon potential to the restricted part which contains the non-topological Maxwellian Abelian potential which describes the color neutral neurons and the topological Diracian potential which describes the non-Abelian monopole, and the valence part which describes the colored chromons. It allows us to calculate the QCD effective potential gauge independently and demonstrate the monopole condensation as the physical vacuum of QCD. It allows us to decompose the QCD Feynman diagrams in such a way that the color conservation is explicit. It generalizes the quark and gluon model to the quark and chromon model in which the chromons become the constituent gluons of hadron, which clarifies the glueball picture of the hadron spectroscopy greatly.

Most importantly, the Abelian decomposition is not just a theoretical proposition. It can be verified by experiment. It tells that there are two types of gluons, the color neutral Abelian neurons which play the role of the binding gluon and the gauge covariant colored chromons which play the role of the constituent gluon. We show how to verify the existence of the two types of gluons, the neurons and chromons, experimentally by reanalyzing the old ALEPH and CMS gluon jet data.

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