Monopole Dominance of Confinement in SU(3) Lattice QCD

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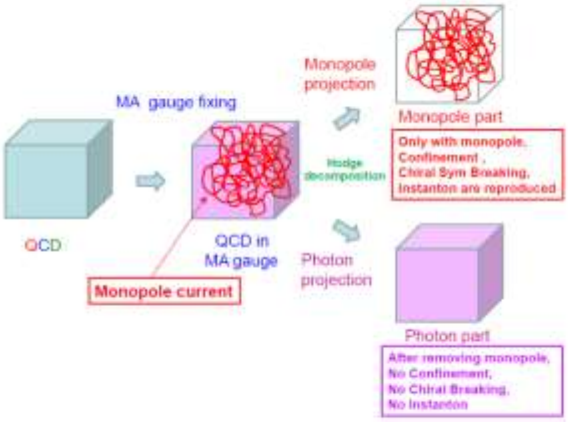
Abstract: We study monopole dominance of quark confinement for both quark-antiquark and three-quark systems in SU(3) quenched lattice QCD in the maximally Abelian (MA) gauge at β=5.8 on $16^3\times32$ with 2,000 gauge configurations.

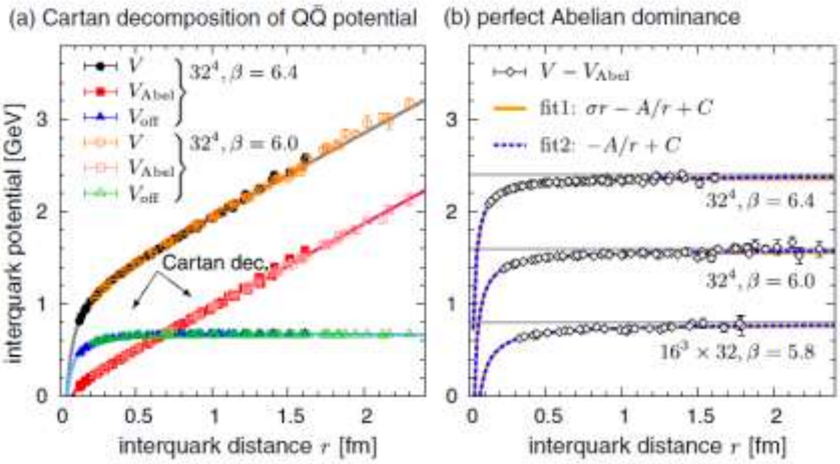


Schematic figure of QCD in the MA gauge [1-3].

- In the MA gauge, infrared QCD becomes Abelian-like [3], and the monopole current topologically appears. $(\partial_\mu F^{\mu\nu} = j^\nu,\ \partial_\mu {}^*F^{\mu\nu} = k^\nu)$
- By the Hodge decomposition [2], the Abelian projected QCD can be divided into the monopole part and the photon part.

$$(\partial_\mu F^{\mu\nu}_{\rm Mo} = 0,\ \partial_\mu {}^*F^{\mu\nu}_{\rm Mo} = k^\nu,\ \partial_\mu F^{\mu\nu}_{\rm Ph} = j^\nu,\ \partial_\mu {}^*F^{\mu\nu}_{\rm Ph} = 0)$$

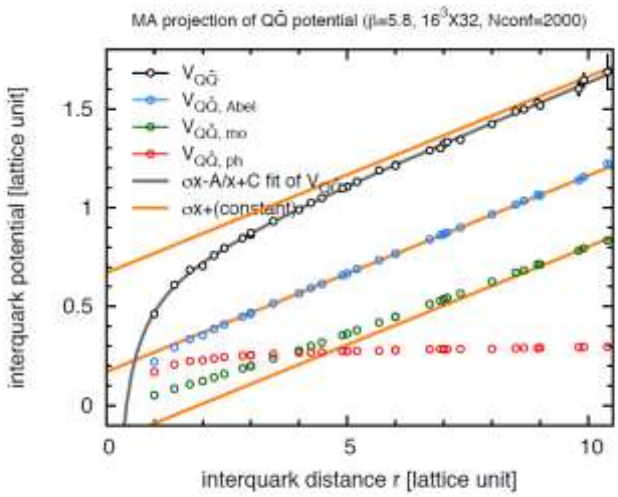
- The monopole part has confinement, chiral symmetry breaking and instantons, while the photon part does not have all of them.

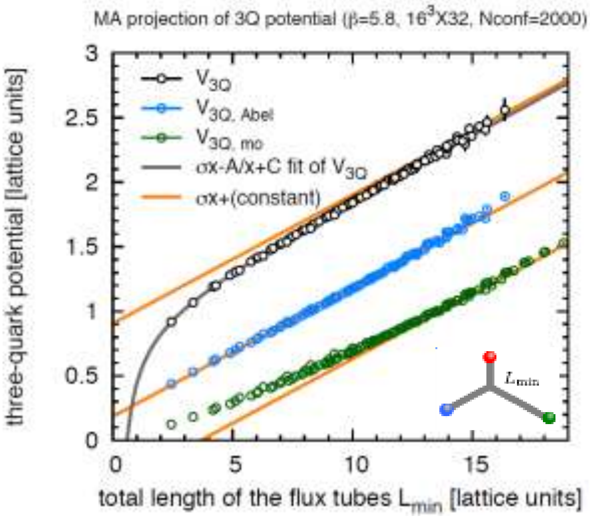


Cartan decomposition and Prefect Abelian Dominance for quark confinement in the MA gauge [3].

Left: The quark-antiquark potential $V(r)$, the Abelian part $V_{\rm Abel}(r)$, and the off-diagonal part $V_{\rm off}(r)$.

Right: The difference $V(r) - V_{\rm Abel}(r)$ can be well fitted with pure Coulomb potential. The absence of linear-potential component in $V(r) - V_{\rm Abel}(r)$ indicates perfect Abelian dominance of quark confinement [3].





Left: The static quark-antiquark potential in SU(3) QCD, Abelian-projected QCD, monopole part, and photon part [3].

Right: The three-quark potential in SU(3) QCD, Abelian-projected QCD, and the monopole part [3].

-The (almost) perfect Abelian dominance $\sigma_{\rm Abel} = \sigma$ is found in both quark-antiquark and three-quark systems [3]

-The monopole dominance is found as $\sigma_{\rm Mo} = 0.92\sigma$ in both quark-antiquark and three-quark systems [3].

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[3] N. Sakumichi and H. Suganuma, Phys. Rev. **D90**, 111501 (R) (2014); Phys. Rev. **D92**, 034511 (2015); in preparation (2018).