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# Mass-deformed Yang-Mills theory in the covariant gauge and its gauge-invariant extension through the gauge-independent BEH mechanism

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We consider the mass-deformed Yang-Mills theory in the Landau gauge which is obtained by just adding a gluon mass term to the Yang-Mills theory in the Landau gauge. We show that the decoupling solution is well reproduced by taking into account loop corrections from the mass-deformed Yang-Mills theory. Then we derive gluon confinement/deconfinement from the reflection-positivity violation/restoration to give a phase structure in the phase diagram of the gauge-scalar model, which includes confinement phase in the pure Yang-Mills theory as a subregion. This result is not restricted to the Landau gauge, rather it is a gauge-invariant result. In fact, we show that the mass-deformed Yang-Mills theory is reproduced as a gauge-fixed version of the gauge-invariantly extended theory which is identified with the gauge-scalar model with a fixed-modulus scalar field in the fundamental representation of the gauge group, as a consequence of the gauge-independent Brout-Englert-Higgs mechanism proposed recently by the author. This result is suggested from the Fradkin-Shenker continuity as an elucidation of the Osterwalder-Seiler theorem for the Confinement-Higgs complementarity on the lattice.

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