Physical unitarity of a massive Yang-Mills theory without the Higgs field and low-energy QCD for color confinement

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In this talk we discuss a massive Yang-Mills theory without the Higgs field and its implication for physical unitarity.

(1) In order to understand the so-called decoupling solution for gluon and ghost propagators in QCD, we give a nonperturbative construction [1] of a massive vector field describing a non-Abelian massive spin-one particle, which has the correct physical degrees of freedom and is invariant under a modified BRST transformation, in a massive Yang-Mills model without the Higgs field, i.e., the Curci-Ferrari model. The resulting non-Abelian massive vector boson field is written using a nonlinear but local transformation from the original fields in the Curci-Ferrari model. As an application, we write down a local mass term for the Yang-Mills field and a dimension-two condensate, which are exactly invariant under the modified BRST transformation, Lorentz transformation and color rotation.

(2) We examine the physical unitarity [2] in a massive Yang-Mills field without the Higgs field in which the color gauge symmetry is not spontaneously broken and kept intact. For this purpose, we use a new framework proposed in the paper [1] based on a nonperturbative construction of a non-Abelian field describing a massive spin-1 vector boson field. In the perturbative framework, we reproduce the preceding result, i.e., violation of physical unitarity in a transparent way. In the nonpertubative framework, however, we propose a possible scenario of restoring the physical unitarity in the Curci-Ferrari model which respects the ghost conjugation symmetry.

For more details, see [1, 2].

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References

[1] K.-I. Kondo, A nonperturbative construction of massive Yang-Mills fields without Higgs fields, arXiv:1208.3521 [hep-th]

[2] K.-I. Kondo, A unitary and renormalizable model for massive Yang-Mills fields without Higgs fields. arXiv:1202.4162 [hep-th], to be revised and a paper in preparation.