



Contribution ID: 239

Type: not specified

Asymptotic freedom in the Hamiltonian approach to binding of colour

Tuesday 30 August 2016 18:50 (20 minutes)

The renormalization group procedure for effective particles (RGPEP) has been developed during the last years as a non-perturbative tool for constructing bound-states in quantum field theories [1]. It stems from the similarity renormalization group procedure (SRG) [2] and introduces the concept of effective particles, which differ from the point-like canonical, bare ones by having a finite size s . The effective particles in the Fock space build the hadronic eigenstates of a family of effective Hamiltonians H_s depending on the size s as the RGPEP scale parameter. We apply the RGPEP to QCD using an expansion in powers of the coupling constant up to third order. The Hamiltonian running coupling, g_s , is extracted from the interaction terms in H_s^{QCD} [3]. We thus demonstrate that the RGPEP passes the test of describing asymptotic freedom, which is a precondition for any approach aiming at using QCD for explaining hadrons in the Minkowski space-time, especially for tackling nonperturbative issues, such as the ones that emerge when one allows effective gluons to have masses [2]. Applications of this method beyond the leading order are under way and it is hoped that the interaction terms relevant to understanding of confinement will be gradually determined.

[1] S. D. Glazek, Acta Phys. Polon. B42 (2011) 1933; Acta Phys. Polon. B43 (2012) 1843.

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[3] M. Gomez-Rocha and S. D. Glazek, Phys. Rev. D92 (2015) 065005.

Summary

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Session Classification: Section A

Track Classification: Section A: Vacuum Structure and Confinement