A modern shape for the non-local Nambu Jona-Lasinio model

Arpan Chatterjee, Stefan Groote

Institute of Physics, University of Tartu, W. Ostwaldi 1, 50411 Tartu, Estonia

The Standard Model of Particle Physics is based on two fundamental theories: the Electroweak theory of Glashow, Weinberg and Salam, and Quantumchromodynamics (QCD) developed by Gross, Wilczek and Politzer. Of these, QCD has two features, not common to the other interactions: Asymptotic Freedom, which can be explained by the running of the strong coupling due to renormalization, and Quark Confinement which does not allow us to "see" quarks as individual particles. The necessity to describe particles which have not and will never be "seen" as free particles led to the development of Effective Field Theories (EFTs). One of these EFT approaches is the one developed by Nambu and Jona-Lasinio in 1961, based on the principles of the BCS theory of superconductivity developed by Bardeen, Cooper and Schrieffer.

While the original approach replaces the interaction vector bosons effectively by local four-fermion interactions (hence non-renormalisable), in our project we consider a non-local version of the NJL model which has been shown to be both renormalisable and confining and hence much more appropriate to be used in elementary particle physics. After introducing a nonlocal factor to the lagrangian, we form the so-called "Dyson-Schwinger tower" and treat it using the Bender, Milton and Savage's method of n-point Green's functions; finally applying to it the 't Hooft limit to get the 'mass-gap for fermions' (something which has striking parallelism with the energy gap (φ) found in the BCS theory of superconductivity).

References

1. Y. Nambu, G. Jona-Lasinio, Phys. Rev. **122** (1961) 345-358; Phys. Rev. **124** (1961) 246-254
2. J. Bardeen, L. N. Cooper, J. R. Schrieffer, Phys. Rev. **106** (1957) 162; Phys. Rev. **108** (1957) 1175-1204
3. M. Frasca, A Ghoshal, S. Groote, "Quark confinement in QCD in the 't Hooft limit", Nucl. Part. Phys. Proc. 324-329 (2023) 85-89
4. A. Chatterjee, M. Frasca, A Ghoshal, S. Groote, "Renormalisable Non-Local Quark-Gluon interaction: Mass Gap, Chiral Symmetry Breaking and Scale Invariance", 2302.10944

Euroopa Liit
Euroopa
Regionaalarengu Fond

Eesti
tuleviku heaks