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Effective coupling for the NJL model based on fractals

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The Nambu–Jona-Lasino model is modified by the inclusion of a running-coupling that was obtained by a fractal approach to QCD. The coupling follows a λ -exponential function and, in the context of high energy collisions, explains the origin of the Tsallis non-extensive statistics distributions. The parameter λ is completely determined in terms of the number of colours and the number of quark flavours. We study several aspects of the extended model and compare our results to the standard NJL model, where a constant coupling is used in combination with a sharp cutoff to regularize the gap equation. We show that the modified coupling regularizes the model in a smooth cutoff fashion and reproduces the pion mass and decay constant, providing an almost identical GOR relation as in the standard NJL model. In both models the relation is satisfied in similar cutoff scales. An important novelty of this work is the physical explanation, in terms of the fractal QCD vacuum, for a running coupling that renormalizes the quark condensate.

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