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Large-N pion scattering,finite-temperature efects and the relationship of the f0(500) with chiral symmetry restoration

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We study how the thermal properties of the f0(500) pole behave in a regime where temperature is below its critical chiral transition value. We attain this by considering an O(N +1)/O(N) invariant Non-Linear Sigma Model (NLSM) for a large number of N massless pions as an approach for the dynamics of Low Energy QCD, and after introducing a thermal bath via the imaginary time formalism. At T = 0, we fit the parameters of the NLSM such that we can describe both older and newer scattering data in the scalar channel and generate dynamically its associated resonance, thus obtaining a pole position that agrees with experimental determinations. Next, we calculate the pion scattering amplitude at finite T and check that exact thermal unitarity holds. Also, we show that one can define a proper renormalization scheme with T = 0 counterterms such that the renormalized T-dependent amplitude can be chosen to depend only on a few parameters. Next, we analyze the behaviour of the f0(500) pole at finite T, which is consistent with chiral symmetry restoration when the scalar susceptibility is saturated by the f0(500) state, in a second-order transition scenario and in accordance with lattice and theoretical analysis. Furthermore, we find its associated critical exponent and check that it lies within the range expected for a O(N) universality class.

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