Dissipation Near the QCD Phase Transition

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As the matter produced in ultrarelativistic heavy ion collisions rapidly expands it cools through the QCD phase transition. One can learn about the nature of the transition by analyzing the behavior of the chiral condensate. Results from the first year run of RHIC suggest almost explosive dynamics, as a result of which the long-wavelength chiral fields fall out of thermal equilibrium. The short-wavelength fields constitute a thermally equilibrated medium.
We present a simple and consistent analysis of the soft chiral condensate fields in the background of hard thermal modes in the framework of the linear sigma model. Effective evolution equations are derived for the inhomogeneous condensate fields coupled to a heat bath. The multiple effects of the thermal background on the disoriented chiral condensate are studied using linear response theory. We determine the temperature dependence of the equilibrium condensate, and examine the modification of the sigma and pion dispersion relations as these mesons traverse a hot medium. We calculate the widths by determining the dissipative coefficients at nonzero temperature at one- and two-loop order with resummed meson masses. Our results show that not only the first order decay processes, but the second order elastic scattering processes are significant at high temperatures, yielding to short relaxation times in the phase transition region. The significance of this is discussed. Throughout this work Goldstone's Theorem is fulfilled when chiral symmetry is spontaneously broken.