Momentum dependence of the spectral functions in the O(4) linear sigma model at finite temperature

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One of the current interests in the strong interaction physics is to find characteristic behaviour in the hadron spectra at finite temperature and/or density, which signals the phase transition of the hadronic matter. At finite temperature there is no Lorentz invariance and therefore the spectral functions depend on two rotationally invariant variables in addition to the temperature, for example the four-momentum squared and the spatial momentum squared. Since the spectra observed in the heavy-ion collision experiment have various spatial momenta, it is important to know theoretically how the spectral functions depend on the spatial momentum.

Here, we study the spatial momentum dependence of the spectral functions in the O(4) linear sigma model at finite temperature. We use a resummation technique called an optimized perturbation theory (OPT)[1] and calculate the spectral functions at the one-loop level.

In Figure 1,we show the spectral functions, $\rho_{\pi,\sigma}(k,T)$, for the absolute values of the spatial momentum, $|\boldsymbol{k}|$=0, 120 ,500,1000 MeV and $|\boldsymbol{k}| \to \infty$ at $T = 120$ MeV as a typical example. In both π and σ channels, the spectral function depends considerably on the spatial momentum. In the π channel as the spatial momentum increases, at the beginning the width of the peak increases, then the peak shifts to higher energy and then the width decreases eventually to 0 in the limit $|\boldsymbol{k}| \to \infty$. In the σ channel as the spatial momentum increases, the peak just above the 2π threshold becomes small and eventually vanishes while the bump around (500MeV)^2 increases. This seems to suggest that the finite temperature effect is maximaized at some spatial momentum and the effect becomes small as $|\boldsymbol{k}|$ increases.

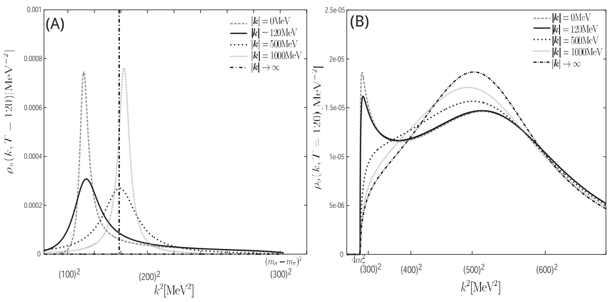

Figure 1: Spectral function in the π channel(A) and in the σ channel(B) at T=120 MeV.

References

[1] S. Chiku and T. Hatsuda,Phys. Rev. D **58**(1998), 076001.