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Dilepton production rates from charged pion-pair annihilations on inhomogeneous chiral condensates

In the context of study of QCD phase diagram, the possibility of inhomogeneous chiral condensed phase in low-temperature and high-density regions has been discussed using the low-energy effective theory of QCD such as the Ginzburg-Landau theory, the Nambu-Jona-Lasinio model and so forth. It has also been pointed out that the dispersion relations of Nambu-Goldstone bosons may change in this phase. Therefore, the dilepton production rates such as the electron-positron pair production rates from charged pion-pair annihilations in the inhomogeneous chiral condensed phase are also expected to be modified as compared with those in the usual vacuum, and this modification may be considered as one of the possible experimental signatures for the existence of the inhomogeneous chiral condensed phase.

In this study, we assume a dual chiral density wave as an inhomogeneous chiral condensate, and start from a low energy effective Lagrangian expanded with respect to the order parameter based on O(4) symmetry up to the sixth order because of the low-energy effective model of QCD. We, then, derive the dispersion relations of the Nambu-Goldstone modes in inhomogeneous chiral condensed phase. As a result, the derived dispersion relation is anisotropic and may contain higher-order terms of momentum than those derived in the usual homogeneous condensed phase.

Using the dispersion relation of the Nambu-Goldstone modes obtained by our model, we calculate dilepton production rates from charged pion-pair annihilation as a function of an invariant mass. We show how the obtained results may be modified compared with the results of dilepton production rates in the homogeneous chiral condensed phase.

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