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Catalytic effects of QCD monopoles on the phase transitions

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The existence of monopoles has been theoretically predicted since P. A. M. Dirac introduced the magnetic monopole in quantum mechanics. Moreover, a large number of experiments to observe monopoles have been conducted. However, monopoles have not been detected yet. The purpose of this research is to find a clue to observe QCD monopoles which closely relate to the color confinement by experiments. To find the evidence, we add the classical fields of the monopole and the anti-monopole to the QCD vacuum and calculate the Dirac operator of the overlap fermion which preserves the exact chiral symmetry in the lattice gauge theory from the QCD vacuum. We then estimate catalytic effects of the additional monopole and anti-monopole on observables by the numerical calculations. In the study of the low temperature, we have shown that the value of the chiral condensate (defined as the minus value) decreases, the pion decay constant increases, and the masses of the light quarks and the mesons become heavy, by varying the values of the magnetic charges of the additional monopole and anti-monopole. Finally, we have discovered that the decay width of pion becomes wider and the lifetime of pion becomes shorter than the experimental results. These are the catalytic effects of monopoles in QCD (arXiv:1807.04808). In this research, we add the monopole and anti-monopole to the configurations of the finite temperature and investigate catalytic effects of monopoles in QCD on quark confinement-deconfinement phase transition, and chiral symmetry breaking and the restoration. We find that the additional monopole and anti-monopole increase the temperature of quark confinement-deconfinement phase transition, moreover, the restoration of chiral symmetry breaking does not occur, by varying the values of the magnetic charges of the additional monopole and anti-monopole. In this talk, we would like to present our preliminary results about the catalytic effects of QCD monopoles in the finite temperature.

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