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Preweighting method in Monte-Carlo sampling with complex action

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Understanding the QCD phase diagram from first principles is one of the ultimate goals in nuclear and particle physics. The largest obstacle towards this goal is the sign problem in lattice QCD at finite chemical potential. The statistical weight is reduced by the average phase factor and it becomes difficult to obtain precise results in the phase reweighting method.

If we know the amount of cancellation beforehand, it would be possible to take account of the reduction during the sampling of configurations. In the case where the phase distribution is Gaussian, the average phase factor is $\exp(-D^2/2)$ [1], where D^2 is the variance of the phase. We can approximately include this reduction in the Monte-Carlo sampling by adding “penalty” terms to the action.

We examine the usefulness of this “preweighting” method in the auxiliary field Monte-Carlo configurations in the strong coupling limit of lattice QCD [2]. We will also apply the preweighting to the strong coupling lattice QCD with $1/g^2$ corrections [3], where the sign problem is more serious.

[1] S. Ejiri, Eur. Phys. J. A 49 (2013) 86.

[2] T. Ichihara, A. Ohnishi and T. Z. Nakano, Prog. Theor. Exp. Phys. 2014 (2014), 123D02.

[3] T. Ichihara, A. Ohnishi, PoS LATTICE2014 (2014), 188.

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