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Phase diagram of the $U(2) \times U(2)$ scalar model in three dimensions

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If the chiral anomaly is effectively restored at finite temperature, the chiral phase transition of 2-flavor QCD with massless quarks is characterised by the symmetry breaking pattern $U_L(2) \times U_R(2) \rightarrow U_V(2)$. Therefore, the order of the phase transition of the $U(2) \times U(2)$ scalar model in three dimensions has been extensively studied.

The results of the perturbative renormalization group (RG) analyses are controversial. Up to 4th order of the perturbative expansion, there was no stable IR fixed point of the beta functions, therefore, the phase transition had been believed to be of first order. However there are reports that an infrared fixed point emerges at 5th order. Then the existence of the IR fixed point (or second order phase transition) is still under debate.

In this talk, we present results of a Monte Carlo simulation of the $U(2) \times U(2)$ scalar model on three dimensional lattice. We will make clear that the system undergoes both second and first order phase transition depending on the choice of the model parameters. We represent a phase diagram in the model parameter space from the view point of the order of the phase transition. We make a comparison the phase diagram with the RG flow of the 5th order RG analyses. We will show both results are consistent and the IR fixed point of the RG flow likely to exist.

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