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Determining the order of chiral phase transition in QCD from conformal bootstrap

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There has been a longstanding debate if the chiral phase transition in two-flavor massless QCD is the first order or the second order. The previous arguments based on epsilon expansions, large N expansions, functional renormalization group, and Monte-Carlo simulations had been all inconclusive with shortcomings. If it were the second order phase transition, there should exist a corresponding three-dimensional conformal field theory which describes the critical phenomenon. The recent development in conformal bootstrap enables us to directly study the (non-)existence of conformal fixed points in a non-perturbative manner.
In this talk, I review the conformal bootstrap method and its application to this problem. Our conclusion is that the corresponding conformal fixed point should exist and the phase transition will be the second order if the U(1) chiral anomaly is effectively restored. This means that the original 1-loop prediction by Pisarski and Wilczek would be incorrect. We further provide the most precise prediction of the critical exponent there. We believe future numerical simulations will confirm our prediction.

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