

## QCD phase diagram at non-zero real and imaginary chemical potential from lattice QCD

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We will show the continuum extrapolated results for all second order and some of the fourth order cumulants of net baryon-number, strangeness and electric charge fluctuations as well as their correlations obtained using the Highly Improved Staggered Quark (HISQ) action in (2+1)-flavour QCD by the HotQCD collaboration. We will show comparisons of our results with hadron resonance gas (HRG) model calculations and argue that the HRG model based description of strongly interacting matter works only upto the pseudo-critical temperature of QCD. The cumulants of net charge fluctuations and their correlations at vanishing values of the charge chemical potentials ( $\mu_{B,Q,S} = 0$ ) provide the basis for Taylor expansions of various thermodynamic observables at non-zero values of the chemical potentials. We will use the updated results of HotQCD on higher order cumulants to constrain the location of a possible critical point in the QCD phase diagram.

We will also show a calculation of (2+1)-flavor QCD with an imaginary chemical potential with the aim to determine the critical quark mass at which the second order transition in the Roberge-Weiss plane turns into a first order transition. We use the Highly Improved Staggered Quark (HISQ) action and perform calculations in the Roberge-Weiss plane, where the value of the critical mass is expected to be largest. We explore a range of quark masses corresponding to pion mass values,  $m_\pi \geq 40$  MeV. Contrary to calculations performed with unimproved actions we find no evidence for the occurrence of first order transitions at the small quark mass values explored so far.

Open Problems/discussions:

- i) Resummation of Taylor series at small value of the non-zero baryon density?
- ii) Interplay between RW transition and Chiral transition in the Chiral limit?

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**Primary author(s)** : Dr GOSWAMI, Jishnu

**Presenter(s)** : Dr GOSWAMI, Jishnu

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