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Search for a Possible QCD Critical Point in the RHIC Beam Energy Scan using the STAR Experiment

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At the sqrt(sNN)=200 GeV top beam energy of the Relativistic Heavy Ion Collider (RHIC), collisions of two 197-Au nuclei result in dense and strongly interacting systems of partons at high temperatures, T, and low baryo-chemical potentials, muB. In central collisions, these systems hadronize at (muB,T) values near (˜20,˜160) MeV via a crossover-type transition. Systems formed at larger values of the baryo-chemical potential may undergo a first-order transition. This implies the possible existence of a critical point. Nuclear systems passing through such a critical point are expected to exhibit divergences of the thermodynamic susceptibilities and correlation lengths that are analogous to those seen in many liquids. The observation of a Quantum ChromoDynamic (QCD) critical point would transform the phase boundaries in (muB,T) space. Increasing the baryo-chemical potential in Lattice QCD calculations is computationally difficult, but it can be accomplished experimentally by reducing the beam energy. In the year 2010 and 2011 runs, the RHIC provided Au+Au collisions at seven beam energies ranging from 7.7 to 200 GeV, which spanned a range of muB from ˜20 to ˜420 MeV. The spectra and event-by-event multiplicities of numerous species of charged hadrons were measured in the wide and azimuthally complete acceptance of the Solenoidal Tracker at RHIC (STAR) experiment. The (muB,T) values at chemical freeze-out for the different beam energies and collision centralities can be inferred from the spectra. The shapes of the event-by-event multiplicity distributions, quantified by their statistical moments, mean, variance, skewness, and kurtosis, are expected to diverge non-monotonically as a result of the divergence of the correlation length expected if the system has passed close to the critical point. In this talk, we will present the status of the STAR Collaboration's exploration of the QCD phase diagram. This will include the study of the identified particle yield ratios to extract the (muB,T) values, and the statistical moments of the multiplicity distributions of several different species of charged hadrons. The particle identification is performed using the ionization energy loss in the Time Projection Chamber and the information from the then newly installed Time of Flight system. The moments values will be compared to the "baseline" behavior implied by the Hadron Resonance Gas model and Poisson statistics.

Primary author: Prof. LLOPE, W.J. (Rice University)

Presenter: Prof. LLOPE, W.J. (Rice University)

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