Measurements of Higher Order Diagonal and Off-Diagonal Cumulants of Deuteron, Net-Lambda, Net-Proton and Net-Kaon Multiplicity Distributions from the STAR experiment at RHIC.

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Higher-order cumulants of event-by-event net-particle multiplicity distributions are extensively used to study the freeze-out dynamics and search for the QCD critical point in high-energy nuclear collisions. Higher-order cumulants of deuteron number distribution are recently proposed to shed light on the synthesis mechanism of light nuclei created in such collisions and could potentially distinguish between statistical thermal and coalescence production scenarios. Additionally, the cumulants of net-lambda multiplicity distributions could provide an access to explore the flavor-dependent chemical freeze-out parameters in the QCD phase diagram. On the other hand, off-diagonal cumulants of net-proton and net-kaon multiplicity distributions could also provide constraints on phenomenologically extracted freeze-out parameters using the lattice QCD and thermal model calculations.

In this context, we report the first measurement of cumulants up to the 4^{th}-order of deuteron number distributions and the correlation between proton and deuteron numbers measured for Au+Au collisions at $\sqrt{s_{NN}}$ = 7.7–200 GeV for Beam Energy Scan Phase - I (BES-I) program in the STAR experiment. We present centrality and energy dependence of cumulants of deuterons measured in the kinematic region: $|y|$ <0.5 and transverse momentum range 0.6< p_T(GeV/c) <4.0. Furthermore, we discuss centrality dependence of cumulants up to 4^{th}-order of net-lambda multiplicity distributions and off-diagonal cumulants between net-proton and net-kaon measured in high statistics Au+Au collisions data at $\sqrt{s_{NN}}$ = 27 GeV from BES-II. Physics implications of these results on the light nuclei to flavor-dependent hadron formation mechanism and the QCD phase structure are discussed.