Study of identified hadrons in Au+Au collisions at $\sqrt{s_{NN}} = 27$ and 54.4 GeV using the STAR detector at RHIC

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Abstract

Quantum Chromodynamics (QCD), the theory of strong interactions, predicts that at sufficiently high temperature and/or high energy density normal nuclear matter converts into a deconfined state of quarks and gluons, known as the Quark-Gluon Plasma (QGP). To investigate the phase diagram of QCD matter, the Relativistic Heavy Ion Collider (RHIC) started the first phase of the Beam Energy Scan (BES-I) program in 2010. Under the BES-I program, Au+Au collision data were taken at $\sqrt{s_{NN}} = 7.7$ to 62.4 GeV in collider mode. In 2017, a high statistics dataset from Au+Au collisions at $\sqrt{s_{NN}} = 54.4$ GeV was recorded by the STAR experiment to fill the energy gap between 39 and 62.4 GeV. The success of the BES-I program justified the second phase of Beam Energy Scan (BES-II) with higher statistics and detector upgrades. The first collider energy from BES-II was 27 GeV, which was recorded in 2018. The spectra of identified hadrons are essential to study bulk properties, such as integrated yield (dN/dy), average transverse momenta ($\langle p_T \rangle$), particle ratios, and freeze-out parameters of the medium produced. The difference in mean transverse mass ($\langle m_T \rangle$) and rest mass (m_0), i.e., $\langle m_T \rangle$ - m_0, as a function of $\sqrt{s_{NN}}$ can shed light on the formation of a mixed phase of a QGP and hadrons during the evolution of the heavy-ion system.

In this talk, we will present the spectra of identified hadrons ($\pi^{\pm}$, $K^{\pm}$, p and $\bar{p}$) at midrapidity in Au+Au collisions at $\sqrt{s_{NN}} = 27$ and 54.4 GeV. The midrapidity yields of identified hadrons show the expected signatures of large baryon stopping region at lower energies and the dominance of the pair production mechanism at higher energies. The constant value of $\langle m_T \rangle$ - m_0 around RHIC BES energies could be interpreted as the formation of a mixed phase. The centrality dependence of dN/dy, $\langle p_T \rangle$, particle ratios, chemical freeze-out, and kinetic freeze-out parameters will also be presented, and their physics implications will be discussed. The rapidity dependence of the identified hadron spectra will also be presented from Au+Au collisions at $\sqrt{s_{NN}} = 27$ GeV to understand the rapidity dependence of freeze-out properties.