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Editorial: Particle production and system evolution in collisions from GeV to TeV

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Editorial on the Research Topic
Particle production and system evolution in collisions from GeV to TeV

In hadron-hadron, hadron-nucleus, and nucleus-nucleus collisions many produced particles are measured in experiments over a wide collision energy range from a few GeV to tens TeV. In hadron-nucleus and nucleus-nucleus collisions, many nuclear fragments also have to be measured. These particles and fragments reflect the properties of the collision mechanism and system evolution, and therefore many scientists engaged in both experiments and theory are attracted in the study of collisions from GeV to TeV energy range.

In high-multiplicity events of hadron-hadron, hadron-nucleus, and nucleus-nucleus collisions at high energies, it is believed that a new state of matter, i.e., the Quark-Gluon Plasma (QGP), is created in the hot and dense environment produced in experiments performed at the Super Proton Synchrotron (SPS) at the European Organization for Nuclear Research (CERN), the Relativistic Heavy Ion Collider (RHIC) at the Brookhaven National Laboratory (BNL), and the Large Hadron Collider (LHC) at CERN. The QGP is initially predicted by the theory of quantum chromodynamics (QCD) to be the phase of strongly-interacting matter in the high-temperature/density regime and discovered later in the experiments on high-energy heavy-ion collisions at the RHIC and CERN. Recently, a new accelerator complex, the Nuclotron-based Ion Collider fAcility (NICA) at the Joint Institute for Nuclear Research (JINR) is expected to study the properties of a dense baryonic matter in nucleus-nucleus collisions at a few GeV range.

In this Research Topic, we aim to collect papers, related to particle production and collision system evolution in hadron-hadron, hadron-nucleus, and nucleus-nucleus collisions over a wide collision energy range from a few GeV to tens TeV. The related topics include, but are not limited to, the properties of hot and dense matter, QGP formation and multiparticle production, QCD phase diagram at kinetic freeze-out, critical energy for the phase transition from hadronic matter to QGP state, system-size and energy dependence of the fireball lifetime.

This Research Topic brings together a collection of articles on "*Particle production and system evolution in collisions from GeV to TeV*". We have published four articles in this Research Topic. We hope this Research Topic will be useful for the researchers working in the field. At the same time, we regret that almost half of the manuscripts, submitted for publication in this Research Topic, have not been accepted for publication following the reviewer's reports and editor's recommendations, based on rigorous acceptance criteria to ensure the high quality of the published manuscripts.

In the original research article entitled "*Investigating effect of coherent emission length on pion interferometry in high-energy collisions using a multiphase transport model*" by Wang and Zhang, the authors have studied the two-pion Hanbury Brown–Twiss correlation functions for a partially coherent source constructed with the emission points and momenta of the identical pions generated by a multiphase transport model. In the study, a coherent emission length has been introduced, the effects of which on the two-pion interferometry results in central gold-gold (Au-Au) collisions at (center-of-mass energy per nucleon pair $\sqrt{s_{NN}}$ =) 200 GeV, central lead-lead (Pb-Pb) collisions at 2.76 TeV, and proton-proton (p-p) collisions at 13 TeV have been investigated. This study found that the effect of coherent emission length reduces the two-pion correlation functions in the nucleus–nucleus collisions, leading to an average decrease of chaoticity parameter by approximately 15% in the high transverse momentum range. However, the influence of coherent emission length on the two-pion correlation functions in the p-p collisions is small, while the effect of coherent emission length on the chaoticity parameter is almost independent of the transverse momentum of pion pair in the p-p collisions.

In the original research article entitled "*Transport model study of transverse momentum distributions of (anti-)deuterons production in Au+Au collisions at $\sqrt{s_{NN}}$ = 14.5, 62.4, and 200 GeV*" by Yuan et al., the authors have studied the transverse momentum distributions of deuterons and anti-deuterons, emitted in Au+Au collisions at $\sqrt{s_{NN}}$ = 14.5, 62.4 and 200 GeV at different centralities, within the framework of the Ultra-relativistic Quantum Molecular Dynamics (UrQMD) model combined with the conventional phase-space coalescence model. The calculated results show a strong reversed correlation between R_0 (the maximal relative distance between hadrons) and P_0 (the maximal relative momentum between hadrons), which is also time dependent. The number of particles generated are inconsistent with experimental data for 40%–60% and 60%–80% centralities, because deuterons have plenty of time to react with other particles. With the decrease of collision energy, the inconsistence becomes more obvious. The calculated results quantitatively describe the experimental data for 0%–10%, 10%–20% and 20%–40% centralities in Au-Au collisions measured by the STAR Collaboration.

In the technology and code article entitled "*DREENA-A framework as a QGP tomography tool*" by Zigic et al., the authors have presented a fully optimised framework for the study of the energy-loss of high-p_T partons crossing the deconfined fireball produced in nuclear collisions, DREENA-A (where "DREENA" stands for Dynamical Radiative and Elastic ENergy loss Approach, and "A" stands for Adaptive). The framework can include any, in principle arbitrary, temperature profile describing the QGP evolution and accounts both for the elastic and radiative energy-loss of high-p_T partons scattering off the thermal consituents of the medium. The framework can be applied to light and heavy flavor observables, different collision energies, and large and smaller systems. Together with the ability to systematically compare data and predictions within the same formalism and parameter set, DREENA-A becomes a unique multipurpose QGP tomography tool. The provided code allows researchers to use their own QGP evolution models to straightforwardly predict the particle productions in the high transverse-momentum region.

In the original research article entitled "*Initial-state temperature of light meson emission source from squared momentum transfer spectra in high-energy collisions*" by Wang et al., the authors have studied the squared momentum transfer spectra of light mesons, π^0, π^+, η, and ρ^0, produced in high-energy virtual photon-proton ($\gamma^* p$) → meson + nucleon process in electron-proton (ep) collisions, measured by the CLAS Collaboration, where the transfer undergoes from the incident γ^* to emitted meson or equivalently from the target proton to emitted nucleon. The calculation is performed by the Monte Carlo method due to the difficulties in the analytic method. In the calculations, the Erlang distribution from a multi-source thermal model is used to describe the transverse momentum spectra of the emitted particles. The results show that the average transverse momentum ($\langle p_T \rangle$) and the initial-state temperature (T_i) increase from the lower squared photon virtuality (Q^2) and Bjorken variable (x_B) to the higher one. This implies that the excitation degree of emission source, which is described by $\langle p_T \rangle$ and T_i, increases with increasing of Q^2 and x_B.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

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