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Non-identical particle femtoscopy as a probe of the heavy-ion collision dynamics

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The momentum correlations in pairs of non-identical particles produced in heavy-ion collisions can be used to determine the space-time asymmetries in the radiation of the two particle species [1]. And these asymmetries, in turn, reflect the peculiarities of the underlying collision dynamics.

Since the system created in a relativistic heavy-ion collision undergoes collective expansion, one of the explanations for the difference in average position and time of emission for different hadron species could be the different shift by the transverse collective flow. The other possible reasons include the different particle interaction cross sections, production via long-lived resonance decays, re-scattering at the hadronic stage of the collision, etc. [2]. However, in the experiment one can hardly separate one factor from another to trace their respective roles in gaining the observed result. That is why to analyze the situation in detail one should rather consider the simulation of the collision in realistic models, where one can fully control the process.

In this work, we analyzed correlations in pion-kaon pairs based on the simulations of lead-lead collisions at the Large Hadron Collider in the well-known iHKM [3] and LQTH [4] models. The results were compared to the experimental data from the ALICE Collaboration [2]. The analysis was carried out at different average pair transverse velocities. The sizes of the particle emission sources and the displacements between the pion and kaon source centers were determined. It was found that the crucial factor affecting the emission asymmetry between pions and kaons are hadronic re-scatterings at the late "afterburner" stage of the system's evolution. The presence of a hadron cascade stage simulation in the iHKM model allows it to provide a much better description of the data as compared to the LQTH model, which lacks the corresponding stage.

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