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Exploring the hadronic phase of ultrarelativistic heavy-ion collisions with resonances in ALICE

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Unlike stable hadrons, whose production yield in relativistic heavy-ion collisions is established by the temperature at the chemical freeze-out, hadron resonances are subject to final-state interactions occurring in the late hadron-gas phase of the collision after the chemical freeze-out. Processes such as the rescattering of the decay products and the regeneration are competing out of chemical equilibrium until the final thermal freeze-out, when all the interactions cease. Consequently, the measured production yield of resonances is modified according to the net balance of these processes, which depend on the time span between chemical and thermal freeze-out, on the cross sections and on the properties of the resonance in the medium.
Resonance yields are measured in central ion-ion collisions, where final-state effects are expected to be large and are compared to the yields measured in peripheral ion-ion collisions and in proton-proton collisions, where a hadron-gas phase is not expected. Also, the comparison with model predictions with and without hadronic interactions helps to disentangle the final-state effects contributing to the measured resonance yields.
With its excellent tracking and particle identification capabilities, the ALICE experiment at the LHC has measured a comprehensive set of both meson and baryon resonances with proper lifetimes ranging from 1.3 fm/c for ρ to 46.3 fm/c for φ. Measurements of the yield of resonances as a function of the collision centrality show a suppression of short-lived resonances increasing from peripheral to central collisions. This is understood as due to the rescattering dominating over regeneration. This allowed for a simple quantitative estimation of the duration of the hadronic phase, spanning from the chemical to the thermal freeze-out, under the assumption that regeneration can be neglected. The results will be critically discussed, showing that the scenario of a sudden thermal freeze-out of all particle species at the same time is likely too simplistic and may indicate that the decoupling of particles from the expanding hadron gas is a continuous process, which takes place over a range of times and temperatures that are different for different hadron species.

Primary author: FRAGIACOMO, Enrico (Istituto Nazionale di Fisica Nucleare)

Presenter: FRAGIACOMO, Enrico (Istituto Nazionale di Fisica Nucleare)

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