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Hypernuclei studies in heavy-ion collisions with the CBM experiment

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Under the extreme conditions of relativistic heavy-ion-collisions hypernuclei are created with large abundancies. Hypernuclei measurements provide insights into the equation-of-state of hadronic matter at high net-baryon densities, as well as into hyperon-nucleon and hyperon-hyperon-interactions. The Compressed Baryonic Matter (CBM) experiment at the future Facility for Anti-Proton and Ion Research (FAIR) in Darmstadt offers the perfect conditions to explore the production of hypernuclei. The excitation function of hypernucleus production is predicted to exhibit a maximum in the FAIR energy range. In combination with the foreseen high interaction rates of up to 10 MHz, an exceptionally high amount of hypernuclei will be created and even very rare double hypernuclei like ${}^{6}_{\Lambda\Lambda}$He are expected with sizeable statistics.

The reconstruction of the hypernuclei-3-body-decay was implemented into the CBM reconstruction software and optimized with respect to important performance indicators. In addition, the reconstruction was performed with a neural network. Expected efficiencies and signal-to-background-ratios were calculated with both approaches for a reliable estimation of the number of reconstructable hypernuclei and systematic uncertainties were studied. The experimental sensitivity to properties of hypernuclei, such as their lifetime, was evaluated. Results for ${}^{3}_{\Lambda}\mathrm{H}\rightarrow d+p+\pi^{-}$ as a case study for the rare 3-body-decay of ${}^{6}_{\Lambda\Lambda}$He will be discussed in detail. The Parton-Hadron-Quantum-Molecular-Dynamics (PHQMD) approach, which includes the production of nuclei and hypernuclei, was employed as input for the detector simulations. The established PHSD model has been extended by a QMD approach which allows to propagate n-body correlations. This is essential for the cluster formation based on attractive potentials between baryons, providing valuable predictions for the upcoming CBM experiment. (Work supported by DFG-grant BL 982/3-1 and BMBF-grant 05P21RFFC3.)

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