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Is the chemical freeze-out connected to the phase transition? A transport study of freeze-out criteria

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The chemical freeze-out is often related to the phase transition to a deconfined state of matter, the Quark Gluon Plasma. We introduce a novel approach based on elastic and inelastic scattering rates to extract the hyper-surface of the chemical freeze-out from a hadronic transport simulation. We use the Ultra-relativistic Quantum Molecular Dynamics (UrQMD) model to extract the chemical freeze-out hyper-surface of pions and kaons in the energy range from $E_{\text{lab}} = 1.23 \text{ AGeV}$ to $\sqrt{s_{\text{NN}}} = 62.4 \text{ GeV}$. By employing a coarse-graining procedure, we can extract the local temperature and baryo-chemical potential and investigate the typical freeze-out criteria $\langle E \rangle / \langle N \rangle = 1 \text{ GeV}$, $s/T^3 = 7$ and $n_B + n_{\bar{B}} = 0.12 \text{ fm}^{-3}$ on the chemical freeze-out surface and compare them to results from statistical model analysis. We find a great agreement leading to the conclusion that the chemical freeze-out can be well described by hadronic transport simulations. We do not observe a relation of the chemical freeze-out line and the phase-transition line. Instead we argue that the freeze-out line is defined by an interplay between elastic, inelastic and pseudo-elastic scattering rates and the expansion rate.

Collaboration

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