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Collective flow at SIS energies within a hadronic transport approach: Influence of light nuclei formation and equation of state

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The interest in the equation of state (EoS) of nuclear matter has been renewed with the observation of gravitational waves from neutron star mergers. Since nuclear matter under similar conditions as in neutron star mergers can be studied in heavy ion collisions at low collision energies, additional information about the EoS can be extracted from the precise measurements performed at GSI or in the future at FAIR.

In this work we apply the hadronic transport approach SMASH to calculate flow coefficients that are known to be very sensitive to the EoS which enters the calculation through nuclear potentials. We present calculations for different equations of state and compare methods of taking the formation of light nuclei into account. At beam energies of $E_{\mathrm{lab}} = 1.23A\,\mathrm{GeV}$ a large fraction of nucleons is bound in clusters, therefore they are crucial to gain an understanding. Without momentum-dependent potentials the hard equation of state is preferred in the comparison to HADES data on $v_1(p_T, y)$ and $v_2(p_T, y)$ and for low transverse momenta the dependence on the clustering method is found to be strong. This work is a starting point for a detailed analysis to determine the equation of state with upgraded nuclear potentials and applying Bayesian methods.

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