Light cluster formation in the PHQMD transport approach

J. Aichelin [a,b], E. Bratkovskaya[c,d,e], V. Kireyeu[f], S. Glässel [g], G. Coci[e], V. Voronyuk[f], M. Winn[a], C. Blume[g]

[a] SUBATECH, Nantes Uni., IMT Atlantique, IN2P3/CNRS, 4 rue Alfred Kastler, 44307 Nantes cedex 3, France
[b] Frankfurt Institute for Advanced Studies, Ruth Moufang Str. 1, 60438 Frankfurt, Germany
aichelin@subatech.in2p3.fr
[c] GSI Helmholtzzentrum fur Schwerionenforschung GmbH, Planckstr. 1, 64291 Darmstadt, Germany
[d] Institut für Theoretische Physik, Johann Wolfgang Goethe University, Max-von-Laue-Str. 1, 60438 Frankfurt, Germany
[e,] Helmholtz Research Academy Hessen for FAIR (HFHF),GSI Helmholtz Center for Heavy Ion Physics. Campus Frankfurt, 60438 Frankfurt, Germany
[f] Joint Institute for Nuclear Research, Joliot-Curie 6, 141980 Dubna, Moscow region, Russia
[g] Institut für Kernphysik, Max-von-Laue-Str. 1, 60438 Frankfurt, Germany

Abstract

The production of light clusters and hypernuclei at midrapidity is presently one of the most exciting research fields in nuclear theory. Clusters have been observed from energies of E_{kin} = 1 GeV up to the highest beam energy of sqrt(s) = 5 TeV. In this energy range the nature of the midrapidity region changes completely, from a baryon dominated to a meson-dominated environment and for even higher energies to a quark-gluon plasma.

Based on the Parton-Hadron-Quantum-Molecular Dynamics (PHQMD) and microscopic transport approach (PHQMD) [1–5], we present comparisons with the experimental results, studies on how these clusters are produced and especially what can explain their smooth energy dependence. For this, we employ different mechanisms for cluster production, from coalescence overproduction in three body collisions to binding of nucleons due to the mutual nucleon-nucleon potential and discuss the experimental possibilities to determine the production mechanism.

Keywords: heavy-ion collisions, cluster production, hypernuclei

1] J. Aichelin, E. Bratkovskaya, A. Le F`evre, V. Kireyeu, V. Kolesnikov, Y. Leifels, V. Voronyuk and G. Coci, Phys. Rev. C 101 (2020) no.4, 044905 [arXiv:1907.03860 [nucl-th]].
[2] S. Gl¨asel, V. Kireyeu, V. Voronyuk, J. Aichelin, C. Blume, E. Bratkovskaya, G. Coci, V. Kolesnikov and M. Winn, Phys. Rev. C 105 (2022) no.1, 014908 [arXiv:2106.14839 [nucl-th]].
[3] V. Kireyeu, J. Steinheimer, J. Aichelin, M. Bleicher and E. Bratkovskaya, Phys. Rev. C 105 (2022) no.4, 044909 [arXiv:2201.13374 [nucl-th]].
[4] G. Coci, S. Gl¨asel, V. Kireyeu, J. Aichelin, C. Blume, E. Bratkovskaya, V. Kolesnikov and V. Voronyuk, Phys. Rev. C 108 (2023) no.1, 014902 [arXiv:2303.02279 [nucl-th]].
[5] V. Kireyeu, G. Coci, S. Gl¨asel, J. Aichelin, C. Blume and E. Bratkovskaya, Phys. Rev. C 109 (2024) no.4, 044906