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Cluster and hyper-cluster production in relativistic heavy-ion collisions within the Parton-Hadron-Quantum-Molecular-Dynamics approach

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The understanding of the production of (hyper) clusters at midrapidity is presently one of the largest theoretical challenges in the physics of relativistic heavy ion collisions. We study this production employing the Parton-Hadron-Quantum-Molecular-Dynamics (PHQMD) approach [1], a microscopic n-body transport model based on the QMD propagation of the baryonic degrees of freedom with density dependent 2-body potential interactions. All other ingredients of PHQMD, including the collision integral and the treatment of the quark-gluon plasma (QGP) phase, are adopted from the Parton-Hadron-String Dynamics (PHSD) approach. In PHQMD the cluster formation occurs dynamically, caused by the interactions. The clusters are recognized by the Minimum Spanning Tree (MST) algorithm.
We present the PHQMD results for cluster and hypernuclei formation in comparison with the available experimental data at AGS, SPS, RHIC-BES and RHIC fixed target energies. We also provide predictions on cluster production for the upcoming FAIR and NICA experiments.PHQMD allows to study the time evolution of formed clusters and the origin of their production, which helps to understand how such weakly bound objects are formed and survive in the rather dense and hot environment created in heavy-ion collisions. It offers therefore an explanation of the 'ice in the fire' puzzle (cf. [2]).

[1] J. Aichelin et al. Phys. Rev. C 101 (2020) no.4, 044905 [arXiv:1907.03860]
[2] S. Gläßel, et al., 2106.14839 [nucl-th], to be published in Phys. Rev. C.

Primary authors: GLÄSSEL, Susanne; KIREYEU, Viktar (Joint Institute for Nuclear Research (RU)); Dr VADYM, Voronyuk (JINR, Dubna); AICHELIN, Joerg (Subatech/CNRS); BLUME, Christoph (Goethe University Frankfurt (DE)); BRATKOVSKAYA, Elena; COCI, Gabriele (GSI - Darmstadt); KOLESNIKOV, Vadim (Joint Institute for Nuclear Research (RU)); MICHAEL, Winn (SUBATECH, Nantes)

Presenter: GLÄSSEL, Susanne

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