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Coupling nuclear structure and relativistic hydrodynamic calculations: collectivity in small systems

Whether or not femto-scale droplets of quark-gluon plasma (QGP) are formed in so-called small systems at high-energy colliders is a pressing question in the phenomenology of the strong interaction. For proton-proton or proton-nucleus collisions the answer is inconclusive due to the large theoretical uncertainties plaguing the description of these processes. While upcoming data on collisions of ^{16}O nuclei may mitigate these uncertainties in the near future, here we demonstrate the unique possibilities offered by complementing ^{16}O+^{16}O data with collisions of ^{20}Ne ions. We couple both NLEFT and PGCM ab initio descriptions of the structure of ^{20}Ne and ^{16}O to hydrodynamic simulations of ^{16}O+^{16}O and ^{20}Ne+^{20}Ne collisions at high energy. We isolate the imprints of the bowling-pin shape of ^{20}Ne on the collective flow of hadrons, which can be used to perform quantitative tests of the hydrodynamic QGP paradigm. In particular, we predict that the elliptic flow of ^{20}Ne+^{20}Ne collisions is enhanced by as much as 1.170(8)(30) for NLEFT and 1.139(6)(39)for PGCM relative to ^{16}O+^{16}O collisions for the 1% most central events. At the same time, theoretical uncertainties largely cancel when studying relative variations of observables between two systems. This demonstrates a method based on experiments with two light-ion species for precision characterizations of the collective dynamics and its emergence in a small system.

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14h00

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