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Multi-fluid dynamics at RHIC BES energies with MUFFIN-2.0: baryon stopping to baryon transparency, flow and first conclusions from the modelling

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Understanding the transition from baryon stopping to transparency provides crucial insights into QCD matter properties at finite baryon density - a key goal of the RHIC Beam Energy Scan program. We present a generalized and improved multi-fluid dynamic approach to model heavy-ion collisions at RHIC Beam Energy Scan energies. The extensions touch two key aspects of the modelling.
The first aspect is the friction terms that represent stopping of the original baryon-rich fluids and production of new ''fireball" fluid (which vaguely corresponds to produced particles). The friction terms are generalized for partial transfer of both energy-momentum and conserved charges (baryon and electric) to the fireball fluid, different from fixed limiting cases used in the original model. Next, the procedure of numerical integration of the friction terms is more precise, which is important as the formation of the fireball fluid happens very fast at relatively large collision energies.
Second aspect is the procedure of fluid unification, which corresponds to the feature of different fluids becoming indistinguishable in a given cell once their velocities are close enough. We improve over the original unification criterion to make it more consistent physics-wise. Lastly, finite shear viscosity is introduced in the evolutions of the fluids.
We demonstrate how different settings of the friction terms translate into the basic resulting observables such as net proton and all charged hadron distributions, as well as transverse momentum spectra (radial flow) and elliptic flow, and what the agreement with the data can tell us about the properties of the underlying system.

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