A MULTI-COMPONENT HYDRODYNAMIC PLASMA MODEL FOR RESOLVING MESOSCOPIC DISEQUILIBRIA

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The present work is motivated by the mixing mechanism in inertial confinement fusion (ICF), which remarkably degrades the ignition performance. The mixing is a direct result of velocity disequilibrium and affected by temperature disequilibrium between different ions species. In order to deal with these disequilibria, we propose a fully-disequilibrium hydrodynamic model (termed as Baer-Nunziato-Zeldovich model or BNZ model) with 9 equations, 4 temperatures (two for ions, and two for electrons), 4 pressures (two for ions, and two for electrons) and 2 ion velocities for two-component dense plasma flows. The model can be used for describing both grain and atomic mixing by choosing corresponding relaxation mechanism. The derivation starts from a multi-component conservative entropy-dissipative Bhatnagar-Gross-Krook (BGK) model to obtain a 14-equation model, which yields a series of reduced models including the BNZ model. The proposed BNZ model and solution methods are verified and validated by some benchmark problems and 1D-2D comparisons. We then evaluate the velocity, pressure and temperature disequilibria during the passage of an ablation shock in ICF.