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A Fick's law recovering relaxation BGK operator for general mixtures of gases

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An increasing interest has surged, in the field of kinetic theory, towards Boltzmann equation as a natural modelization result of many problems issued through various physics domains. Unfortunately, associated Boltzmann operators, which provide an accurate statistical description of microscopical collisions occuring within gases, suffer from the consequential complexity of their kernels. As a result, BGK operators appear as simpler alternatives, relying on overall relaxation considerations instead of comprehensive microscopical descriptions. The price to pay includes the difficulty of recovering all physical properties of the underlying gases. In this study,we extend the derivation of the Fick-relaxation BGK model, performed in [1], to general mixtures of monoatomic and polyatomic gases. The construction of the present model is based on the introduction of relaxation coefficients and by solving an entropy minimization problem, in order to recover both physical properties and the H-Theorem. The distribution functions of each species are described by adding a supplementary continuous variable collecting vibrational and translational energies. Finally, by using a Chapman-Enskog equation, we recover the Fick matrix, the volume viscosity as well as the shear viscosity under interesting conditions.

References

[1] S. Brull, V. Pavan, J. Schneider, Derivation of BGK models for mixtures, *European Journal of Mechanics B/Fluids*, 2012.

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