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A general framework for the kinetic modeling of polyatomic gases

Abstract

In the context of kinetic models of polyatomic gases, we propose a Boltzmann framework where the internal structure of molecules is described in a general way, considering the internal states to live in a general measured space. We prove the H theorem in this framework, which gives in particular the equilibrium distribution: the product of a Maxwellian and a Gibbs distribution. We show that this framework contains the monoatomic case, and the two existing polyatomic models, which are the models with continuous internal energy and discrete energy levels. We build new models in this framework directly from physical considerations, which allows in particular to also describe non polytropic gases. Finally, we detail "model reduction", which allows to associate a model with continuous internal energy to any general model. This notably gives a formula to compute the integration weight present in this latter model directly from the description of the molecule. We briefly discuss the extension of this framework to a mixture of gases with chemical reactions.