Navier–Stokes transport coefficients of a granular gas of inelastic and rough Maxwell particles

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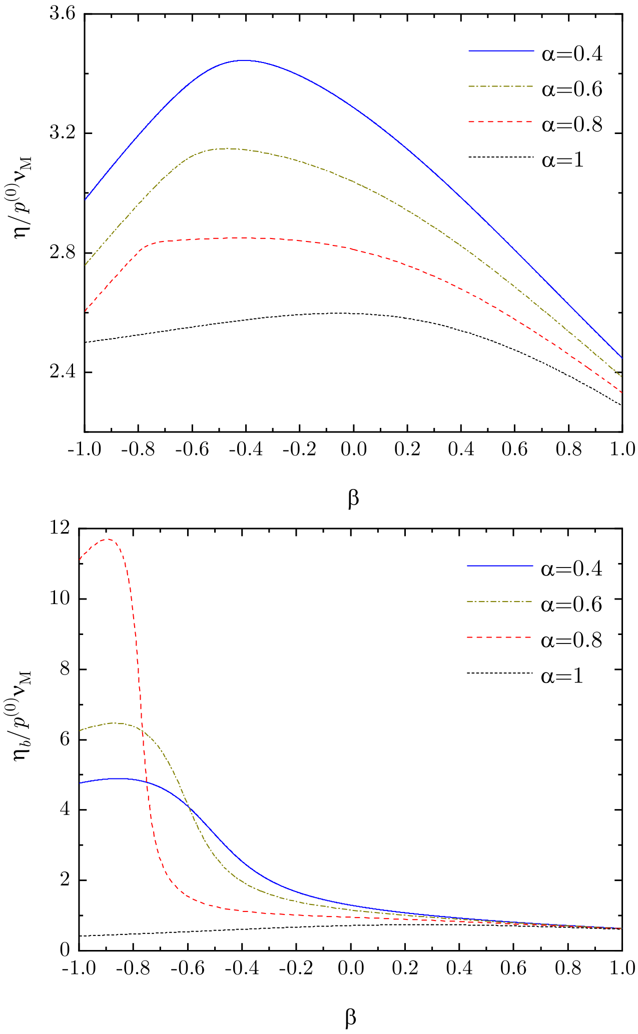

Fig. 1. Plot of the shear (η) and bulk (η_b) viscosities as functions of β for $\alpha = 0.4$, 0.6, 0.8, and 1.

The most widely used model for a granular gas is the inelastic hard-sphere model (IHSM), where the grains are assumed to be perfectly smooth spheres colliding with a constant coefficient of normal restitution α [1, 2]. A much more tractable model is the inelastic Maxwell model (IMM), in which the velocity-dependent collision rate is replaced by an effective mean-field constant [3]. This simplification has been taken advantage of by many researchers in the past to find a number of exact results within the IMM. On the other hand, both the IHSM and IMM neglect the impact of roughness on the dynamic properties of a granular gas. This is remedied by the inelastic rough hard-sphere model (IRHSM), where, apart from the coefficient of normal restitution, a constant coefficient of tangential restitution β is introduced [4].

In parallel to the simplification carried out when going from the IHSM to the IMM, we have recently proposed an inelastic rough Maxwell model (IRMM), as a simplification of the IRHSM, and derived the corresponding exact expressions for the most relevant collisional moments [5]. The aim of the present work is to apply the IRMM to the derivation of the exact Navier–Stokes transport coefficients predicted by the model.

As an example, Fig. 1 shows the shear and bulk viscosities as functions of β for $\alpha = 0.4$, 0.6, 0.8, and 1. As we can see, both coefficients are nonmonotonic functions of both α and β.

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[1] N. V. Brilliantov, T. Pöschel, *Kinetic Theory of Granular Gases* (Oxford University Press, Oxford, 2004).

[2] V. Garzó, *Granular Gaseous Flows. A Kinetic Theory Approach to Granular Gaseous Flows* (Springer Nature, Switzerland, 2019).

[3] A. V. Bobylev, J. A. Carrillo, and I. M. Gamba, J. Stat. Phys. **98**, 743–773 (2000).

[4] J. T. Jenkins and M. W. Richman, Phys. Fluids **28**, 3485–3494 (1985).

[5] G. M. Kremer and A. Santos, J. Stat. Phys. **189**, 23, pp. 1–24 (2022).