Abstract Submitted
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Macroscopic equations for rarefied gases from the elimination of fast variables PAUL DELLAR, University of Oxford — We derive macroscopic descriptions of rarefied gases from a hierarchy of moment equations (Maxwell's equation of transfer) using van Kampen's procedure for eliminating fast variables. The elimination leaves closed evolution equations for the five moments unaffected by collisions – the mass, momentum, and energy densities. We show that the equations of Chen, Rao, and Spiegel [2000, *Phys. Lett. A*, **271**, 87], like the Navier–Stokes–Fourier equations, emerge from van Kampen's procedure. We propose related equations using the concept of a translational temperature, following work on polyatomic gases. These equations offers excellent agreement with experimental data on the phase speed of ultrasound, in both the continuum and highly rarefied limits. They are equivalent to a nonlocal relation for the entropy production rate, with a sampling distance of a mean free path. Using moment equations offers a definitive treatment of the Prandtl number problem using model collision operators, greatly reduces the labor of deriving equations for different collision operators, and clarifies the rôle of solvability conditions applied to the distribution function.

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