Abstract Submitted
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Hypersonic Shock Wave Computations Using the Generalized Boltzmann Equation[1] RAMESH AGARWAL, RUI CHEN, Washington University in St. Louis, FELIX G. CHEREMISIN, Russian Academy of Science — Hypersonic shock structure in diatomic gases is computed by solving the Generalized Boltzmann Equation (GBE), where the internal and translational degrees of freedom are considered in the framework of quantum and classical mechanics respectively [1]. The computational framework available for the standard Boltzmann equation [2] is extended by including both the rotational and vibrational degrees of freedom in the GBE. There are two main difficulties encountered in computation of high Mach number flows of diatomic gases with internal degrees of freedom: (1) a large velocity domain is needed for accurate numerical description of the distribution function resulting in enormous computational effort in calculation of the collision integral, and (2) about 50 energy levels are needed for accurate representation of the rotational spectrum of the gas. Our methodology addresses these problems, and as a result the efficiency of calculations has increased by several orders of magnitude. The code has been validated by computing the shock structure in Nitrogen for Mach numbers up to 25 including the translational and rotational degrees of freedom. [1] Beylich, A., "An Interlaced System for Nitrogen Gas," Proc. of CECAM Workshop, ENS de Lyon, France, 2000. [2] Cheremisin, F., "Solution of the Boltzmann Kinetic Equation for High Speed Flows of a Rarefied Gas," Proc. of the 24th Int. Symp. on Rarefied Gas Dynamics, Bari, Italy, 2004.

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Ramesh Agarwal
Washington University in St. Louis

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