Moving boundary problems for a rarefied gas: Spatially one-dimensional case

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Unsteady flows of a rarefied gas in a full space caused by an oscillation of an infinitely wide plate in its normal direction are investigated numerically on the basis of the Bhatnagar-Gross-Krook (BGK) model of the Boltzmann equation. The talk aims at showing properties and difficulties inherent to moving boundary problems in kinetic theory of gases using a simple one-dimensional setting. More specifically, the following two problems are considered: (Problem I) the plate starts a forced harmonic oscillation (forced motion); (Problem II) the plate, which is subject to an external restoring force obeying Hooke's law, is displaced from its equilibrium position and released (free motion). The physical interest in Problem I lies in the propagation of nonlinear acoustic waves in a rarefied gas, whereas that in Problem II in the decay rate of the oscillation of the plate. An accurate numerical method, which is capable of describing singularities caused by the oscillating plate, is developed on the basis of the method of characteristics and is applied to the two problems mentioned above. As a result, the unsteady behavior of the solution, such as the propagation of discontinuities and some weaker singularities in the molecular velocity distribution function, are clarified. Some results are also compared with those based on the existing method.