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Problem in kinetic theory

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Using the successive approximation scheme, normal solutions of Boltzmann's equations are obtained for a dilute simple gas of rigid spheres. The integral equation of each approximation is reduced to a set of ordinary differential equations by the use of the collision dynamics of two rigid spheres, and certain auxiliary functions which are defined. This reduction is quite general, being applicable to all orders in the development of the distribution function in spherical harmonics. The second approximation to the distribution function involves terms of order $n = 1$ and $n = 2$, and the third approximation, terms of order $n = 0, 1, 2, 3$ and 4. Accordingly the general theory is specialized for $n = 0, 1, 2, 3$ and 4, thereby giving the differential equations necessary to solve the first two non-trivial approximations to Boltzmann's equation.

The differential equations of the second approximation are solved numerically, and the second approximation to the distribution function is obtained from the relationship with the auxiliary functions in which the differential equations are written. Integration of this to calculate the pressure tensor and heat flux vector gives the coefficients of shear viscosity and thermal conduction exactly. This procedure obviates the need to expand the distribution function in terms of an infinite series of Sonie polynomials which is usually done in calculating transport coefficients.

Using the exact numerical solution for the second approximation to

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the distribution function the differential equations for the third approximation to Boltzmann's equation are then solved. From the third approximation to the distribution function so obtained, the pressure tensor and heat flux vector dependent on terms non-linear in the gradients of number density, temperature and mean velocity are obtained by direct integration. These values are checked by a second more direct calculation and are compared with previous approximate calculations. In this approximation the necessity of enforcing the subsidiary conditions to allow solution of the original integral equation is pointed out.

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