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# Role of Radiation in Modern Gasdynamics

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## Introduction

MODERN aerodynamics requires investigation of flows of high temperature radiating gas. Therefore, we must examine the problems of interaction between a moving gas and a radiation field. In general this reduces to a complex system of integro-differential equations.

Equations for the motion of a gas taking into account an almost black-body radiation were given by Rosseland,[2] and have been used in stellar hydrodynamics. In papers by Ye. S. Kuznetsov[4] equations are given for the fluid mechanics of a moving radiating gas in connection with investigation of atmospheric phenomena, and several of them are examined. Ya. B. Zel'dovich and Yu. P. Rayzer have examined a set of problems concerning the effect of radiation on the character of strong shockwaves in a gas.

In this paper we shall undertake a systematic examination of the effect of radiation on the character of a high temperature gas flow past a body. Special attention will be given the limiting phenomena associated with different values of the parameters characterizing the radiation influence. Radiation will exert a substantial effect on flows past bodies only at high gas temperatures, when it is basically linked, apparently, to recombination of the electrons and ions present in the flows. We calculate, therefore, the recombination radiation and energy-yield attributable thereto in the case of oxygen and nitrogen. This will enable us to establish the lower bound for the parameters in question, and it will afford a possibility of examining more concretely the formulation of a series of problems and of finding solutions for some of them.

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## 1. Basic Results of Radiation Theory

We shall restate briefly certain results of the theory of radiation in gases needed in what follows.

Let us assume that a certain gas volume is moving generally in accordance with an arbitrary law, the temperatures of which are so high that radiation and absorption of light occur. We shall assume also that the velocities of motion of this volume are nonrelativistic and that light is neither diffused nor refracted in it, such that each gas element can only emit light and absorb it.

We shall proceed from the radiation theory of Einstein (see, for example, Ref. 1), according to which the following holds.

**A)** Radiation from an element consists of two parts: Spontaneous radiation, which is associated only with the quantum-mechanical properties of the particles and is not dependent on the collective interactions, and induced radiation, which is proportional (at the point in question) to the density of just those quanta (of energy, direction, polarization, etc.)