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Kinetic theory of two-temperature polyatomic plasmas

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Abstract

We investigate the kinetic theory of two-temperature plasmas for reactive *polyatomic* gas mixtures. The Knudsen number is taken proportional to the square root of the mass ratio between electrons and heavy-species, and thermal non-equilibrium between electrons and heavy species is allowed. The kinetic non-equilibrium framework also requires a weak coupling between electrons and internal energy modes of heavy species. The zeroth-order and first-order fluid equations are derived by using a generalized Chapman-Enskog method. Expressions for transport fluxes are obtained in terms of macroscopic variable gradients and the corresponding transport coefficients are expressed as bracket products of species perturbed distribution functions. The theory derived in this paper provides a consistent fluid model for non-thermal multicomponent plasmas.

Keywords: kinetic theory; non-thermal plasmas; polyatomic gas mixtures; Chapman-Enskog method; transport coefficients.

1 Introduction

The kinetic theory of plasmas has been an important subject of research over the past decades. The sound derivation of a multicomponent fluid plasma model is indeed of crucial interest for a wide range of practical applications, ranging from laboratory plasmas, space plasmas, to re-entry vehicles and atmospheric phenomena.

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