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THE MULTI TERM BOLTZMANN EQUATION ANALYSIS OF NON-CONSERVATIVE ELECTRON TRANSPORT IN TIME-DEPENDENT ELECTRIC AND MAGNETIC FIELDS

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Abstract. A multi term technique for solving the Boltzmann equation has been developed to investigate the time-dependent behavior of charged particle swarms in an unbounded neutral gas under the influence of spatially uniform time-dependent electric and magnetic fields (Dujko 2008). The hierarchy resulting from a spherical harmonic decomposition of the Boltzmann equation in the hydrodynamic regime is solved numerically by representing the speed dependence of the phase-space distribution function in terms of an expansion in Sonine polynomials about a Maxwellian velocity distribution at an internally determined time-dependent temperature. This technique avoids restrictions on the electric and magnetic field amplitudes and frequencies and/or the charged particle to neutral molecule mass ratio traditionally associated with many investigations. To our knowledge, it represents the first rigorous treatment of the explicit effects of non-conservative processes on transport coefficients in ac electric and magnetic fields. The variation of the transport coefficients with electric and magnetic field strengths, field frequency, phase difference between the fields and angle between the fields is addressed using physical arguments. Results are given for electron swarms in certain model and real gases. The errors associated with the two term approximation for solving the Boltzmann equation and inadequacies of the Legendre polynomial expansion procedure are highlighted. The results of the Boltzmann equation analysis are compared with those obtained by a Monte Carlo simulation code. The comparison validates the basis of transport theory and numerical integrity of both approaches.

References

Dujko S.: 2008, PhD Thesis, School of Mathematics, Physics and IT, James Cook University, Townsville, Australia, 2008.