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Transport and collisional processes for electrons in gases and their application to study non-equilibrium plasmas[1]

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As atomic and molecular collisions critically shape distributions and rates in low temperature plasmas the advancements in modern day technology associated with the non-equilibrium plasma discharges are critically dependent on accurate modeling of the underlying collision and transport processes for charged particles in gases. To meet these challenges, we have undertaken a program to understand the kinetic behavior of charged particles under the combined action of electric and magnetic fields in neutral gases. A multi term theory for solving the Boltzmann equation has been developed and used to calculate transport coefficients of charged-particle swarms in neutral gases. In this talk, I will focus on non-equilibrium magnetized plasma discharges where the electric and magnetic fields can vary in space, time and orientation depending on the type of discharge and where attention must be paid to the correct treatment of temporal and spatial non-locality within the discharge. In particular, I will highlight the duality of transport coefficients arising from the explicit effects of non-conservative collisions. As an example of fluid modeling, I will discuss the recently developed high order fluid model for streamer discharges. Starting from the cross sections for electron scattering, it will be shown how the corresponding transport data required as input in fluid model should be calculated under conditions when the local field approximation is not applicable. Comparison between the temporal evolution of electron number density and electric field from the classical first order and that from high order model are made and differences will be addressed using physical arguments.

[1]This work has been done in cooperation with Dr Zoran Petrovic, Dr Ron White and Dr Ute Ebert.