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Multi-fluid modeling of low-temperature plasmas at low-pressure[1]

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Most of the fluid models for gas discharges are based on the drift-diffusion approximation that neglects the inertial terms of the different species within plasma. However, the drift-diffusion approximation fails at low-pressure, when the ion mean-free-path become larger or comparable to the size of the device. Alternatively, we propose the resolution of velocity-moment closure hierarchies, also known as multi-fluid models. These models contain the inertial terms and solve for higher moments, i.e., mass, momentum, energy, heat flux, etc, for each of the species within plasma. The resolution of higher moments allows for capturing non-equilibrium phenomena, consequence of deviations from the Maxwellian distribution. We will show that multi-fluid models are able to correctly capture the plasma-sheath transition and the evolution of macroscopic variables of the discharge at low-pressure, as compared to PIC simulations. For this, we will study different 1D and 2D ICP discharges with and without the presence of a magnetic field and compare them to PIC simulations. The integration of the collisional terms for different gases as well as the numerical methods will be discussed.

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