Simulation by COMSOL® for the Dynamics of Nanoparticles in a Plasma

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Dusty plasmas are ionized gases containing solid particles ranging in size from nanometers to millimeters. These unique environments are encountered in various domains, including planetary atmospheres, comet tails, microelectronics, nanotechnologies, and thermonuclear fusion reactors [1]. The objective of this work is to investigate the distribution of nanoparticles within the plasma under different conditions. To achieve this, the initial step involves simulating the plasma parameters (density, electronic temperature, plasma potential, etc.) in the absence of nanoparticles. Subsequently, we will integrate the nanoparticles into the model, taking into consideration the fact that these particles become electrically charged within the plasma [2]. This charge is contingent upon the plasma parameters and, in turn, influences the surrounding plasma, resulting in a strong coupling of the equations. Once this coupling is established, we will proceed to calculate the various forces acting on the nanoparticles [3,4]. This analysis will enable us to define their distribution and dynamics within the plasma.
To simulate a dusty radio-frequency argon discharge within a CCP reactor with dimensions following the PKE-Nefedov configuration [5], we will employ one- and two-dimensional fluid models using the COMSOL Multiphysics® software. In this model, we will calculate key quantities such as fluxes, densities, and electric fields. The results obtained from this simulation are presented in the figures below and compared to the findings of Akdim et al. [2,3]. Remarkably, a high level of agreement exists between the two sets of results.

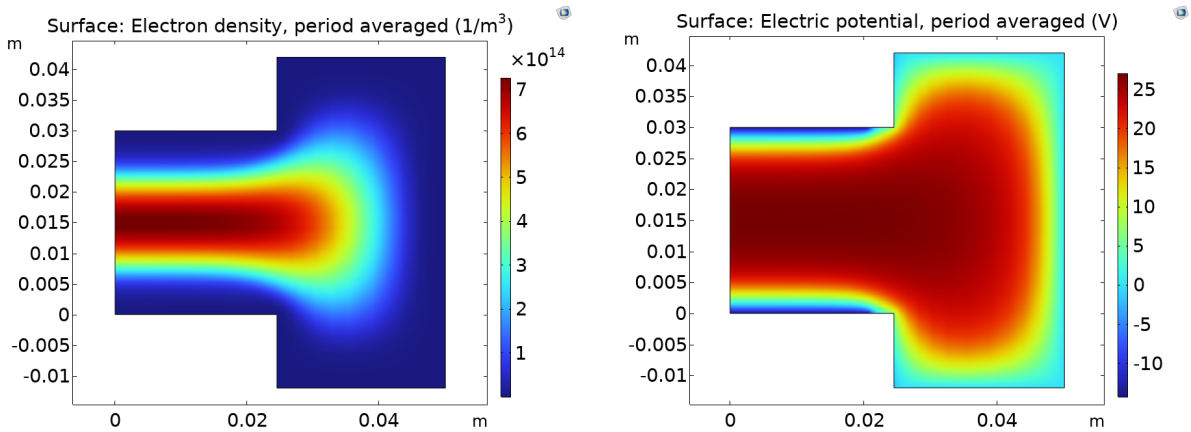

Figure 1 : *2 D results*

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