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PhD Thesis Abstract

Molecular Dynamics Simulations of Rydberg and Strongly Correlated Plasmas

To model and accurately reproduce the plasma properties we see in today's tokamaks and infer the best-In order to create plasma, high temperatures are needed to sustain ionization. The electron temperature is used as reference to define the scale and it is a defining feature of the plasma. The temperature of a classical plasma goes around 1000 to 108K. However, the development in atom cooling and trapping methods have enabled studies in a new domain of plasma physics. In this new regime, the plasma is formed by photo-ionizing laser-cooled atoms near the ionization threshold. These new type of plasmas are known as ultra-cold neutral plasmas. In ultra-cold plasmas, the electron temperature varies from 1 to 103K and the ion temperature is around 1K. These kind of plasmas can be in or near the strongly coupled regime. The strongly coupled regime then becomes an interesting research area, because many of the classical plasma assumptions are no longer valid and new phenomena can be found. Strong coupling is manifested through the presence of spatial correlations between particles, which can be important in the collective dynamics of the system. In general, strongly coupled plasmas require high densities and low temperatures to be obtained. On the other hand, ultra-cold plasmas have shown strong coupling among the constituents without the necessity of high density, and for this reason these plasmas have opened an opportunity to study strong coupled plasmas in table top experiments. The main goal of the present research will be carried out on numerical simulations of collective effects of charged particles in ultra-cold and Rydberg plasmas. Simulations of collective effects in strongly coupled plasmas are important sources that can be used to obtain information on plasma density, pressure, and temperature. Also, collective effects in ultracold plasmas prevent reaching higher values of the coupling parameter among ions, preventing reach stages of higher correlation. The capacity to produce more complex and more strongly coupled plasmas experimentally is the main challenge in the study of ultracold plasmas and numerical simulations can provide new schemes to achieve this goal. Finally, the simulations performed in this work will open the possibility to suggest new scenarios for experiments to be executed in the laboratory of quantum plasmas at IPFN-IST and expand the knowledge on this exotic and new regime.