Theory of Strongly Coupled Complex Plasmas in Spherical Traps

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The question about the self-organized structure formation emerges as a key issue for strongly coupled Coulomb systems at completely different energy and length scales [1]. A unique example for such collective phenomena are complex plasmas: In a rf-discharge with a typical electron temperature of a few eV, an additional micro-particle component can acquire thousands of elementary charges, which leads to a strongly repulsive interaction amongst these plasma constituents. In recent experiments the repelling forces are balanced by a 3D spherical electrostatic confinement which allows to realize one of the most fascinating properties of complex plasmas: by controlling the confinement strength the particle cloud can be transformed from a weakly coupled phase to a strongly coupled, highly ordered crystal-like state—the 3D plasma (Wigner) crystal.[2]

In my talk I will address some of the fundamental properties of strongly coupled plasmas in traps such as the structural properties in the ground state [3, 4] and their average particle distribution at finite temperature [5]. Besides the influence of collective effects on the equilibrium properties, also the dynamics is found to be substantially influenced by many-particle correlations. Various non-equilibrium features will be discussed concerning the probability of metastable configurations [6], the spectral properties [7], and the correlation buildup and the cluster formation dynamics [8]. The presented results will be put into the broader context of similar physical systems from other branches of physics.

References

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