On the possibility of "metal–insulator" Mott transition in the ultracold plasmas

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Spontaneous evolution of a cold Rydberg gas into the plasma was observed long time ago in the experiments with atomic beams [1]. Such a process developed as avalanche, composed of the individual interparticle interactions between the Rydberg atoms, electrons, and ions. It was also speculated in the same works that it would be interesting to realize such transformation in the "collective" Mott regime. Unfortunately, it was impossible at that time to produce the sufficiently cold (almost immobile) atoms. However, such a possibility emerged when the magneto-optical traps were employed for the creation of ultracold plasmas [2] and, especially, when such plasmas were generated in the steady-state regime [3].

It is the aim of our report to present the analytical model of Mott transition in the ultracold plasmas, which is based on the ensemble of electrons moving in centrifugal potentials of nearby ions and possessing the effective "virial" temperature due to the multi-particle interactions. As follows from our calculations, the concentration of free electrons exhibits a very sharp dependence on the overall density of the system (i.e., actually on the interionic separation), which resembles very much the well-known Mott transition. From our point of view, this should be an interesting topic for further experimental research of ultracold plasmas.

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