WHAT IS THE NATURE OF SUBHARMONICS OF THE ELECTRON EMISSION FROM ULTRACOLD PLASMAS?

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One of the most interesting phenomena in ultracold plasmas are multiple subharmonics of the electron emission caused by its irradiation by radiowaves. Although this effect was found quite a long time ago [1], its theoretical interpretation remains poorly understood till now. Particularly, the approach based on the so-called Tonks–Dattner (TD) resonances, i.e., actually the standing plasma waves [2, 3], encounters a number of serious problems. For example, this is a lack of the adequate boundary conditions in the freely-expanding plasma cloud. Besides, as follows from the experimental data, the subharmonics of electron emission become more pronounced with decrease in the electron temperature, while the opposite behavior should take place for the TD resonances. Finally, TD calculations depend crucially on the shape of the plasma cloud, while the experimental measurements show that the resonances remain almost the same even in the strongly-distorted clouds, e.g., the dumbbell-shaped ones.

It is the aim of the present work to suggest an alternative interpretation, which is based on the radiowave ionization of the "secondary" Rydberg atoms formed due to recombination in the expanding plasma cloud. According to our numerical simulations, the efficiency of ionization exhibits a number of sharp peaks, resulting in the quasi-periodic modulation of the flux of electrons escaping from the expanding plasma cloud. As distinct from the Tonks–Dattner resonances, this mechanism is evidently irrelevant both to the boundary conditions and shape of the cloud. Besides, it provides a correct dependence of the intensity of the electron flux on the plasma temperature.

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