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Selective properties of a Paul trap with the asymmetrical power supply

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It is widely known that in a classical quadrupole Paul trap with endcap electrodes the localization of the particles with the narrow-defined charge to mass ratio realizes at fixed power supply parameters. If we consider a Coulomb crystal in a classical Paul trap, one can see the radial splitting of the crystal associated with the effective potential form at different voltages on the rod and endcap electrodes [1].

In the present work, we discuss an effective potential transformation in a linear Paul trap with an asymmetrical power supply system. Only the AC voltage is applied to the one pair of opposite rod electrodes and only the DC voltage is applied to the other pair of rod electrodes, also, we apply the DC voltage on the end cap electrodes as usual.

Performing the experiment with starch microparticles we observe an axial Coulomb crystal splitting (along the axis of the trap) at the asymmetrical power supply system. Also, we show that it is possible to obtain three groups of starch particles localized along the trap axis at fixed AC and DC voltages components on all electrodes. The central group of particles has one charge to mass ratio and for them, the single-well effective potential configuration is realized. Extreme left and right particles clouds have the distinctive charge to mass ratio. Due to this at the same time and voltages, for the extreme left and right particles clouds, the double-well effective potential configuration realizes. As a result, we observe three groups of trapped particles with different charge to mass ratios simultaneously.

Showed axial splitting effect in a linear Paul trap with the asymmetrical power supply system can be of service for precise measurements of particles characteristics, isotope separation and spatial selection, targeted laser cooling, and frequency standards [2 –5]. The axial particle separation gives more opportunities for precise manipulations with trapped ions than the radial one because, generally, the length of the trap is several times larger than the trap's radius.

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