LOCALIZATION OF BUNCHES OF CHARGED PARTICLES IN A LINEAR ELECTRODYNAMIC TRAP WITH A CHARGED FILAMENT

Syrovatka R.A., Filinov V.S., Vasilyak L.M., Deputatova L.V., Vladimirov V.I., Pecherkin V.Ya.*

JIHT RAS, Moscow, Russia
**vpecherkin@yandex.ru*

Confinement of localized systems of charged particles is necessary both for the creation and research of Coulomb systems, and for various devices and technologies. According to Eamshaw's theorem, a static system of charged particles is unstable, therefore traps, including traps with variable electromagnetic fields, are necessary for their stable retention. In this paper, the possibility of additional stabilization and confinement of charged particles levitating in a linear electrodynamic quadrupole Paul trap using an additional elastic charged filament was investigated. In this work, a linear quadrupole electrodynamic trap with a length of 30 cm with four electrodes with a diameter of 4 mm was used. The electrodes of the trap were located at the vertices of a square with a side of 2 cm. An alternating electric potential with a frequency of 50 Hz was applied to the electrodes, and the same for the electrodes located in opposite corners of the square, and with a phase difference of 180 degrees between the electrodes in adjacent corners. A nylon thread with a diameter of 30 μm was stretched along the axis of the trap. Polydisperse particles of Al_2O_3 charged up to $(4-6)\times10^5$ units of elementary charge were injected into the trap. The dynamics of microparticles and nylon filament was recorded by a high-speed video camera. At the amplitude of the alternating voltage of 4-6 kV, the filament begins to bend and rotate. Due to the ends of the filament are fixed, the movement of the filament is stabilized and becomes like a standing wave with localized nodes and antinodes. The charged nylon filament, during its vibrational-rotational movement, affects the charged microparticles confined in the trap, which leads microparticles to gradually shift along the trap axis and concentrate in the antinodes of waves. The filament is actually another dynamic trap that collects particles from the entire volume and localizes them in the antinodes, as a result of which the concentration of charged particles increases, despite their mutual repulsion. The use of such an additional trap makes it possible to create bunch of charged particles with a higher concentration and a higher volume charge.