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Gravity vector detection by extended orbits of trapped charged microobjects

Introduction: In the present, RF traps for charged particles containment get a widespread use as a tool for work with single particles, like spores [1]. Wherein trapping of the particle can occur in a vacuum and in a medium, which more suitable for biological and medical research [2]. The motion in dissipative medium gets special role in studying charged particle's trajectories, because path's configuration carries information not only of a confined particle (for example particle size or particle shape), but also of the physical characteristics of the medium [3]. One of the manifestation of atypical particle dynamics are so-called extended orbits (similar to ZC-orbits in a linear ion trap under linear friction [2]). The formation of extended orbits significantly depends on unneutralized gravity. **Methods:** Paul's radiofrequency trap is designed with a single AC voltage toroidal electrode with a mechanical rotational degree of freedom ϕ for experimental studying of influence of the gravity projection g_{eff}. Dried spores Lycopodium Clavatum with a characteristic size of $= 32 \pm 2$ μm were used as a confined particle. Secular motion of particle is absent because of dissipative terms presence in motion equations, thus the particle oscillation frequency is determined by the RF field frequency $\Omega = 50$Hz. Effect of the period doubling occurs with increasing voltage and the frequency of the particle decreases to $\Omega/2$ in the radial direction. An orbit of the localized particle is symmetric at the tilt angle $\phi = \pi/2$. Asymmetry of the orbit is observed with a gradual change of the tilt angle of the electrode. The extended orbit shape caused by tilt angle of the ring electrode relative to the gravity vector g_{eff} and is uniquely defined as $\phi = \arcsin(R_1/R_2)$, where R_1 and R_2 are the lengths of the arms of orbit measured from the «nodal point» of the extended orbit. **Results:** A significant difference between the formation of extended orbits and localization in linear traps was obtained and the distinctive features of the formation of extended orbits in Paul trap were studied. A direct dependence of the numerical characteristic of the asymmetry of the orbits on the value of the tilt angle ϕ is shown. **Discussion:** The maximum resolving power for this trap configuration is 11 arc minutes with a laser $\lambda = 532$ nm. This resolution is not limiting and depends on the laser wavelength, particles and orbit size and can reach angular seconds. The proposed estimates bear testimony to the possibility of using method as a gravity anomaly detector by observing the deviation of the gravity vector.

Reference list:

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