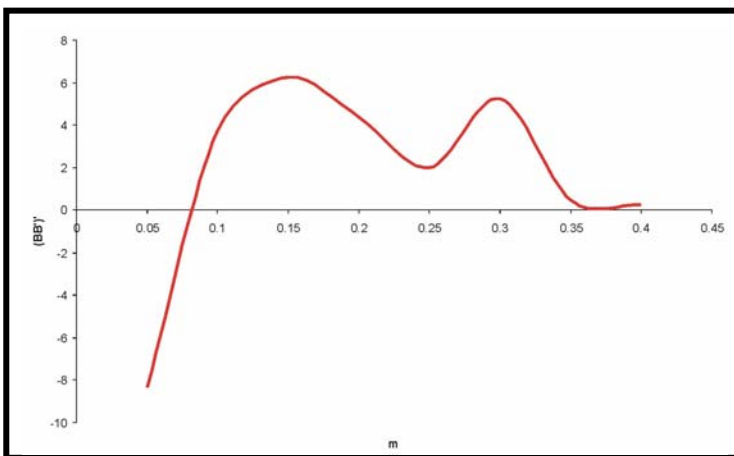


Vertical vibrations of paramagnetic particles in discharge plasmas are treated taking into account the magnetic force associated with gradients of an external magnetic field. For a single particle a novel type of oscillation associated with these gradients is found. In a one-dimensional particle string the magnetic force causes a new low-frequency oscillatory mode. The study of vertical vibrations of magnetized grains provides a tool for determining complex plasma parameters.

Up to now, oscillatory modes of magnetized grains in a discharge plasma were considered only in homogeneous magnetic fields [1], which implies that a magnetic levitation was not discussed as well as the role of inhomogeneous magnetic field in the particle dynamics. At the same time, recent complex plasma experiments with paramagnetic particles immersed in a magnetic field demonstrated that levitation heights could be controlled by the magnetic force [2]. In this work



we therefore treat the grain levitation in an external magnetic field and consider vertical vibrations of the magnetized particles around an equilibrium taking into account magnetic field gradients.

For a single magnetized particle a novel type of vertical vibrations in discharge plasmas is found. These vibrations can be stable or unstable depending on the distribution of the

magnetic field inside the particle cloud. The normalized magnetic frequency as a function of the distance between the magnetic coils and levitating particles is shown in Fig. 1. The vertical resonance frequency is independent on particle mass, but is completely specified by the magnetic field profile inside the complex plasma and magnetic properties of the grain material. A numerical estimate of the resonance frequency for the typical complex plasma parameters in the magnetic experiments [2], gives magnitudes $\sim 50\text{-}70\text{ s}^{-1}$. Such values can be easily measured in experiments and the latter can provide a tool for determining the complex plasma parameters. In a one-dimensional particle string the magnetic force causes a new low-frequency oscillatory mode, which is characterized by inverse optic-mode-like dispersion when the wavelength far exceeds the intergrain distance. The characteristics of the mode are specified by the gradients of the external magnetic field and thus can be effectively controlled in experimental conditions. This opens new opportunities for the investigation of the particle behavior at the kinetic level as well as for stimulating phase transitions in the system, and for the study of self-organized structures in the experiments.

References:

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