**Abstract**

Dusty (complex) plasmas are composed of weakly ionized gas and charged microparticles that represent the plasma state of soft matter. A growing field for physics research, measuring the spatial distribution of the electric field in the plasma sheath has been the goal of much research. A method based on the experimental investigation of vertical oscillations of a single particle in the sheath of a low-pressure radio-frequency discharge is proposed. The theory of anharmonic oscillations gives estimates for the first two anharmonic terms in an expansion of the sheath potential around the particle equilibrium.

**Theory**

Without excitation, a particle is levitated in the minimum of the potential well (z = 0) where:

\[ M_g = Q E_0 \]  

(1)

The electrostatic energy of the particle, 

\[ U = \frac{Q^2}{2}\epsilon_0 \frac{z}{z_0} \]  

(2)

can be expanded around z = 0 in the series

\[ U(z) = U_0 + z^2 \frac{U_0''}{2} + z^3 \frac{U_0'''}{6} + z^4 \frac{U_0'''}{24} + O(z^5) \]  

(3)

Using the equilibrium condition

\[ M_g = U_0' \]  

(4)

And the definition of resonance frequency

\[ M_{w0} = \frac{Q E_0}{U_0''} \]  

(5)

We rewrite the potential as

\[ U(z) = M \left( a z^2 + \frac{1}{2} w_0^2 z^2 + \frac{1}{3} z^3 + \frac{1}{4} z^4 \right) \]  

(6)

Where alpha and beta are the anharmonic coefficients. Using perturbation theory, and solving for the Forced Damped Linear Oscillator, we solved for these coefficients and estimated the potential in a rather wide

**Results**

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**References**