Step- and pulse excitation methods for the characterization of a dust particle confined in a RF plasma

A. Mengel[1], M. Artz[1], F. Greiner[1]

[1] *Institute for Experimental and Applied Physics, Kiel University, Kiel, Germany*

The fact that a micrometer-sized dust particle trapped in the lower sheath of a RF plasma behaves like a damped harmonic oscillator is often employed for diagnostics of particle properties. Examples for such methods are the classical resonance method [1], the phase resolved resonace method (PRRM) [2], or the alteration of the particle's equilibrium position via RF power variation [3]. We present a new approach which involves only a small perturbation of the plasma parameters via an applied bias voltage on the lower electrode. This excitation signal is either a short pulse or a step, each resulting in a damped vertical oscillation (see Fig. 1) of the particle which can then be observed with a high-speed camera. From the well-known equation of motion, one can, using the system's Green function, derive the form of the particle response. This response function contains parameters such as the Epstein neutral drag γ or the eigenfrequency ω_0, which in turn contains the charge-to-mass ratio of the particle. Fitting the response function to the data yields said parameters. Implementing this method promises to yield results comparable in precision to the PRRM, which has a relative error of $< 0.1\%$ for the eigenfrequency ω_0, while being extremely fast (a few seconds per measurement).

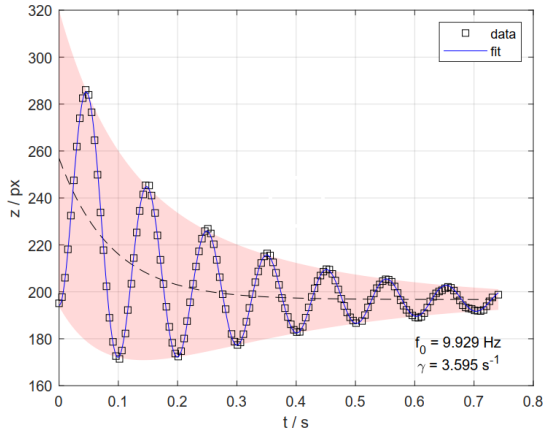

Figure 1: *damped harmonic motion of a particle*

References

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