Particle charges determination for two vertically aligned dust particles in a complex plasma

L.Couedel[1], A.A. Samarian[2]
1-Ecole de physique, Universite Joseph Fourier, Grenoble Cedex 9, France
2-School of Physics, The University of Sydney, NSW 2006, Australia

In typical complex plasma experimental situations, particles are levitated in the plasma sheath above a confinement electrode due to a balance of the electric force and the gravitational force. Despite the mutual Coulomb repulsion between the particles, unusual plasma crystal structures in which the layers of particles are positioned on top of each other have been observed. Hence, the charge on the particles is a crucial parameter for particle trapping as well as for the formation of ordered plasma crystal. There are several existing theories which explain the dust charging in plasma environment, but none of them is satisfactory. As a result, experimental measurement of the charge on the dust particle becomes very important. One of the simplest and most accurate charge measurement techniques is by obtaining the resonant frequency of a single particle in the plasma sheath. But recently, it was shown that the case of two particles placed in the plasma flow is different from the case of one particle [1]. Thus an experimental investigation of the charges carried by two vertically aligned particles in the sheath is necessary.

In this paper, we will explain a new method to determine the charges of vertically aligned dust particles in complex plasma using experimental data from two particle resonances in the vertical direction. It was found that such system in the plasma sheath can be approximated with a spring model with features dependent on parameters such as charges, gradient of the vertical electric field in the sheath, etc. The method in using simulations to fit experimental results and deduce important parameter of our system will be discussed. The use of the amplitude ratio as a new fitting parameter for single driven particle experiments will also be shown.