

# Phase Transitions in Plasma Crystals

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Dusty plasma consists of neutral gas, ions, electrons, and micron-size particles that have a negative charge, when emission processes are negligible. Under certain conditions, the dust immersed in plasma may form the stable structures similar to the liquid or the solid. There are two known empirical rules for fluid-solid first-order phase transition. The first rule is the Lindemann criterion, which determines the ratio of the mean-square displacement and the interparticle distance at the melting line of the solid as a value close to 0.15. The second rule, the Hansen criterion, determines the first maximum of the liquid structure factor as a value less than 2.85.

The phase transitions of a plasma crystal consisting of several layers of dust particle in a planar rf discharge in argon were investigated. The phase transitions were produced as results of variation of power and pressure. The melting point was determined by analysis of the 2D pair correlation function. We suggest the new empirical rule for fluid-solid transition, which based on the ratio of the minimum  $G_{\min}$  and maximum  $G_{\max}$  value of the pair correlation function.

Using this rule it was been found that the phase transition in multilayer crystals depends on number of layers. The few (one, two) layer plasma crystals are shown to be solid at higher pressure (100mTorr) and low discharge power (20 W), and melting occurs when the gas pressure reduce or discharge power increase. In the case of a multilayer structure the phase state dependence on discharge power is non-monotonic; a frozen structure obtained by decreasing power can be melted again as power continues to decrease. The position and behaviour of interstate equilibrium curve is strongly dependent on number of layers in crystal structure. The dependence on particle size is also found. The influence of ion dust and confining instabilities on trigger the phase transition was studied.