Coulomb clusters of diamagnetic particles in a magnetic trap

S.F. Savin[1], L.G. D'yachkov[2], M.M. Vasiliev[2], O.F. Petrov[2], V.E. Fortov[2]

[1]S.P. Korolev Rocket-Space Corporation "Energy", Korolev, Russia

[2]Joint Institute for High Temperatures RAS, Moscow, Russia

Dusty plasma structures are frequently considered as a macroscopic physical model of strongly coupled Coulomb systems which can visually be observed. However, charged dust particles in plasma are screened, and the potential of interparticle interaction becomes a Debye one. Besides, in dusty plasmas, the charge of the dust particles is responsible both for interaction with other particles (and consequently for the formation of a cluster or structure) and for its levitation in electrical fields. So, varying any parameter of the system, one changes others.

We present an alternative way for formation of macroscopic Coulomb systems using the known possibility of the stable levitation of diamagnetic particles in nonuniform magnetic fields. So, we can form a cluster of charged diamagnetic particles. In this case the levitation conditions are independent on the particle charge and depend on the magnetic susceptibility of the particle matter. We present an experimental setup for keeping in a stable state the Coulomb clusters of charged graphite grains in magnetic trap with fields B ~ 1 T and grad$B$ ~ 10 T/cm. An analysis of the cluster structure and dynamics is performed. We have developed a simple theoretical model for calculations of the conditions of equilibrium levitation of the diamagnetic grains in the trap, estimation of their charge, and oscillation frequencies.