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Formation of helical structures in the complex plasma

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Typical laboratory complex plasmas consist of microspheres immersed in a gaseous plasma environment. These "dust" grains tend to accumulate high negative charges (on the order of 10^4e or more), due to their asymmetric interaction with the plasma electrons and ions. When confined, dust populations can either maintain self-organized dynamical structures, or condense into so called dust crystals or Coulomb clusters. The nature of these clusters is strongly dependent on the strength and shape of the confinement in which they form, and from a theoretical standpoint, on the model used to describe them. Previous numerical work on the formation of helical structures in complex plasma by Tsytovich *et al.* [1] has indicated that helices represent a fundamental and stable configuration under conditions where a non-linear screened interaction between dust particles dominates. This work has generated a certain amount of interest, not least of all because these structures can display properties which are commonly attributed to biological matter such as memory, evolution and self-organization.

Here, we explore the possibility of finding similar structures under conditions which are more appropriate to discharge plasmas. The equilibrium configurations for dust particles in a confined plasma environment are analyzed numerically, with particular attention being paid to the formation of helical structures. Methods of detecting certain helical configurations are developed, enabling relatively simple procedures for ascertaining the conditions under which such structures will form. These procedures are applied to molecular dynamics-type simulations where the strength of confinement in one direction is varied. It is found that for certain particle numbers (typically N<30), there are definite intervals in the value for this confinement strength that correspond to the formation of single-winding helices, double helices and even planar structures of three or more particles.

Reference

[1] Vadim Tsytovich, Namik Gusein-Zade, and Gregor Morfill, 2004 *IEEE Transaction on Plasma Science*, Vol. 32, No.2.