Annexure –IV

UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI -110 002

UTILIZATION CERTIFICATE

Certified that out of the grant of Rs. 5,81,800 /- (Rupees Five Lacks Eighty One Thousand Eight Hundred only) received during the financial year 1/4/2007 to 31/09/2010 from the University Grants Commission under the scheme of support for Major Research project entitled "The study of the charging of dust particles in plasma and dynamics of complex plasma" vide UGC letter No. F. 32 – 9/2006 (SR) dated March 19, 2007, an amount of Rs. 5,72,450/- (Rupees Five Lacks Seventy Two Thousand Four Hundred Fifty only has been utilized during the financial year 1/04/2007 – 31/09/2010 for the purpose for which it was sanctioned and accordance with the terms and conditions laid down by the University Grants Commission.

PRINCIPAL INVESTIGATOR
Date: 10/6/2011

FINANCE OFFICER
Tezpur University
Date: 14/6/11

REGISTRAR
Tezpur University
Date: 15/6/11

SUMMARY OF THE FINDINGS:

Drift instability is investigated in collisional dusty plasma, in the low frequency regime. The dust density gradient is perpendicular to the magnetic field B_0, which causes the drift wave. It is interesting to see whether this drift wave becomes unstable in the system and how the dust neutral collision affects the instability. Elaborate study has been made to estimate the growth rate of drift instability for different values of physical parameters of interest. It is interesting to see that dust-neutral collision plays a crucial role on the growth rate of drift instability.

A molecular dynamics (MD) code is developed to study the crystal formation in complex plasma. The interaction potential among the dust grains is taken as Yukawa type. The structure of the complex plasma system is investigated by calculating Pair correlation function (g(r)) for different values of temperature, density and size of dust grains. The triple point of phase transition between solid (FCC) to solid (BCC) and solid to fluid phase is found out.

An effort has been made to study the importance of external magnetic field on the formation of dust crystal and phase transition of a three-dimensional dusty plasma system. The interaction potential among the dust grains gets modified and becomes anisotropic in presence of magnetic field. The pair correlation function has been calculated to characterize the structural properties of the dusty plasma for different values of magnetic field strength. The phase diagrams show the existence of solid (FCC-like), solid (BCC-like) and fluid phases for the system.

Role of attractive shadowing force on Coulomb crystal formation has been investigated in a 3D dusty plasma system. For this study the interaction potential is considered to be consist of repulsive Yukawa potential and attractive Shadowing potential. Pair correlation function g(r) has been calculated for different ranges of Coulomb coupling parameter Γ, screening constant κ and grain radius r_d, for this purpose.

A comparative study between the effect of coupled Yukawa-Shadowing potential and coupled Yukawa-Overlapping Debye Sphere (ODS) potential on 2D dust crystal formation have been made by using MD simulation. Here, by calculating Radial Distribution Function (g(r)) for different values of κ and Γ, the structure of the system is investigated.

Work done, Achievements from the Project:

1. Drift instability has been widely studied in presence of dust particles. However here we have developed a detailed theory of drift instability that includes the collision effect of dust grains and neutrals in plasma. Our theory clearly shows that dust-neutral collision plays a crucial role on the growth rate of drift instability. At short wavelengths, a dissipative instability is found to occur. The dissipation rate increases with the increase in dust-density gradient and dust-neutral collision.
2. Molecular Dynamics (MD) code has been developed during the tenure of the project to study about dust crystal formation. Our code has been developed in such a way that we can study role of different repulsive and attractive potentials on dust crystal. Our investigation also shows that in presence of Yukawa potential as the temperature of dust T_d is reduced, the structure becomes highly ordered. However, the crystal formation becomes more probable with grains of relatively large size. The phase diagram for the system shows the existence of three phases, solid (FCC), solid (BCC) and fluid. The study may be helpful to identify accurately the parameters suitable for the formation of Coulomb crystal in a Yukawa dusty plasma system.
3. From the study of the effect of the attractive Shadowing force it is seen that Shadowing force predominates over repulsive Yukawa force for grains with large size and for large screening parameter. However, from the comparative study between the effect of coupled Yukawa-Shadowing potential and coupled Yukawa- Overlapping Debye Sphere (ODS) potential on 2D dust crystal formation it is found that Coulomb coupling parameter does not have significant effect on both ODS and Shadowing force. The attractive Shadowing force is more dominant for grains with large screening parameter. The comparison of our simulation results with the experimental observation clearly reveal that Yukawa-Shadowing potential leads to better agreement with the real situation.
4. Our code can also be used in presence of magnetic field. From the results of our simulation, we can identify the dust parameters for which it is possible to get plasma crystal. Besides that critical magnetic field has been calculated for particles with different

sizes at which phase transition takes place. Our code can be used to study the phenomena of phase transition for dust crystal in presence of magnetic field.

Publications:

a) "The effect of magnetic field on the structure of Coulomb Crystal in Dusty Plasma", Swati Baruah and Nilakshi Das, Phys. Plasmas. 17, 073702-1 (2010).

b) "A comparative study between effects of Shadowing potential and ODS on Coulomb crystal formation", Swati Baruah and Nilakshi Das J. Plasma Phys. doi:10.1017/S0022377810000723 (2010).

c) "Role of shadowing force in formation of 3D dust crystal", Swati Baruah and Nilakshi Das, Physica Scripta, Manuscript No. 384869 (Accepted).

d) "Electrostatic drift instability in collisional dusty plasma", Swati Baruah and Nilakshi Das J. Assam Sc. Soc. 50, 2 (2010).

e) "The effect of dust parameters on Coulomb crystal formation using MD simulation", Swati Baruah, Nilakshi Das, and Manoj Warrier, J. Assam Sci. Soc. (Accepted).