

Crystallization of a quantum plasma at finite temperature.

E.Jaupart¹ and G. Chabrier ^{1,2}

¹ *CRAL- ENS de Lyon, Lyon, France*

² *University of Exeter, Exeter, United Kingdom*

We have conducted Path Integral simulations of a fluid and a crystal of charged particles at finite temperature. Path integration is carried out via Molecular Dynamics while using a semi-classical pair potential derived from the Coulomb potential which takes into account quantum diffraction effects at small distance.

The melting curve is obtained with the so called dynamical melting criterion. This simply brackets the phase transition by examining the stable phase towards which relaxes one simulation. To determine the stable phase, we examine the structure factor and the empirical Lindeman Criterion (Chabrier 1993 [1]).

We verify the importance of finite size effects by running simulations with growing values of the number of polymers P made in the discretization of the Path Integrals. We compare our melting curve with the one obtained analytically (Chabrier 1993 [1]) and the one obtained numerically with $P = 54$ (Jones & Ceperley 1996 [2]).

Finally, we briefly address the problem of quantum statistics.

Besides the fundamental problem of crystallization of the quantum One Component Plasma (OCP) this problem bears consequences for the thermal evolution of compact astrophysical bodies such as massive white dwarfs and neutrons stars.

REFERENCES

- [1] G. Chabrier, *"Quantum effects in dense coulombic matter: application to the cooling of White Dwarfs"*, The Astrophysical Journal, 414, 695-700 (1993).
- [2] M. Jones & D. M. Ceperley *"Crystallization of the one-component plasma at finite temperature"*, Physical review letters, 76(24), 4572 (1996).