Abstract Submitted
for the DPP09 Meeting of
The American Physical Society

Thermodynamic Theory of Spherically Trapped Coulomb Clusters JEFFREY WRIGHTON, JAMES DUFTY, University of Florida, MICHAEL BONITZ, HANNO KÄHLERT, Christian-Albrechts-Universität zu Kiel — The radial density profile of a finite number of identical charged particles confined in a harmonic trap is computed over a wide ranges of temperatures (Coulomb coupling) and particle numbers. At low temperatures these systems form a Coulomb crystal with spherical shell structure which has been observed in ultracold trapped ions and in dusty plasmas. The shell structure is readily reproduced in simulations. However, analytical theories which used a mean field approach[1] or a local density approximation[2] have, so far, only been able to reproduce the average density profile. Here we present an approach to Coulomb correlations based on the hypernetted chain approximation with additional bridge diagrams. It is demonstrated that this model reproduces the correct shell structure within a few percent and provides the basis for a thermodynamic theory of Coulomb clusters in the strongly coupled fluid state.[3]

[1]C. Henning et al., Phys. Rev. E 74, 056403 (2006)
[2]C. Henning et al., Phys. Rev. E 76, 036404 (2007)
[3]J. Wrighton, J.W. Dufty, H. Kählert and M. Bonitz, J. Phys. A 42, 214052 (2009) and Phys. Rev. E (2009) (to be submitted)

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Date submitted: 17 Jul 2009 Electronic form version 1.4