Interacting Ultracold Boson-Fermion Mixtures in a Trap

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1. Introduction – In this study, an approach based on the Density Functional Theory (DFT) for the determination of ground state of a trapped boson-fermion mixture is presented. Also, we have discussed how one can analyze such a sytem witrhin the Thomas-Fermi (TF) approach. An algorithm was developed to solve the so obtained equations and the ground state boson and fermion density distributions of the system were calculated. Considering the resulşts obtained from these calculations we have discussed how the ground state boson and fermion density distributions of the system were influenced by the parameters such as the number of bosons, number of fermions, ratio of boson-fermion and boson-boson interaction parameters, and ratio of boson and fermion masses. Furthermore, considering the agreement between the results from TF and DFT methods we have commented on the applicability and weaknesses of TF method.

2. Theory – Ignoring the fermion-fermion interactions the Kohn -Sham equations for an interacting mixture of bosons and fermions, can be given as $[-\hbar 2\nabla 2\ 2mB + VB + 4\ \pi\ \hbar 2aBB\ mB\ nB + 2\ \pi\ \hbar 2aBF\ mR\ nF + \delta\ EXC\ \delta\ nB\ ]\ \phi = \mu\ B\ \phi$ and $[-\hbar 2\nabla 2\ 2mF + VF + 2\ \pi\ \hbar 2aBF\ mR\ nF + \delta\ EXC\ \delta\ nF\ ]\ \psi = \varepsilon\ i\ \psi\ i$ where $nB(r) = NB|\ \phi\ (r)|2$ and $nF(r) = \sum\ i=1\ NF\ |\ \psi\ i(r)|2$ we solve these coupled set of equations by a self consistent approach to obatin boson and fermion distributions within the trap.

3. Results and Discussion – We present our results for various interaction strengths and various effective correlation potentials.

4. References

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