Degeneracy and interference quantum effects in phase space distribution function. Path integral approach.

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Introduction

- Quantum effects disturb the equilibrium momentum distribution function.
- Kinetic properties of matter, combustion, detonation, nuclear fusion.
- At low temperatures and under extreme conditions system of particles is strongly coupled and perturbative methods does not work.
- *Ab initio* approaches in phase space are required.

Aim

- Calculations of thermodynamic values and distribution functions of strongly coupled systems of particles.

Methods

- Quantum Monte Carlo method based on path integrals in phase space: harmonic approximation and single-momentum Wigner function

Results & Discussion

- The methods was tested on simple models: single particle in 1D and 3D potential wells of different forms and degenerate ideal Fermi gas. Results are in very good agreement with available theoretical and independent numerical data. Some of them are in Figs.1 and 2.

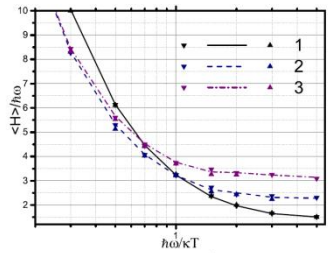

Figure 1 : dependence of average energy $< \hat{H} >$ on inverted temperature $\beta = 1/kT$ for potential $V(r) = ar^2 + br^4$. Parameters $a = m\omega^2/2$ for all cases, $b = 0$ (1), $b = m^2\omega^3/2\hbar(2)$ and $b = 8m^2\omega^3/3\hbar(3)$. Turned triangles refer to harmonic approximation calculations, straight triangles – to single momentum calculations, curves – to usual path integral Monte Carlo method.

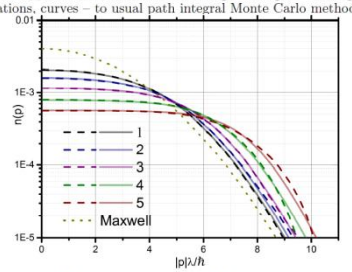

Figure 2 : Fermi distributions $n(p)$ for increasing densities at the same temperature. Degeneracy parameter $n\lambda^3$ are equal to: $1 - 1.3$, $2 - 2.0$, $3 - 3.0$, $4 - 5.0$, $5 - 7.0$. Solid semi-transparent lines are analytical, dashed lines correspond to single-momentum numerical method. Maxwell distribution is shown by dotted yellow line.

Conclusion

- New representation of Wigner function.
- Harmonical approximation method
- Single momentum method for degenerate Fermi systems

Acknowledgements

- We acknowledge stimulating discussions with Profs M. Bonitz and V .I. Man'ko