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Thermodynamics of the Noninteracting Bose Gas in a Two-Dimensional Box HEQIU LI, QIUJIANG GUO, JI JIANG, Zhejiang University, DAVID C. JOHNSTON, Iowa State Univ — Bose-Einstein condensation (BEC) of a noninteracting Bose gas of N particles in a two-dimensional (2D) box with Dirichlet boundary conditions is studied. Confirming previous work, we find that BEC occurs at finite N at low temperatures T without the occurrence of a phase transition. We further show that the crossover temperature between weak and strong increases in BEC upon cooling is $T_{\rm E} \sim 1/\log(N)$ at fixed area per boson, so in the thermodynamic limit there is no significant BEC in 2D at finite T. Calculations of thermodynamic properties versus T and area A are presented, including Helmholtz free energy, entropy S, pressure p, ratio of p to the energy density U/A, heat capacity at constant area $C_{\rm V}$ and at constant pressure $C_{\rm p}$, isothermal compressibility $\kappa_{\rm T}$ and thermal expansion coefficient $\alpha_{\rm p}$, obtained using both the grand canonical ensemble (GCE) and canonical ensemble (CE) formalisms. The GCE formalism gives acceptable predictions for S, p, $p/(U/A)$, $\kappa_{\rm T}$ and $\alpha_{\rm p}$ at large N, T and A, but fails when N is small or BEC is significant, whereas the CE formalism gives accurate results even at low T and/or A where BEC occurs.

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