Ground-State Energy of a Weakly Interacting Bose Gas: Calculation Without Regularization

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The textbook calculation of the ground-state energy of a dilute gas of Bose particles is examined in detail, and certain mathematical inconsistencies are pointed out. On the basis of this analysis, a refined approach suitable for soft interaction potentials which lend themselves to a low-order Born approximation is developed. This procedure emphasizes the low-density character of the resulting formula for the ground-state energy, and avoids all divergent expressions at intermediate stages of the computation. It is stressed that the standard Bogoliubov approximation, if not augmented by some additional device, leads to an error which manifests itself already in the lowest order of the density. – PACS 03.75.Hh, 05.30.Jp, 03.65.Nk.

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