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Pseudobosons and quasiphonons: The hidden side of bogoliubov collective excitations

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In a gas of N interacting bosons, Bogoliubov's first step is dropping all the interaction terms between free bosons with moment $\hbar\vec{k} \neq 0$, which leads to the truncated Hamiltonian H_c. Bogoliubov's second step (Bogoliubov Canonic Approximation) is approssimating H_c with a bi-linear canonic form H_{BCA} in the creation/annihilation operators, which can be diagonalized by the well known Bogoliubov transformations. All this leads to the current notion of *quasiphonons*, i.e. collective bosonic excitation, with wave-like character (at low k), each carrying a finite moment $\hbar\vec{k}$. Here we show what happens when H_c is diagonalized *exactly*. The resulting eigenstates $|S,\vec{k},\eta\rangle$ depend on two discrete indices $S, \eta=0,1,...$ where η numerates the quasiphonons carrying a moment $\hbar\vec{k}$, responsible for transport or dissipation processes. S, in turn, numerates a ladder of vacua $|S\vec{k}0\rangle$, with increasing equispaced energies, formed by boson pairs with opposite moment. Passing from one vacuum to another $(S \to S \pm n)$, results from creation/annihilation of new *momentless* collective excitations, reminiscent of bosonic cooper pairs, that we call pseudo-bosons. Exact quasiphonons originate from one of the vacua by creating an asymmetry in the number of opposite moment bosons. The well known Bogoliubov quasiphonons (QPs) are shown to coincide with the exact eigenstates $|0,\vec{k},\eta\rangle$, i.e. with the QPs created from the lowest-level vacuum (S=0). All this is discussed, in view of existing or future experimental observations of what we call the hidden side of Bogoliubov collective excitations (CEs), i.e. the pseudobosons.

Biography

Loris Ferrari is graduated in Physics at the University of Bologna, with highest praise. He was awarded with Guglielmo Marconi prize in 1974. He became Assistant of Analytical Mechanics at University of Ferrara (Italy). He became Associate Professor of Condensed Matter Physics in 1981. Since 1985 he held a number of courses in the field of condensed matter at the Department of Physics of the University of Bologna. His research work was initially concerned with glasses and glass transition. In this period he cooperated with Sir N F Mott and W A Phillips of the University of Cambridge. Then he worked in the field of renormalization group theory and non autonomous quantum systems. At present, he works on ultracold bosonic systems and superfluidity. He has published about 80 papers in reputated scientific reviews.

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