**Entanglement and Spin Squeezing in Systems of Identical Bosons**

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Quantum entanglement is treated for identical particle systems based on requiring the density operator to satisfy the symmetrisation principle (SP) and to comply with super-selection rules (SSR) prohibiting states with coherences between differing total particle numbers [1]. The subsystems are distinguishable modes [2], and for non-entangled states the subsystem density operators also satisfy the SP and SSR forbidding coherences between differing subsystem particle numbers [3], [4] - in contrast to other approaches [5]. Other approaches are also considered, including treating labeled identical particles as subsystems. We consider two mode $(a, b)$ entanglement for massive bosons, showing (see [4]) that spin squeezing in any spin component $\hat{S}_x = (\hat{b}^\dagger \hat{a} + \hat{a}^\dagger \hat{b})/2$, $\hat{S}_y = (\hat{b}^\dagger \hat{a} - \hat{a}^\dagger \hat{b})/2i$ and $\hat{S}_z = (\hat{b}^\dagger \hat{b} - \hat{a}^\dagger \hat{a})/2$ and a simple correlation test $|\langle \hat{a}^m (\hat{b}^\dagger)^m \rangle|^2 > 0$ for $m = 1, 2, ..$ are new sufficiency tests for mode entanglement. Proofs of spin squeezing tests [6] based on ignoring the SP are now superceded. Previous spin squeezing related tests for entanglement in two mode systems, such as [7] $\langle \Delta \hat{S}_x^2 \rangle + \langle \Delta \hat{S}_y^2 \rangle < \frac{1}{2} \langle \hat{N} \rangle$ and strong correlation tests [7], [8] $|\langle \hat{a}^m (\hat{b}^\dagger)^m \rangle|^2 > \langle (\hat{a}^\dagger)^m \hat{a}^m (\hat{b}^\dagger)^m \hat{b}^m \rangle$ for $m = 1, 2, ..$ , in which the subsystem particle number SSR is ignored, still apply. For relative phase eigenstates [9], the new spin squeezing test for entanglement is satisfied (for principle spin operators and new modes), whilst the previous test above is not. We show that a simple two mode interferometer can be used to measure the quantities involved in all the spin squeezing and correlation tests, and then examine key experimental results [10], [11] aimed at demonstrating entanglement in two mode systems.

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