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Composite-fermionization of rapidly rotating bosons in two dimensions[1]

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The non-perturbative effect of interaction can sometimes make interacting bosons behave as free fermions. The system of neutral bosons in a rapidly rotating atomic trap is equivalent to charged bosons coupled to a magnetic field, which has opened up the possibility of fractional quantum Hall effect like physics for bosons interacting with a short range interaction. Motivated by the composite fermion theory of the fractional Hall effect of electrons, we test the idea that interacting bosons map into non-interacting spinless fermions carrying one vortex each, by comparing wave functions incorporating this physics with exact wave functions available for systems containing up to 12 bosons. We find that the analogy of interacting bosons at "filling factors" $\nu = n/(n+1)$ with non-interacting fermions at $\nu^* = n$ provides a good account of the ground state as well as the low-energy excited states for small n, but interactions between fermions become increasingly important with increasing n. At $\nu = 1$, which is obtained in the limit $n \to \infty$, the composite-fermionization overcompensate for the repulsive interaction between bosons, producing an attractive interactions between composite fermions, resulting in a paired state.

[1]In collaboration with C.-C. Chang, N. Regnault, and T. Jolicoeur.