Coexistence of two kinds of superfluidity in Bose-Hubbard model with density-induced tunneling

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With use of the U(1) quantum rotor method [1] in a path integral effective action formulation and S=1 pseudospin mapping [2], we have analytically confirmed the mathematical similarity of the phase Hamiltonian and the extended Bose-Hubbard model with density-induced tunneling. Moreover, we have shown that the latter model exhibits two coexisting (single-particle and pair) superfluid phases. Phase separation of the two has also been confirmed, determining that there exists a range of coefficients in which only pair condensation, and not single-particle superfluidity, is present.

References:
[1] T. P. Polak and T. K. Kopeć, Physical Review B 76 (2007), 10.1103/PhysRevB.76.094503
[2] T. K. Kopeć, Phys. Rev. B 70, 054518 (2004)