BEC of Non-Equilibrium Quasiparticles in 3He and Beyond

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Bose-Einstein condensation (BEC) of excitations whose number is not conserved is presently one of the debated phenomena of condensed matter physics. In thermal equilibrium the chemical potential of excitations vanishes and, as a result, their condensate cannot not form as an equilibrium state. BEC of excitations may exist only as a dynamic non-equilibrium phenomenon, when BEC is either decaying with time, or persists as a steady state in which the decay of the number of excitations is compensated by pumping of new excitations. The BEC of excitations was first discovered for magnons in superfluid ^{3}He-B and later observed in other systems (different phases of magnon BEC identified in ^{3}He liquids including those formed in magnetic traps, magnon BEC in YIG; polariton and photon BEC, etc.). The BEC of magnons is manifested as the spontaneous phase-coherent precession of spins and is accompanied by superfluidity in the magnetic subsystem of a condensed matter – spin superfluidity. The observed signatures of spin superfluidity include: spin supercurrent transporting the magnetization on a macroscopic distance more than 1 cm long; spin current Josephson effect which shows interference between two condensates; spin current vortex – a topological defect analogous to a quantized vortex in superfluids; Goldstone modes of the broken $U(1)$ symmetry – phonons of the magnon system; etc. [1]

[1]Yu.M. Bunkov, G.E. Volovik, Spin superfluidity & magnon BEC, arXiv:1003.4889.