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Spin Superfluidity and Magnone BEC in He-3[1]

YURY BUNKOV, Institut Neel, Grenoble

The spin superfluidity – superfluidity in the magnetic subsystem of a condensed matter – is manifested as the spontaneous phase-coherent precession of spins first discovered in 1984 in ^{3}He-B. This superfluid current of spins – spin supercurrent – is one more representative of superfluid currents known or discussed in other systems, such as the superfluid current of mass and atoms in superfluid ^{4}He; superfluid current of electric charge in superconductors; superfluid current of hypercharge in Standard Model of particle physics; superfluid baryonic current and current of chiral charge in quark matter; etc. Spin superfluidity can be described in terms of the Bose condensation of spin waves – magnons. We discuss different states of magnon superfluidity with different types of spin-orbit coupling: in bulk ^{3}He-B; magnetically traped "Q-balls" at very low temperatures; in ^{3}He-A and ^{3}He-B immerged in deformed aerogel; etc. Some effects in normal ^{3}He can also be treated as a magnetic BEC of fermi liquid. A very similar phenomena can be observed also in a magnetic systems with dinamical frequensy shift, like $MnC0_3$. We will discuss the main experimental signatures of magnons superfluidity: (i) spin supercurrent, which transports the magnetization on a macroscopic distance more than 1 cm long; (ii) spin current Josephson effect which shows interference between two condensates; (iii) spin current vortex – a topological defect which is an analog of a quantized vortex in superfluids, of an Abrikosov vortex in superconductors, and cosmic strings in relativistic theories; (iv) Goldstone modes related to the broken $U(1)$ symmetry – phonons in the spin-superfluid magnon gas; etc. For recent review see Yu. M. Bunkov and G. E. Volovik J. Phys. Cond. Matter. **22**, 164210 (2010)

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