Spatio-temporal dynamics of magnon BEC at room temperature

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In my talk I will address Bose-Einstein condensation of magnons in a quasi-equilibrium gas of magnons parametrically pumped in a high-quality yttrium-iron garnet (YIG) films. The energy exchange of pumped magnons with different subsystems of YIG leads to the formation of the room-temperature magnon Bose-Einstein condensate (mBEC). mBEC is an excellent model system for investigation of macroscopic quantum phenomena at room temperature. On one hand, using locally applied magnetic field, we can disturb and govern the condensate. On the other hand, by means of Brillouin light scattering spectroscopy we are able to record the local density of the condensate with sub-micrometer spatial- and 5-ns temporal resolutions.

In particular, I will present three recently discovered phenomena:

a) **Second sound**

Second sound waves were coherently excited by a spatially non-uniform radio-frequency magnetic field of the frequency f_{rf}=0.5-10 MHz, created by a long, stripe-shaped conductor. The resulting modulation of the total magnetic field acts as a time-dependent potential, causing an oscillation of the magnon density in the vicinity of the conductor, which, in turn, excites waves of magnon density (magnonic second sound). We have investigated the dependence of the sound velocity on its wavevector and have found a linear dispersion law, with the speed of sound being dependent on the applied magnetic field

b) **Magnon laser**

We experimentally demonstrate a magnon laser based on mBEC brought into motion by using a time-dependent spatially inhomogeneous magnetic field. We show that the application of a short field pulse results in a formation of a condensate cloud moving with the constant velocity of 930 m/s for the used parameters of the experiment. The number of magnons building the cloud does not change during propagation, which is reminiscent of the magnon superfluidity.

c) Lateral transport in inhomogeneous potentials

Since magnons are believed to have attractive interaction with each other, mBEC should be fundamentally unstable with respect to collapse in the real space, which is in an apparent contradiction with experimental findings. We investigate mBEC placed in inhomogeneous potential well provoking such a collapse. We recorded spatio-temporal lateral dynamics of the condensate and compare experimental findings with the developed theoretical model based on Gross-Pitaevskiy equation. We directly demonstrate an attractive interaction of magnons and found that the effective time, describing the relaxation of linear momentum of the condensate is surprisingly long - about 10 μs, which is much longer that the magnon lifetime in YIG due to spin-lattice relaxation, (< 1μs), which might also indicate the onset of magnon superfluidity