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NATO Advanced Research Workshop

RPTU

Functional Spintronic Nanomaterials for Radiation Detection and Energy Harvesting

NATO OTAN This workshop is supported by: The NATO Science for Peace and Security Programme

Bose–Einstein condensation of magnons in nanoscaled devices

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Bose–Einstein condensation (BEC) is a fundamental physical phenomenon exhibiting fascinating properties such as superconductivity and superfluidity. Its practical implementation can be divided into two types: BEC is achieved by reducing the temperature in ultracold atomic gases and cryogenic liquids or by an external injection of bosonic quasiparticles. In magnon gas in single-crystal films of yttrium iron garnet (YIG, $Y_3Fe_5O_{12}$), BEC can be obtained even at room temperature by parametric microwave pumping [1, 2]. Such a condensate has significant potential in high-speed and low-energy information processing [3].

The miniaturization of BEC-based devices is crucial for their future applications and opens the way to new BEC methods. For instance, a recently discovered rapid cooling mechanism allows the formation of magnon condensate using short DC electrical pulses that heat microscopic spintronic structures based on nano-thick YIG films [4]. Along with this, the magnon BEC formation due to such spintronic phenomena as the spin Seebeck effect (SSE) [5] and the spin Hall effect (SHE) [6] is of considerable scientific interest.

Here, I present SHE control of magnon BEC induced by the rapid cooling mechanism [7]. By employing a Pt layer sputtered onto the surface of the YIG film as a heater and spin injector, it was possible to significantly enhance or completely suppress the condensation process in the near-threshold regime in the cases of magnon injection or annihilation, respectively.

Reference list

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