Contribution ID: **53** Type: **Poster**

The electric field quantum control of spin-waves dynamics in easy-axis antiferromagnets

Tuesday, 24 September 2024 17:25 (5 minutes)

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Magnetic materials are widely used in current computers and have the potential to expand their applicability [1]. The most important step forpractical applications is understanding how to manipulate spin dynamics in magnetic materials efficiently. One method that has been actively discussed is usingan electric field. It is well known that spin waves with different chirality exist in antiferromagnets, however, in the absence of external influence these spin waves are degenerated. An electric, E, field can split them and manipulate each polarization differently. This phenomenon is an example of a topological effect known asthe Aharonov-Casher effect [2,3]. In the linear order approximation, this effect can be accounted for by adding a term to the system's free energy expression like the Dzyaloshinskii-Moriya interaction.
We present the results on the E-field effect on chirality-dependent spin-waves dynamics in a two-sublattice easy-axis antiferromagnet [4,5]. The research was conducted using a phenomenological approach based on the Landau-Lifshitz-Gilbert equations. It was shown that the electric field can split spin waves of different chirality, and the magnitude of the splitting is proportional to the magnitude of the electric field. This splitting can be further enhanced by applying a magnetic field. More details are provided on the E-field effect on the propagation of spin waves and their damping length. The electric field affects the propagation of the right-handed and left-handed spin waves differently, while a small magnetic field doesn't influence the damping length. These findings could be useful for field-effect transistors or interferrometric devices [6] based on spin waves. Since the application of the electric field is easier than that of a large magnetic field, the Aharonov-Casher effect has great potential for practical applications.
The authors acknowledge the financial support by the STCU, project "Magnetism in Ukraine Initiative", project Agreement No. 9918.

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Session Classification: Poster Session

Track Classification: CONDENSED MATTER PHYSICS