Electrical Control of Quantum Coherent Phenomena in Insulating Antiferromagnets

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Usually, antiferromagnets only function as passive spintronics components. However, antiferromagnets' markedly different properties as compared to ferromagnets make them interesting and attractive in a more dynamic role. Furthermore, in insulators, there are no moving charges involved so that the power reduction can be significant.

Antiferromagnetic insulators couple strongly to electric currents in adjacent normal metals. Therefore, antiferromagnets can fulfill the role as active components in spintronics devices despite their lack of a macroscopic magnetic moment, and even when they are insulating.

We explore routes for electrical control of quantum coherent magnon phenomena in insulating antiferromagnets.

First, we describe the formation of steady-state magnon condensates controlled by a spin accumulation in adjacent normal metals. Spin-transfer by this spin accumulation affects the staggered field of the antiferromagnet. The resulting condensation may occur even at room temperature when the spin transfer to the metal is faster than the relaxation processes in the antiferromagnet.

Second, we will discuss how antiferromagnets may exhibit long-range spin superfluidity in insulators, which studies indicate are good spin conductors. The spin superfluidity can be detected in non-local geometries and can reach several micrometers.