Can electrical signals flow through an insulator?

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Driven by a demand for faster and more effective technologies, the advancement in the electronics industry has grown at a tremendous rate over the past decades. Although electronics is still constantly improving by reaching atomic scales, at the same time it started to face certain problems. There are limits to miniaturization that can be hardly crossed due to the heating of elements at the nanoscale level. The smaller a device gets and the higher operation frequency is required, the more waste heat is generated.

In the search for alternative routes to current technologies, spin waves and their quanta called magnons are being envisioned to address those issues. In the classical sense, they are oscillations of magnetization that can propagate in a form of a wave. Since no translational motion of electrons is necessary for their flow, it is predicted that they can be used for low-power logic applications. Moreover, their operational frequencies cover a broad range from hundreds of megahertz up to terahertz which is suitable for high-speed communication technology.

Spin waves, to be useful for data processing, should be properly excited, detected, and controlled in specifically designed waveguides. Almost a perfect medium for spin-wave propagation is Yttrium Iron Garnet ($Y_3Fe_5O_{12}$) in the single crystal phase. Furthermore, this material is an insulator. It means that there is no waste heat coming from electron scattering processes. During the talk, the experimental results of spin-wave propagation in such material will be presented. From an electrical point of view, with the help of microwave currents, the transmission of the electric signal via magnetic excitations will be shown.