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JINR-India collaborative investigations of Josephson nanostructures

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We present unique results of collaborative investigations of Josephson nanostructures obtained in recent years.We have studied a Josephson junction involving a Weyl and a multi-Weyl semimetals separated by a barrier created by putting a gate voltage over the Weyl semimetal.It was shown that the product of the critical current on the normal-state resistance for such junctions, has a universal value independent of the barrier potential, which is a consequence of change in topological winding number across the junction. We have investigated the perspectives of magnetization control in superconductor / ferromagnet / superconductor (S/F/S) Josephson junctions on the surface of a 3D topological insulator hosting Dirac quasiparticles. It was demonstrated that this can lead to splitting of the ferromagnet's easy-axis which can lead to stabilization of an unconventional four-fold degenerate ferromagnetic state. We have studied a magnetization reversal by an electric current pulse in a superconductor / insulating ferromagnet / superconductor Josephson junction placed on top of a 3D topological insulator (TI). It was demonstrated that strong spin-momentum locking in the TI surface states provides a possibility of efficient reversal of the magnetic moment by current pulse with amplitude lower than the critical current, that results in strongly reduced energy dissipation. We have demonstrated that a current sweep along IV-characteristic of the S/F/S ϕ_0 junction may lead to regular magnetization dynamics with a series of specific phase trajectories. It was shown that an external electromagnetic field allows to control the magnetic moment dynamics and can lead to a topological transformation of precession trajectories.

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