Transport investigation of two-dimensional materials for topological superconductivity

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We develop in the following experimental investigations of two material candidates to achieve topological superconductivity: SiGe heterostructures and InAs/GaSb bilayers.

Ge one-dimensional nanowires with large spin-orbit could host robust helical states and form very good contacts with metals and superconductors. Starting from nominally undoped SiGe/Ge/SiGe quantum-well heterostructures grown by reduced pressure chemical vapor deposition, we fabricated quantum wires through a top-down approach. One-dimensional (1D) ballistic hole transport was clearly revealed by conductance quantization at 0.3 K [Fig. 1a] [1]. Next, we fabricated Ge 2DHG device with aluminum contacts to realize Josephson field effect transistors (JoFET) by proximity effect. Measurement at 16 mK revealed a gate tunable supercurrent for channel length up to 800nm [Fig. 1b].

It has been predicted that InAs GaSb heterojunctions can be turned into a topological regime showing the quantum spin Hall behavior due to unusual band alignment. However, despite that edge states transport has been probed experimentally, uncertainties remain about the topological nature of this material. We present here preliminary results on fabrication and transport measurement of InAs/GaSb bilayers. Our objective is to conclude about their topological nature by searching for edge states and channel length independent conductance quantization in a diversity of sample geometries.

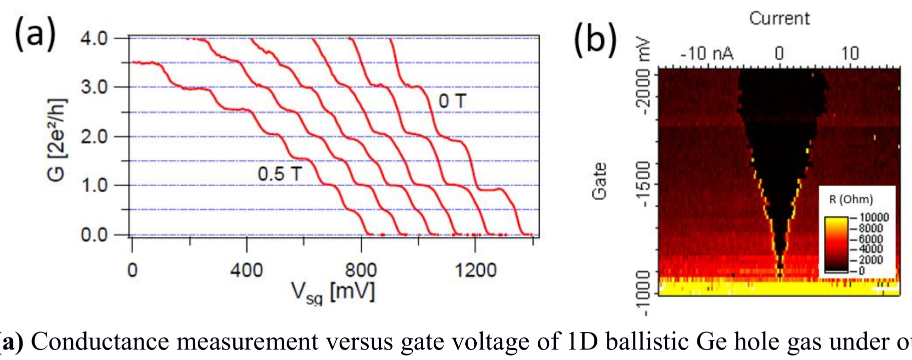

Figure 1: (a) Conductance measurement versus gate voltage of 1D ballistic Ge hole gas under out-of-plane magnetic field. **(b)** Resistance measurement of Ge JoFET versus current and gate voltage showing a superconducting transition.

[1] R. Mizokuchi et al., "Ballistic one-dimensional holes with strong g-factor anisotropy in germanium" arXiv:1804.04674.