北京大学量子材料科学中心

Seminar

Majorana Fermions in Ballistic Nanowire Devices

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Venue: Room w563, Physics building, Peking University

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Majorana fermions are quasiparticles predicted to show non-Abelian exchange statistics, and can be used for topological quantum computing. Following proposals for their detection in a semiconductor nanowire coupled to a superconductor[1,2], several electron transport experiments reported characteristic Majorana signatures[3-7]. The prime challenge to strengthen these signatures unravel the predicted topological properties of Majoranas is to reduce the remaining disorder in this hybrid system. Disorder not only mimics Majorana signatures, but also results in a soft induced superconducting gap. This soft-gap renders the topological properties experimentally inaccessible. Here[8], by eliminating disorder in our Majorana devices, we report ballistic transport behavior based on observation of a quantized conductance for normal carriers and a strong enhancement of conductance resulting from Andreev reflection. Gate tuning the device to a tunnel probe reveals an induced hard-gap. Spatial control of carrier density using local gates and an application of a magnetic field induces a zero bias peak that is rigid over large region in the parameter space of gate voltage and magnetic field. The extracted parameter region of this zero bias peak matches with the Majorana topological phase diagram. We of no theoretical framework other than those based on Majorana fermions that is consistent with our observations.

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[3] V. Mourik, et al, Science 336, 1003-1007 (2012)

[4] M. Deng, et al, Nano Lett. 12, 6414-6419 (2012)

[5] A. Das, et al, Nat. Phys. 887-895 (2012)

[6] H. Churchill, et al, Phys. Rev. B 87, 241401 (2013)

[7] A. Finck, et al, Phys. Rev. Lett. 110, 126406 (2013)

[8] H. Zhang, et al, arXiv:1603.04069

Hao Zhang received his B.S. in Physics from Peking University in 2010. He obtained his PhD in Physics (Albert Chang group) from Duke University in 2014, working on electron correlation effect in quantum point contacts. He started working as a postdoc in Leo Kouwenhoven group at TU Delft since 2014. His current research focuses on Majorana Fermions in hybrid superconductor-semiconductor nanowire systems.