ac Josephson Effect in Finite-Length Nanowire Junctions with Majorana Modes

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In 1937, Majorana proved that the Dirac equation could admit real solutions that describe particles that are their own antiparticle. Importantly, matter and anti-matter are related by a charge conjugation operation so Majorana particles must be charge neutral.

In the first part of the talk, I will present an introduction discussing these concepts in the context of condensed matter where various theoretical proposals have predicted exotic quasiparticule excitations with Majorana character. I will briefly explain the main idea behind these proposals which always involve hybrid systems with a Dirac-like material, such as a topological insulator or a semiconductor with strong spin-orbit, in contact with a superconductor. This second ingredient is crucial as charge neutral fermionic excitations, electron-hole mixtures, in the superconductor may appear at zero energy as Majorana bound states (MBS).

It has been predicted that the Josephson effect in junctions of such hybrid systems could provide a strong experimental signature of Majoranas, owing to a 'fractional' phase dependence which originates from the nontrivial fusing of these MBS across the junction. However, I will argue that the equilibrium supercurrents of realistic, finite-length, junctions are always trivial. The ac Josephson current, on the other hand, retains its anomalous components during long-lived transients in the topological phase. Hence, transient spectral properties may be effectively used to detect Majorana states.

A coffee break will be served at 11h00. The seminar will be given in English.