Topological superconductivity and Majorana pair in gold

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A Majorana pair is a Fermionic state separated in space into two parts known as Majorana zero modes (MZM): each of the pair is an antiparticle of itself, while the pair is required to always appear together. We investigated this phenomenon based on the theoretical prediction by A. Potter and P. Lee that gold with its large Rashba spin-orbit split Shockley surface states could host the MZM. This is a classic example of surfaces and interfaces playing critical role displaying the topologically driven nontrivial quantum phenomena. The theory was that under the right conditions, a (111) crystalline superconducting gold nanowire surface could display MZM in the presence of sufficient Zeeman field. Experimentally optimizing a novel stable heterostructures, to achieve the needed three interactions, we observed the MZM pair utilizing a low temperature, high vector field STM. With this two-dimensional stable metal platform of gold with induced superconductivity, one could envision a novel approach to building a highly scalable non-local topological qubits, that are intrinsically fault-tolerant. In order to reach this goal, a number of challenges need to be overcome.

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Supported by John Templeton Foundation Grants No. 39944 and 60148, ONR Grants N00014-16-1-2657, N00014-20-1-2306 and NSF DMR 1700137, NSF C-Accel Track C Grant No. 2040620

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