Quantum computing now one step closer with defect-free logic gate

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What does hair styling have in common with quantum computing? The braiding pattern has inspired scientists as a potential new approach to quantum calculation. The idea is to rely on a network of intersecting chains, or nanowires, containing two-dimensional quasi-particles. The way these quasi-particles evolve in space time produces a braid-like pattern. These braids could then be used as the logic gate that provides the logical function required for calculations in computers. Due to their tight assembly, such braids are much more difficult to destabilise and less error-prone. Yet, local defects can still arise along nanowires.

In a study published in *EPJ B*, Jelena Klinovaja from the University of Basel, and Daniel Loss from Harvard University, Cambridge, MA, USA, identify the potential sources of computer errors arising from these defects.

Scientists have now created a 2D network of intersecting nanowires within which quasi particles create braided patterns in space time; these are called Majorana Bound States, or MBSs. In this context, the electrons' inner degree of freedom, called spin, interacts with their own movement, leading to spin-orbit interaction (SOI). The trouble is that the SOI direction is not uniform in such braided networks, resulting in local defects along nanowires and at nanowire junctions.

The authors therefore focus on how such defects arise in relation to the SOI direction. They show that the nanowires, in which the SOI changes direction, host novel states referred to as Fermionic Bound States

(FBSs). These FBSs, the study shows, occur simultaneously with Majorana fermions, albeit at different locations in the network. FBSs could therefore destabilise quantum information units, or qubits, and accelerate their loss of coherence, thus becoming a source of errors in quantum computing. The authors believe that such new knowledge of the characteristics of FBSs can help identify the best remedy to avoid their negative effects on MBSs.

More information: "Fermionic and Majorana Bound States in Hybrid Nanowires with Non-Uniform Spin-Orbit Interaction," *Eur. Phys. J.* B 88: 62, DOI: 10.1140/epjb/e2015-50882-2

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