Chiral effects for quantum technologies

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Chirality, the property of systems having mirror-image patterns that cannot be superimposed onto each other, can play a crucial role in a variety of quantum technologies. In the realm of quantum computing, a chiral qubit has been proposed based on chiral fermions[1]. Additionally, chiral induced spin selectivity has been proposed to initialize, process and readout the states of molecular spin qubits and qudits[2]. Chiral light-matter interactions have been investigated for their potential in high-precision measurements and imaging techniques as well as for the design of quantum network[3]. In quantum communications, chiral effects can also be harnessed to improve the security and efficiency of quantum information processing. Here, we introduce the concept of spin-orbital chiral fermions[4] and discuss their basic properties for the design of chiral light-matter interaction for quantum applications in sensing and communication. Hence, we present how chirality affects the Cooper pairing by leading to Cooper pairs with net orbital polarization. The emerging superconducting phase texture allows the design Josephson junction to exploit the tunneling of Cooper pairs with net orbital polarization to achieve physical configurations for 0- π qubit[5]. We examine the benefits of chiral superconductor-based qubits by exploring the resulting qubit relaxation time and coherent time.

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