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(54) **TOPOLOGICALLY PROTECTED QUANTUM CIRCUIT WITH SUPERCONDUCTING QUBITS**

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(57) **ABSTRACT**

There is described herein a topologically protected quantum circuit with superconducting qubits and method of operation thereof. The circuit comprises a plurality of physical superconducting qubits and a plurality of coupling devices interleaved between pairs of the physical superconducting qubits. The coupling devices comprise at least one φ-Josephson junction, wherein a Josephson phase φ_0 of the φ-Josephson junction is non-zero in a ground state, the coupling devices have a Josephson energy $E_{J\varphi}$, the physical superconducting qubits have a Josephson energy E_{Jq}, and the circuit operates in a topological regime when

$$\frac{E_{Jq}}{2} > -E_{J\varphi}\cos\varphi_0 > \frac{E_{Jq}}{3}.$$