PHYSICS
ARTS AND SCIENCES

SUMMER RESEARCH OPPORTUNITIES FOR UNDERGRADUATE students

FOR APPLICATION YEAR: 2026

PROJECT TITLE: Designing a Two-Qubit Topological Quantum Computer

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Project Description

Quantum computation is poised to revolutionize technology, offering computational power far beyond the capabilities of classical computers. While classical computers store information in bits (0 or 1) and perform operations on pairs of bits, quantum computers use qubits—quantum states that can represent complex superpositions of 0 and 1. This unlocks an inherent parallel processing and computational capacity through quantum phenomena such as superposition and entanglement.

Despite its promise, quantum computing faces significant challenges. Qubits are highly sensitive to environmental noise, leading to decoherence, and gate operations often introduce errors. These obstacles hinder the scalability of quantum computers. A groundbreaking solution involves fractionalizing qubits into anyons, exotic quasiparticles that are kept apart. By encoding information non-locally in these anyons, we can mitigate the effects of local noise, enabling the creation of robust, topologically protected qubits. Computations are performed through braiding operations, where anyons are exchanged in space, leveraging the intrinsic topology for error resilience.

This theoretical project focuses on designing a simple two-qubit topological quantum computer using Kondo anyons, a novel and unexplored avenue in the field. The project offers an exciting opportunity to contribute to cutting-edge research in topological quantum computation.

Eligibility and Skills:
1. Strong foundation in linear algebra and quantum mechanics.
2. Proven proficiency in computer coding (MATLAB, Python or C++).
3. Curiosity and enthusiasm for exploring innovative ideas in quantum science.
4. Experience with numerical simulations is a plus.

Apply now to join this cutting-edge research!