Opportunity Title: Semiconductor-inspired superconducting quantum computing
Opportunity Reference Code: IC-16-35

Organization Office of the Director of National Intelligence (ODNI)

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Complete your application – Enter the rest of the information required for the IC Postdoc Program Research Opportunity. The application itself contains detailed instructions for each one of these components: availability, citizenship, transcripts, dissertation abstract, publication and presentation plan, and information about your Research Advisor co-applicant.

Application Deadline 4/15/2016 6:00:00 PM Eastern Time Zone

Description The goal of this effort is to advance technical progress in the understanding, design, and operation of superconducting circuits for quantum computing. Superconducting circuits offer tremendous design flexibility in the quantum regime culminating most recently in the demonstration of few qubit systems supposedly approaching the threshold for fault-tolerant quantum information processing. Competition in the solid-state comes from semiconductor qubits, where nature has bestowed some very useful properties which can be utilized for spin qubit based quantum computing. We recently proposed that selective design principles deduced from spin-based systems could be used to advance superconducting qubit science [http://arxiv.org/abs/1507.07923]. Our results show that this design philosophy holds promise, enables microwave-free control with unexpectedly low overhead in terms of physical two-qubit gates, and offers a pathway to future qubit designs with new capabilities such as with higher fidelity or, perhaps, operation at higher temperature. The approach is especially suited to qubits based on variable super-semi junctions. In addition to continued theoretical consideration, this proposal would benefit from experimental corroboration and further development with respect to practical implementation. Here we seek experimental proposals to address these goals.

Example Approaches:

The principle aim of this research is to develop superconducting circuits that advance the state of the art in quantum information processing and in particular take advantage of design principles derived from spin-based semiconductor qubit systems. Attention could be placed on the experimental demonstration of systems that offer new functionality in control (e.g., microwave-free), intrinsic quantum properties (e.g., long lifetime qubits), and/or ability to operate in unexplored but technologically useful operating regimes. Proposals that do not follow the currently perceived paradigm for superconducting quantum computing are encouraged over conventional, iterative approaches. Proposals should lay out a technical plan advancing the state-of-the-art in these systems along

with associated milestones and the questions that are expected to be answered.

Proposals should be focused on experimental aspects of superconducting devices. As such, a successful proposal might address one or more of the following questions or goals:

- Can superconducting qubit systems benefit from design principles based on spin qubits?
- Can encoded qubits and encoded gates using state-of-the-art tunable superconducting circuits be realized? What is the actual overhead in their operation fidelity and time?
- Can a superconducting qubit (encoded or otherwise) be initialized or read out with high fidelity without the use of microwaves?
- What are better practical realizations of superconducting qubits that follow these design principles?
- How high a temperature can an appropriately designed superconducting qubit operate at and still be a functioning quantum information processing device?
- Do superconducting-semiconductor junctions offer special advantage for superconducting qubit operation in-line with the above design approaches?
- What are alternative approaches to flux-based tunability in superconducting qubits?

Eligibility Requirements

- **Citizenship:** U.S. Citizen Only
- **Degree:** Doctoral Degree.
- **Discipline(s):**
  - **Business** (11 👁)
  - **Chemistry and Materials Sciences** (12 👁)
  - **Communications and Graphics Design** (6 👁)
  - **Computer, Information, and Data Sciences** (16 👁)
  - **Earth and Geosciences** (21 👁)
  - **Engineering** (27 👁)
  - **Environmental and Marine Sciences** (14 👁)
  - **Life Health and Medical Sciences** (45 👁)
  - **Mathematics and Statistics** (10 👁)
  - **Other Non-Science & Engineering** (13 👁)
  - **Physics** (16 👁)
  - **Science & Engineering-related** (1 👁)
  - **Social and Behavioral Sciences** (28 👁)