Opportunity Title: Noise in Superconducting Qubits
Opportunity Reference Code: IC-18-28

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.

Additional information about the IC Postdoctoral Research Fellowship Program is available on the program website located at: https://orau.org/icpostdoc/.

If you have questions, send an email to ICPostdoc@orau.org. Please include the reference code for this opportunity in your email.

Application Deadline 3/12/2018 11:59:00 PM Eastern Time Zone

Description **Research Topic Description, including Problem Statement:**

- Superconducting circuitry is a leading approach for the implementation of a quantum computer due to ease of fabrication, fast processing power, and simple coupling schemes. However, superconducting qubit devices suffer from unidentified noise sources that typically limit their quantum state lifetimes (i.e., coherence time) to < 10 micro-seconds for standard magnetic-field tunable qubit devices thus limiting achievable qubit gate fidelities. This noise, which can be both magnetic-field and charge-like in character, is thought to be caused by microscopic defects or contamination in the materials making up the qubit device. Hence, a major topic of research in this field aims to identify and remove the sources of these noises.
- There are two main qubit performance parameters: the energy relaxation time (T_1), and the phase relaxation time (T_2). Qubit energy relaxation is limited by dielectric defects that couple resonantly to microwave electric fields in the device while phase relaxation could be due to magnetic defects or thermal fluctuations that induce uncontrolled variations of the qubit operating frequency. Recently, it has been shown that surface adsorbates are a dominant contributor to both qubit energy relaxation and dephasing and that appropriate surface treatments can lead to reductions in both dielectric noise and magnetic flux noise.
- The goal of this topic is to identify, quantify, eliminate, and/or circumvent noise sources that effect either T_1 or T_2 of superconducting qubit devices thus boosting achievable qubit gate fidelities.

Example Approaches:

There are three complementary research paths that could eliminate and/or circumvent noise sources after identification:

- Improve materials, fabrication steps, handling, and/or cleaning processing to remove identified noise. For example, the recently identified adsorbates mentioned previously, could be removed by novel surface treatment techniques. In particular, some research teams are exploring UV radiation and/or vacuum encapsulation as methods to remove this or similar sources of contamination.

- An alternative approach is to design qubit circuits which are immune to identified noise sources. For example, fluxonium qubits have been designed to suppress T_1 processes with great success reaching lifetimes of up to 8 ms. However, work remains to make these, or related designs, similarly immune to T_2 noise processes.
- A third approach involves engineering the qubits to be sensitive to one dominant source of noise which can be then error-corrected using low-overhead techniques. For example, superconducting resonator-based qubits encoded into so-called “Cat-states” have been recently developed. These states are primarily sensitive to photon loss which can be measured without destroying the quantum information. These measurements can then be used for error correction purposes. Work remains to make this approach fault-tolerant and to develop gates protocols compatible with this novel qubit encoding scheme.

Qualifications

Postdoc Eligibility

- U.S. citizens only
- Ph.D. in a relevant field must be completed before beginning the appointment and within five years of the application deadline
- Proposal must be associated with an accredited U.S. university, college, or U.S. government laboratory
- Eligible candidates may only receive one award from the IC Postdoctoral Research Fellowship Program.

Research Advisor Eligibility

- Must be an employee of an accredited U.S. university, college or U.S. government laboratory
- Are not required to be U.S. citizens

Eligibility Requirements

- **Citizenship:** U.S. Citizen Only
- **Degree:** Doctoral Degree.
- **Discipline(s):**
  - **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** (5)
  - **Physics** (16)
  - **Science & Engineering-related** (1)
  - **Social and Behavioral Sciences** (28)