Opportunity Title: Quantum state transduction
Opportunity Reference Code: ICPD-2019-17

Organization Office of the Director of National Intelligence (ODNI)

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How to Apply

Create and release your Profile on Zintellect – Postdoctoral applicants must create an account and complete a profile in the on-line application system. **Please note: your resume/CV may not exceed 2 pages.**

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://orise.orau.gov/icpostdoc/index.html.

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

Application Deadline 3/1/2019 6:00:00 PM Eastern Time Zone

Description

Research Topic Description, including Problem Statement:

- Superconducting circuitry is a leading approach in quantum information science due to ease of fabrication, fast processing power and simple coupling schemes. However, these devices operate at microwave frequencies and thus must reside at milli-kelvin temperatures inside a dilution refrigerator in order to preserve their quantum information. However, quantum information is best sent over long distances using optical photons due to their immunity to thermal fluctuations at room temperature. Hence, in order enable long distance communication between remote microwave quantum nodes, high efficiency quantum state transduction from microwave to optical wavelengths is required with high rep-rates and low added noise. This capability is particularly relevant for future quantum networks which could have applications for remote quantum sensing, secure communications and distributed quantum computing.
- The goal of this topic is to work towards the transfer of quantum information from a microwave photon into an optical photon and visa-versa with high fidelity. The ultimate objective is to entangle two remote superconducting qubits via optical photons.

Example Approaches:

- There are many approaches currently being explored for microwave-to-optical quantum state transduction purposes. Example approaches include:
  - Electro-optics: Traditionally microwave signals are converted into optical signals using electro-optics. However this process is very inefficient and thus not suitable for quantum applications. To overcome these limitations researchers are working towards resonant electro-optic devices coupled

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with optical pumping schemes. (Ref: Tsang, PRA 81; 063837, 2010)
- Opto-mechanical: Mechanical devices can couple to both microwave and optical resonant cavities and can serve as a low-noise transduction element between these two systems. (Nature Phys 10, 321, 2014)
- Rare-earth crystal: Rare-earth doped crystals can have both narrow linewidth microwave and optical transitions. When coupled to a microwave and optical cavity, efficient conversion could be possible (PRL 113, 203601 (2014))
- Neutral atoms: A single atom in a Rydberg state has a large enough dipole moment to couple to a superconducting resonator. This state can then be coupled to an optical transition via laser control and thus could be used for quantum state transduction (PRA, 96, 013833, (2017))

Relevance to the Intelligence Community:

- Long distance quantum state transfer is an enabling technology for future quantum networks. Such networks could have many potential applications relevant to the IC community including remote quantum sensing, secure quantum communications and distributed quantum computing.

Key Words:

Quantum computing, quantum communications; quantum networking; superconducting qubits, photons, qubits, microwave, optical

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 👁)

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- **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 👁)