Title: Los Alamos National Laboratory Quantum Overview

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Intended for: Report

Issued: 2020-09-15

Los Alamos National Laboratory Quantum Overview

Los Alamos supports the National Quantum Initiative and the Laboratory's national security mission by tackling quantum science and technology challenges. Los Alamos is a strategic partner of the Quantum Science Center hub and leads the simulations and algorithms thrusts.

Computing: Los Alamos efforts focus on quantum algorithms to provide efficient methods for advanced computation, including simulation of quantum systems and other algorithms providing computation speedups relative to classical computers. Quantum-related work at Los Alamos includes:

- Algorithms for quantum simulation with optimal error behavior
- Robust methods for combating errors on noisy quantum computers
- Quantum simulation methods for noisy quantum computers

Sensing: Los Alamos efforts in quantum sensing combine technologies for exploiting quantum behavior in ultra-cold atoms with new quantum metrology algorithms to deliver quantum-enhanced inertial force and electromagnetic field sensors. Current areas of interest include:

- High-performance rotation sensors using matter wave circuits
- Algorithms and hardware using quantum discord for sensing beyond standard quantum limits
- Electromagnetic field sensors using cold-trapped Rydberg atoms

Materials: Los Alamos's experimental research and theoretical studies of quantum materials focus on f-electron materials including synthesis, characterization, spectroscopy, cryogenic/dilfridge use, modeling, and prediction. Industry can access expertise and resources through two Los Alamos user facilities:

- The National High Magnetic Field Laboratory provides the world's largest, non-destructive pulsed magnetic fields with access to thermodynamic, transport, optical, and structural techniques.
- The Center for Integrated Nano-Technologies offers state-of-the-art electrical, ultra-fast and quantum optical characterization facilities, and two complementary deterministic quantum-defect implantation facilities.

Communications and Encryption: Los Alamos efforts focus on leveraging quantum mechanical properties to ensure the Nation's communication and critical infrastructures are reliable and secure. Recent work at Los Alamos includes:

- Quantum key distribution and random number generation
- Analysis of system resiliency
- Interoperability of quantum communications via extension of range and link/node security