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RESEARCH & COLLABORATION PROFILE

KEY WORDS: Quantum Sensors, Atom Interferometry, Atomic Optics, Atomic Magnetometry, Laser and Fiber Optics



Research Snapshot. Dr. Lee develops atom-based quantum sensors for inertial and magnetic measurements. His work combines laser cooling and atom interferometry with atomic spectroscopy, laser and fiber optics, and thermal and magnetic modeling. Current research focuses on a single-zone ^{87}Rb atom interferometer and vapor-cell platforms for spin-exchange relaxation-free (SERF) magnetometry.

RESEARCH EXPERTISE

- **Atom interferometry:** Laser cooling, state preparation, Raman interferometry, capture–recapture, and gravity and inertial measurements.
- **Atomic magnetometry:** Optical pumping, Faraday-rotation readout, vapor-cell heating, and magnetic-field control for SERF sensors.
- **Atomic optics and spectroscopy:** Polarization-dependent light–atom interactions, multilevel atomic dynamics, and nonlinear spectroscopy.
- **Laser and fiber optics:** Raman laser phase locking, optical heterodyne detection, fiber interferometry, and polarization stabilization.
- **Modeling and experimental control:** Thermal and magnetic finite-element analysis, Monte Carlo error analysis, FPGA timing, and synchronized data acquisition.

RECENT RESEARCH HIGHLIGHTS

- **Single-zone ^{87}Rb interferometer:** Demonstrated 20 Hz operation with trapping, cooling, Raman interrogation, and detection in a single interaction zone, using capture–recapture scheme for atomic ensemble reuse.
- **SERF sensor heating:** Combined oven design, finite-element simulations, experiments, and Monte Carlo analysis to quantify thermal behavior and magnetic disturbances from fabrication, mounting, and wiring errors.
- **Atomic dynamics and optical stability:** Studied polarization-controlled MOT dynamics and polarization-selective four-wave mixing. Contributed to Raman laser phase locking and active fiber polarization stabilization.

POTENTIAL RESEARCH COLLABORATIONS

Best-fit collaborator areas: atomic physics, optical engineering, sensor systems, and multiphysics design.

- **1. Compact quantum sensors:** Joint development of atom-interferometer-based inertial sensors and optically pumped magnetometers, including packaging and integration.
- **2. Laser and photonic subsystems:** Low-noise Raman sources, frequency and phase stabilization, and stable fiber delivery for atomic experiments.
- **3. Multiphysics sensor design:** Vapor-cell ovens, shielding and compensation coils, and thermal and magnetic optimization.
- **4. Hybrid inertial sensing:** Integration of atom interferometers with classical accelerometers for vibration correction, continuous readout, and long-term bias calibration.

SELECTED RECENT PUBLICATIONS

- **J. Korean Phys. Soc. 88, 303–311 (2026).** Parametric excitation of a cold atom in an optical polarization-modulated magneto-optical trap.
- **Sci. Rep. 15, 24145 (2025).** Error analysis of a heating oven for a spin-exchange relaxation-free magnetometer.
- **Curr. Appl. Phys. 72, 51–55 (2025).** Long-term polarization stabilization of a polarization maintaining fiber via dynamic temperature control.
- **Sci. Rep. 14, 5705 (2024).** Polarization-selective four-wave mixing in a degenerate multi-level system.
- **Curr. Appl. Phys. 51, 29–33 (2023).** Characterization of optical phase-locked two distributed-feedback fiber lasers for ^{87}Rb atom interferometry.

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REPRESENTATIVE RESEARCH FIGURES / SCHEMES

