GEOL MOON, Ph.D.

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RESEARCH & COLLABORATION PROFILE |
KEY WORDS: Quantum Sensing, Atomic Magnetometry, Cold-Atom Inertial Sensors, Quantum Gravimetry, Nonequilibrium and Nonlinear Dynamics

Research Snapshot. Prof. Moon develops atom-based quantum sensing and precision-metrology technologies using alkali-atom vapor cells and laser-cooled neutral atoms. His research spans atomic magnetometry, cold-atom inertial sensing and gravimetry, quantum optics and laser spectroscopy, and nonlinear/non-equilibrium cold-atom dynamics, with applications in biomagnetism, navigation, geophysics, and defense sensing.

RESEARCH EXPERTISE

• Atomic magnetometry: SERF and vapor-cell OPMs, Faraday-rotation detection, magnetic shielding, thermal management, and integrated polarization detection.
• Cold-atom inertial sensing: laser cooling/trapping, Raman-laser systems, atom-interferometric accelerometers, gyroscopes, and gravimeters.
• Quantum optics & spectroscopy: polarization spectroscopy, four-wave mixing, frequency/phase locking, and polarization control.
• Nonlinear cold-atom dynamics: parametric excitation, limit cycles, Hopf bifurcations, and noise-induced switching in MOTs.
• Quantum-sensor engineering: compact vapor-cell ovens, low-magnetic-noise components, photodetectors, and sensor integration.

RECENT RESEARCH HIGHLIGHTS

• Chip-scale OPM detection (Microsystems & Nanoengineering, 2026): packaged in-line polarization-resolved detector for miniaturized optically pumped magnetometers.
• Spatial symmetry-broken atomic magnetometry (Optics Express, 2025): four-wave-mixing magnetometer with ±5 μT linear range and 18.25 kHz bandwidth.
• SERF oven engineering (Scientific Reports, 2025): thermal/magnetic error analysis of a compact non-magnetic vapor-cell oven.
• Cold-atom nonlinear dynamics (2025–2026): parametric excitation, limit-cycle oscillations, and stochastic switching in laser-cooled Rb/Cs systems.

POTENTIAL COLLABORATION RESEARCH

Best-fit collaborator areas: quantum sensing & metrology | atomic/optical physics | inertial navigation | biomagnetism | photonics & sensor hardware
• 1. Quantum magnetometry & biomagnetism: compact OPM heads and arrays, integrated polarization detectors, and low-noise readout for MEG/MCG and precision field sensing.
• 2. Cold-atom inertial sensors: accelerometers, gyroscopes, gravimeters, and hybrid navigation for GPS-denied environments.
• 3. Atomic optics & laser control: compact spectroscopy, frequency/phase locking, fiber-polarization stabilization, and photonic integration.
• 4. Nonlinear atomic systems: driven-dissipative dynamics, parametric resonance, bifurcations, and stochastic switching.

SELECTED RECENT PUBLICATIONS

• Microsystems & Nanoengineering (2026) — Chip-scale packaged in-line polarization-resolved detector for optically pumped magnetometers.
• Optics Express (2025) — Spatial symmetry-broken atomic magnetometry.
• Scientific Reports 15, 24145 (2025) — Error analysis of a heating oven for a spin-exchange relaxation-free magnetometer.
• Current Applied Physics (2025) — Long-term polarization stabilization of a polarization-maintaining fiber via dynamic temperature control.
• Scientific Reports 14, 5705 (2024) — Polarization-selective four-wave mixing in a degenerate multi-level system.
• JOSA B 40, 1735–1741 (2023) — Characterization of a forced damped harmonic oscillator in a MOT of 133Cs atoms.

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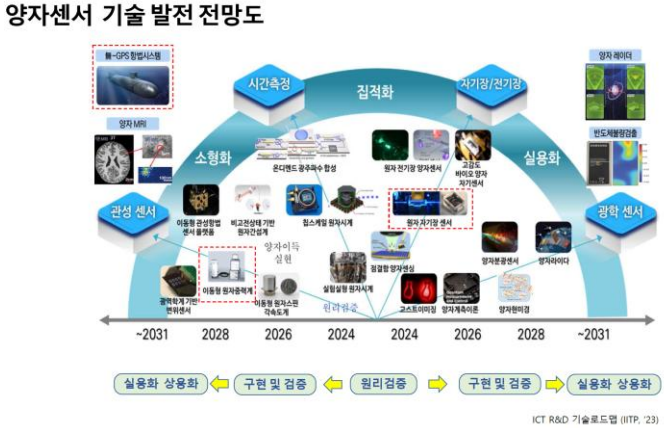
REPRESENTATIVE RESEARCH FIGURES / SCHEMES