

# Gisung Sim

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## Interest Research Areas

Fundamental Physics / Precision Measurement / Quantum Optics / Quantum Metrology / Cavity QED / Quantum Simulation / Quantum Many-Body Physics / Quantum Information Science / and **their applications**

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## Education

**Bachelor of Science in Physics** / Pusan National University  
Mar. 2016 - Feb. 2023, Busan, Republic of Korea  
GPA: 3.70 / 4.00 (major 3.79 / 4.00), Magna Cum Laude, and Dean's List

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## Publications

1. Tentative Title: **Generation and characteristics of a two-mode squeezed state of light with compact diode-laser pumping and electro-optic modulation**  
Gisung Sim, Heewoo Kim, and Han Seb Moon\*  
(expected to submit by early 2024.)
2. Tentative Title: **Quantum-enhanced electrometer based on a Rydberg atom with squeezed light**  
Gisung Sim, Kyungmin Joo, Heewoo Kim, Jinhyuk Bae, and Han Seb Moon\*  
(in preparation)
3. Tentative Title: **Sensitive electric field sensing using a Rydberg atom**  
Kyungmin Joo, Heewoo Kim, Jinhyuk Bae, Gisung Sim, Han Seb Moon\*  
(to be submitted)

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## Key Research Experiment

**Generation of two-mode squeezed state of light via hot atomic vapor cell**  
Jun. 2022 – Present, at Atomic & Quantum Optics Lab  
Accomplished the first in Korea using rubidium vapor; generated two-mode squeezed state of light from four-wave mixing in hot <sup>85</sup>Rb vapor cell and measured -6 dB of intensity difference squeezing; leading to subsequent researches:

- Quantum-enhanced electric field sensing with a Rydberg atom
- Quantum-enhanced optical magnetometry
- Covariant quantum measurement of two-mode squeezed state with dual homodyne detection

expected to write three papers based on the findings of this experiment.

**Covariant quantum measurement of two-mode squeezed state with dual homodyne detection**  
Oct. 2023 – Present, at Atomic & Quantum Optics Lab  
(currently preparing the experimental setup)

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## Other Research Experience

- Atomic & Quantum Optics Lab**  
Mar. 2023 – Present, Researcher
1. **Generation of photon pairs from four-wave mixing with single beam**  
Generated photon pairs in strong coherence between two ground states from four-wave mixing in hot <sup>85</sup>Rb vapor cell; achieved it with single beam to minimize optical noise. This research has led to the generation of squeezed states.
  - 2.
  3. **Frequency stabilization & modulation**  
Operated frequency stabilization system with acousto-optic modulator (AOM) and stable frequency modulation system with electro-optic modulator (EOM) and AOM as well.

### *Atomic & Quantum Optics Lab*

Jan. 2022 – Feb. 2023, Undergraduate Research Student

Mar. 2023 – Present, Researcher

#### **1. Noise reduction**

Improved the experimental environment by suppressing fatal noises for quantum metrology experiment; achieved it with a great amount of noise reduction of over 99% by using appropriate homemade noise filters.

#### **2. Generation of photon pairs from four-wave mixing with twin beams**

Generated photon pairs in strong coherence between two ground states from four-wave mixing in hot  $^{85}\text{Rb}$  vapor cell with two independent lasers.

#### **3. Laser power amplification**

Achieved to amplify laser power from 20 mW to 1.5 W with a tapered amplifier to obtain enough power for generating the four-wave mixing. This system provided a stable, compact, and low-cost laser source.

#### **4. Spectroscopy**

Implemented saturated absorption spectroscopy (SAS) as a basic technique for guaranteeing the accuracy of our lasers' wavelength.

#### **5. Research on Rydberg atoms for ultra-precision sensing**

Supported as an assistant; tested lasers and optical components; made balanced detectors for saturated absorption spectroscopy and Helmholtz coil.

### *Heavy Ion Physics Experiment Lab*

Feb. 2018 – Jul. 2018, Undergraduate Research Student

#### **1. ALICE project at CERN**

Conducted test and inspection for new detectors for ALICE project at the European Organization for Nuclear Research (CERN), the process of which involves electrical test and visual inspection to verify proper functioning.

#### **2. Particle Adventure**

Translated "Particle Adventure" website of Lawrence Berkeley National Laboratory (LBNL) into Korean with studying, which was a small but long-term project in the lab.

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## **Conference Presentations**

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### *Oral Sessions*

1. "Generation of two-mode squeezed light from four-wave mixing in hot  $^{85}\text{Rb}$  vapor cell," Gisung Sim, Heewoo Kim, and Han Seb Moon\*. Optics and Photonics Congress 2023 (OPC 2023), Jeju, Korea. August 27-30, 2023.
2. "Four-wave mixing in a double-lambda system of  $^{85}\text{Rb}$  vapor cell towards generation of squeezed states," Gisung Sim, Heewoo Kim, The 1st Joint Workshop for Young Physicist (Brain Korea 21), Muju, Korea. January 08-10, 2023

### *Poster Sessions*

1. "Towards squeezed states: Four-wave mixing in a double- $\Lambda$  system of a hot  $^{85}\text{Rb}$  vapor cell," Gisung Sim, Heewoo Kim, Jinhyuk Bae, and Han Seb Moon\*. Awarded *Best Student Paper Award*. Advanced Lasers and Their Applications 2023, Jeju, Korea. May 01-04, 2023.
2. "Towards quantum-enhanced sensing: generation of two-mode squeezed light from four-wave mixing in hot  $^{85}\text{Rb}$  vapor," Gisung Sim, Heewoo Kim, and Han Seb Moon\*. 2023 KPS Fall Meeting, Changwon, Korea. October 24-27, 2023.
3. "Towards quantum-enhanced sensing: generation of two-mode squeezed light from four-wave mixing in hot  $^{85}\text{Rb}$  vapor," Gisung Sim, Heewoo Kim, and Han Seb Moon\*. 2023 Quantum Sensor ITRC Workshop, Busan, Korea. August 24-25, 2023.
4. "Four-wave mixing in a double- $\Lambda$  system of  $^{85}\text{Rb}$  vapor cell towards the generation of squeezed state," Gisung Sim 34<sup>th</sup> Annual General Meeting and 2023 Winter Academic Conference, Busan,

Korea.  
February 14-17, 2023.

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## Work Experience

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### *Academic club with computing*

Jan. 2017 – Jul. 2018, President & Team Leader

#### 1. Open Lab

Led a team in the department's academic event, OpenLab; creating a visual simulation of a black hole to spark participants' interest in physics; successfully captured attention and interest of the public.

#### 2. Python and Arduino study

Led a study group for learning Python and Arduino for the purpose of conducting beneficial academic activities for physics; resulted in the participation in the OpenLab event organized by the department.

### *Military*

May. 2019 – Mar. 2020, Mechanized infantry division, Republic of Korea Army

Served as a foot soldier and an administration clerk as well; aided to prepare military training; participated in various military training; did many tasks with comrades from various backgrounds.

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## Volunteer Activities

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### *Incheon Welfare Center for the Blind*

Jun. 2020 – May. 2021, Public Service Worker

Assisted staff and blind individuals at the welfare center; supported facility management, implementing COVID-19 prevention measures; aided in the operation of programs for the blind; delivered meals to blind individuals facing financial difficulties.

### *Mentoring for first-year students of the department of physics*

Mar. 2022 – Dec 2022, Mentor

Participated in the department-offered tutoring program for students who were struggling with physics; successfully supported five juniors over the course of a year, all of whom achieved good grades in their physics studies.

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## Awards & Scholarship

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### *Awards*

1. Best Student Paper Award, Advanced Lasers and Their Applications, 2023  
given by the chairman of the Quantum Electron Division of the Optical Society of Korea.
2. Academic Excellence Award, College of Natural Sciences at Pusan National University, 2023  
given by the president of the alumni association of Pusan National University College of Natural Sciences.
3. Excellence Award, Department of Physics at Pusan National University, 2017  
given by the dean of the Department of Physics at Pusan National University.

### *Scholarship*

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|---|-----------------------|
| 1. National Scholarship                         | Mar. 2016 – Dec. 2022 |
| 2. School Scholarship                           | Mar. 2016 – Dec. 2022 |
| 3. KT Group Hope Sharing Foundation Scholarship | Sep. 2017 – Dec. 2017 |
| 4. Short-Term Study Abroad Program              | Sep. 2017 – Dec. 2017 |
| 5. University Innovation Support Project        | Mar. 2022 – Dec. 2022 |
| 6. Gyeongdo Development Fund                    | Mar. 2022 – Dec. 2022 |

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## Skills & Others

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- *Computer*  
Python, Mathematica, TensorFlow, and AutoCAD.
  - *Mathematics*  
Took classes and studied for linear algebra, analysis, abstract algebra, and group theory to obtain profound understanding of mathematical concepts essential for physics.
  - *Electronics*  
Network analysis, Arduino, Soldering.

- *Hobby*

Reading (mainly about anthropology, philosophy, politics, etc.), Running, Camping, Barbecuing, Singing, Drumming.