

# Department of Physics Inha University

GEUNSEOP LEE

DEPARTMENT OF PHYSICS, INHA UNIVERSITY

## INHA UNIVERSITY

Inha University, a private university located in Incheon, South Korea, was founded as the Inha Institute of Technology in 1954 with the help of Korean immigrants in Hawaii and Dr. Seung-Man Rhee, the first president of Republic of Korea. The university was established with the objective of leading the industrial development of the country right after the Korean war. In 1968, the Hanjin Group, led by the former chairman Choong-Hoon Cho, adopted the administration of Inha University. Inha University has a tradition and heritage focusing on the natural sciences and engineering, and has produced generations of qualified engineers, entrepreneurs, and experts in various industrial sectors. Inha University has been consistently among the best in various college evaluations, both nationally and internationally.

### **Ideal of Inha University-Development of Character, the Search for the Truth, and Service to Society.**

Founded in 1954 to empower and bring prosperity to the nation, Inha University strives to build students' characters, to search for truth, and to serve society.

'Truth' is Inha University's motto. Inha University, as a research university, expresses this pursuit for truth through education. The university also promotes academic achievements that contribute in improving the nation as well as all of human society. Inha University strives to attain the following goals:

1. Inha University endeavors to nurture talented individuals who contribute to the betterment of humanity based on ethical conduct and critical judgement.



**Fig. 1:** Inha University's Main Building and the Main Garden.

We strive to cultivate qualified leaders by offering a diverse general education program to equip our students with both scientific and ethical knowledge, and to provide access to multi-disciplinary scientific research and technology.

2. Inha University endeavors to foster talented individuals who possess creativity and the ability to rise to challenges with insight into global trends, while pursuing practical knowledge and truth.

3. Inha University endeavors to nurture talented individuals who possess the skills to lead and pursue prosperity for the nation.

Since we are located in the Incheon megalopolis, which is positioned on the geographical axis of the Northeast Asia region, we have the potential to lead our nation's future and to assume a role as a key source for higher education. in the area.

## DEPARTMENT OF PHYSICS



**Fig. 2:** Building #5 where the Department of Physics is situated.

Since its founding in 1978 as part of the College of Natural Sciences, the Department of Physics has educated students who have been able to contribute to scientific-industrial development through the creative application of scientific thinking. The Department of Physics has a finely tuned curriculum that combines lectures and lab courses to provide a thorough understanding of the fundamental principles of physics. The department emphasizes experience and practice in the lab, in conjunction with traditional coursework, to offer students a comprehensive education that includes theory and expertise with experimental equipment.

As physics majors, students will learn and practice several important areas of physics, which are the basis for all natural sciences. The program aims to provide a solid foundation of principles in physics, which is a means for adapting to the demands of any state-of-the-art facility and contemporary science and technology industries, and the development of leadership skills needed in industry and the nation.

There are 185 undergraduate students and about 30 graduate students enrolled in the physics department. Graduate students are mostly supported by various scholarship programs, including the 'Jeongseok' scholarship, teaching assistantships and laboratory assistantships provided by university, and research assistantships provided by each faculty member's research funds.

## RESEARCH ACTIVITIES

Currently, there are 19 faculty members (including 1 non-tenure track faculty member) in the Department of

Physics at Inha University. The research in the department focuses on four main fields, including condensed matter physics, optics, nuclear physics, and statistical physics. Their activities are briefly described below.

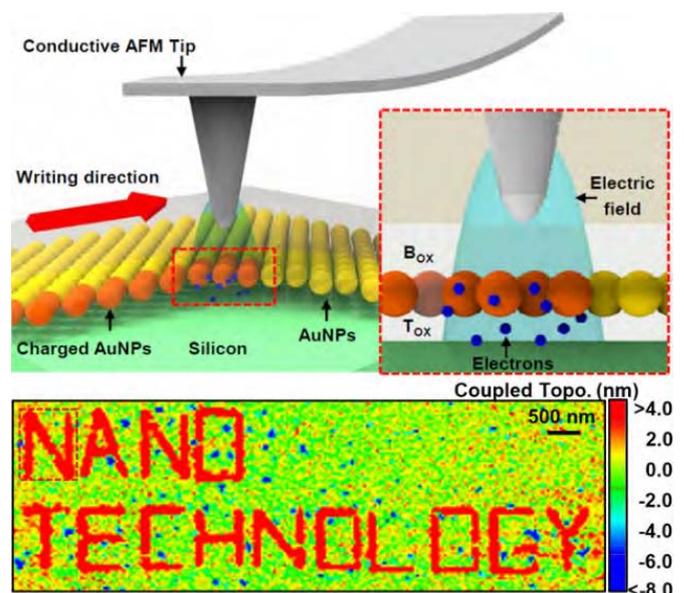
### Condensed Matter Physics Groups

The condensed matter physics group has tried to develop a fundamental understanding of condensed matters to realize novel functionality of materials for industrial applications. The research focusses on the experimental realization and characterization and theoretical comprehension of various materials such as multiferroics, piezoelectrics, magnetic metals, and conventional semiconductors.

Byung Chan LEE (Theoretical Magnetic Material Group) investigates spin-dependent transport properties in magnetic nanostructures, and explores theoretical models to explain new experimental results in magnetic tunnel junctions and magnetic multilayers.

Geunseop LEE (Surface-Nano Lab.) in low-dimensional phenomena in nanostructures formed at surfaces by studying their atomic and electronic structures using scanning tunneling microscopy (STM) and photoelectron spectroscopy (PES).

Jong Hoon JUNG (Quantum Functional Materials Lab.) investigates the fundamental physics of transition metal chalcogenides (oxide, sulfide) thin films, and their electronic and energy harvesting device applications.



**Fig. 3:** Measurement of nanoscale charge traps via AFM.

Namjung HUR (Novel Material Physics Lab.) studies synthesis and the characterization of novel multifunctional materials and strongly correlated systems, and magnetic and thermal/electronic transport properties of exotic magnetic materials.

Minbaek LEE (Smart Nano-Device Lab.) studies nano-Field-Effect-Transistors and energy harvesting devices with piezoelectric and triboelectric effects. Such topics includes electrical characterization, surface investigation using atomic force microscopy (AFM).

Minseok CHOI (Computational Materials Physics Group) works on computational and theoretical research, particularly for semiconductors and insulators, using first-principles approaches based on density functional theory.

**Optics Groups**

Of the main research that interests the optics group, the group also focuses on understanding the fundamental optical principles and conducting experimental studies of thin film optics, geometrical optics, quantum optics, nanophotonics, plasmonics, semiconductor photonics, and optoelectronics.

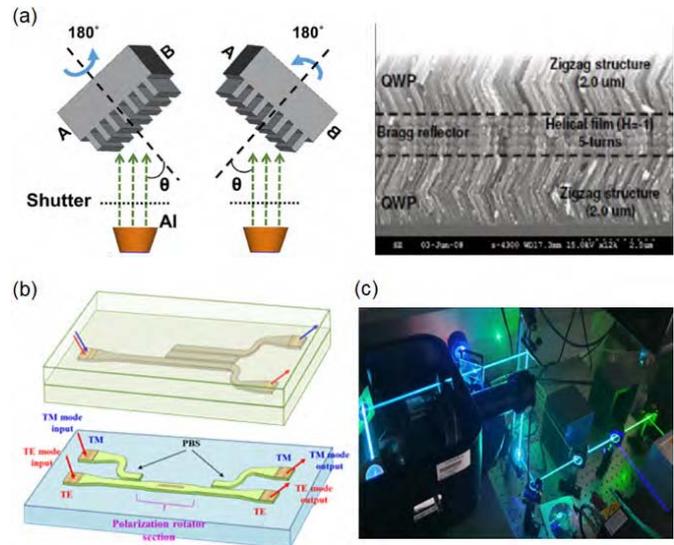
Chang Kwon HWANGBO (Thin Film Optics Lab.) studies the design, deposition, and characterization of optical thin films for optical applications, nanophotonics, plasmonics, metamaterials, display, and extreme ultraviolet lithography.

Kisik KIM (Optical Coherence Lab.) studies coherence properties of light in terms of various correlation functions of optical fields in both quantum and classical domains.

Sukmook LEE (Optical Testing Lab.) develops optical metrology test methods for large mirrors and nanometric Ronchi ruling characterization using a high-precision Talbot test.

Kyong Hon KIM (Photonic Science Lab.) investigates photonic integrated devices based on silicon waveguides along with magneto-optic materials for optical interconnections, quantum communications, and lidar sensor applications.

Jae Woo NOH (Quantum Optics Lab.) studies experimental quantum optics related to quantum information. His main interest is in the entangled state generation us-



**Fig. 4:** (a) Oblique angle deposition schematic and zig zag films. (b) Integrated polarization beam splitter and polarization rotator based on Si photonics. (c) Laser setup.

ing parametric down conversion, quantum cryptography, ghost imaging and quantum interference.

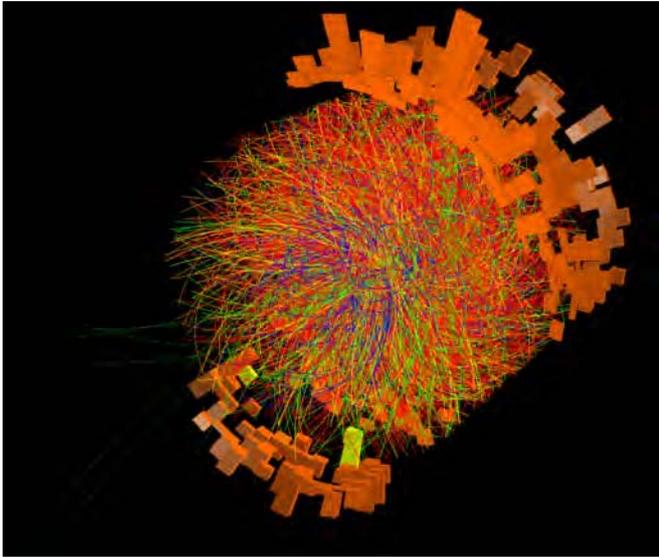
Han-Youl RYU (Semiconductor Optics Lab.) studies device physics of semiconductor optoelectronic structures such as laser diodes, light-emitting diodes, nano-photonics devices, and silicon photonic devices.

Kyu-Tae LEE (Multifunctional Nanoscale Optics Lab.) explores the manipulation of light in photonic, plasmonic and optoelectronic nanostructures and optical nanomaterials to understand the fundamentals at the nanoscale and build multifunctional devices.

**Nuclear Physics Groups**

The nuclear physics group studies the fundamental nuclear forces in nature, their symmetries, the resulting complex interactions among quarks inside hadrons, and new QCD phases such as the quark-gluon plasma created shortly after the Big Bang. This group develops theoretical models and performs experiments by colliding heavy nuclei at high energies followed by data analysis.

Jin-Hee YOON (Nuclear Physics Theory Lab.) is working on the phenomenological study of the Quark Gluon Plasma (QGP), in which quarks and gluons are free under the prediction of quantum chromodynamics (QCD). She is searching for its clue from two particle correlations and quarkonia productions.



**Fig. 5:** ALICE heavy-ion collision event.

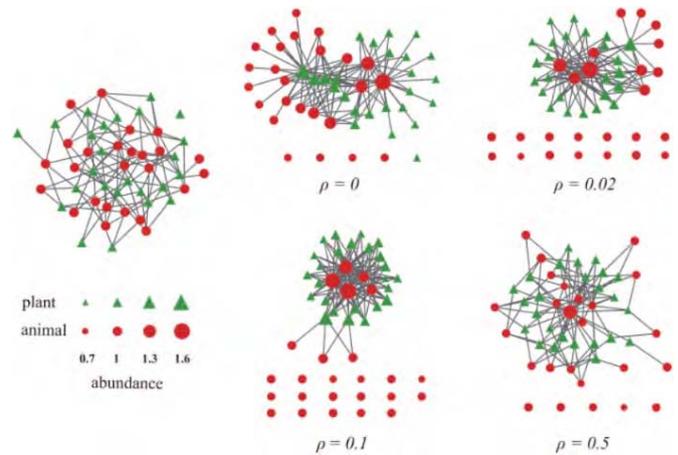
Hyun Chul KIM (Hadron Theory Group) studies the structure and spectroscopy of hadrons, and the nature of chiral symmetry and quark confinement, which are the essential and crucial features of the strong interaction.

MinJung KWEON (High Energy Nuclear Physics Lab.) investigates nuclear matter at extreme temperatures and densities created by ultra-relativistic heavy-ion collisions. The experiments are performed in ALICE (A Large Ion Collider Experiment) at the Large Hadron Collider (LHC) which provides high-energy beams of Pb ions.

Ulugbek YAKHSHIEV is involved in studies of strong interactions. He is investigating the structure of hadrons and their interactions, and the properties of hadrons under the extreme (high density and temperature) conditions.

### Statistical Physics Groups

The statistical physics group investigates the emergent features and the underlying fundamental principles of



**Fig. 6:** Plant-pollinator network evolving towards maximizing species abundance.

various complex systems in nature and society by using data analysis, mathematical modeling, and developing the theoretical framework based on the concepts and methods of statistical mechanics.

Jae Woo LEE (Statistical Physics Lab.) investigates statistical physics and the science of complex systems, including nonequilibrium statistical physics, critical phenomena, complex networks, econophysics, social physics, neural networks and brain dynamics, and chaos.

Deok-Sun LEE (Complex Systems Lab.) studies the design and working principles of complex systems from cellular networks to economical systems in the framework of statistical physics and complex network theory.

More information can be found in the department's website at: [physics.inha.ac.kr](http://physics.inha.ac.kr).

**Acknowledgements:** This material is a combined version of contributions provided by all of the faculty members in our department. The contributions of Minseok Choi, Kyu-Tae Lee, MinJung Kweon, and Deok-Sun Lee are especially appreciated.



**Geunseop Lee** is a professor and since 2018, chair of the Department of Physics at Inha University. After receiving his PhD from the University of Pennsylvania (USA) in 1995, he worked at Pennsylvania State University (USA) and the Korea Research Institute of Standards and Science before joining Inha University in 2003. His research field is experimental condensed matter physics specializing in surface science using STM and PES.