

The Department of Physics at Universiti Putra Malaysia (UPM)

CHEN SOO KIEN, CHAN KAR TIM, NURISYA MOHD SHAH, JOSEPHINE LIEW YING CHYI,
FARAH DIANA MUHAMMAD,
DEPARTMENT OF PHYSICS, UNIVERSITI PUTRA MALAYSIA

BACKGROUND AND HISTORY

The humble beginnings of the Department of Physics at Universiti Pertanian Malaysia (currently known as Universiti Putra Malaysia) started when the Division of Basic Sciences was established in 1972. During that time, the main objective of the division was to offer foundational courses in the sciences for programs mainly focused on agricultural and veterinary sciences. In 1975, the Division of Basic Sciences was upgraded to a faculty, known as the Faculty of Science and Environmental Studies. The faculty then went through a series of restructuring processes and eventually was renamed as the Faculty of Science (Fig. 1) in 2004. The Faculty of Science consists of four departments, namely, the Department of Biology, the Department of Chemistry, the Department of Mathematics and the Department of Physics.

Currently, the Department of Physics is headed by Dr. Zulkifly Abbas, associate professor, and is assisted by 32 academic members and 18 supporting staff members. The department offers four undergraduate programs, which are as follows:

- 1) Bachelor of Science (Honors) in physics;
- 2) Bachelor of Science (Honors) in instrumentation science;
- 3) Bachelor of Science (Honors) in materials science; and
- 4) Bachelor of Science (Honors) in physics with education.

The department also offers postgraduate and postdoctoral programs in a wide range of research areas including applied optics, applied radiation, materials science, microwaves, ultrasonics, sensors and instrumentation, complex networks, and theoretical and computational physics. As of July 2017, we have 431 undergraduate students, 105 postgraduate students (59 enrolled in Master's programs and 46 in the doctoral program) and three post-doctoral fellows.



Fig. 1: The Building for the Faculty of Science.

The department has essentially five main research groups focusing on the following topics: magnetic and superconducting materials; condensed matter physics; lasers and photonics; instrumentation sciences and technology; and theoretical and computational physics. Many state-of-the-art research instruments such as an ellipsometer, a UV-visible spectrophotometer, an RF magnetron sputtering system, X-ray diffraction (XRD) and atomic force microscopy (AFM) are available in the department and can be used by all research groups. Furthermore, there is also strong collaboration among the academic members of the department with several research institutes in Universiti Putra Malaysia such as the Institute for Mathematical Research (INSPEM), the Institute of Advanced Technology (ITMA) and the Institute of Bioscience (IBS).

RESEARCH ACTIVITIES

Theoretical & Computational Physics

Research in the group for theoretical and computational physics encompasses fundamental studies of quantum

systems, cosmology and more broadly the area of mathematical physics. The group is led by Assoc. Prof. Hishamuddin Zainuddin who is also the deputy director for the Institute for Mathematical Research (INSPEM) at UPM. Some topics of current interest include quantization and quantum foundations, geometry and topology in physics, quantum information, categorical quantum mechanics, quantum states on hyperbolic spaces, complex networks, non-commutative quantum mechanics (NCQM), complex Hermite polynomials and other polynomials associated to NCQM, and computational methods in physics.

The group members are also associated to INSPEM as research associates under the Laboratory of Computational Sciences and Mathematical Physics. Through the collaboration between INSPEM and the Department of Physics, many notable events have been organized. The lecture series, “Expository Quantum Lecture Series” (EQuaLS,) has become a successful, regular event that began in 2007. A primary objective of the lecture series is to expose and update researchers and students, especially those from Malaysia, with the latest developments in quantum sciences, mathematical physics and other related areas.



Fig. 2: Group photo taken during EQuaLS8.

Experimental Condensed Matter Physics

Experimental condensed matter physics is further divided into five research subgroups. The fields covered by these subgroups include semiconductor materials, dielectric materials, nanomaterials, glass and ceramic materials and biophysics. Most of the laboratories in the department are well equipped to undertake advanced experiments. Together with support from the Institute of Advanced Technology and the Institute of Bioscience, the Condensed Matter Physics group at UPM has become influential in frontier condensed matter research in Malaysia.

Magnetic & Superconducting Materials

The group is actively engaged in experimental and theoretical studies on various aspects of magnetism and superconductivity. For magnetism, the areas of interest include single crystal yttrium iron garnet, ferrites, and permanent magnets such as Nd-Fe-B.

On superconductivity, the areas of research include the experimental study of cuprate high temperature superconductors (HTS), magnesium diboride and iron chalcogenides. A particular strength of the group is materials processing and optimization of heat treatment conditions. The samples are prepared and processed through various methods including mechanical milling, thermal treatment, solid state reactions, sol-gel as well as co-precipitation. For HTS, we are interested in the preparation of Y-Ba-Cu-O and Bi-based systems. In addition, the effect of dopant (both magnetic and non-magnetic) concentration on the electrical and magnetic properties of HTS is studied. On magnesium diboride superconductors, the focus is on enhancing the flux pinning properties via dopant addition and sample processing techniques. Following this, we also investigate the intragrain and intergrain properties of the samples and their influence on the critical current density. For iron chalcogenides, we mainly study the S and Se doped $\text{FeTe}_{1-x}\text{Ax}$ ($A = \text{S, Se}$) bulks. So far, the group has successfully synthesized the samples at ambient pressure without resort to vacuum conditions. The superconducting transition temperature of the samples is comparable to those prepared in vacuum conditions.

Lasers & Photonics

Photonics includes the generation, emission, transmission, modulation, signal processing, switching, amplification and detection/sensing of light. The main study of photonics is related to electro-optics, optoelectronics and laser dynamics in free-space optics or a fiber optics medium. These studies investigate the properties of light in light sources, transmission media, optical amplifiers, detectors, light intensity modulation, phase manipulation, polarization properties and photonics integrated circuits. Applications of photonics include a wide range of areas, from everyday life to the most advanced scientific uses, e.g., light detection, telecommunications, information processing, lighting, metrology, spectroscopy, holography, medicine (surgery, vision correction, endoscopy, health monitoring), military technology, laser material processing, visual art, biophotonics, agriculture and robotics. The two subgroups under this research group are the photonics and laser subgroups.

Instrumentation Sciences & Technology

This group researches sensors and systems, instrumentation electronics, measurement environments, signal processing and analysis, sensor interfacing to PC and industrial controllers and programming for instrumentation.

They focus on microwave, optical, photothermal and photoacoustics instrumentation and their applications, including monitoring and data logging for environmental studies.



Dr. **Chen Soo Kien** is an associate professor with the Superconductor and Thin Films Group at the Department of Physics, Faculty of Science, Universiti Putra Malaysia. His research mainly focuses on various types of superconducting materials.
Email: chensk@upm.edu.my



Dr. **Chan Kar Tim** is currently a senior lecturer at the Department of Physics, Faculty of Science, Universiti Putra Malaysia. He is also a research associate at the Institute for Mathematical Research (INSPEM), UPM. His research works mainly focus on fundamental studies and mathematical physics such as spectral studies on punctured hyperbolic surfaces and complex networks.
Email: chankt@upm.edu.my



Dr. **Nurisya Mohd Shah** obtained her PhD in physics from Concordia University, Montreal, Canada. She is also a research associate at the Institute For Mathematical Research (INSPEM), UPM. Her research interests are in mathematical physics such as noncommutative quantum mechanics (NCQM) models and some families of biorthogonal polynomials that arise in NCQM.
Email: risya@upm.edu.my



Dr. **Josephine Liew Ying Chyi** is currently a senior lecturer at the Department of Physics, Universiti Putra Malaysia. Her major research areas involve synthesis, characterization and utilization of chalcogenide semiconductor materials for solar cell applications. Her work involves synthesizing polycrystalline chalcogenide semiconductors via various methods of preparation and characterizing the resulting materials in powder and thin films. The characterization involves structural, morphological, electrical, optical and thermal properties of the synthesized chalcogenide semiconductor materials.
Email: josephine@upm.edu.my



Dr. **Farah Diana Muhammad** is currently a senior lecturer at the Department of Physics, Universiti Putra Malaysia. Her research interests include the development of ultrafast fiber lasers, saturable absorbers, mode-locked and Q-switched fiber lasers, supercontinuum generation, radio frequency generation and single-longitudinal mode fiber lasers.
Email: farahdiana@upm.edu.my
