RESEARCH HANDBOOK 2018

Department of Physics
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The current Department of Physics can be traced back through a long and rich history: its earliest forerunner was founded in 1904 as Straits Settlements and Federated Malay States Government Medical School. It was renamed to Raffles College in 1929 and established as a proper university as University of Malaya in 1949. After a further renaming to University of Singapore in 1962 and a merger with Nanyang University in the year 1980, the National University of Singapore was established. It is worth mentioning that famous physicists visited the department, such as Paul A. M. Dirac – a picture of him during a lecture is on display still in the departmental meeting room.

Until around 1990, the department was essentially a teaching department with little research activities. At that time, NUS began to transform itself into a research university. Over these past two decades, tremendous efforts have been made in developing the research capabilities of our department, which is now classified as “research intensive”. Below we list the current major research directions.

- Physics of Nanoscience
- Condensed Matter and Advanced Materials
- Biological Physics
- Physics of Nonlinear and Complex Systems
- Atomic, Molecular Physics (including Nonlinear Optics)
- Computational and Theoretical Physics (including String Theory, Cosmology, Particle Physics, etc)
- Quantum Information
- Graphene and 2D Materials

There are several unique groups in our department, firstly the Centre for Quantum Technologies (CQT), which originated in the physics department and is now a separate research centre, the first Research Centre of Excellence (RCE) funded by the Singapore government. Recently the Centre for Advanced 2D Materials and Graphene Research Centre was set up to spearhead graphene and 2D materials research. The Centre for Ion Beam Application (CIBA) is a unique entity, dedicated to ion beam applications. Many of our faculty members have very active research programmes and have produced high impact research work. Some of them hold editorial positions at prestigious journals and are elite members of professional organizations (such as APS or IoP fellows).

The 2017 and 2018 “QS world university ranking by subjects” has ranked NUS physics at the 25th position in the physics and astronomy category. Over the years, the research output produced by the department has grown quite strongly, as shown in figure 1 below. The figure indicates the number of journal publications indexed by the Web of Science with an author/coauthor from our department. Clearly, tremendous progress has been made.

From this handbook you can quickly find out who is doing what in our department. For more in-depth information, please check out our department webpage at http://www.physics.nus.edu.sg/.

Number of publications from NUS physics department that have been listed as “highly cited papers” by Web of Science during 1998-2017.

Number of total citations per year contributed by all publications from NUS physics department recorded by Web of Science during 1999-2018.
HEAD OF DEPARTMENT
Professor Sow Chorng Haur

DEPUTY HEADS OF DEPARTMENT
Professor Gong Jiangbin
Professor Scarani, Valerio
Associate Professor Phil Chan Aik Hui
PROFESSORS
Breese, B. H. Mark
Englert, Berthold-Georg
Feng Yuan Ping
Gong Jiangbin
Ho, Peter
Ji Wei
Kurtsiefer, Christian
Lai Choy Heng
Lim Hock
Liu Xiang Yang
Özyılmaz, Barbaros
Scarani, Valerio
Sow Chorng Haur (Head)
Vedral, Vlatko
Venkatesan, Thirumalai Venky (Provost’s Chair)
Wang Jian-Sheng
Wee Thye Shen, Andrew
Yan Jie

EMERITUS PROFESSOR
Oh Choo Hiap
Tan Tiong Gie, Bernard

DISTINGUISHED PROFESSOR
Castro-Neto, Antonio Helio

LEE KONG CHIAN CENTENNIAL PROFESSOR
Ekert, Artur Konrad

ADJUNCT PROFESSOR
Ong Chong Kim
Phua Kok Khoo

DISTINGUISHED VISITING PROFESSORS
Geim, Andre (Nobel Laureate in Physics 2010)
Leggett, Anthony J. (Nobel Laureate in Physics 2003)

VISITING PROFESSOR
Hänggi, Peter

VISITING RESEARCH PROFESSOR
Miniatura, Christian
ASSOCIATE PROFESSORS
Adam, Shaffique
Ariando (Dean’s Chair)
Barrett, Murray Douglas
Bettiol, Andrew A.
Chan Aik Hui, Phil
Chua Lay-Lay
Chen Wei (Dean’s Chair)
Chung Keng Yeow
Dieckmann, Kai
van Kan, Jeroen Anton
Kaszlikowski, Dagomir
Lim Hock Siah, Paul
Ling Euk Jin, Alexander
van der Maarel, Johan R. C.
Mahendiran, Ramanathan
Martin, Jens
Osipowicz, Thomas
Rusydi, Andrivo
Singh, Kuldip
Tan Meng Chwan
Tay Seng Chuan
Tsang Mankei
Teo Ho Khoon, Edward
Tok Eng Soon
Wang Xuesen
Wang Zhisong
Zhang Chun

ADJUNCT ASSOCIATE PROFESSORS
Lee Cheow Lei, James
Goh Kuan Eng, Johnson
Koh Wee Shing
Pan Jisheng
Wang Shijie
Yakovlev, Nikolai

VISITING RESEARCH ASSOCIATE PROFESSOR
Gremaud, Benoit

PRINCIPAL RESEARCH SCIENTIST (CRISP)
Liew Soo Chin
ASSISTANT PROFESSORS
Eda, Goki
Garaj, Slaven
Li Wenhui
Loh, Duane
Loh Huanqian
Matsukevich, Dzmitry
Mirsaidov, Utkur
Mukherjee, Manas
Nicholson, Travis Lee
Pereira, Vitor Manuel
Quek Su Ying
Viana-Gomes, José Carlos

INSTRUCTORS
Ching Chee Leong
Dewanto, Andreas
Lam Poh Fong, Lydia
Lim Yen Kheng
Ng Siow Yee
Tao Ye

ADJUNCT ASSISTANT PROFESSORS
Feng Ling
Lee Ching Hua
Lim Geok Kieng

SENIOR TUTORS
Foo Chuan Wei, Darryl
Quek Yihui
Tan Ying Zhe, Ernest

LECTURERS
Chan Taw Kuei
Hong Chong Ming, Kenneth
Ng Wei Khim
Yang Jiahui, Abel

TEACHING ASSISTANTS
Bomantara, Raditya Weda
Shu Sze Yi, Angeline
Tan Meng Ho

PART-TIME LECTURER
Kuok Meng Hau

SENIOR LECTURERS
Ng Shao Chin, Cindy
Sharma, Nidhi
Udalagama, Chammika N B
Wang Qinghai
Yeo Ye
STAFF PROFILES

Department of Physics
CURRENT RESEARCH

Associate Professor Adam’s background is in mesoscopic quantum condensed matter theory. He is currently interested in:

- theoretical studies on the effects of disorder and interactions in Dirac fermion systems such as graphene and topological insulators;
- exploring the effects of impurities and electronic screening on experimentally measurable quantities such as transport and scanning probe experiments;
- application of graphene for new electronic devices.

RECENT PUBLICATIONS

CURRENT RESEARCH
The primary goal of Assistant Professor Ariando’s research effort is to explore heterostructure, superlattices, quantum wells between various epitaxial films, both from a fundamental as well as device-oriented viewpoint. The current research activity has a particular emphasis on atomically controlled functional materials with unconventional electronic, optical, magnetic and thermal properties.

SELECTED PUBLICATIONS
• X. Renshaw Wang et al., “Parallel charge sheets of electron liquid and gas in La_{0.5}Sr_{0.5}TiO_{3} heterostructures”, Sci. Rep. 5, 18282 (2015).
• T.C. Asmara et al., “Mechanisms of charge transfer and redistribution in LaAlO_{3}/SrTiO_{3} revealed by high-energy optical conductivity”, Nat. Commun. 5, 3663 (2014).
• A. Annadi et al., “Anisotropic two dimensional electron gas at the LaAlO_{3}/SrTiO_{3} (110) interface”, Nat. Commun. 4, 1838 (2013).
CURRENT RESEARCH
Dr. Barrett’s research has shifted towards high precision metrology and focuses on the advancement optical atomic clocks. The CQT clock is based on singly-ionized lutetium, which provides three suitable clock transitions within the one atom. Two of these transitions have favourable systematics compared to world-leading clock systems. His group hopes to further clock performance with a multi-ion system to improve clock stability.

SELECTED PUBLICATIONS
CURRENT RESEARCH
Optics and Photonics
- Ion beam modification of materials for applications in micro/nanophotonics.
- Terahertz spectroscopy and optics - Application in metamaterials.
- Active plasmonics, loss mitigation in micro-optical systems, enhancement of light emission using plasmonics.
- Mid-IR optics, passive and active devices for biosensing.

Nuclear Microscopy and Radiobiology
- Proton induced fluorescence microscopy in biological systems - Super-resolution imaging.
- Radiation effects in single live cells - Applications in cancer treatment using particle therapy.
- Development of diamond based radiation hard particle detectors, delta-E detectors using thin membranes, radiation dosimetry.

SELECTED PUBLICATIONS
- Y.J. Yan, L.F. Ng, L.T. Ng, K.B. Choi, J. Gruber, A.A. Bettiol and N.V. Thakor, “A continuous-flow C. elegans sorting system with integrated optical fiber detection and laminar flow switching”, Lab Chip 14, 4000 (2014).
CURRENT RESEARCH

- Professor Breese’s ion beam research activities are centred around the use of focused high-energy beams of charged particles as a means of imaging the structure and crystallinity of materials and to modify their properties. This work includes areas such as porous silicon formation, electrochemistry, ion optics, and ion channeling, accelerator physics. Much of the current work is on the use of silicon micromachining to fabricate micro- and nanoscale components for silicon photonics.

- His Synchrotron research activities include X-ray lithography, X-ray optics, accelerator physics, soft X-ray scattering.

SELECTED PUBLICATIONS


ANTONIO HELIO CASTRO-NETO
Distinguished Professor
PhD, University of Illinois at Urbana-Champaign, USA (1994)

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CURRENT RESEARCH
Graphene: all aspects. Strongly correlated systems: spin and charge density wave, quantum magnetism, superconductivity. Disordered magnetic systems.

SELECTED PUBLICATIONS
CURRENT RESEARCH
• QCD soft-hadron phenomenology
• Neutrinos and Large scale structures of the Universe
• Large Hadron Collider (CERN): CMS Collab-NUS EOI co-ordinator

SELECTED PUBLICATIONS
CURRENT RESEARCH

- High-resolution depth profiling of elements in advanced materials using methods of Ion Beams Analysis (IBA).
- Ion beam modifications of advanced materials in novel device and technology research.

SELECTED PUBLICATIONS

CURRENT RESEARCH

- Molecular-level interface engineering for organic electronic devices, organic photovoltaic cells, 2D-materials and nanostructured materials;
- Rational design of self-assembled molecular nanostructure arrays over macroscopic area with superior multi-functionalities for molecular nano-devices;
- Interface-controlled nanocatalysis for energy and environmental research.

SELECTED PUBLICATIONS

CURRENT RESEARCH

- Materials development for high-performance organic electronic devices, such as photocrosslinkers and injection layers.
- Structure–morphology–property relations of pi-conjugated semiconducting materials.
- Functionalization and development of new applications for solution-processable graphenes.
- Transfer method and development of new applications for CVD graphenes.

SELECTED PUBLICATIONS

CURRENT RESEARCH
• Use of laser-cooled atoms and Bose-Einstein condensates in ultra-high precision measurements
• Study the feasibility of using atom interferometers to detect effects of quantum gravity

SELECTED PUBLICATIONS
KAI DIECKMANN
Associate Professor
PhD, University of Amsterdam, The Netherlands (2001)

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CURRENT RESEARCH
• Experimental Atomic and Molecular Physics and Quantum Optics (AMOP)
• Many body quantum physics with degenerate Bose and Fermi gases and dipolar molecules
• Laser cooling and atom trapping
• Atom interferometry
• Laser spectroscopy and frequency combs

SELECTED PUBLICATIONS
CURRENT RESEARCH
Prof. Eda studies electronic and optical phenomena in two-dimensional (2D) solids. His research group aims to develop novel electronic and photonic devices based on 2D semiconductors for information technologies and energy harvesting applications.

- Light-matter interaction
- Electrooptics and optoelectronics
- Mesoscopic charge transport
- 2D materials growth
- Crystal phase engineering

SELECTED PUBLICATIONS


CURRENT RESEARCH

• Professor A Ekert is one of the world’s leading authorities in quantum information science, in particular in quantum cryptography. He is the founding Director of the Centre for Quantum Technologies (CQT) at NUS, established as Singapore’s first Research Centre of Excellence in December 2007. He had previously led the Quantum Information Technology group in NUS, which formed the core of the new centre. He has enriched the intellectual environment of the University, attracting outstanding physicists and computer scientists to collaborate with Singapore-based researchers and to join CQT. As of 2013, CQT has more than 200 staff and students.

• His research extends over most aspects of information processing in quantum-mechanical systems, with a focus on quantum cryptography and quantum computation. It is a cross-disciplinary field bringing together theoretical and experimental quantum physics, mathematics, logic, computer science and information theory. His work is mostly theoretical but its results also bear directly on issues of experimental implementation. One reason why it has attracted attention from industry and government agencies is that quantum cryptography can guarantee perfectly secure communication. Another is that projected quantum computers will be capable of efficiently solving some problems for which there is believed to be no efficient classical algorithm.

SELECTED PUBLICATIONS


CURRENT RESEARCH
• Robust storage of quantum bits
• Quantum state estimation, quantum process estimation
• Sampling from the quantum state space
• Ultracold gases of bosonic or fermionic atoms
• Energy functionals for interacting fermions

SELECTED PUBLICATIONS
CURRENT RESEARCH
Complex Networks and critical phase transitions
• Cascading phenomenon in multiplex network theories.
• Spreading/resilience on social/economic networks.
• Criticality on Deep Learning networks.

SELECTED PUBLICATIONS
Spin-dependent transport in zigzag graphene nanoribbon. The spin-polarization and direction of electric current in the graphene nanoribbon can be controlled by magnetization of electrodes and bias voltage, allowing implementation of spin logic gates.

CURRENT RESEARCH
Computational Materials Physics, focusing on first-principles studies of
• Physics and applications of advanced materials,
• Materials and devices for spintronics,
• Two-dimensional materials &
• Materials prediction using genomic approach.

SELECTED PUBLICATIONS
CURRENT RESEARCH
Prof. Garaj explores nanoscale phenomena emerging at the interface of solid-state devices and soft-matter systems. He is interested in behaviour of water molecules and ions in atomic-scale confinements; control and analysis of individual biomolecules using physical methods; and electrical and structural properties of 2D materials. The research is often guided by the desire to address a real technological challenge, and it includes:

• Ultra-fast, inexpensive DNA sequencing using physical methods.
• Nanopore devices for detection, fingerprinting and sequencing of individual proteins
• Electrical sensors based on 2D materials.
• 2D materials as next-generation membranes for filtration and water desalination.

SELECTED PUBLICATIONS

• B. Radha et al., “Molecular transport through capillaries made with atomic-scale precision”, Nature 538, 222 (2016).
• S. Garaj et al., “Graphene as a subnanometre trans-electrode membrane”, Nature 467, 190 (2010).
ANDRE GEIM  
Distinguished Visiting Professor  
PhD, Institute of Solid State Physics, Chernogolovka, Russia (1981)  
Email: phyga@nus.edu.sg / geim@manchester.ac.uk

CURRENT RESEARCH

• Sir Andre Geim is the Regius and Royal Society Research Professor at the University of Manchester. He was awarded the 2010 Nobel Prize for his groundbreaking work on graphene, a one-atom-thick material made of carbon. He has also received numerous international awards and distinctions, including medals from the US National Academy of Sciences and the UK Royal Society, and holds honorary doctorates and professorships from many countries.

• Thomson-Reuters repeatedly named him among the world’s most active scientists and attributed to him three new research fronts – diamagnetic levitation, gecko tape and graphene. He was also awarded the IgNobel prize in 2000 for his work on levitation, becoming the first and only recipient of both Nobel and IgNobel Prizes. He has also received both Dutch and British knighthoods.

SELECTED PUBLICATIONS


CURRENT RESEARCH
• Additive Manufacturing
• Atomic Precision Manufacturing
• Nanofabrication by scanning probe microscopy and molecular beam epitaxy
• Quantum effects in low-dimensional systems
• High-K dielectrics
• Quantum computing

SELECTED PUBLICATIONS
• S. Chen, H. Xu, K.E.J. Goh, L. Liu, and J.N. Randall, “Patterning of sub-1 nm dangling-bond lines with atomic precision alignment on H:Si(100) surface at room temperature”, Nanotechnol. 23, 275301 (2012).
CURRENT RESEARCH
Topological Aspects of Driven Quantum Systems; Quantum Thermodynamics; Nonlinear Dynamics and Quantum Chaos; Quantum Dynamics Control and Quantum Simulation.

SELECTED PUBLICATIONS
CURRENT RESEARCH
Ultracold quantum gases, condensed matter, quantum Hall effects. Quantum transport and disorder: weak and strong localization.

SELECTED PUBLICATIONS
CURRENT RESEARCH
Theoretical physics: time-dependent quantum dynamics and quantum control, decoherence and dissipation in quantum mechanics, quantum tunneling, classical and quantum information processing, molecular electronics, Brownian Motors, Stochastic Resonance, colored noise, theory of reaction rates, nonlinear dynamics in systems far from thermal equilibrium, stochastic processes, transport theory and instabilities, relativistic statistical physics and thermodynamics.

SELECTED PUBLICATIONS
CURRENT RESEARCH
Physics and technology of organic semiconductor devices (light-emitting diodes, field-effect transistors and solar cells)

SELECTED PUBLICATIONS


CURRENT RESEARCH
Black holes in higher dimensions.

SELECTED PUBLICATIONS
Professor Ji Wei’s research interests cover nonlinear optics and ultrafast nonlinear spectroscopy, for nonlinear optical and quantum materials which have photonic and optoelectronic applications. He has co-authored over 230 research papers, and his h-index is above 50. Recently, his research interests have been extended to optoelectronics with 2D materials and metal-organic frameworks.

**SELECTED PUBLICATIONS**

CURRENT RESEARCH

• Micro and Nano fabrication using: Proton Beam Writing (PBW), Nano Imprint Lithograph (NIL) and mold fabrication
• Micro & Nanofluidic lab on chip devices for single molecule detection and particle separation
• Materials modification using ion beams, e.g. Graphene, Magnetic materials and Diamond films.
• Ion source development for next generation ion nano-probes.

SELECTED PUBLICATIONS

CURRENT RESEARCH

- It has been recently shown that large systems in thermal equilibrium can be in entangled states even for high temperatures. Associate Professor Kaszlikowski is interested in how entanglement, which is one of the most fundamental properties of quantum objects, can affect thermodynamic properties of such systems (magnetic susceptibility, heat capacity etc.).
- He currently investigates a connection between entanglement and phase transitions (Bose-Einstein condensation, quantum phase transitions etc.).
- He is also interested how to detect and quantify entanglement in quantum systems where the effects of Bose-Einstein and Fermi-Dirac statistics cannot be neglected (entanglement in Fock space).

SELECTED PUBLICATIONS

CURRENT RESEARCH

• Nano-Photonics and Plasmonics
• Solar cell design and Optoelectronic device physics
• Plasma and particle-in-cell simulations
• Urban environmental & green building modeling - solar irradiance & daylighting

SELECTED PUBLICATIONS

Direct observation of the Dzyaloshinskii-Moriya interaction in an ultrathin Pt/Co/Ni film. Stokes and anti-Stokes Brillouin spectra measured at a fixed incident angle $\theta = 45^\circ$ under oppositely-oriented external magnetic fields $H_0 = 97$ mT/µ$_0$. Inset: Schematic of the Cartesian coordinate system and 180° back-scattering geometry. The incident and scattered light beams lie in the x-y plane and are at an angle $\theta$ to the y-axis. The magnon wave vector is denoted by $k$. 

CURRENT RESEARCH
Spin dynamics and acoustic dynamics of nanostructures; Magnon/phonon dispersion in magphonic, magnonic, and phononic nanostructured crystals; spin wave nonreciprocity; Magnetic Skyrmions; Brillouin light scattering.

SELECTED PUBLICATIONS
CURRENT RESEARCH

- Experimental Quantum Information and Communication
- Single Photon Technologies, Atom-Light interaction

SELECTED PUBLICATIONS

CURRENT RESEARCH

• Deep learning and Renormalization Group
• Criticality and brain dynamics
• Complex networks and applications

SELECTED PUBLICATIONS


CURRENT RESEARCH
Medical Physics for Radiotherapy:
• Radiation dosimetry techniques for verification of
dose and advanced dose algorithms
• Advanced treatment planning studies
• Monte Carlo simulation of radiation transport for
radiotherapy
• Effects of motion in radiotherapy

SELECTED PUBLICATIONS
• R. Soh, J.C.L. Lee, F. Harianto, “Determination
and Comparison of Correction Factors Obtained
for TLDs in Small Field Lung Heterogeneous
Phantom Using Acuros XB and EGSnrc”, AAPM
56th Annual Meeting, Austin, Tx, USA, 20-24 Jul
• J. Hu, K.W. Fong, Z. Master, J. Yap, J.C.L. Lee,
J. Wee, “Comparison of conformity Index (CI)
and Homogeneity Index (HI) between RapidArc
and Intensity Modulated Radiation Therapy (IMRT)
for 9 Nasopharyngeal Carcinoma(NPC) cases at
National Cancer Centre of Singapore (NCCS)
13th AOCMP and 11th SEACOMP, Singapore, 12-
14 Dec 2013.
of a Deformable Registration Method for Critical
Organs and Target in Head and Neck Patients”,
9th SEACOMP, Manila-Bohol, Philippines, 16-19
Nov 2011.
• J.C.L. Lee, J.H.H. Yap, W.L. Chow, P. Salleh, K.W.
Fong, “Reduction of Fetal Dose in IMRT of
Nasopharyngeal Carcinoma”, 9th Asia Oceania
Congress of Medical Physics (AOCMP), 7th South
East Asia Congress of Medical Physics (SEACOMP),
• I.K.T. Weng, W.H. Siew, R.M. Yeo, P. Salleh,
J.C.L. Lee, T.C. Eu, W.F. Kum, T.W. Tan, J.T. Wee,
“Treatment of Nasopharyngeal carcinoma using
Intensity Modulated Radiotherapy – the National
Cancer Centre Singapore Experience”, Int. J.

Chief Physicist,
Division of Radiation Oncology,
National Cancer Centre Singapore
• www.nccs.com.sg/PatientCare/Clinical-
Specialties/RadiationOncology/Pages/
PatientCare
• app.sgdi.gov.sg/listing.asp?agency_sub-
type=dept&agency_id=0000002737

JAMES LEE CHEOW LEI
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www.nccs.com.sg/PatientCare/Clinical-
Specialties/RadiationOncology/Pages/
PatientCare
app.sgdi.gov.sg/listing.asp?agency_sub-
type=dept&agency_id=0000002737

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CURRENT RESEARCH

My research explores the intriguing interplay of energetics and topology on strongly interacting electrons. Current directions include:

• realization of non-abelian fractional quantum Hall (FQH) states

• holography and conformal field theory

• fractional Chern insulators and anisotropic FQH

• out-of-equilibrium (Floquet) studies

I am also interested in realizing topological states beyond electronic systems. In various classical systems, the effects of topology can be exploited for novel technological applications. Specific directions include:

• topological circuits and their robust electrical resonances

• topological photonics

• topological mechanics

• Floquet topological metamaterials

SELECTED PUBLICATIONS


ANTHONY J. LEGGETT
Distinguished Visiting Professor
DPhil, University of Oxford, UK (1964)

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CURRENT RESEARCH
- Aspects of cuprate superconductivity
- Experimentally oriented studies of basic conceptual issues in the foundations of quantum mechanics
- Superfluidity and phase coherence in very degenerate atomic gases

SELECTED PUBLICATIONS
CURRENT RESEARCH

• Experimental atomic and molecular physics, quantum gases, quantum many-body physics.
• Collective excitation to high-lying Rydberg states from a degenerate gas of ground-state atoms in optical lattices;
• Laser cooling and trapping;
• Many-body physics with atomic Fermi gases;
• Long-range interaction and strong correlation of Rydberg gases.

SELECTED PUBLICATIONS

LIEW SOO CHIN
Principal Research Scientist, CRISP
PhD, University of Arizona, Tucson, USA (1989)

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CURRENT RESEARCH
- Remote sensing of the aquatic, terrestrial and atmospheric environment using optical, thermal and synthetic aperture radar data
- Ocean optics, optical properties of suspended particles in water, derivation of water quality parameters from remote sensing data
- Radiative transfer in atmosphere and water, characterization of aerosol optical properties
- Hyperspectral data analysis and applications

SELECTED PUBLICATIONS
CURRENT RESEARCH
• Solution processible graphenes and related materials
• Ceramic processing
• Nanomaterials

SELECTED PUBLICATIONS
• G.K. Lim, J. Wang, S.C. Ng, L.M. Gan, J. Mater. Chem. 9, 1635 (1999).
CURRENT RESEARCH
Prof Lim Hock is the founding Director of Temasek Laboratories at the National University of Singapore (TL@NUS). The research areas of TL@NUS include electromagnetics, aeronautics, control and guidance, information security, signal processing and nonlinear dynamics. His personal research interest are on the dynamics of atmosphere and ocean, image restoration, synthetic aperture radar imaging, and electromagnetic materials.

SELECTED PUBLICATIONS
CURRENT RESEARCH
Associate Professor Paul Lim’s current research is centered on the theoretical calculations of acoustic phonons and dipole-exchanged spin waves in periodic nanostructures.

SELECTED PUBLICATIONS

• H.S. Lim, and M.H. Kuok, “Spin Waves in Ferromagnetic Nanowires and Nanotubes”. In Handbook of Nanophysics: Nanotubes and Nanowires, ed. Klaus D. Sattler, CRC Press (Taylor and Francis Group), Chapter 31 (2010).
CURRENT RESEARCH

- Associate Professor Ling’s research group works to leverage optical technology for building compact, rugged & effective optical entanglement systems.
- He is currently working on a project called SPEQS (Small Photon-Entangling Quantum Systems) which is designed to incorporate photon-pair sources and detectors into a single package of 300 millilitres, capable of running off a single CR1220 battery for 3 hours.

SELECTED PUBLICATIONS

LIU XIANG YANG
Professor
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CURRENT RESEARCH

• Biological Materials and Physics: Biomacromolecule crystallization, self-assembly and aggregation in the bulk and at the surface; Antifreeze mechanism; Biomineralization; Silk formation mechanism; Bio mimicking of structural colors, lotus leaves, etc.
• Micro/Nano Materials and Soft Materials Formation and Engineering: Supramolecular self-assembly and micro/nano architecture; Micro/nano particle self assembly; Controlled self assembly of colloidal spheres, etc.
• Crystallization, Molecular Assembly and Hybrid materials: Colloidal, biomolecule crystallization; Surface roughening; Morphologies (shapes) of crystals; Nucleation and crystals growth; Crystal network (and aggregation) formation, etc.

SELECTED PUBLICATIONS

CURRENT RESEARCH

Microscopy is inherently data-informed. We combine modeling, machine learning and optics to create computational lenses to re-invent high-resolution microscopy. My group uses a data-informed approach to tackle fundamental and applied problems in the following fields:

- three-dimensional single-particle imaging,
- structural motifs in disordered materials,
- order-disorder phase transitions,
- nanoparticle dynamics in thin films,
- transient heterogeneous ensembles in non-equilibrium systems.

SELECTED PUBLICATIONS

Ultracold molecules exhibit long nuclear spin coherence times, making them promising candidates for quantum memory.

CURRENT RESEARCH
Our lab focuses on the manipulation of molecules at the single-molecule, single-quantum-state level. To access this regime, we will develop methods to precisely control the motion, internal quantum states, and spatial arrangement of individual molecules. These molecular building blocks will be used to study few- to many-body physics and quantum chemistry, with an eye towards quantum simulation of new materials and quantum data storage.

SELECTED PUBLICATIONS

CURRENT RESEARCH

Associate Professor van der Maarel’s main interest is the dynamic assembly, complexity and emergence of complex fluids with a relevance for biology and/or nanobiotechnology. His methodology includes molecular and microbiology, nanofluidics, microrheology, light, neutron and x-ray scattering, nuclear magnetic resonance, optical, fluorescence, scanning probe and electron microscopy, and computer simulation.

SELECTED PUBLICATIONS


CURRENT RESEARCH

• Oxide Spintronics: Materials, physics and devices
• Magnetic and Resistive Non-volatile Memories
• Electron correlation effects in oxides
• Magnetocalorics, Thermoelectrics and Spincaloritronics
• Multiferroics and Relaxor Ferroelectrics
• High frequency magnetotransport
• Magnetization dynamics in nanostructures
• Magnetic Shape Memory alloys
• Giant Magnetoresistive materials
• Ordered magnetic nanostructures
• Energy harvesting

SELECTED PUBLICATIONS

• P. Kumar, and R. Mahendiran, “Magnetothermopower, Magnetic entropy change and Magnetoresistance in ferromagnetic Cobaltites: R$_{0.7}$Sr$_{0.3}$CoO$_3$ (R = La, Gd)”, Appl. Phys. Lett. 106, 142401 (2015).
• R. Thiagarajan, S.E. Muthu, R. Mahendiran, and S. Arumugam, “Effect of hydrostatic pressure on magnetic and magnetocaloric properties of Mn-site doped perovskite manganites Pr$_{0.8}$Ca$_{0.2}$Mn$_{1-x}$B$_{0.04}$O$_{3}$ (B = Co, Cr)”, J. Appl. Phys. 115, 043905 (2014).
CURRENT RESEARCH

- Electronic systems in low dimensions have been intensively investigated for many years because of the novel physical phenomena emerging when the phase space of electrons is restricted. A famous example is the quantum Hall effect in 2-dim electronic systems. Moreover, the role of electron interactions is enhanced in low dimensional systems resulting in even more surprising effects, for example the appearance of fractional charge.

- Recently, the discovery of graphene introduced a new and exciting material system which enables us to investigate a truly 2-dim electronic system with relativistic electrons.

- In his research he will focus on the experimental investigation of electronic properties in graphene and other 2-dimensional systems, employing a combination of electronic transport and unconventional scanning probe techniques. In particular, he is interested in: Novel quantum Hall and topological states in mono- and bilayer graphene, Electro-mechanical interaction and artificial gauge fields, Local modification of graphene using scanning probe techniques.

SELECTED PUBLICATIONS


CURRENT RESEARCH

Our group uses single trapped ions to address problems in quantum information processing, quantum thermodynamics, and precision measurements. We build small heat machines that consist of only a few atoms and study their performance in the regime where quantum effects become important. We explore how control and manipulation of motional states can be used for quantum computing. We are also working on preparation, manipulation, and detection of internal states of molecular ions via “quantum logic” techniques.

SELECTED PUBLICATIONS

**CHRISTIAN MINIATURA**
Visiting Research Professor
PhD, Laser Physics Laboratory, University Paris 13, France (1990)

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**CURRENT RESEARCH**
- Quantum Transport and Disorder
- Quantum Degenerate Gases
- Artificial Gauge Fields

**SELECTED PUBLICATIONS**
CURRENT RESEARCH
Our experimental group uses advanced nanofabrication and Electron Microscopy techniques to explore material and devices properties at nanoscale. Our main research directions are:
• Synthesis of new materials
• Discovery of new pathways in material synthesis
• Self-assembly of nanostructures
• Fabrication of nanoscale devices for next generation microelectronic devices
• Development of new in situ Electron Microscopy techniques.

SELECTED PUBLICATIONS
CURRENT RESEARCH
A single or few ions trapped in a linear radiofrequency ion trap and laser cooled to low temperatures provide a simple and clean quantum system. A linear chain of such ions is equivalent to a chain of quantum oscillators. We prepare such systems for different kind of studies including emulating condensed matter systems, understanding the inherent geometry of a quantum system and tests of fundamental physics. We are also interested in using trapped ions for quantum information processing and metrology. In parallel we are also developing surface based ion trap chips.

SELECTED PUBLICATIONS
• P. Mandal, A. Sen, and M. Mukherjee, “Radium ion: A candidate for measuring atomic parity violation”, Hyperfine Interact. 196, 261 (2010).
Joint confidence-level plot for the cosmographic parameters, using the data from various astrophysical observations.

CURRENT RESEARCH
• Dark energy models: scalar field, quintessence, modified gravity theories, braneworld model, teleparallel gravity, f(T), f(R)
• Testing models with observational data: supernovae, baryon acoustic oscillation, CMB, etc.
• Cosmography
• Education: visualization tools

SELECTED PUBLICATIONS
CURRENT RESEARCH

• Theoretical and phenomenological high energy physics: Neutrino physics & Matter and Anti-matter asymmetry.
• Nonlinear quantum theory: Formalism and phenomenological applications.
• Quantum Theory: Foundations and symmetries & Generalised Uncertainty Principles.

SELECTED PUBLICATIONS

CURRENT RESEARCH
Ultracold strontium trapped in optical lattice potentials is the basis for the world’s best atomic clocks. Meanwhile ultracold atoms in Rydberg states have realized high-fidelity quantum gates. We aim to combine these two approaches to realize many-qubit quantum logic with high fidelity. With single-site spatial resolution, mHz-level spectroscopy, and tunable long-range interactions (achieved with Rydberg dressing), we can use degenerate strontium in optical lattices for quantum logic with minimal error. We are also interested in using Rydberg dressing to generate squeezed states that can beat the standard quantum limit to measurement precision.

SELECTED PUBLICATIONS
CURRENT RESEARCH

• Quantum information including quantum cryptography, entanglement, topological quantum computation, quantum simulation, cold atoms and quantum memory.

SELECTED PUBLICATIONS

CURRENT RESEARCH

• Superconductivity, magnetism and ferroelectricity
• Microwave measurements and materials characterization
• Electromagnetic materials and photonics
• Electronics and nanostructures of oxide thin films
• Microwave electronics

SELECTED PUBLICATIONS

• D.H. Wang, W.C. Goh, M. Ning, and C.K. Ong, “$\mathrm{BiFeO}_3$ film deposited on Si substrate buffered with $\mathrm{La}_{0.77}\mathrm{Sr}_{0.3}\mathrm{MnO}_3$ electrode”, Appl. Phys. Lett. 89, 212907 (2006).
CURRENT RESEARCH

• Application of ion beam based techniques to a wide range of problems in materials science and solid state physics.

• Development of Nuclear Microscopy and the various analytical and lithographic techniques associated with it, eg ERDA, IBIC, RBS, Proton Beam Writing.

• Proton beam writing, a true 3D micromachining process that was invented and developed at the Centre for Ion Beam Applications (CIBA) at the physics department, NUS.

• Development and applications of high resolution (magnet spectrometer) RBS and ERD, a quantitative technique for the analysis of ultrathin film systems.

SELECTED PUBLICATIONS


CURRENT RESEARCH

• Fundamental studies of spin, charge and phonon transport in graphene, phosphorene and 2D van der Waals heterostructures.
• Semiconductor device application of graphene and other 2D crystals, e.g. Ferroelectric-graphene non-volatile memory, Black phosphorus effect transistor.
• Graphene based biomedical applications: cellular force sensing, stem cell differentiation and growth.
• Energy storage applications of nano-porous graphene and its derivatives, e.g. Supercapacitors.

SELECTED PUBLICATIONS

CURRENT RESEARCH

- Photoemission technique development
- Surface nanostructure formation, characterization and applications
- Growth and characterization of thin films for microelectronic device fabrication
- Ion beam pattern of semiconductor surfaces
- Industry surface analysis and consulting service

SELECTED PUBLICATIONS

CURRENT RESEARCH
• Various topics in quantum condensed matter theory.
• Physics of graphene and other 2D systems, covering the topics of electronic transport, strain, disorder and localization, electron-electron interactions, phonons, geometro-elastic phenomena, new device functionalities and applications.

SELECTED PUBLICATIONS
PHUA KOK KHOO
Adjunct Professor
PhD in Mathematical Physics, University of Birmingham, UK (1970)

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BIODATA

Professor Phua Kok Khoo is the Founding Director of the Institute of Advanced Studies at Nanyang Technological University (NTU), Adjunct Professor of Department of Physics at National University of Singapore (NUS) and Chairman and Editor-in-Chief of World Scientific Publishing Co Pte Ltd.

He obtained his BSc DIC from Imperial College, London University and Ph.D. in Mathematical Physics from Birmingham University, United Kingdom and as a theoretical high energy physicist he did some interesting and useful work in particle physics, particularly in the field of phenomenology in high energy collisions.

Professor Phua is the Founding President of the South East Asia Theoretical Physics Association (SEATPA). Together with Nobel Laureate Professor C. N. Yang and other senior physicist, he is one of the founding council members of the Association of Asia-Pacific Physical Society (AAPPS).

He is an Advisory Board Member of Singapore-China Association for Advanced Science & Technology. He was elected as a Fellow of the American Physical Society (APS) for his contributions to research and education in physics in 2009 and was also awarded the IPS President’s Award by the institute of Physics Singapore (IPS) Council, for his outstanding contributions to physics research and education in Singapore in 2006. He is an Honorary Professor at Nankai University and also holding a number of honorary professorships in China.
CURRENT RESEARCH
Assistant Professor Quek’s group uses first principles approaches to make predictions on the electronic structure, vibrational properties, and transport properties of materials. They use state-of-the-art methods to understand the physical mechanisms governing macroscopic observables. Based on these studies, simpler predictive models are often developed. They have recently focused on research involving emerging 2D materials and organics.

SELECTED PUBLICATIONS
CURRENT RESEARCH

• Study of interplay of spin, charge, orbital and lattice degrees of freedom at interface and surface of novel complex systems and nanostructured strongly correlated electron systems, such as magnetic materials, high temperature superconductors, organic semiconductors, and molecular electronics materials.

• Develop and use in-situ synchrotron-based characterizations including resonant soft X-ray magnetic scattering, spectral generalized magneto-optical spectroscopic ellipsometry (from mid-infrared to vacuum-ultraviolet) and angular resolved photoemission spectroscopy, and in-situ (ultra) film growth (atomically layer-by-layer molecular beam epitaxy) at Singapore Synchrotron Light Source.

SELECTED PUBLICATIONS


VALERIO SCARANI
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CURRENT RESEARCH
• Device-independent certification of quantum devices.
• Quantum thermodynamics.
• Foundations of quantum physics, in particular Bell nonlocality.
• Description of light-matter interactions (atoms, nanomechanical systems), in collaboration with experimental groups.

SELECTED PUBLICATIONS
• A. Coladangelo, K.T. Goh, V. Scarani, “All pure bipartite entangled states can be self-tested”, Nat. Comm. 8, 15485 (2017)
CURRENT RESEARCH
• Materials synthesis and characterization
• Sol-gel method: Nano materials
• Li-ion batteries

SELECTED PUBLICATIONS
CURRENT RESEARCH
• Geometrical Methods in Physics
• Quantum Algebras
• Quantum Theory

SELECTED PUBLICATIONS
CURRENT RESEARCH

- Studies of hybrid nanostructured functional materials and their unique electrical, optical and mechanical properties.
- Investigation of potential applications of these nanostructured materials as field emitter, photosensor, transistor, etc.

SELECTED PUBLICATIONS

CURRENT RESEARCH
- M-theory, string theory, quantum field theory, and their deep implications for contemporary mathematics.
- Emergent spacetime in quantum theories of gravity.

SELECTED PUBLICATIONS
CURRENT RESEARCH
- Microwave applications of semiconductors and dielectrics.
- Digital musical sound analysis and synthesis.
- Psychoacoustics of time-delayed multiple sound sources.

SELECTED PUBLICATIONS
TAY SENG CHUAN
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PhD, National University of Singapore (1999)

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CURRENT RESEARCH
• Discrete-Event Systems
• Parallel Simulation
• Information Technology and Applications in Education

SELECTED PUBLICATIONS
CURRENT RESEARCH
Associate Professor Edward Teo’s research lies in the areas of General Relativity and Gravitation. He is very interested in exact solutions of general relativity, particularly those describing black holes. More recently, he has been focusing on black holes and black rings in higher dimensions.

SELECTED PUBLICATIONS
CURRENT RESEARCH
Associate Professor Tok Eng Soon’s research group aim to understand the fundamental relationship between surface science and material properties of low dimensional structures at the atomic scale. Research emphasis is placed on elucidating growth kinetics, dynamics and energetics that controls scaling phenomena and growth processes (adsorption, desorption, nucleation and self-assembly) occurring during thin film formation on semiconducting surfaces and interfaces.

SELECTED PUBLICATIONS
• B.L. Ong, S.W. Ong, and E.S. Tok, “Endotaxial growth of CoSi$_2$ nanowires on Si(001) surface: The influence of surface reconstruction”, Surf. Sci. 647, 84 (2016).
CURRENT RESEARCH
• Superresolution
• Quantum Optics
• Quantum Measurement Theory

SELECTED PUBLICATIONS
The image is of an event-by-event Monte Carlo simulation of MeV protons (i.e. with millions of electron-volts of energy) plunging into a material. The protons lead to secondary electron (delta-ray) cascades (seen as fiery streaks) that are the predominant mode of energy deposition.
VLATKO VEDRAL
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CURRENT RESEARCH
• Many body entanglement
• Geometrical phases and quantum computation
• Generalised entropies in information theory and physics
• Cluster state quantum computation

SELECTED PUBLICATIONS
THIRUMALAI VENKY VENKATESAN
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CURRENT RESEARCH
• Current Research
• Nanoscience
• Nanotechnology

SELECTED PUBLICATIONS
CURRENT RESEARCH

José Carlos Viana-Gomes
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CURRENT RESEARCH
• Professor Wang’s research focus is on the problems of quantum thermal transport in nanostructures and the development of nonequilibrium Green’s function (NEGF) method for such problems. Most recently, he studies full counting statistics of heat transport in junctions. Other topics of current interests include molecular dynamics simulation with quantum baths, transport in oxides, quantum master equation approach to heat transport, Joule heating and electron-phonon interaction.
• His earlier research has been in Monte Carlo method and cluster algorithms for efficient computer simulations in statistical physics.

SELECTED PUBLICATIONS
WANG QINGHAI
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CURRENT RESEARCH
• Non-Hermitian PT-symmetric quantum mechanics
• Quantum field theory
• Mathematical physics

SELECTED PUBLICATIONS
CURRENT RESEARCH

• Nanoelectronics and nanophotonics
• Surface and interface physics: high-resolution transmission electron microscopy, in-situ x-ray photoemission spectroscopy and first-principles calculations.
• Functional oxide growth: Pulsed laser deposition and ultra-high vacuum sputtering.

SELECTED PUBLICATIONS

Green Gold: Gold nanoparticles covered with PTCDA molecules. Their height and lateral size are about 2 nm and 3-5 nm, respectively. Their plasmonic resonance is strongly blue-shifted so they may appear green instead of golden. Additionally, they are effective catalyst for CO conversion to CO2.

CURRENT RESEARCH
- Scanning tunneling microscopy and spectroscopy (STM/STS) characterization of surfaces, thin films and nanostructures.
- Self-assembly of functional hybrid nanostructures from combination of semiconductor, metal, semimetal and organic materials, such as organic molecule-metal nanoparticle for molecular electronics, and semiconductor-metal hybrid for photocatalysis.
- Growth, STM/STS characterization and computational studies of Bi, Sb and P ultrathin films and nanostructures for novel electronic and spintronic applications.

SELECTED PUBLICATIONS
CURRENT RESEARCH

- Bioinspired artificial nanomotors
- Motor protein biophysics

SELECTED PUBLICATIONS

ANDREW WEE THYE SHEN
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CURRENT RESEARCH
Professor Wee’s research interests are in the field of surface and interface science, and include scanning tunneling microscopy (STM) and synchrotron radiation studies of the molecule-substrate interface, organic-organic heterojunctions, graphene and 2D materials and devices.

SELECTED PUBLICATIONS
NIKOLAI YAKOVLEV
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CURRENT RESEARCH
• Technology in ultra high vacuum, deposition of thin films, study of their properties using electron and X-ray diffraction, optical spectroscopy, scanning probe microscopy, precision ellipsometry.
• Study of structural and magnetic properties of epitaxial films and atomic arrangement on surfaces and interfaces.
• Study of composition of surfaces and multilayer structures using secondary ion mass spectrometry.

SELECTED PUBLICATIONS
• N.L. Yakovlev, X. Xie, K.P. Loh, and H. Xu, “Reconstructions 3 x 3 and r3 x r3 on SiC(0001) studied using RHEED”, Surf. Sci. 603, 2263 (2009).
CURRENT RESEARCH

Our research is based on advanced single-molecule manipulation and imaging technologies. Current research interests include:

- Molecular mechanisms of mechanosensing of cells
- Interfering mechanosensing of cells using compounds
- DNA packaging, gene regulation and DNA damage repair
- Bacterial biofilm initiation and maintenance

SELECTED PUBLICATIONS

CURRENT RESEARCH
Galaxy Clustering, Large Scale Structure of the Universe, Astroinformatics and Astronomy Education.

SELECTED PUBLICATIONS
CURRENT RESEARCH
Dr. Yeo’s current research interest is in quantum entanglement associated with many parties. It lies at the heart of quantum information processing. Entanglement is one of the most striking features of quantum mechanics, but it is also one of its most counterintuitive consequences of which we still have rather incomplete knowledge. Although the concentrated effort during the past decade has produced impressive progress, there is no general qualitative and quantitative theory of entanglement. It is hoped that we would be able to gain more understanding about the nature of multipartite entanglement by analyzing the roles of multipartite entangled states in various quantum information processes.

SELECTED PUBLICATIONS
CURRENT RESEARCH

Dr. Zhang Chun’s research is focused on the theoretical modeling and simulation of materials at nanoscale, such as molecules, nanowires and thin films. Related interests are nano electronics/spintronics and nanocatalysis.

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