Information Theory and Thermodynamics.

Asst Prof Nelly Ng Huei Ying
School of Physical and Mathematical Sciences

Date: 27 February 2021 (Saturday)
Time: 11.30am - 12.30pm
Venue: SPMS Lecture Theatre 2

Abstract

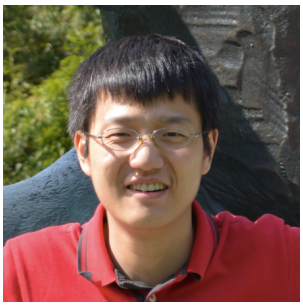
The study of thermodynamics has a long history. Motivated by the desire to understand and improve the performance of heat engines, classical thermodynamics was established by a series of discoveries made by the giants of the field: Joule, Clausius, Carnot, Kelvin, Boltzmann, and many more. Today, thermodynamics enjoys a special role in physics: it seems to find significant applications in various other areas of study, such as biology and chemistry, engineering and even economics. The mystery is gradually revealed in the realisation that the processing of information lies at the heart of thermodynamics. Even as we explore the processing of quantum information today, these steps continue to change the way we understand thermodynamics for nanoscale quantum systems, which I review in this talk.

Biography

Nelly is an assistant professor at PAP, SPMS since November 2020. She received her B.Sc. (Hons) from the same department in 2012, and subsequently worked as a research assistant at the Centre for Quantum Technologies. In 2017, she received her PhD on the study of quantum information theory and thermodynamics from Delft University of Technology, the Netherlands. She was an Alexander von Humboldt fellow at the Free University of Berlin, Germany, and conducted post-doctoral research there for a few years, before returning to NTU. Her research focus is on the interplay of quantum thermodynamics and information, which aims at building and analysing fundamental models of thermodynamic interactions between quantum systems. These efforts identify the possibilities of improving the preparation and control of quantum systems in the presence of external environments.

The Quantum Hall Effect.

Asst Prof Yang Bo
School of Physical and Mathematical Sciences



Date: 28 February 2021 (Sunday)
Time: 1.30pm - 2.30pm
Venue: SPMS Lecture Theatre 2

Abstract

The quantum Hall effect arises from an interesting low-dimensional electronic system subject to a strong magnetic field, which gave birth to a number of modern research topics in condensed matter physics. These include topological protection of quantum states, anyonic and non-Abelian statistics, as well as dissipationless charge/energy transportation. I will try to give a taste of the theoretical approaches in understanding exotic systems, how they can be classified beyond the conventional paradigm, as well as their possible practical applications.

Biography

Yang Bo is an assistant professor at the Division of Physics and Applied Physics, SPMS since August 2018. In addition to holding a National Research Foundation Fellowship since 2020, he is a research scientist at the Institute of High Performance Computing, A*STAR since 2014. He had received his B.Sc. (Physics and Mathematics Double Major) from Stanford University in 2007, and his PhD on Theoretical Condense Matter Physics in 2013 from Princeton where he was a recipient of Joseph Henry Prize in 2008. His main research interests include condensed matter and strongly correlated systems, complex systems and non-linear dynamics, traffic modelling and optimization as well as transportation engineering.

Condensed Matter Physics: Playing with Solids to Understand Our Universe.

Dr Kristian Hauser Villegas
School of Physical and Mathematical Sciences

Date: 28 February 2021 (Sunday)
Time: 3pm - 4pm
Venue: SPMS Tutorial Rooms

Abstract

In this talk, I wish to convey the broad spectrum of condensed matter physics research, from applied to fundamental physics. On the applied side, I will argue how this field is like playing with a Lego, but using quantum rules, resulting in various spectacular phenomena. I will share the work that I have done in the past two years on hybrid Bose-Fermi systems and heterostructures. On the fundamental side, I will talk about how studying condensed matter systems helped us understand our universe. I will discuss how understanding the gauge invariance and Meissner effect in superconductors led to our understanding of the electroweak symmetry breaking and the prediction of the Higgs boson. I will share my current work on how the Higgs bosons in superconductors can be optically excited and mediated by Berry curvature and quantum metric – a phenomenon that have no counterpart in particle physics. Moving forward, I will discuss how condensed matter can advance further our understanding of the universe and even challenge our basic assumptions. In particular, I will argue the possibility, using our understanding of condensed matter systems such as He-3, that the symmetries of the standard model in particle physics might be emergent symmetries. Lastly, I will talk about one of my present interests and possible future research direction about strange metals, blackholes, and AdS/CFT.

Biography

Kristian Hauser Villegas is currently a Research Fellow at NTU working on Condensed Matter Theory. He earned his PhD from University of the Philippines Diliman in 2015. He is previously a Research Fellow at the Institute for Basic Science in Korea, where he worked on hybrid Bose-Fermi systems and the light interaction of heterostructures involving superconductors, graphene, semiconductors, and transition metal dichalcogenides. He is currently working on two main projects: One is on the anomalous Higgs bosons in superconductors mediated by Berry curvature and quantum metric, with an important application to twisted bilayer graphene. The other is on the phonon dynamics in a quantum spin liquid environment. In particular, he is investigating if this can explain the observed thermal Hall effect in the pseudogap regime of cuprates. His other interest, and possibly future research direction, is on the application of holographic duality to quantum matter and strange metals.

Small steps to a Better Negotiator.

Mr Gan Beng Yee
Centre for Quantum Technologies

Date: 28 February 2021 (Sunday)
Time: 3pm - 4pm
Venue: SPMS Tutorial Rooms

Abstract

We negotiate daily on matters ranging from high stakes to smaller issues, from the time we wake up to the time we go to sleep. Yet, this important soft skill is often not covered in the curriculum of science degrees. Huge costs will be incurred if one not knowing how to negotiate where a bad negotiation might result in one being exploited by others or a breakdown in relationships. In this session, we will be exploring the fundamental principles behind negotiation and the essential factors one has to be taken into consideration during the negotiation. Realistic examples will be given to illustrate the impacts of good negotiation skills.

Biography

Gan Beng Yee received his B.Sc.(Hons) in Physics from Nanyang Technological University (NTU) in 2020. He is currently a year 1 Ph.D. student from Assoc Prof Dimitris Angelakis's group in Centre for Quantum Technologies, National University of Singapore. He is researching the area of quantum computation and simulation, specifically looking for applications of near-term quantum computers on quantum machine learning, quantum chemistry, etc. He was the inaugural batch of SPMS's Odyssey Research Programme participants and one of the kick-ass students represented NTU in PLANCKS 2019. He is interested to learn things other than sciences as he realizes the importance of broadening his horizon in all areas.

The Physics of Music Theory.

Mr Ha Quang Trung
School of Physical and Mathematical Sciences

Date: 28 February 2021 (Sunday)
Time: 3pm - 4pm
Venue: SPMS Tutorial Rooms

Abstract
Although music is arguably one of the few modes of expression that can be understood and enjoyed universally by people with hearings, music theory is often viewed as confusing by music lovers and beginner students. This is largely because music theory is "descriptive", i.e. the music comes first and the theory second. On the other hand, with some understanding of the science of sound and human hearing, one can try to formulate a "prescriptive" theory of music that is built upon fundamental concepts. This talk presents a little personal attempt at doing so. I will describe the physics of sound waves and demonstrate how we may borrow from physics concepts such that gravity and interactions to understand features of a musical composition. This talk is especially catered to the self-proclaimed "tone-deaf" among the audience, although I believe people with already some training in music may also gain some new perspectives on the nature of things.

Biography
Trung graduated from NTU in 2019 with a major in Physics and second major in Mathematical Sciences and is currently a Ph.D. student at NTU. His main research interest lies in the field of mathematical and computational physics. Trung is also a multi-instrumentalist who was classically trained in composition. He composes and produces music in his free time.