KTH Physics PhD Conference 2021

The KTH Physics PhD Conference is a biannual event where PhD students of the KTH Physics and KTH Applied Physics departments are given an opportunity to present their research in short popular or technical talks as part of their research education.

The 2021 edition of the conference will be held May 27-28 with the first day dedicated to popular talks open to the public. Due to the Covid-19 pandemic, the conference will be fully digital on Zoom.

The May 27 popular session will open at 9.15 and last until 15.45 with several breaks (see program). The Zoom room for the session can be joined through the link `https://kth-se.zoom.us/j/67067903561` and is open to the public. There will be some limited time for questions after each talk.

Program summary

May 27 – Popular session

Time: 9.15	**Popular scientific part (Open) - Zoom session opens**
Time: 9.25	**Speaker:** Mattias Blennow
Affiliation:	Program director, PhD Physics
Title: Introduction	
Time: 9.30	**Speaker:** Rabia Shaheen
Affiliation:	KTH Physics, Particle and astroparticle physics
Title: Discovery of Higgs Boson With ATLAS Detector, CERN	
Time: 9.45	**Speaker:** Albert Peralta Amores
Affiliation:	KTH Applied Physics, Quantum and biophotonics
Title: Quantum key distribution	
Time: 10.00	**Speaker:** Mats Barkman
Affiliation:	KTH Physics, Condensed Matter Theory
Title: Critical phenomena, phase transitions and universality	
Time: 10.15	**Speaker:** Max Widarsson
Affiliation:	KTH Applied Physics, Laser Physics
Title: Up-conversion LIDAR	
Time: 10.30	**Break**

Time: 10.45	**Speaker:** Andreas Bodén
Affiliation:	KTH Applied Physics, Biophysics
Title: Imaging life through modern microscopes	
Time: 11.00	**Speaker:** Jonatan Alvelid
Affiliation:	KTH Applied Physics, Biophysics
Title: STED nanoscopy – next-generation microscopy	
Time: 11.15	**Speaker:** Qigui Yang
Affiliation:	KTH Physics, Nuclear Engineering
Title: The theoretical evaluation of the nuclear waste storage	
Time: 11.30	**Break**
Time: 11.45	**Speaker:** Yangli Chen
Affiliation:	KTH Physics, Nuclear Power Safety
Title: Fukushima Daiichi Nuclear Severe Accident: A Review and Lessons Learned	
Time: 12.00	**Speaker:** Wei Zhang
Affiliation:	KTH Physics, Nuclear Physics
Title: Shape coexistence in nuclei	
Time: 12.15	**Speaker:** Yan Xiang
Affiliation:	KTH Physics, Nuclear Power Safety
Title: A scoping study of metal melt fragmentation and debris formation in water	
Time: 12.30	**Lunch break**
Time: 13.30	**Speaker:** Huan Liu
Affiliation:	KTH Physics, Nuclear Engineering
Title: Accident-tolerant Fuel	
Time: 13.45	**Speaker:** Patrick Mutter
Affiliation:	KTH Applied Physics, Laser Physics
Title: Quasi-phase-matching	
Time: 14.00	**Speaker:** Hongdi Wang
Affiliation:	KTH Physics, Nuclear Power Safety
Title: Thermo-mechanical behavior of the reactor pressure vessel wall in the nuclear severe accidents	
Time: 14.15	**Speaker:** Yucheng Deng
Affiliation:	KTH Physics, Nuclear Power Safety
Title: Experimental study on Oxidation of Zr-Fe Alloy	
Time: 14.30	**Break**
Time: 14.45	**Speaker:** Maryam Sanaee
Affiliation:	KTH Applied Physics, Quantum and Biophotonics
Title: New drug delivery systems based on exosomes and exosome-mimetic nanovesicles	
Time: 15.00	**Speaker:** Felix Vennberg
Affiliation:	KTH Applied Physics, Photonics
Title: Introduction to optical metamaterials and structural color applications	
Time: 15.15	**Speaker:** Yuefei Liu
Affiliation:	KTH Applied Physics, Materials and Nanophysics
Title: Introduction of quantum entanglement between magnons	

Time: 15.30	**Speaker:** Yuchuan Fan
Affiliation:	KTH Applied Physics, Photonics
Title: Fast signal quality monitoring for coherent communications enabled by CNN-based EVM estimation	

Abstracts

May 27 – Popular session

Time: 9.15	**Popular scientific part (Open) - Zoom session opens**
Time: 9.25	**Speaker:** Mattias Blennow
Affiliation:	Program director, PhD Physics
Title: Introduction	
Welcome to the PhD Physics Conference 2021 and introduction of the program and proceedings. Information about the course requirements for FSH3000.	
Time: 9.30	**Speaker:** Rabia Shaheen
Affiliation:	KTH Physics, Particle and astroparticle physics
Title: Discovery of Higgs Boson With ATLAS Detector, CERN	
The Large Hadron Collider (LHC) is a high energy particle collider at the European Laboratory for Particle Physics (CERN). Its primary goal is to deliver proton-proton collisions at a centre of mass energy of 13 to 14 TeV. The LHC has four main experiments: ATLAS, CMS, ALICE and LHCb. Of these, ATLAS and CMS are general purpose detectors (GPD) designed for high luminosity and searches in a wide variety of channels. In July 2012, the ATLAS and CMS collaborations at CERN's Large Hadron Collider announced the discovery of a Higgs-like boson, a new heavy particle at a mass more than 130 times the mass of a proton. This talk presents a brief introduction of Standard model (SM), Large Hadron collider (LHC) and its detectors. Subsequently, i will present an overview of importance of Higgs boson and its discovery in scientific world.	
Time: 9.45	**Speaker:** Albert Peralta Amores
Affiliation:	KTH Applied Physics, Quantum and biophotonics
Title: Quantum key distribution	
Quantum computing will provide mankind with unapparelled computational power. Rendering the vast majority of today's cybersecurity protocols, which rely on the computational difficulty of certain mathematical functions, useless. Quantum key distribution (QKD) is the core feature of secure quantum communication networks. Due to the principles of quantum mechanics, any attempt to observe the communication will perturb the system leading to transmission errors that can be detected by the legitimate users to verify the security of the distributed keys. As a result, QKD can use authenticated communication channels (resistant to tampering but not to overheating) and transform then into secure channels (tampering and overhearing resistance). Additionally, the security of QKD can be rigorously proven in contrast to classical key distribution protocols.	

Time: 10.00	**Speaker:** Mats Barkman
Affiliation:	KTH Physics, Condensed Matter Theory

Title: Critical phenomena, phase transitions and universality

As water is heated or cooled, it turns into vapor or freezes to ice. These are phase transitions, where changes in some particular variable leads to dramatic changes in the material's properties. This phenomenon is ubiquitous in nature, especially in my field of research – condensed matter physics, which concerns remarkable material properties under extreme conditions. In this presentation, I will discuss what characterizes these phase transitions and the concept of universality, which establishes connection between seemingly unrelated systems.

Time: 10.15	**Speaker:** Max Widarsson
Affiliation:	KTH Applied Physics, Laser Physics

Title: Up-conversion LIDAR

One technique for high resolution LIDAR is to use single photon counting detectors. This works very well in the visible and the near-infrared when silicon detectors can be used. Unfortunately, these detectors do not work in the mid-infrared (MIR) where it is of interest to have LIDARS due to the higher transmission through certain media and molecular fingerprints. One solution is to use nonlinear optics to perform the LIDAR with MIR light and then up-convert it to visible light which can then be detected by the standard detectors. A LIDAR based on this technique has been built.

Time: 10.30	**Break**

Time: 10.45	**Speaker:** Andreas Bodén
Affiliation:	KTH Applied Physics, Biophysics

Title: Imaging life through modern microscopes

For more than 100 years, fluorescence microscopy has been an invaluable tool enabling a plethora of scientific discoveries. From its first implementation in the early 20th century it has undergone an astonishing development leading up to the modern day systems enabling multicolor, high resolution 3D imaging of tissues, cells and even intracellular machinery with protein specificity and an ever increasing speed and resolution. This presentation will summarize the development of fluorescence microscopes and discuss the topics of image quality, analysis and interpretation both in a general sense and in the context of fluorescence microscopy.

Time: 11.00	**Speaker:** Jonatan Alvelid
Affiliation:	KTH Applied Physics, Biophysics
Title: STED nanoscopy – next-generation microscopy	

Nanoscopy is the next-generation fluorescence microscopy family which allow us to see not only down to the microscale, but even to the nanoscale. Being techniques utilizing fluorescence means that the images obtained have a high specificity to specific molecules. The main usage is in life sciences and biological imaging, where biological molecules in the cell can be labelled with specific probes, which in turn can be imaged. The resulting image represents the cellular distribution of the biological molecule. STED, short for stimulated emission depletion, is a type of nanoscopy which in practice is similarly executed as the more traditional confocal fluorescence microscopy. In confocal microscopy, one laser beam is focused and used to excite the probes of interest. The resolution achieved is entirely limited by the diffraction limit of light, a physical limit affecting how well you can focus light, which was long thought to be impassable. In STED nanoscopy, the setting is similar but with an additional laser beam inducing stimulated emission from the fluorescent molecules. By shaping the second laser beam not as a focused spot, but instead as a donut, means that you can spatially affect only the outer parts of the diffraction-limited excitation spot. In this way, the molecules allowed to fluoresce come from a much smaller spot than the diffraction-limited excitation spot, and through that you can break the physical limits imposed on fluorescence microscopy. The achievable resolution is theoretically unlimited but practically up to 10-fold better than in traditional fluorescence microscopy, down to 20 nm, meaning that one can observe cellular processes with a much higher precision than before, and discover processes previously hidden by the diffraction limit.

Time: 11.15	**Speaker:** Qigui Yang
Affiliation:	KTH Physics, Nuclear Engineering
Title: The theoretical evaluation of the nuclear waste storage	

The nuclear wastes from nuclear power plants are no longer useful in generating power. However, they are still radioactive and hence need to be properly stored to avoid radiation exposure to people and environment. For spent fuel, their half-lives can be over 100000 years. Therefore, to avoid the leakage of the nuclear waste during such a large time scale, it is vital to evaluate the radiation damage on the storage materials over 100000 years. In this presentation, the nuclear wastes storage and the theoretical evaluation of the radiation damage over large time scale will be briefly introduced.

Time: 11.30	**Break**

Time: 11.45	**Speaker:** Yangli Chen
Affiliation:	KTH Physics, Nuclear Power Safety

Title: Fukushima Daiichi Nuclear Severe Accident: A Review and Lessons Learned

On March 11th 2011, an earthquake with the magnitude of 9.1 occurred in the Pacific coast of Japan. The tsunami initiated by the earthquake later inundated a large portion of the east cost of Japan, and caused massive devastation and casualties. The tsunami also led to one of the most severe nuclear accidents at Fukushima Daiichi Nuclear Power Plant. Three among the six reactors suffered severely damaged, and the generated Hydrogen gas caused explosion. The radioactive releases contaminated a large area of the Fukushima Prefecture and others. Ten years have passed since this nuclear accident. Massive researches and investigations have helped people better understand the trigger and the aftermath of the accident. This presentation will provide the popular science knowledge on the development of nuclear energy and the Fukushima severe accident, and deliver the lessons learnt from this severe accident for different perspectives.

Time: 12.00	**Speaker:** Wei Zhang
Affiliation:	KTH Physics, Nuclear Physics

Title: Shape coexistence in nuclei

The realm of nuclear shapes is usually dominated by those of quadrupole type, prolate and oblate shapes, axial or triaxial. Shape coexistence is a very peculiar nuclear phenomenon that in the same nuclei, two or more different intrinsic shapes each having well-defined and distinct electromagnetic properties can present in the same nuclei. Shape coexistence in nuclei appears to be unique in the realm of finite many-body quantum systems. It has now been a feature of nuclear structure and much effort has been devoted to the manifestations for over 60 years.

Time: 12.15	**Speaker:** Yan Xiang
Affiliation:	KTH Physics, Nuclear Power Safety

Title: A scoping study of metal melt fragmentation and debris formation in water

The hypothetical core meltdown accident in a light water reactor is a severe accident situation during which the energetic dispersion of core materials and their relocation may pose a threat to the integrity of reactor containment. Motivated to understand the processes which govern the formation and characteristics of a debris bed and hence its coolability during a postulated severe accident, experimental studies on DEFOR (DEbris FORmation) test facility were conducted with metallic melt. Visualization of melt jet fragmentation process and debris formation was obtained via high speed camera. Molten Tin was used as the corium melt simulant. The 3D-lasers scanning technique was applied to get the open porosity of debris bed. The scoping experiments revealed the effect of melt superheat and subcooling on the debris bed characteristics. Quantification of debris bed configuration, particles morphology and sizes distribution, and porosity of debris bed were discussed with the existing database and correlations. The results are useful in assessing the coolability characteristics of debris bed and the mitigation strategy in severe accident.

Time: 12.30	**Lunch break**

Time: 13.30	**Speaker:** Huan Liu
Affiliation:	KTH Physics, Nuclear Engineering

Title: Accident-tolerant Fuel

Nuclear power has proven to be a reliable, environmentally sustainable, and cost-effective source of large-scale electricity. In the interest of continued technological improvement, further improvements in operational reliability, economics, and safety are being pursued worldwide. Ten years ago, station blackout accidents at three of the Japanese Fukushima Dai-ichi reactors occurred following the devastating earthquake. The Fukushima accident renewed interest in exploring the possibility of further design and fuel system improvements that could improve the safety of LWRs under accident scenarios, i.e, the accident tolerant fuel (ATF) concept. ATF can extend the life of current reactors by making them cheaper and nearly meltdown-proof, while simultaneously paving the way for advanced nuclear reactors that can greatly exceed the capabilities of the current fleet. ATF technology including two sections: ATF cladding and ATF fuel. The former can be achieved by coatings on current Zircaloy claddings or alter to silicon carbide composites to increase maximum tolerable cladding temperature (up to 2000 °C), fuel cycle cost benefits, and corrosion resistance. The latter can be achieved by replacing the conventional oxide fuel with the uranium silicide or waterproofed uranium nitrides which can improve the thermal conductivity and fissile material proportion significantly.

Time: 13.45	**Speaker:** Patrick Mutter
Affiliation:	KTH Applied Physics, Laser Physics

Title: Quasi-phase-matching

Quasi-phase matching (QPM) can be used to generate coherent light at desired wavelength and can be especially efficient in waveguides. This work shows how to fabricate QPM structures and waveguides in KTP as well as the optical performance of those crystals.

Time: 14.00	**Speaker:** Hongdi Wang
Affiliation:	KTH Physics, Nuclear Power Safety

Title: Thermo-mechanical behavior of the reactor pressure vessel wall in the nuclear severe accidents

The reactor pressure vessel (RPV) of a nuclear reactor is one of the key barriers to prevent the release of radioactive substances to the environment during a severe accident. One of the promising severe accident management (SAM) strategies to retain the heat-generating radioactive material inside the RPV is to cool the external surface of the vessel by water. In this presentation, we present the response of an RPV of a Nordic boiling water reactor (BWR) under in the severe accidents.

Time: 14.15	**Speaker:** Yucheng Deng
Affiliation:	KTH Physics, Nuclear Power Safety
Title: Experimental study on Oxidation of Zr-Fe Alloy	

Previous FCI(Fuel Coolant Interaction) study was mainly focused on oxidic materials (UO2/ZrO2 and its simulants).The Zr-Fe alloy is one of the major components in corium during a severe accident.Oxidation of the corium melt during FCI is an important phenomenon, which was recognized but not well understood, occurring when the melt contains a metallic component that is chemically reactive with water. Modeling of oxidation is a challenge for FCI codes, with little experimental data available for understanding and validation.

Time: 14.30	**Break**

Time: 14.45	**Speaker:** Maryam Sanaee
Affiliation:	KTH Applied Physics, Quantum and Biophotonics
Title: New drug delivery systems based on exosomes and exosome-mimetic nanovesicles	

Exosomes are extracellular vesicles of endocytic origin that are key actors for communications among cells and play a crucial role in the response of immune systems as well as in several pathologies, including cancer. They carry with them biological information reflecting the status of their parent cell, which makes them extremely interesting as potential biomarkers for a number of diseases. Moreover, due to their targeting functionality and low immunogenicity they are extremely promising as therapeutic drug delivery vehicles. Among different techniques used for exosome detection and characterization, fluorescence correlation spectroscopy (FCS) affords unique possibilities even for biomolecular analysis at single exosome level. Here we apply advanced FCS techniques for the analysis of exosomes loaded with therapeutic drugs and use them to quantify the average number of drug-loaded exosomes and the efficiency of the loading process at single vesicle level. Exosomes isolated from horse seminal plasma, were loaded with dUTP molecules fluorescently tagged by a green dye (Alexa 488), while their outer membrane was stained with a lipophilic red dye (CellVue Claret). Fluorescence Cross-Correlation Spectroscopy (FCCS) experiments were performed with a dual-color confocal laser excitation. FCS results for exosomes and dUTP molecules and their cross correlation has been measured, from which an average exosome loading yield of 25% was inferred. Bursts analysis on red and coincident red-green photon streams are used to dig out the size histograms of loaded vesicles. The overall exosome population peaked at a diameter of 70 nm, while the one of loaded exosomes at 120 nm. Moreover, by doing AFM and FCCS time traces analyses, the efficiency of loading as a function of exosome size and the number of loaded molecules per vesicle have been quantified.

Time: 15.00	**Speaker:** Felix Vennberg
Affiliation:	KTH Applied Physics, Photonics
Title: Introduction to optical metamaterials and structural color applications	

The optical properties of materials are mainly determined by their refractive index and their absorption. For applications in the visible spectra it is generally desirable for such materials to be transparent, i.e. low absorption, and have a high refractive index. The naturally occurring materials all fall within a limited range in terms of these two properties. It has recently been shown that it is possible to construct artificial metamaterials which can expand the range of optical properties. Metamaterials are constructed from designed structures that are smaller than the wavelength, which allows for engineering of the optical response. One application of such metamaterials is to produce structural colors. Structural colors arise from optical phenomena stemming from the shape and structure of materials, in contrast to absorption like in pigments and dyes. The talk will introduce the concept of metamaterials and their applications as well as structural coloration, how it is produced and used.

Time: 15.15	**Speaker:** Yuefei Liu
Affiliation:	KTH Applied Physics, Materials and Nanophysics
Title: Introduction of quantum entanglement between magnons	

Entanglement among magnetic excitations, such as magnons, is a new exciting platform for realizing entangled quantum states of matter. Especially antiferromagnets with degenerate modes is a strong candidate for this [D.Bossini et al., arxiv:1710.03143]. Entanglement of magnetic excitations is a sub-field of solid state magnetism, that clearly is in its infancy, with the potential to become an entirely new research area. The advantages compared to investigations of entanglement of photons is the much-reduced wave-length of magnons and the ability to approach nanometer-sized quantum technologies.

Time: 15.30	**Speaker:** Yuchuan Fan
Affiliation:	KTH Applied Physics, Photonics
Title: Fast signal quality monitoring for coherent communications enabled by CNN-based EVM estimation	

We propose a fast and accurate signal quality monitoring scheme that uses convolutional neural networks for error vector magnitude (EVM) estimation in coherent optical communications. We build a regression model to extract EVM information from complex signal constellation diagrams using a small number of received symbols. For the additive-white-Gaussian-noise-impaired channel, the proposed EVM estimation scheme shows a normalized mean absolute estimation error of 3.7% for quadrature phase-shift keying, 2.2% for 16-ary quadrature amplitude modulation (16QAM), and 1.1% for 64QAM signals, requiring only 100 symbols per constellation cluster in each observation period. Therefore, it can be used as a low-complexity alternative to conventional bit-error-rate estimation, enabling solutions for intelligent optical performance monitoring.