Available Positions for
KTH-CSC joint scholarship programme
Entry 2023

CONTENT

Full PhD student: 48 months

Biomechanics (Reg. No. 2301)

Type of position Full PhD student: 48 months	**Main supervisor** Ruoli Wang
KTH School SCI	**Co-supervisor(s)** Lanie Gutierrez-Farewik
KTH Department Engineering Mechanics	**Main email contact** ruoli@kth.se

Specific subject area(s)
Medical imaging, ultrasound, MRI, in vitro validation
Title of project
In vivo muscle morphology and property investigation using medical imaging
Number of available position
1
Earliest start date
2023-09-01
Latest start date
2023-12-15

Short description of the project

In the study of neuromuscular-affected diseases and evaluation of the corresponding therapies or interventions, monitoring muscle morphology, composition and mechanical properties are essential to better understand the nature of the impairment. B-mode ultrasound, elastography and magnetic resonance imaging (MRI) based methods are the main non-invasive evaluation techniques. 2D ultrasound allows a reproducible evaluation of the muscle by measuring muscle thickness, a section of muscle surface and pennation angle. 3D freehand ultrasound combines B-mode ultrasound and motion caption, which allows quantification of 3D information, such as muscle volume. The share wave elastography implies the production of share waves through the tissues, thus generating a strain on the tissue. The elasticity of muscle tissue is quantified by measuring either strain ratio or the elastic modulus. Alternatively, MRI is considered as the 'gold standard' in constructing three-dimensional subject-specific musculoskeletal anatomical structures. Other specific MRI methods, such as diffusion tensor imaging (DTI), MDixon and magnetic resonance imaging (MRE) have also been applied in evaluating muscle properties in different pathological populations. The overall goal of the project is two folds:1) to evaluate the reliability and validity of different image-based methods in quantifying mechanical properties of the musculotendon system. 2) to develop feasible workflow to apply medical image-based approaches in clinical assessment.

In this project, the PhD student will be part of MoveAbility Lab, which is a state-of-art biomechanics/human movement laboratory equipped with a 10-camera motion capture system, 3 force plates, wireless electromyography, inertial sensor system, pedograph, diagnostic ultrasonography and high-density electromyography etc. The student will work closely with other PhD students and postdoc from the MoveAbility lab as well as national and international experts in biomedical engineering, physicians, and physiotherapists in rehabilitation from Karolinska Institutet and Karolinska University Hospital.

The applicant will be expected to be involved in experimental and computational methodology development, data collection and analysis. Experience with medical imaging and good programming skills are required.

Project website
https://www.kth.se/en/sci/kth-moveability-lab/home-1.901385

Engineering Acoustics (Reg. No. 2302)

Type of position Full PhD student: 48 months	**Main supervisor** Leif Kari
KTH School SCI	**Co-supervisor(s)** Bochao Wang
KTH Department Engineering Mechanics	**Main email contact** leifkari@kth.se

Specific subject area(s)

Engineering acoustics at the Marcus Wallenberg Laboratory for Sound and Vibration Research (MWL) at KTH Royal Institute of Technology span from fundamental to applied research and consist of such as modeling, simulating and experimentally testing materials and components for sound and vibration applications. MWL is famous world-wide and the largest university center in northern Europe for experimental and theoretical work related to sound and vibration challenges.

Title of project
Characterization of the magnetic-electric-mechanical coupling of magneto-electric elastomers
Number of available position
1
Earliest start date
2023-08-01

Short description of the project

The magneto-electric (ME) effect, defined as the change in the electrical polarization of a material with an applied magnetic field and the change of the magnetization behavior of a material upon application of an electric field. As a bridge between the electrical and magnetic properties, the ME effect has attracted increasing interest due to its possible application in information storage, sensors, antennas, among others. Traditionally, ME materials are mainly fabricated by the combination of ceramic and metal-based magnetostrictive/piezoelectric constituents. Due to the large modulus and brittleness of those ME materials, they cannot be applied where large deformation may encounter.

Recently, by adding hard magnetic micro particles (e.g. NdFeB) into the polymer matrix, hard magnetic elastomers are fabricated. Under the application of an external magnetic field, a large deformation is generated through the interaction between the external magnetic field and the intrinsic magnetic dipoles of the hard magnetic MRE. By combining hard magnetic elastomer with polymer-based dielectric material, the drawback of the traditional multi-ferroic ME composites are overcome and a broader application scenarios of the ME effect is endowed. Specifically, the large deformation ability of the matrix enables the material to be customized into any shape. Furthermore, compared to the magneto-strictive material, the magnetic induced strain for hard magnetic elastomer is much larger and controllable, therefore, the coupling ME response will be much pronounced.

The intent of this research work is three-fold. The multi-field coupling behavior (magnetic, electric and deformation) of magneto-electric elastomers are characterized. Subsequently, a constitutive model and the corresponding finite element implementation module of ME elastomers are developed by utilizing continuum mechanics and electromagnetism theory. Finally, the application prospect of ME elastomers in wireless charging which is used to power the in-vivo medical micro robot and the sensing of magnetic field to realize wireless information transmission are explored.

Biomechanics (Reg. No. 2303)

Type of position Full PhD student: 48 months	**Main supervisor** Ruoli Wang
KTH School SCI	**Co-supervisor(s)**
KTH Department Engineering Mechanics	**Main email contact** ruoli@kth.se

Specific subject area(s)

Motion analysis, eye tracking and sensor data fusion

Title of project

Vision navigation and Body Movement in Daily Activities

Number of available position

1

Earliest start date

2023-09-01

Latest start date

2023-12-15

Short description of the project

Eye movements are the basis of how humans gather information about the environment, which is then used to allow the perception of vital information needed for safe navigation or task performance. Advancements in eye-tracking technologies have enabled eye movements to be monitored with small-scale devices that can be used in a variety of environments. Human locomotion requires precise coordination between biomechanics of the body parts and eye movements. Flexible and adaptive motor control requires optimal integration of all available sensory inputs. It is generally believed that person without proprioception loss usually use visual feedback to adapt the terrain differences. However, little is known about how the visual and locomotion system work together to support the movement. This knowledge helps to understand the adaptation and control compromised by loss of vision and proprioception in elderly or pathological groups. The overall purpose of this project is to develop feasible experimental methods which integrates an eye tracking system and marker-based or markerless motion capture system to simultaneously record eye movement and full-body kinematics and kinetics during different daily activities. We will investigate the association of gaze with body movement adaption with the different vision scenarios, possibly in both indoor and outdoor environment.

In this project, the PhD student will be part of MoveAbility Lab, which is a state-of-art biomechanics/human movement laboratory equipped with a 10-camera motion capture system, 3 force plates, wireless electromyography, inertial sensor system, pedograph, diagnostic ultrasonography and high-density electromyography etc. The student will work closely with other PhD students and postdoc from the MoveAbility lab as well as national and international experts in biomedical engineering, physicians, and physiotherapists in rehabilitation from Karolinska Institutet and Karolinska University Hospital.

The applicant will be expected to be involved in methodology development, data collection and analysis. Experience with biomechanics of human movement and biological signal post-processing are required. Basic knowledge about electronics is desired.

Project website
https://www.kth.se/en/sci/kth-moveability-lab/home-1.901385

Engineering Mechanics (Reg. No. 2304)

Type of position Full PhD student: 48 months	**Main supervisor** Peter Göransson
KTH School SCI	**Co-supervisor(s)** Romain Rumpler
KTH Department Engineering Mechanics	**Main email contact** pege@kth.se

Specific subject area(s)
Sound and Vibration
Title of project
Design 3D Anisotropic Cellular Acoustic Metamaterials
Number of available position
1
Earliest start date
2023-08-01
Short description of the project

The objective of this project is to investigate methods for the systematic design of architectured materials exhibiting exceptional macroscale physical and mechanical properties which can be controlled by a careful design at the microstructural level. Such non-intuitive materials, sometimes referred to as acoustic metamaterials, offer the potential for radical changes in our approach to noise and vibration control. Traditional or human-centered approaches to design are however incapable of achieving optimal solutions in the vast design spaces these materials offer, a challenge intended to be overcome with the proposed research. For this purpose, a balance of physics-based and data-driven methods are intended to be investigated. The latter is particularly motivated by the fact that it is practically impossible to theoretically explore the full anisotropic design space offered for instance by cellular materials, in focus here. In order to address this challenge, a cellular design strategy will be deployed, which bypasses expensive simulations and leverages very promising early results obtained by the applicant in controlling macroscale effective properties through tailored topological features.

Photonics (Reg. No. 2305)

Type of position Full PhD student: 48 months	**Main supervisor** Oskars Ozolins
KTH School SCI	**Co-supervisor(s)** Xiaodan Pang
KTH Department Applied Physics	**Main email contact** ozolins@kth.se

Specific subject area(s)
Optical and wireless communication
Title of project
XR-COMM: 5G/6G communication systems for future XR technologies
Number of available position
2
Earliest start date
2023-03-01
Latest start date
2024-03-01
Short description of the project

The Fourth Industrial Revolution (4IR) drives economic growth opportunities through the fast evolution of production, operation, and service delivery processes, where Sweden is already a frontrunner in many vertical industries. The Industrial Internet of Things (IIoT) is a key enabler of 4IR, bringing digital transformation to digitize processes. However, IIoT still faces many challenges, especially in implementation and cost. Another promising future application for businesses and society is the eXtended Reality (XR), which also imposes stringent requirements on real-time, high-resolution, and holographic experiences with mobility without interruption. 5G will only set the basis for new use cases using XR technologies and intelligent factories where its digital representation of physical machines and processes is done through "digital twins." The key performance indicators of 5G for download and upload speeds are 100Mbps and 50Mbps, which are substantially lower than the long-term requirements for XR and digital twins. Thus, a new solution that can provide higher data rates and ubiquitous service is needed for the sixth-generation (6G) mobile networks. Foreseen requirements and use cases have shown that current mobile network implementations must be reconsidered. In cases where large bandwidth signals and low complexity radio units are a must, current digital fronthaul interfaces, e.g., the (enhanced) Common Public Radio Interface (CPRI/eCPRI), face complications due to their limited spectral efficiency and flexibility. Unlike the CPRI-like interfaces with the data rate scaling problem, the analog optical interface directly modulates wireless signals on the optical carrier, i.e., analog radio-over-fiber (ARoF) signals. XR-COMM project will show that distributed multiple input and multiple out (D-MIMO) realized with ARoF technology has unique and significant advantages in terms of bandwidth and power consumption. We are going to collaborate with Ericsson, Coherent and RISE Research Institutes of Sweden, in the Kista High-Speed Transmission Lab.

Project website
https://www.kth.se/en/sci/kth-moveability-lab/home-1.901385

Vehicle and Maritime Engineering (Reg. No. 2306)

Type of position Full PhD student: 48 months	**Main supervisor** Zuheir Barsoum
KTH School SCI	**Co-supervisor(s)** Mansoor Khurshid
KTH Department Engineering Mechanics	**Main email contact** zuheir@kth.se

Specific subject area(s)
Lightweight Structures
Title of project
Static and Fatigue strength assessment of welded steel structures
Number of available position
1
Earliest start date
2023-02-01
Short description of the project

Load-carrying structures in construction machineries, cranes, mining equipment, transport vehicles and agricultural equipment are often complex welded steel. One of the goals are to make the products from these industries lightweight and sustainable compared to existing products. Lightweight structures reduce environmental impact by decreased fuel consumption, material usage, and production resources. However; it comes with challenges such as availability of materials, existing strength assessment methodologies, production processes, and understanding of load cases. The introduction of lightweight structures is connected to the possibility to use high strength steel (HSS). The benefits of using HSS is well utilized in meeting static strength requirements but they are limited in fatigue strength when such steels are welded. A large contributors of the slow introduction of HSS is also due to the large scatter in the production process and applicability of suitable fatigue strength assessment methodologies. With a reduced scatter in production, better load estimation, using post weld improvement techniques (Grinding and High Frequency Mechanical Impact treatment) and choice of strength assessment method a better utilization of HSS is possible with the great potential of lightweight structures. The project focuses on developing lightweight welded steel components in HSS (S900-S1300) with potential application in above mentioned industrial sectors, identifying most accurate fatigue strength assessment methodologies, and developing numerical methods for simulating production processes. Real case studies from spreaders will be studied within the project. Long term goals of the project is to develop tools and knowledge for reducing weight of spreaders through the use of HSS, increasing payload capacities and reliability, address the scientific gap of increase need of understanding of steels of yield strength greater 700MPa, and reducing environmental impact. This project will address United Nations Sustainable Development goals such as Quality education, industry, innovation and infrastructure, responsible consumption and production, and climate action.

Nuclear Power Safety (Reg. No. 2307)

Type of position Full PhD student: 48 months	**Main supervisor** Sevostian Bechta
KTH School SCI	**Co-supervisor(s)** Weimin Ma
KTH Department Physics	**Main email contact** bechta@safety.sci.kth.se

Specific subject area(s)

Safety of Gen-IV reactors

Title of project

Safety assessment of Gen-IV reactors

Number of available position

1

Earliest start date

2023-09-01

Short description of the project

Generation IV reactors have been receiving more and more attention worldwide, since they are touted as both safer and more efficient than conventional light water reactors (LWRs). Public demonstrations of Gen IV are expected to confirm negligible risk of severe accidents with core melting and large radioactive releases practically eliminated. Some of the safety concepts/principles/criteria and safety analysis tools are evolutionary or adapted from the conventional LWRs using similar methodologies. The proposed project is intended to contribute to safety assessment of a selected Gen IV design. Safety methodologies and analysis tools will be critically reviewed, adapted or further developed for applications to plant calculations. Accident tolerance of the specific reactor design in respect to severe core damage will be assessed together with some other safety criteria. Effectiveness of various accident management measures will be evaluated.

Nuclear Power Safety (Reg. No. 2308)

Type of position Full PhD student: 48 months	**Main supervisor** Weimin Ma
KTH School SCI	**Co-supervisor(s)** Andrei Komlev
KTH Department Physics	**Main email contact** weimin@kth.se

Specific subject area(s)
Safety of light water reactors
Title of project
Investigation on melt oxidation in water during severe accidents
Number of available position
1
Earliest start date
2023-09-01
Short description of the project

The proposed work is concerned with safety improvement of light water reactors (pressurized water reactors and boiling water reactors). The research is conducted to investigate corium oxidation phenomenon during melt fragmentation in water at the ex-vessel phase of a severe accident and oxidation effects on steam explosion, melt quenching and debris formation/coolability. The project results are instrumental for safety analyses of ex-vessel melt stabilization strategies applied for severe accident management in various light water reactors. The study involves the contents of multi-phase, multi-physics, physical chemistry and material science. Both analytical study and experimentation with corium simulant materials are expected. The project will leverage on the previous development of research infrastructure and ongoing programs at KTH/NPS.

Applied Physics (Reg. No. 2309)

Type of position Full PhD student: 48 months	**Main supervisor** Ilya Sychugov
KTH School SCI	**Co-supervisor(s)**
KTH Department Applied Physics	**Main email contact** ilyas@kth.se

Specific subject area(s)

Nanophotonics, Physical Chemistry

Title of project

Nanomaterials for semi-transparent photovoltaics

Number of available position

1

Earliest start date

2023-09-01

Short description of the project

This PhD degree project deals with chemical synthesis and optical characterization of nanophosphors, such as quantum dots, nanoclusters, rare-earth and transition metal ion doped nanoparticles, etc. and is expected to last for four years. Mass fabrication of nanoparticles in liquid and solid phases will be done in our chemical lab as well as measurements of their quantum efficiency and other optical properties. A recipe for fabrication of nanostructures with high quantum yield and appropriate emission spectrum is expected to be developed for application in transparent photovoltaics. For more detailed information see our recent publications below.

Key activities include:

· Fabrication nanoparticles

· Characterization of ensembles and single nanoparticles by optical methods

· Photovoltaic device fabrication and tests

Pre-requisites:

· Hand-on experience and theoretical knowledge of chemical synthesis and processing of nanomaterials

· Familiarity with optical characterization methods, such as photoluminescence spectroscopy and photovoltaic characterization

· Good communication skills in English

Project website

https://www.aphys.kth.se/sv/photonics/nas/

Materials Science (Reg. No. 2310)

Type of position Full PhD student: 48 months	**Main supervisor** Muhammet Toprak
KTH School SCI	**Co-supervisor(s)** Bejan Hamawandi
KTH Department Applied Physics	**Main email contact** toprak@kth.se

Specific subject area(s)

Materials Science, Chemistry, Nanotechnology

Title of project

Nanostructured Thermoelectric Materials and Development of Hybrid Thermoelectrics.

Number of available position

1

Earliest start date

2023-04-01

Latest **start date**

2023-08-21

Short description of the project

The project is aiming at developing nanostructured thermoelectric (TE) materials using a range of solution chemical techniques. Materials will be selected from environment-friendly categories, and energy-resource effective methods of synthesis will be developed. The fabricated materials will be throughly evaluated for the structural and transport properties. Nanoarchitectonics concepts will be developed to identify the best performing morphology and size of the TE nanomaterials for the intended TE energy harvesting applications. A detailed surface study, and the integration of the developed nanomaterials with various polymeric matrices will be undertaken for the fabrication of hybrid TE films and devices. Additive manufacturing techniques will also be utilized to generate inks that can be printed using a diverse set of 3D printing techniques. Sustainable polymeric materials will be prioritized in the realization of the project.

Project website

our ongoing EU project: http://uncorrelated.uji.es

Transportation Science (Reg. No. 2311)

Type of position Full PhD student: 48 months	**Main supervisor** Erik Jenelius
KTH School ABE	**Co-supervisor(s)** Zhenliang Ma
KTH Department Civil and Architectural Engineering	**Main email contact** erik.jenelius@abe.kth.se

Specific subject area(s)
Urban Rail Transit
Title of project
SimMetro: Digital Twin Simulation for Urban Rail Transit Systems
Number of available position
1
Earliest start date
2023-09-01
Short description of the project

The United Nations estimates that 55% of the world's population resides in urban environments, with projections reaching 68% by 2050. In such a context of rapid population growth and concentration, the concept of smart cities has emerged, responding to the challenge of quality of living and sustainable development of these urban environments. Urban rail transit (Tram, Light Rail, Metro, and Suburban) plays a major role in delivering quality mobility in urban areas with low carbon emissions and energy consumption given its high-frequency, high-capacity, and high-reliability service. However, the urban railway system (particularly the metro system) in major metropolitan areas faces operational challenges, especially during peak periods when they operate close to capacity. Climate change and public health (e.g., covid19) bring further constraints on operating capacities (e.g., sanitation, maintenance), together with the increasing demand for urban mobility, that stress the need for new and innovative planning and operating practices and tools for urban rail systems.

The simulation tool has been widely used for planning practices to answer what-if questions in traffic (e.g., Vissim), public transport (e.g., BusMezzo), and (long-distance) railway systems (e.g., RailSys). However, there is a lack of simulation models for urban rail systems, which have significantly different characteristics from other modes, for example, signaling control systems, infrastructure mixed with general car traffic, complex interactions between passengers and services, traffic signal priorities, etc. Moreover, the increasing advancement of technologies, particularly the ubiquitous, real-time sensors and connectivity, allows the collection of diverse data and direct customer communications. These constitute the primary sources of the ongoing digitalization of urban rail transit systems to shift the planning and operation practices from an offline, reactive manner to an online, predictive paradigm. However, there are yet research and practice gaps in leveraging these new data and connectivity to innovate the simulation models to interact between the virtual environment and the real world and importantly support holistic and predictive decision-making.

This project aims to develop digital twin simulation models for urban transit systems (SimMetro), to simulate changes in infrastructure, operations, technology, and demographics that will impact the movement, accessibility, and productivity of a given area. At the core of its technology are a rigorous causal-predictive modeling and optimization platform and agent-based simulation models. For this, data-driven models work in parallel with real-life measurements to reproduce findings and predict the results of response actions. The models are typically agent-based (ABM) and open-source, which can enable city authorities and urban rail transit agencies to recognize their own roles and management models for informative decision-making for urban rail transit planning and operations toward more livable and healthy cities.

The project is a collaboration between KTH iMobility Lab and MIT Transit Lab, which both have extensive research experience in public transport and data-driven simulation modeling and practical applications for urban rail transit systems in Stockholm, Hong Kong, Boston, and London. The successful candidate would work closely with lab members on the project.

Transport Science (Reg. No. 2312)

Type of position Full PhD student: 48 months	**Main supervisor** Xiaoliang Ma
KTH School ABE	**Co-supervisor(s)**
KTH Department Civil and Architectural Engineering	**Main email contact** liang@kth.se

Specific subject area(s)

Intelligent Transport Systems

Title of project

IGNITE Intelligent sensinG and coNtrol of urban traffIc and environmenT by smart Edges

Number of available position

2

Earliest start date

2023-08-15

Short description of the project

Digitalisation is an indispensable procedure for developing future smart cities. For urban traffic and environment, a large amount of IoT sensors and innovative systems have been developed based on emerging technologies, e.g., 5G communication, and they are now being installed on urban roads in order to more effectively monitor and control traffic flows and their impacts based on new policy goals.

IGNITE project will develop a methodological framework for building digital representation of traffic environment and predicting traffic flows based on data from various sensors and other sources. The project has access of online data from radars, lidars, cameras and V2X communication etc., and intends to process them into a holistic and consistent model of real-time traffic states. This work may involve processing of measurement data, synchronising the data with real-time simulation, applying statistical machine learning methods for system identification and prediction as well as validation of the digital twin models of different levels.

Another objective of the project is to develop intelligent urban traffic controls and implement the software in a cloud-edge computing framework. Based on the previous research results achieved in the iTensor project, multi-agent control approaches will be further developed for urban traffic management systems. Traffic signal control in the Nordic countries is based on signal groups operating as individual intelligent agents that may access traffic state estimation and prediction from the digital twin model. The agents can interact with each other, forming together a swarm of intelligence. The digital twin guarantees that all agents have the same understanding of the traffic situation. Intelligent control methods are applied in a distributed way to optimise, in real time, signal phasing and timing as well as coordination among intersections. The research approach encompasses flexible and context dependent operations that may take into account various policy goals of the cities.

Land and Water Resources Engineering (Reg. No. 2313)

Type of position Full PhD student: 48 months	**Main supervisor** Maria Malmström
KTH School ABE	**Co-supervisor(s)** Liangchao Zou and Vladimir Cvetkovic
KTH Department Environmental Science and Engineering	**Main email contact** maria.malmstrom@abe.kth.se

Specific subject area(s)

Hydrogeology

Title of project

Analysis of cement grout propagation in fractured rocks

Number of available position

1

Earliest start date

Latest start date

2023-12-31

Short description of the project

Modeling of cement grout propagation in fractured rocks is important for the design, monitoring, and operation of rock grouting that has been widely used for groundwater flow management in the construction and maintenance of underground infrastructures. This project aims to develop a 3D fracture network model to analyze cement grouts propagation in fractured rocks, which is a major step toward high-precision modeling of the grouting process. The complex geometrical conditions of rock fracture networks and the complex rheological properties of cement grouts will be explicitly considered in the 3D fracture network model. Thus, this project will finally provide a new computational tool to model the rock grouting process more precisely. Using the 3D fracture network model, the impacts of 3D network structures, heterogeneous fracture transmissivity, and grout rheological properties on the grouting process will be investigated and a workflow of rock grouting based on 3D fracture network modeling will be proposed to be implemented in engineering practice. The developed 3D fracture network model and investigation results will contribute to the advancement of the rock grouting technique for sustainable infrastructure development.

Electrical engineering (Reg. No. 2314)

Type of position Full PhD student: 48 months	**Main supervisor** Qianwen Xu
KTH School EECS	**Co-supervisor(s)** Stefan Östlund
KTH Department Electrical Engineering	**Main email contact** qianwenx@kth.se

Specific subject area(s)
Power electronics and microgrids
Title of project
Design, control and energy management of sustainable electric railway systems
Number of available position
1
Earliest start date
2023-09-01
Latest start date
2023-11-01
Short description of the project

Moving towards climate neutral society, railway systems are going through the electrification with the utilization of clean energy sources. Fuel cell based electric railway systems attract increasing attention. However, a main shortcoming of fuel cell is its efficiency and lifecycle that are significantly impacted by loading profile. Moreover, as new sources and loads in electrical railway systems are connected through interface converters, another challenge is the power quality issues caused by interactions of power converters and fast loading profiles. Using energy storage to compensate fuel cell is promising to enhance the overall efficiency and enhance power quality. Then how to design the size, control and energy management system is a significant challenge to achieve optimized cost, minimized harmonics and enhanced overall performance.

This PhD project aims to develop optimal sizing, advanced control and energy management strategies for sustainable electric railway systems with fuel cell and energy storage.

Electrical engineering (Reg. No. 2315)

Type of position Full PhD student: 48 months	**Main supervisor** Luca Peretti
KTH School EECS	**Co-supervisor(s)** Bin Liu, Xiongwei Wang
KTH Department Electric Power and Energy Systems	**Main email contact** lucap@kth.se

Specific subject area(s)

Electric machines and drives

Title of project

Optimal control solutions for WBG-based next-generation robotic drivetrains

Number of available position

1

Earliest start date

2023-03-01

Short description of the project

The latest years showed significant growth in robotics R&D, with many potential applications in industry and healthcare. China plans to become the global leader in the industry, and Elon Musk declared that the business ""[…] has the potential to be more significant than the vehicle business over time"".

For many years, robotic drivetrain solutions relied on established components that required minimal theoretical knowledge. Wide-bandgap (WBG) devices and more aggressive electric machine designs for higher torque densities changed the scenario recently. New drivetrain concepts, including extreme converter-machine integration, are possible, and the players must follow this trend – or risk ""death"" in the market.

This project proposal evaluates the technology, builds models, and develops optimal control structures for the upcoming generation of robotic drivetrains based on WBG devices (Silicon-Carbide and Gallium-Nitride) and electric machines with higher torque density. The approach is system-based, meaning that the overall optimization is achieved by considering the many operational parameter combinations at our disposal. The target is a conceptual drivetrain demonstration, incorporating control solutions that achieve:

Torque generation with overall system electric loss minimization;

Dynamic switching frequency patterns for different operational regions;

DC-bus voltage level and voltage derivatives considerations to account for their effect on the motor lifetime;

A learning mechanism from the repetitive operational cycles of the robot.

The project involves KTH and ABB Corporate Research, supporting the additional scholarship fee. The aim is to train a student with electromechanical energy conversion, motor control, and robotics competencies. The plan is to host the doctoral student for an extended period at ABB for closer work on relevant hardware and software, which will be duplicated at KTH. This project is the first initiative in a more significant attempt to expand the collaboration between the partners in this critical research area.

Information and Communication Technology (Reg. No. 2316)

Type of position Full PhD student: 48 months	**Main supervisor** Jiantong Li
KTH School EECS	**Co-supervisor(s)** Carl-Mikael Zetterling
KTH Department Electrical Engineering	**Main email contact** jiantong@kth.se

Specific subject area(s)
Electronics
Title of project
Fully-Printed Disposable On-Paper Self-Charging Power Systems
Number of available position
1
Earliest start date
2023-06-01
Latest start date
2023-10-01
Short description of the project

Paper-based wearable electronics offer great opportunities to develop smart paper products that can directly contact human body for long-term monitoring of physiologic signals for personalized healthcare and therapy. However, their practical applications are hindered by the lack of suitable power sources that can retain the comfortability and eco-friendliness of the conventional paper products. In this project, we will develop a "full inkjet printing" technology for simple yet scalable fabrication of miniaturized self-charging power systems on paper substrates to provide efficient and sustainable power solutions to paper-based skin-interfaced wearable electronics. Likely for the first time, inkjet printing for a comprehensive set of biocompatible materials, mainly including graphene, conducting/semiconducting polymers, and piezoelectric polymers, will be developed to fully print the entire “metal-free” self-charging power systems on paper substrates, including all the components (piezoelectric energy harvesters, microsupercapacitors and rectifiers) and interconnects. After their life cycle, the on-paper power systems can be thrown away in the trash with negligible impact to the environment. The research is expected to greatly expedite the application of skin-interfaced wearable electronics and substantially contribute to the fields of smart paper products for personalized healthcare and therapy to improve people's life and wellbeing.

Biotechnology - bioprocessing (Reg. No. 2317)

Type of position Full PhD student: 48 months	**Main supervisor** Veronique Chotteau
KTH School CBH	**Co-supervisor(s)** Håkan Hjalmarsson; Johan Rockberg
KTH Department Industrial Biotechnology	**Main email contact** chotteau@kth.se

Specific subject area(s)

Process Analytical Technology - perfusion culture - monoclonal antibody

Title of project

Process Analytical Technology for on-line monitoring and control of antibody producing mammalian cell culture

Number of available position

1

Earliest start date

2023-05-01

Latest start date

2023-11-01

Short description of the project

The project will focus on the production monoclonal antibodies in high cell density perfusion culture, and will be performed in collaboration with AdBIOPRO, Competence Centre for Advanced BioProduction by Continuous Processing, and the companies ArgusEye (Sweden), BioInvent (Sweden), TimeGate (Finland) and ERBI (USA). Monoclonal antibodies represent a class of therapeutic molecules of very high economic importance. high cell density perfusion cultures provide continuous bioproduction offering intensification, lower capital expenditure, higher flexibility and sustainability in comparison with legacy batch processes. Real-time (on-/in-line) monitoring of bioprocesses has gain a lot of attraction in biopharmaceutical production. This is even more important for continuous perfusion process where feedback control strategy can be put in place to master the product quality and yield in a way much more powerful than fed-batch processes dominated by transient dynamical behavior. The aim of this project will be to develop and use for monitoring and control Process Analytical Technology (PAT) such as time gated Raman spectroscopy to monitor important metabolites and antibody quality attributes and surface plasmon resonance sensor to monitor the antibody titre. The work will be carried out in screening antibody producing high cell density perfusion bioreactors systems of 2 mL for screening and 200 mL stirred tank bioreactors for validation. During the first phase of the project, the sensor technologies will be adapted to be mounted in the bioreactors. The second phase will be dedicated to the development of the partial least square models for the Raman probe to quantify metabolites and quality attributes. In the third phase, these PAT will be used in the cultures, to develop and validate model-based feedback control strategies to control the antibody production and its quality with a digital twin approach, where the models will be derived from KTH's current work.

Solid mechanics (Reg. No. 2318)

Type of position Full PhD student: 48 months	Main supervisor Xiaogai Li
KTH School CBH	**Co-supervisor(s)** Madelen Fahlstedt, Zhou Zhou
KTH Department Biomedical Engineering and Health Systems	**Main email contact** xiaogai@kth.se

Specific subject area(s)
Computational mechanics, Head injury; Finite element modeling; Head protection systems

Title of project
Mechanisms of head and neck injuries for a diverse population - towards improved head protection systems

Number of available position
1

Earliest start date
2023-09-01

Short description of the project

Up to 69 million people worldwide suffer from traumatic brain injury (TBIs) each year, causing not only tremendous socioeconomic burden but also long-lasting consequences for the victims and close relatives. A better understanding of injury mechanisms is critical for developing novel and effective head protection systems to reduce the severity and prevent TBIs. In recent years, computational mechanics has become a powerful tool for studying and predicting TBIs. This PhD project aims to develop detailed and personalized models representing a diverse population to study mechanisms of head and neck injuries, based on which to design and develop innovative protection systems. The research will be carried out at the Division of Neuronic Engineering at KTH, which has a long tradition of performing multidisciplinary research focusing on developing new and effective technology innovations for head and neck injury prevention using advanced human head models. The candidate is expected to have a solid background in solid mechanics. Experience in finite element modeling and computer programming are desirable, but not mandatory. The successful candidate will gain substantial experience in computational mechanics, head injury biomechanics, finite element modeling, and innovative product design.

Project website
https://www.kth.se/mth/neuronik/division-of-neuronic-engineering-1.741783

Applied Medical Technology (Reg. No. 2319)

Type of position Full PhD student: 48 months	**Main supervisor** Svein Kleiven
KTH School CBH	**Co-supervisor(s)** Zhou Zhou; Xiaogai Li
KTH Department Biomedical Engineering and Health Systems	**Main email contact** sveink@kth.se

Specific subject area(s)

Medical engineering; Biomechanics; Solid mechanics

Title of project

Neuroimaging-informed modeling of traumatic brain injury

Number of available position

1

Earliest start date

2023-09-01

Short description of the project

Traumatic brain injury (TBI) is a public health threat worldwide with traffic accidents and falling as the leading causes. As numerical surrogates, finite element (FE) models of human brain are instrumental to narrow down the knowledge gaps between external insults and injury outcomes. However, the applicability of FE models is often limited by the anatomical details incorporated. This is directly relevant to the heterogeneity of TBI that impairs various intracranial structures with diverse pathological outcomes. Prosperous development of imaging techniques generates various types of modalities, delineating different aspects of the intracranial complexity. Thus, incorporating neuroimaging-revealed anatomical details with FE models opens vast new opportunities to decipher the heterogeneous mechanics behind TBI.

This project will be divided into two major parts: 1. Integrating state-of-the-art biomechanical modelling approaches with sophisticated biomedical imaging techniques to advance mechanobiological understanding of TBI; 2) Evaluating and optimizing head protection systems (e.g., helmets, airbags, seatbelts, floors) via high-fidelity simulations to reduce the severity and consequences of TBI.

The research will be carried out at Division of Neuronic Engineering at KTH. The Division has a long tradition of performing multidisciplinary research focusing on developing new and effective technology innovations for head and neck injury prevention as well as clinical treatment using advanced human head models. The group also maintains thematically diverse international research collaborations and national industrial partners. The research results have led to a number of spin-off companies, which fulfilled the Division's vision - bring technical expertise in clinical neuroscience.

We are seeking a highly motivated and ambitious Ph.D. student for the above-outlined research project. The candidate is expected to have a solid background in solid mechanics and medical imaging. Experience in FE modeling and computer programming is desirable, but not mandatory. The successful candidate will gain substantial experience in injury biomechanics, computational modeling, and neuroimaging analysis.

Project website
https://www.kth.se/mth/neuronik/division-of-neuronic-engineering-1.741783

Biotechnology (Reg. No. 2320)

Type of position Full PhD student: 48 months	**Main supervisor** Torbjörn Gräslund
KTH School CBH	**Co-supervisor(s)**
KTH Department Protein Science	**Main email contact** torbjorn@kth.se

Specific subject area(s)
Biotechnology
Title of project
Affibody molecules for medical applications
Number of available position
1
Earliest start date
2023-07-01
Short description of the project

Affibody molecules are folded and small engineered affinity protein domains, which can be generated to interact specifically with desired targets with high affinity. In recent years our group has focused on the development of affibody molecules for cancer diagnostics and therapy as well affibody molecules to enhance the efficacy of biological drugs.

Three key high-impact publications describe some of our efforts concerning affibodies and other research questions:

Bronge M, et al. Science Adv. 2022, 29;8(17):eabn1823

Xu T, et al. Cancers (Basel). 2020 Dec 30;13(1):85.

Altai M. et al. J Control Release. 2018 Aug 30;288:84-95.

We now aim to take the research to the next level where we will:

1. Select affibody molecules to novel targets for application in oncology, immunity, and inflammation.

2. Utilize other classes of affinity proteins to create drug conjugates.

The student will work with combinatorial and rational engineering and design of proteins for medical applications. More specifically, the student will learn cell-display-based selection from combinatorial libraries, rational design of proteins, protein production and purification, and protein analysis using a number of state-of-the-art techniques. In collaboration with other groups in Sweden and internationally, as well as small biotech companies, studies of the in vivo function of the designed proteins will be conducted.

Biotechnology (Reg. No. 2321)

Type of position Full PhD student: 48 months	**Main supervisor** Adil Mardinoglu
KTH School CBH	**Co-supervisor(s)** Cheng Zhang
KTH Department Protein Science	**Main email contact** adilm@kth.se

Specific subject area(s)
Systems biology and translational medicine
Title of project
Exploring potential novel diagnosis and treatment for liver cancer
Number of available position
1
Earliest start date
2023-07-01
Short description of the project

Non-alcoholic fatty liver disease encompasses a broad spectrum of pathological conditions, ranging from simple steatosis to various degrees of liver inflammation and can ultimately progress to hepatocellular carcinoma (HCC) — the most common liver cancer. When the liver reaches a state of HCC, the only possible treatment option for patients right now is liver transplantation.

Single-cell sequencing technologies experienced a dramatic breakthrough during the last decade enabling researchers to investigate the genome-wide transcriptomic changes of different cell types in liver. In addition, systems biology approach in general, and biological networks as well as genome scale metabolic models (GEMs) in particular, can facilitate this hurdle and bridge this gap by allowing multi-layer integration of omics data in the context of multi-cell-type system.

In this project, the applicant will adopt an iterative multi-scale, systems biology approach coupled to in vitro and in vivo experimentation to identify several new therapeutic gene targets as well as lead compounds with different scaffolds; this will dramatically increase the chances to obtain an ideal drug candidate to treat HCC. The identified targets and drugs will also be tested in vitro and in different mouse models. The unbiased approach using biological network models that integrate multi-omics data will also significantly advance our understanding of the pathophysiological responses of the disease.

Biotechnology (Reg. No. 2322)

Type of position Full PhD student: 48 months	**Main supervisor** Adil Mardinoglu
KTH School CBH	**Co-supervisor(s)** Cheng Zhang
KTH Department Protein Science	**Main email contact** adilm@kth.se

Specific subject area(s)
Systems biology and translational medicine
Title of project
Exploring potential novel diagnosis and treatment for cirrhosis of liver
Number of available position
1
Earliest start date
2023-07-01
Latest start date
2023-12-15
Short description of the project

Non-alcoholic fatty liver disease encompasses a broad spectrum of pathological conditions, ranging from simple steatosis to various degrees of liver inflammation and can ultimately progress to cirrhosis and hepatocellular carcinoma (HCC) — the most common liver cancer. Cirrhosis is a direct consequence of non-alcoholic steatohepatitis (NASH) and causes irreversible damage to the liver. When the liver reaches a state of cirrhosis, the only possible treatment option for patients right now is liver transplantation. Importantly, it is projected that NASH is currently the leading cause of liver transplantation in the USA.

Single-cell sequencing technologies experienced a dramatic breakthrough during the last decade enabling researchers to investigate the genome-wide transcriptomic changes of different cell types in liver. In addition, systems biology approach in general, and biological networks as well as genome scale metabolic models (GEMs) in particular, can facilitate this hurdle and bridge this gap by allowing multi-layer integration of omics data in the context of multi-cell-type system.

In this project, the applicant will adopt an iterative multi-scale, systems biology approach coupled to in vitro and in vivo experimentation to identify several new therapeutic gene targets as well as lead compounds with different scaffolds; this will dramatically increase the chances to obtain an ideal drug candidate to treat liver cirrhosis. The identified targets and drugs will also be tested in vitro and in different mouse models. The unbiased approach using biological network models that integrate multi-omics data will also significantly advance our understanding of the pathophysiological responses of the disease.

Machine design (Reg. No. 2323)

Type of position Full PhD student: 48 months	**Main supervisor** Sergei Glavatskih
KTH School ITM	**Co-supervisor(s)** Thomas Norrby
KTH Department MMK	**Main email contact** segla@kth.se

Specific subject area(s)
Tribology
Title of project
Lubrication design for electrified drivetrains
Number of available position
1
Earliest start date
2023-06-01
Short description of the project

Innovative technical solutions for meeting the engineering needs of the future in a sustainable way requires disruptive developments in the field of machine design including optimization of lubricants and lubrication. The entire tribosystem of a machine or an application needs to be carefully tailored and sustainable.

The research project aims at the development of new lubrication technologies to enhance electric machinery. The demands on lubricants for increased energy efficiency and sustainability in “green” electric machinery are escalating. The goal of the project is to understand lubrication mechanisms of novel lubricant formulations to control friction and decrease wear in the electric machinery. The lubrication technology will also bring additional functionality such as tunable electric conductivity.

Lubricated contacts in gears and bearings will be modelled and studied by using our research test rigs. A range of equipment will be used to analyse surfaces worn in the tests and lubricant properties. This is a multidisciplinary research effort that links simulations, tribology and machine design. The project is carried out in a close collaboration with industry.

Production engineering (Reg. No. 2324)

Type of position Full PhD student: 48 months	Main supervisor Xi (Vincent) Wang
KTH School ITM	**Co-supervisor(s)** Lihui Wang, Magnus Wiktorsson
KTH Department Production Engineering	**Main email contact** wangxi@kth.se

Specific subject area(s)

Robotics, Digital Twins

Title of project

Digital Twins and robots towards Safe Smart Construction

Number of available position

1

Earliest start date

2023-05-01

Short description of the project

Background: Smart construction, relating to the automation of construction sites to the highest possible degree, is a promising but also extremely challenging upcoming industrial field. It carries the idea from flexible automation, i.e. producing a large variety of different goods and products through a singular manufacturing site with on-demand reconfiguration of machines and robots, into the construction domain where products typically have lot size 1 (one-off production). However, while construction sites rely today (still) to a large amount on manual labor, the vision for the future is to leverage automation equipment (machines, robots) to the largest extent possible in order to speed-up the production cycle, enhance quality while also reducing human risks, carbon emissions and costs.

Scope: It is broadly accepted regarding smart construction that the realization of this vision is only possible by a stringent digitalization of the construction site in terms of real-time digital twins of products and production systems paired with sophisticated algorithms for the control of machines, the coordination of robots and the assurance of safety at the workspace. This project focuses on answering the research questions underneath. How to create models for the digital twin of the robotic environment, including geometric, kinematic and dynamic model. Other models may be considered too based on the needs and requirements of the case study. Models will be visualized through the digital twin. How to collect and integrate physical sensor data and robot control commands for the digital twin. Data analytics combined with AI algorithms will support the decision process for the next research Question. How to perform what-if analysis and commissioning in the digital twin 'prediction' method. How to develop an integrated digital twin-robot environment for remote real-time monitoring and control of robot(s).

Expected background/experiences : Good skills in programming, robotics and AI.

Visiting PhD student: 6 - 12 months

Biomechanics (Reg. No. 2325)

Type of position Visiting PhD student: 12 months	**Main supervisor** Ruoli Wang
KTH School SCI	**Co-supervisor(s)** Yan Li
KTH Department Engineering Mechanics	**Main email contact** ruoli@kth.se

Specific subject area(s)
motion analysis, wearable sensors, amputee and rehabilitation
Title of project
Motion Analysis in the subjects with osseointegrated bone-anchored prosthesis using wearable sensors during post-operative rehabilitation
Number of available position
1
Earliest start date
2023-09-01
Latest start date
2023-12-15
Short description of the project

Standard of care after lower limb amputation involves the attachment of a customized prosthetic limb that interfaces with the residual limb via a socket. However, traditional socket-suspended prostheses are associated with many complications, namely soft tissue ulcers, skin irritation, and pain in the back and residual limb. Compared with conventional socket prostheses, the direct skeletal attachment of prosthesis by osseointegration avoids irritations to soft tissues. Also, the osseointegrated bone-anchored prosthesis provides more physiological weight bearing, improved range of motion, and sensory feedback by “osseoperception”, which dramatically improved the quality of life for amputees. As an orthopedic field under rapid development, there is still no formal consensus regarding the standard post-operative rehabilitation for bone-anchored prostheses. For patients, the limits for maximal loadings and exertional moments of bone-anchored prosthesis are still largely unknown. It is therefore urgent to develop a motion tracking system to facilitate the preoperative planning, to guide postoperative rehabilitation and daily prosthetic usage. Marker-based 3D motion analysis using an optical motion tracking system is considered as a golden standard to quantitatively study motion patterns and as an evaluation tool in rehabilitation training. This solution usually provides the best metrological performances in terms of accuracy and repeatability, however, with several major limitations in analyzing biomechanics of prothesis gait. The marker-based motion analysis is restricted in a highly specialized lab environment therefore the accessibility of patients and clinicians is poor. Nevertheless, many other essential musculoskeletal adaptations after amputee such as joint and bone contact forces and individual muscle-tendon force are impossible to evaluate with 3D motion analysis alone.

In this project, the student will be part of MoveAbility Lab, which is a state-of-art biomechanics/human movement laboratory equipped with a 10-camera motion capture system, 3 force plates, wireless electromyography, inertial sensor system, pedograph, diagnostic ultrasonography and high-density electromyography etc. The student will work closely with other PhD students and postdoc from the MoveAbility lab as well as physicians, orthopedic surgeons and physiotherapists in rehabilitation from Karolinska Institutet and Karolinska University Hospital, to evaluate the reliability and feasibility of using wearable sensors to accurately quantify biomechanical parameters during rehabilitation process in subjects the osseointegrated bone-anchored prosthesis.

The applicant will be expected to be involved in experimental methodology development, data collection and analysis. Experience with biomechanics of human movement is required. Basic programming skill is desired.

Project website
https://www.kth.se/en/sci/kth-moveability-lab/home-1.901385

Biomechanics (Reg. No. 2326)

Type of position Visiting PhD student: 12 months	Main supervisor Ruoli Wang
KTH School SCI	**Co-supervisor(s)**
KTH Department Engineering Mechanics	**Main email contact** ruoli@kth.se

Specific subject area(s)

musculoskeletal model, motor unit decomposition, and neurological disorders

Title of project

Neural data-driven musculoskeletal simulation of human movement

Number of available position

1

Earliest start date

2023-09-01

Latest start date

2023-12-15

Short description of the project

Impaired motor function is one of the major results of a malfunctioning nervous system, wherein patients may lose their ability to perform daily activities. Personalized computational models of the neuromusculoskeletal system could facilitate objective predictions of patient-specific functional outcomes for various treatment designs. However, despite significant computational, experimental, and technological advances, scant understanding of the neuromechanical interplay in the composite neuromusculoskeletal system remain as one major obstacle. This project will focus on developing an innovative neural data-driven workflow that can predict biomechanical functions of a personalized neuromusculoskeletal system. Decoded motor neuron activity by high-density electromyography recordings will be used to drive a data-driven forward musculoskeletal simulation. The goal of the project is to provide a better understanding of the neuro-mechanical causalities in human movement and the alterations caused by impairment. The target group includes individuals with physical disabilities due to neurological disorders.

In this project, the student will be part of MoveAbility Lab, which is a state-of-art biomechanics/human movement laboratory equipped with a 10-camera motion capture system, 3 force plates, wireless electromyography, inertial sensor system, pedograph, diagnostic ultrasonography and high-density electromyography etc. The student will work closely with other PhD students and postdoc from the MoveAbility lab as well as national and international experts in biomedical engineering, physicians, and physiotherapists in rehabilitation from Karolinska Institutet and Karolinska University Hospital, to develop neural-driven musculoskeletal models and evaluate its application in neurophysiological assessment, assistance device design and intervention evaluation in various neurological affected groups.

The applicant will be expected to be involved in methodology development, data collection and analysis. Experience with biomechanics of human movement and biological signal post-processing are required. Basic knowledge about neuromusculoskeletal biomechanics is desired.

Project website

https://www.kth.se/en/sci/kth-moveability-lab/home-1.901385

Engineering Mechanics (Reg. No. 2327)

Type of position Visiting PhD student: 12 months	**Main supervisor** Gunnar Tibert
KTH School SCI	**Co-supervisor(s)** Huina Mao
KTH Department Engineering Mechanics	**Main email contact** tibert@kth.se

Specific subject area(s)
Mechanics
Title of project
Soft Metamaterials
Number of available position
1
Earliest start date
2023-08-01
Short description of the project

Metamaterials, artificial composite structures with exotic material properties, have emerged as a new frontier of science involving physics, material science, engineering, and chemistry. However, most metamaterials are manufactured with rigid and semi-rigid materials, which severely constrain their functionalities and applications. Soft elastomeric material possesses excellent mechanical properties and is one of the key materials to construct intelligent flexo-systems including soft machines, flexible structures, etc. Our recent research reveals that meta-structures built with soft materials exhibit significantly improved design freedom and mechanical properties. Recently developed multi-material 3D/4D additive manufacturing technology for soft materials, which is a breakthrough for complex soft-meta-structures manufacturing. This project will focus on the design, and additive manufacturing of soft metamaterials, e.g., multifunctional structures for damping applications. The exchange Ph.D. project aims to promote the collaboration of the research between both sides and promote the education and training of Ph.D. via the scientific exchange.

Vehicle Engineering (Reg. No. 2328)

Type of position Visiting PhD student: 12 months	**Main supervisor** Lars Drugge
KTH School SCI	**Co-supervisor(s)**
KTH Department Engineering Mechanics	**Main email contact** larsd@kth.se

Specific subject area(s)

Vehicle dynamics of over-actuated autonomous electric vehicles

Title of project

Motion control strategies for autonomous electric vehicles

Number of available position

1

Earliest start date

2023-05-01

Short description of the project

Energy efficient operation of autonomous vehicles is of high importance due to environmental awareness and for economic reasons. Furthermore, safe motion planning and control of autonomous vehicles is important to consider especially in safety-critical manoeuvres. The introduction of vehicles with more advanced drive systems consisting of multiple electrical actuators will open up for new and cost-efficient solutions for motion control, which makes it possible to develop vehicle control strategies that can enhance for example energy efficiency without compromising comfort and safety.

A vehicle with more control outputs available than required to control the number of degrees of freedom is often referred to as an over-actuated vehicle. The aim is to analyse the potential of over-actuation and to develop control strategies that can handle possible conflicts between e.g. energy efficiency, environmental impact, safety and comfort for different transportation tasks and in different driving conditions. Several different active chassis systems are considered, for example electric wheel hub motors, individual steering, active suspension, camber control as well as different combinations of over-actuation. To solve this, a combination of optimisation techniques, vehicle modelling, knowledge of intended transportation mission, relevant requirements and boundary conditions are needed.

Photonics (Reg. No. 2329)

Type of position Visiting PhD student: 12 months	Main supervisor Xiaodan Pang
KTH School SCI	**Co-supervisor(s)** Oskars Ozolins, Sergei Popov
KTH Department Applied Physics	**Main email contact** xiaodan@kth.se

Specific subject area(s)

Optical Communications

Title of project

Optimal modulation techniques for THz and mid-IR free-space communications

Number of available position

1

Earliest start date

2023-04-01

Latest start date

2023-09-01

Short description of the project

This project aims to investigate the optimal modulation techniques, including the choice of modulation formats and the operational condition of amplitude and phase modulators in the terahertz (THz) and long-wave infrared (LWIR) bands. The outcomes of this study will support the ongoing activities of the EU H2020 FET Project cFLOW, in which KTH is partly responsible for setting up the final free-space transmission demonstrator.

The targeted unlicensed spectrum window, connecting the radio and the optical frequencies, has intrinsic advantages to support next-generation free-space communications in both terrestrial and ground-to-satellite applications, compared with either the near-IR telecom frequencies or the microwave/millimetre-wave (MMW). It has higher tolerance than the near-IR to atmospheric channel perturbations such as dust, fogs, and turbulence effects such as scintillation, beam broadening and beam wandering, and has much broader bandwidth than the microwave/MMW to support a sustainable technology roadmap beyond the next decade. Moreover, it is currently underexploited yet with rich potential to be explored.

Scientifically, this project requires in-depth theoretical and numerical analysis on the trade-offs between the bandwidth and noise based on the Shannon capacity theorem, while taking account of the specific dynamic channel properties of the atmospheric links. Candidates with theoretical and experimental experience in optical communications are welcome to apply. The successful candidate will be involved in the discussions and joint activities with other partners in EU within the cFLOW project.

Photonics (Reg. No. 2330)

Type of position Visiting PhD student: 12 months	**Main supervisor** Oskars Ozolins
KTH School SCI	**Co-supervisor(s)** Xiaodan Pang
KTH Department Applied Physics	**Main email contact** ozolins@kth.se

Specific subject area(s)
Photonics hardware for Reservoir Computing
Title of project
BRAIN: Photonic-Assisted Hardware for Reservoir Computing
Number of available position
2
Earliest start date
2023-03-01
Latest start date
2024-03-01
Short description of the project
We live in a complex world where problems range from climate dynamics to world economy, and pandemics. An understanding of such complex challenges is critical. This could impact the progress of our society, for instance, in fighting pandemics, mitigating climate change, or creating economic growth. In the information age, the ability to process large sets of data and extract crucial information has become critical. The ever-growing demand for data processing will continue as more smart gadgets are integrated into our daily lives. Many emerging applications such as self-driving cars, autonomous robotics, fake news moderation, and pandemic growth prediction are enabled by advanced machine learning (ML) models. Industries using these tools in artificial intelligence (AI) applications and high-performance computing (HPC) are mostly supported by microelectronic platforms. These companies heavily rely on improvements in hardware. The BRAIN project aims at exploring the most efficient photonic-assisted hardware for Reservoir Computing (RC). Analog computing hardware tailored for ML—have significant potential for achieving ultrahigh computing speed and energy efficiency. Optical approaches to neural networks were pioneered decades ago but could not be made competitive while electronics provided more effective answers. That is not the case anymore. Such photonic-assisted neuromorphic hardware is inspired by the extremely low energy consumption of the human brain [1]. Neuromorphic engineering is partly an attempt to move elements of ML algorithms to hardware that can implement their massively distributed nature, leading to an effective single instruction stream over multiple data streams (SIMD) architecture with a high degree of data parallelism. In the BRAIN project, we will study cost, energy efficiency, resiliency, scalability, and robustness of large-scale photonic-assisted hardware for Reservoir Computing. This is the first step towards photonic brain.
Project website
https://www.kth.se/profile/ozolins?l=en

Engineering (Reg. No. 2331)

Type of position Visiting PhD student: 12 months	**Main supervisor** Liangchao Zou
KTH School ABE	**Co-supervisor(s)**
KTH Department Sustainable Development, Environmental Science and Engineering (SEED)	**Main email contact** lzo@kth.se

Specific subject area(s)
Hydrogeology
Title of project
Modeling of fluid flow and mass/energy transport in rock fractures
Number of available position
1
Earliest start date
2023-09-01
Latest start date
2023-12-31
Short description of the project

Modeling of fluid flow and mass/energy transport in rock fractures is important for many geo-engineering projects, such as underground storage of oil/gas, extraction of geothermal energy, and geological disposal of hazardous waste. Natural rock fractures have complex geometry due to surface roughness and fracture networks, which cause complex fluid flow patterns and mass transport behaviors in addition to complex hydraulic conditions in reality. This project aims to investigate the impacts of geometry and hydraulic conditions on fluid flow and mass/energy transport in rock fractures through high-resolution numerical simulations. The more realistic features of fracture surface roughness will be considered. It is planned for a visiting PhD student for 12 months. The student is expected to conduct flow and transport laboratory experiments at the student's home university and perform numerical simulations at KTH during the visit.

Transportation Science (Reg. No. 2332)

Type of position Visiting PhD student: 12 months	**Main supervisor** Zhenliang Ma
KTH School CBH	**Co-supervisor(s)** Wilco Burghout
KTH Department Civil and Architectural Engineering	**Main email contact** zhema@kth.se

Specific subject area(s)
Urban Mobility
Title of project
Integrated Electric Public Transport Optimization and simulation for Coupled Transport and Energy Systems
Number of available position
2
Earliest start date
2023-09-01
Short description of the project

The ever-changing mobility landscape, new vehicle technologies, and ambitious climate goals continue to challenge existing planning models and the responsiveness of planners, policymakers, and regulators. The project aims to develop a high-fidelity simulation model and tool to support the decision-making and development of sustainable electric transport solutions that integrate the efficiencies of public transport with agile, on-demand modes on an as-needed basis (e.g., micro-mobility and shared mobility). The technical focus will be on models and algorithms for designing and operating such integrated systems, an area with key research gaps. The application focus will be on developing the simulation tool and demonstrating it in integrated operations of electric public transport and micro-mobility/shared mobility services and cooperative disruption management for a resilient transportation network. The project is partially funded by Region Stockholm, and the successful candidates would have opportunities to be involved in various activities within the Center of Traffic Research (CTR) and Integrated Transportation Research Lab (ITRL) at KTH.

Transport Science (Reg. No. 2333)

Type of position Visiting PhD student: 12 months	Main supervisor Fariya Sharmeen
KTH School ABE	**Co-supervisor(s)**
KTH Department Urban Planning and Environment	**Main email contact** Sharmeen@kth.se

Specific subject area(s)

Transport modelling, Safety and Accessibility Planning, Urban Design

Title of project

The role of novel transport modes in daily urban travel

Number of available position

2

Earliest start date

2023-09

Latest start date

2023-12

Short description of the project

The project will focus on the (design) elements of safety and accessibility of micro mobility for short urban trips as individual transport modes as well as feeder modes to public transit. One method is through a novel data mining. The urban design features as we have in the open access maps now are limited. To extend our understanding further novel methodologies of data collection such as image processing, can be used to discern features of safety, shelter, etc. in transport network. Subject to availability of behavior survey data a behavioral modelling can be extended as well. Moreover role of social networks can be explored to understand the adoption and use of new micro mobility options in cities offering novel modal distributions.

A comparative analysis of Scandinavian and Asian contexts will be sought. Studies show that there are important learning elements from such comparative analysis that allows for fresh perspectives, knowledge exchange and policy adoption leading to effective solutions.

Fluid mechanic and built environment (Reg. No. 2334)

Type of position Visiting PhD student: 12 months	**Main supervisor** Wei Liu
KTH School ABE	**Co-supervisor(s)**
KTH Department Civil and Architectural Engineering	**Main email contact** weiliu2@kth.se

Specific subject area(s)
Fluid and climate technology
Title of project
Implementation of fast fluid dynamics on GPU for simulating indoor airflow
Number of available position
1
Earliest start date
2023-05-01
Latest start date
2023-12-31
Short description of the project

Fast and high-resolution prediction of heat and mass transfer plays a critical role in many engineering applications. For example, in creating a desired indoor climate, fast and high-resolution simulation of airflow and contaminant transport would help sustain life, reduce cost, and minimize energy consumption. In specific scenarios such as emergency management, conceptual design, and heating, ventilation, air conditioning and refrigeration (HVAC&R) system control, faster-than-real-time simulation (simulation time less than physical flow time) is desired. For airflow modeling, the use of fast fluid dynamics (FFD) has been proven to reduce the computing cost in comparison with CFD. However, it is still difficult to achieve faster-than-real-time simulation when it comes to a large-scale or complex case with millions of grid cells. Therefore, this project aims to implement the FFD on GPU, which can have hundreds of thousands of cores, for parallel computing and investigate the potential to realize faster-than-real-time simulation of indoor airflow.

Space physics, space plasma, satellite observations (Reg. No. 2335)

Type of position Visiting PhD student: 12 months	**Main supervisor** Andris Vaivads
KTH School EECS	**Co-supervisor(s)**
KTH Department lectrical Engineering	**Main email contact** vaivads@kth.se

Specific subject area(s)

turbulence, energy conversion

Title of project

Kinetic scale processes in solar wind

Number of available position

1

Earliest start date

2023-05-01

Short description of the project

Two spacecraft missions have been launched in recent years with a goal to fly closer to Sun and to study the physics of solar wind and it's source regions, NASA Parker Solar Probe and ESA Solar Orbiter. This has opened new possibilities to study the fundamental plasma processes controlling the development of the solar wind evolution from global scales down to the smallest kinetic scales. The guest PhD student would address the kinetic scale physics of solar wind that can be of importance for solar wind heating and acceleration. Of particular interest would be to study the boundaries of switchbacks for possible magnetic reconnection signatures. Where possible, a comparative study with the multi-spacecraft missions of MMS and Cluster in the near Earth solar wind will be carried out.

Computational Plasma Physics (Reg. No. 2336)

Type of position Visiting PhD student: 12 months	**Main supervisor** Svetlana Ratynskaia
KTH School EECS	**Co-supervisor(s)** Panagiotis Tolias
KTH Department Electrical Engineering	**Main email contact** srat@kth.se

Specific subject area(s)
Plasma-surface interaction
Title of project
Modelling of macroscopic melt motion in fusion reactors
Number of available position
1
Earliest start date
2023-03-01
Short description of the project
The understanding of the mechanisms and consequences of the melt motion induced by the impact of transient intense plasma heat fluxes in the presence of strong magnetic fields is of profound importance to the development of magnetic confinement fusion reactors operating with metallic plasma-facing armor. The KTH Complex Plasma group has developed a state-of-the-art numerical tool; the macroscopic metallic melt motion code MEMENTO based on the physics model of MEMOS-U. The model has been validated against multiple dedicated melt experiments, carried out in major European tokamaks, building confidence in the code predictions and leading to its near-exclusive use for predictive ITER and EU-DEMO studies. MEMENTO efficiently solves a melt dynamics model that outputs detailed predictions of reactor wall deformations. In the worldwide fusion community, it stands as the only code that is capable of such modelling. For the major references refer to the project website.
Although the MEMENTO physics model has been validated in current machines, transient events in future machines such as ITER and EU- DEMO will bring forth presently inaccessible plasma-material interaction regimes and new physical processes affecting melt generation and dynamics. Currently, the physics processes expected to govern melt generation and macroscopic melt motion in future fusion reactors are being incorporated in the MEMENTO code to facilitate realistic predictions of gross melt erosion.
A visiting PhD candidate is sought for to further expand the core activities in this effort. The visiting PhD student project aims include;
I. employing the MEMENTO code for benchmarking against the results of designed melting experiments in the cutting-edge large experimental facility of China; the Experimental Advanced Superconducting Tokamak (EAST),
II. applying the MEMENTO code to specific scenarios relevant for the China Fusion Engineering Test Reactor (CFETR), assisting in the assessment of the required levels of transient mitigation that its operation must satisfy.
Project website
https://www.kth.se/ee/spp/research/projects/modelling-of-melt-motion-1.1022839

Electrical Engineering (Reg. No. 2337)

Type of position Visiting PhD student: 12 months	**Main supervisor** Ming Xiao
KTH School EECS	**Co-supervisor(s)**
KTH Department Intelligent Systems, Information Scicence and Engineering	**Main email contact** mingx@kth.se

Specific subject area(s)
Wireless Communications, Machine Learning
Title of project
6G wireless communications
Number of available position
1
Earliest start date
2023-08-01

Short description of the project

With 5G being rolled out world wide, the research in 6G mobile has started to attract substantial research interests. Key concept of 6G mobile include e.g., TeraHertz communications, AI, Satellite Communications, ultra-massive MIMO etc. This project seeks to address general areas of 6G mobile. The students aligned with above topics (not limited) are welcome to apply.

Information Science and Engineering (Reg. No. 2338)

Type of position Visiting PhD student: 12 months	**Main supervisor** Zhibo Pang
KTH School EECS	**Co-supervisor(s)**
KTH Department Intelligent Systems	**Main email contact** zhibo@kth.se

Specific subject area(s)
Intersection of AI, computer vision, safety engineering, and automatic control
Title of project
Machine vision and swarm intelligence for safety-critical industrial systems
Number of available position
1
Earliest start date
2023-08-01
Latest start date
2023-12-31
Short description of the project

In this project, we will address the long-standing research challenge about functional safety of the AI-enabled autonomous systems such as robots in critical industrial systems when it is in the populated scenarios such as hospitals, retails, and restaurants. Under the critical constraints of functional safety, we need to optimize the operation efficiency and availability of the entire mobile fleet. The AI-powered machine vision and swarm intelligence are promising tools to be investigated. However, the requirements for determinism (high correctness within bounded latency and interpretability) due to the safety constraints make everything essentially challenging including object recognition and tracking, map formulation and sharing, proactive collision avoidance, and multi-robot cooperation, etc. Fundamentals in AI/ML tools need to be addressed in this work as well, such as safety boundary/guards of neural network models and traceability of failures/mistakes. As a key member of this project, you will contribute to the theoretical modeling, simulation, prototyping and experimental validation of novel ideas. You will get hands-on supervision from world-class researchers in this area and access to world-class academic and industrial lab facilities on industrial 5G, edge computing, machine vision, and autonomous systems and robotics.

Project website
https://www.kth.se/profile/zhibo

Fiber and polymer science (Reg. No. 2339)

Type of position Visiting PhD student: 12 months	**Main supervisor** Yuanyuan Li
KTH School CBH	**Co-supervisor(s)**
KTH Department Fibre and Polymer Technology	**Main email contact** yua@kth.se

Specific subject area(s)
Biocomposite
Title of project
Nano structured wood for water remediation
Number of available position
1
Earliest start date
2023-05-01
Short description of the project

There are increasing issues linked to water security. Heavy metal ion contamination of aqueous media from industrial activities is an increasing threat to both the environment and human health. Bio-adsorption is promising technology to remove heavy metal ions due to its low cost, high capacity, wide pH range and the possibility of metal recovery. Cellulose with huge annual production, has been intensively investigated, particularly nanocellulose. But complex processing and high energy consumption are issues for nanocellulose scale-up production. Top-down synthesis, exploiting the natural hierarchical and anisotropic native wood structure, can solve the issues.

To achieve a high performing absorbent, structures with high specific surface area and beneficial chemistry (e.g. negative charge) is preferred. Combined multi-scale pores are favorable since micro- and mesopores provide high specific surface area while macropores guarantee mass diffusion in the structure and accessibility to the surface. Anisotropic pores preferentially aligned in the transport direction can provide an essential materials advantage by enabling faster transport at high structural density.

The objective of this project is nanoengineering of renewable wood for sustainable water remediation with a focus on metal ion removal. Sustainable nanoporous wood featuring high specific surface area, surface charge and mechanical strength will be fabricated, where scalable processing and sustainability are integrated. Fundamental understanding of wood structure and structure evolution will be revealed. The relationship between water purification efficiency and wood structure will be documented. The scientific question regarding materials processing-structure-property-performance relationship will be answered. The aim is to build the competitiveness of the Swedish forestry industry and education and deliver impacts on global sustainable development goals especially clean water.

Chemical engineering (Reg. No. 2340)

Type of position Visiting PhD student: 12 months	**Main supervisor** Michael Svärd
KTH School CBH	**Co-supervisor(s)** Kerstin Forsberg
KTH Department Chemical engineering	**Main email contact** micsva@kth.se

Specific subject area(s)
Crystallization, nucleation
Title of project
Clusters and primary nucleation
Number of available position
1
Earliest start date
2023-03-01
Short description of the project

Despite many decades of dedicated research, crystal nucleation maintains its status of being one of the most important yet one of the least understood phenomena in the natural sciences. Recently, however, the situation is beginning to change at a rapid pace. Developments in analytical techniques are allowing sub-micrometre scale structures in solution to be studied, and this has led to numerous reports and investigations of mesoscale clusters, of the order of 100 nm, which have been observed in a range of chemically diverse systems. In particular for inorganic compounds and macromolecules, these clusters have been tightly linked to nucleation, driving the development of new non-classical nucleation theories to replace or complement the classical theory. For small- and medium-sized organic molecules, however, comparatively few studies have so far been published, and the level of understanding of clusters, their properties, and their effect on crystal nucleation, is poor.

In this project, mesoscale clustering in solutions of organic molecules will be systematically studied using dynamic light scattering. The size and concentration of clusters will be determined in solutions at various conditions, and the kinetics behind the establishment of cluster distributions will be investigated. The links between clusters and non-classical primary nucleation will be studied by varying the pre-treatment conditions of solutions before establishment of supersaturated conditions.

The ideal candidate has a background in crystallization, crystal nucleation and/or growth, or crystallography. The candidate is expected to be able to work well independently. Furthermore, the candidate should have well-developed laboratory and analytical skills, as well as good proficiency in written and spoken English.

Project website
https://www.researchgate.net/project/CLUSTER-Non-classical-pathways-to-primary-nucleation-from-solution

Chemical Engineering (Reg. No. 2341)

Type of position Visiting PhD student: 12 months	**Main supervisor** Kerstin Forsberg
KTH School CBH	**Co-supervisor(s)**
KTH Department Chemical Engineering	**Main email contact** kerstino@kth.se

Specific subject area(s)
Separation processes
Title of project
Industrial Crystallization for Resource Recovery
Number of available position
1
Earliest start date
2023-03-01
Short description of the project

The project concerns developing crystallization processes of relevance for resource recovery from waste streams, such as spent batteries or magnet scrap. The research will build on our previous and on-going work in this area (please see the website below). The work will be carried out in an international environment with strong links to industry in Sweden and Europe.

The aim will be to develop crystallization processes aiming at high purity and low energy consumption compared to conventional processes. The work will include developing both the fundamental understanding and industrial applicability. The work will consist of planning and performing laboratory experiments and evaluating the data in collaboration with the supervisors at KTH.

We seek a candidate with a background in chemical engineering or hydrometallurgy, having expertise in crystallization/ precipitation and with the ability to apply this knowledge to develop industrially applicable processes. The candidate is expected to be able to work both independently and together with colleagues. Furthermore, the candidate should have well-developed analytical and problem-solving skills, strong laboratory/ instrumental skills and good proficiency in written and spoken English.

Project website
https://www.kth.se/profile/kerstino?l=en

Chemistry (Reg. No. 2342)

Type of position Visiting PhD student: 12 months	**Main supervisor** Markus Kärkäs
KTH School CBH	**Co-supervisor(s)** Peter Dinér
KTH Department Department of Chemistry	**Main email contact** karkas@kth.se

Specific subject area(s)
Organic Chemistry
Title of project
Photoredox Catalysis for Activation of Strong Chemical Bonds
Number of available position
1
Earliest start date
2023-03-01
Short description of the project

The use of visible light photoredox catalysis for promoting single-electron transfer processes has enabled formerly inaccessible or challenging reaction manifolds to be explored under exceptionally mild reaction conditions.

The main objective of the proposed research concerns the application of photoredox catalysis for activation of strong/unreactive chemical bonds, especially carbon–hydrogen (C–H) and carbon–oxygen (C–O) bond activation/functionalization through free-radical processes. The current research program aims to deliver key advances in free-radical chemistry and a crucial framework for utilizing single-electron transfer (SET) processes for straightforward activation/functionalization of strong, native bonds. The potential of photoredox-based strategies to achieve efficient and sustainable catalysis has quickly been adopted by the chemical industry, allowing for academic discoveries to be rapidly translated into the applications of tomorrow.

Theoretical physics and chemistry (Reg. No. 2343)

Type of position Visiting PhD student: 8 months	**Main supervisor** Victor Kimberg
KTH School CBH	**Co-supervisor(s)**
KTH Department Chemisry	**Main email contact** kimberg@kth.se

Specific subject area(s)
X-ray spectroscopy
Title of project
Advanced theory for novel ultrafast X-ray pump-probe spectroscopy
Number of available position
2
Earliest start date
2023-05-01
Latest start date
2023-10-01
Short description of the project

Strong field X-ray physics is at the frontier of modern science, promoted by the recent advances of X-ray free electron laser (XFEL) radiation facilities, opens the door to nonlinear X-ray physics and ultrafast pump-probe techniques. XFELs pulses have reached intensities, wavelengths, and pulse duration that hitherto have not been utilized and we expect effects that have not been encountered before. Theory plays a crucial role as a tool to simulate present and future experiments, as well asto investigate where novel effects might be expected.
The present project is devoted to theoretical development of new spectroscopic techniques utilizing short X-ray and UV (ultraviolet) pulses for accurate modeling of ro-vibrational dynamics triggered by electronic excitations in molecules. Our objective is to bring up new theory and numerical procedures for adiabatic and non-adiabatic formation of ro-vibrational wave packet by resonant and non-resonant pump pulse of different shapes and intensities. Our study aims to support recent experiments performed by our colleagues at world-leading XFEL facilities, as well as to investigate and propose principally new X-ray pump-probe schemes.
The visiting PhD student will be involved in discussion and development of theory, which requires some basic knowledge of quantum mechanics. Writing of small computer codes using scientific programming is essential part of the work, given that the candidate has general experience in programming languages, preferably Python. A part of simulation will be performed at high-performance computing clusters. As a results of this visiting PhD position we expect publication of one-two scientific papers in high impact journals. For our resent research outcomes please refer to the supervisor's publication list: https://www.kth.se/profile/kimberg/publications.
Project website
https://www.kth.se/profile/kimberg/page/research-activities

Radiochemistry (Reg. No. 2344)

Type of position Visiting PhD student: 11 months	Main supervisor Longcheng Liu
KTH School CBH	**Co-supervisor(s)** Weihong Yang
KTH Department Chemical Engineering	**Main email contact** lliu@kth.se

Specific subject area(s)

Radioactive waste gas treatment

Title of project

An adsorption device and technology for obtaining extremely low radioactive air

Number of available position

1

Earliest start date

2023-08-01

Short description of the project

Radon and its daughters are important sources of radioactive background in underground laboratories. As a noble gas, radon gas is ubiquitous and difficult to shield, and its decaying daughter bodies will also attach to the surface of detectors and interfere with the study of dark matter . Meanwhile, radon and its daughters, as natural radionuclides that can be inhaled by humans, are one of the 19 carcinogens identified by the World Health Organization (WHO). Therefore, in underground projects, reducing radon concentration to a sufficient low level is key for studies of dark matter and health protection.

Due to the difficulty of dilution by deep underground ventilation, the adsorption technique of activated carbon on radon was commonly used to reduce the concentration of radon and its daughters in laboratories in China and Europe Countries. For instance, the Borexino laboratory in Italy used liquid nitrogen cooling to enhance the dynamic adsorption coefficient of activated carbon, reached a value of $(2.4 \pm 1.5)\times 10^4$ L/g at − 196 °C . Peking University used liquid nitrogen cooling to measure dynamic adsorption coefficients for activated carbons and found that the absorption capacity of coconut shell-based activated carbons at − 48 °C is more than 20 times higher than room temperature.

Based on the theory of activated carbon radon reduction technology, we propose the use of air cooler to establish and test the radon reduction system. We will obtain high dynamic radon adsorption coefficient and achieve high pressure and low temperature controllability by reducing temperature and increasing air pressure. In addition, in order to fully reduce the energy consumption of the adsorption device, the development of high-performance carbon-based radon gas adsorption materials through model simulations and experimental research is necessary for this project.

Reactive flow simulation and automated analysis (Reg. No. 2345)

Type of position Visiting PhD student: 12 months	**Main supervisor** Christophe Duwig
KTH School CBH	**Co-supervisor(s)** Kai Zhang
KTH Department Chemical Engineering	**Main email contact** duwig@kth.se

Specific subject area(s)

CFD, Machine learning, combustion, heat-transfer, OpenFOAM

Title of project

Reactive flow simulation and automated data analysis

Number of available position

1

Earliest start date

2023-02-01

Latest start date

2023-09-30

Short description of the project

The goal of this project is to use computational-fluid-dynamics (CFD) and machine learning methods for the analysis of reactive fluid heat transfer and/or multi-regime turbulent combustion. To this end, finite rate detailed chemistry methods will be employed in large eddy simulations of the reactive fluids generating massive amounts of high-dimensional data. The purpose is to extract a new set of low dimensional variables from the data and to describe the multi-physics system involving heat transfer, turbulence, and combustion. Then a space-prediction of reactive flow characteristics such as the pollutant, radical formation, heat release, and absorption etc. will be performed (for efficient heat transfer and for clean-burner design). The tasks will also include the use of our existing inhouse deep-learning network for time sequence prediction of the reactive flow characteristics.

The candidate will have access to the supercomputing facilities available at KTH.

Candidate Profile:

1. Skills in Python Programming and preferably some fundamentals of TensorFlow, scikit-learn and Matplotlib.

2. Hands-on experience of using HPC, Linux Kernel, and Bash Shell for parallel computation.

3. Knowledge of how to use OpenFOAM for reactive flow simulation is a merit.

4. English communication skills, both written and oral

5. Independence and good time-management skills.

Chemistry and Biology (Reg. No. 2346)

Type of position Visiting PhD student: 12 months	Main supervisor Yaoquan Tu
KTH School CBH	**Co-supervisor(s)**
KTH Department Chemistry	**Main email contact** yaoquan@kth.se

Specific subject area(s)
Theoretical Chemistry and Biology
Title of project
Molecular recognition in protein-ligand binding for ligand/drug optimization and design
Number of available position
2
Earliest start date
2023-09-01
Short description of the project

The knowledge of protein-ligand interactions and the role of water molecules in protein-ligand binding are essential for understanding many biological processes and for structure-based drug design. With the development of computer technologies, theoretical modelling has become an increasing powerful tool in the study of protein-ligand binding. In this project, we will use theoretical modelling to study molecular recognition in protein-ligand binding. In particular, we will use thermodynamic signatures to identify the characteristics of protein-ligand binding and the inhomogeneous solvent model to study the role of water molecules in some important drug targets with the aim to design/optimize ligands/drugs, such as through replacing unfavorable water molecules with new ligand groups complementary to the protein surface.

Project website
https://www.kth.se/profile/yaoquan/page/research

Engineering Materials Science (Reg. No. 2347)

Type of position Visiting PhD student: 12 months	Main supervisor Peter Hedström
KTH School ITM	**Co-supervisor(s)** Tao Zhou
KTH Department Materials Science and Engineering	**Main email contact** pheds@kth.se

Specific subject area(s)

Physical Metallurgy

Title of project

Precipitation engineering for high-performance martensitic steels

Number of available position

1

Earliest start date

2023-08-01

Short description of the project

Precipitation hardening, since its discovery by Wilm in an aluminum system, has been widely used to increase the mechanical properties of metallic materials, and has facilitated the fast development of different kinds of alloys. This cannot be achieved without the fast development of characterization techniques, like transmission electron microscopy which has been largely accelerating the understanding of precipitation phenomena at nanoscale. This project is aiming for materials design and optimization through a fundamental understanding of precipitation in martensitic/maraging steels by combining advanced characterization techniques and computational thermodynamic and kinetic modelling. The visiting PhD students will focus on quantitative characterization of precipitation kinetics of carbides or/and intermetallics in different martensitic steels (additively manufactured or conventionally rolled materials) using mainly our new atom probe tomography instrument, complemented by transmission electron microscopy and small angle scattering (using X-rays or neutrons). Through this project, the students will not only be able to develop their practical skills and theoretical knowledge on sample preparation, measurement, and data analysis for the aforementioned state-of-the-art characterization techniques, but also deepen their understanding of solid-state phase transformation by integrating the experimental tools and thermodynamic and kinetic models embedded in the latest version of Thermo-Calc software.

Engineering Materials Science (Reg. No. 2348)

Type of position Visiting PhD student: 12 months	**Main supervisor** Peter Hedström
KTH School ITM	**Co-supervisor(s)** Wangzhong Mu
KTH Department Materials Science and Engineering (MSE)	**Main email contact** pheds@kth.se

Specific subject area(s)
Sustainable Metallurgy
Title of project
Scrap-tolerant and recycling-friendly metallic alloys
Number of available position
1
Earliest start date
2023-07-01
Short description of the project

The metal production and manufacturing industries use enormous amounts of energy and are the largest contributing industries to greenhouse gas emissions (GHGE) with approximately 30% of the GHGE. Therefore, the production of metallic materials from scrap, i.e. secondary

raw materials, is indisputably a key factor to address several of the sustainability targets of society. The project aims at developing an efficient integrated computational and experimental framework for rational design of high-performance metallic alloys made from mainly scrap. The framework will subsequently be applied to design novel steels, e.g. duplex stainless steel made from a high ratio of secondary raw material, i.e. scrap. The proof-of-concept alloy will have excellent durability in harsh service environments, i.e. highly mechanically loaded components in corrosive environment. Durability in these service environments are key to enhance efficiency in, for example, chemical processes and energy conversion applications. The scientific challenges to be tackled in order to reach 99% circularity of metallic alloys is huge, and include e.g.: (i) sensitivity towards impurities that inevitably exist in scrap material, (ii) poor compositional tolerance of current alloy recipes though production from almost pure scrap certainly give varying chemical composition between batches, iii) insufficient compositional control in metallurgical processing. These three challenges will all be addressed when developing the design framework, bearing in mind that it should be broadly applicable for design of novel metallic alloys. Hence, a successful project would have large long-term impact on circularity for metallic materials such as steel, aluminum and nickel alloys. The visiting PhD student(s) will work with a team of professors, researchers and other PhD students with comprehensive background for this multidisciplinary research.

Materials Science and Engineering (Reg. No. 2349)

Type of position Visiting PhD student: 12 months	**Main supervisor** Joakim Odqvist
KTH School ITM	**Co-supervisor(s)** Wangzhong Mu
KTH Department Materials Science and Engineering	**Main email contact** odqvist@kth.se

Specific subject area(s)

Computational Materials Science

Title of project

Modelling of sustainable metallurgy towards a fossil-free future

Number of available position

1

Earliest start date

2023-08-01

Latest start date

2023-12-30

Short description of the project

Globally, sustainability is a common aim that involves almost all fields of human activities. In particular, the global annual CO2 emission from the iron and steel industry is approximately 2.8 billion tons, corresponding to 7% of the global CO2 emission. Therefore, utilizing hydrogen to replace carbon as the reducing agent is urgently needed to offer a promising pathway for a fossil-free future. Among the solutions for sustainable ironmaking, hydrogen-based direct reduction (HDR) technology, e.g. Hydrogen Plasma, etc. is one of the most attractive methods with high technology readiness considering the environmental impact.

The reduction of iron ores with hydrogen is a complex solid/gas reaction process, the underlying mechanisms governing this process are characterized by a complex interaction of several issues of physical, chemical, and mechanical principles, influencing issues such as mineralogy, phase transformations, transport phenomenon, stress between pellets are needed to consider. Quite some thermodynamic and kinetic issues are still unknown, for instance, the influence of nature of each mineral phase limits the understanding of this technique. A deep fundamental study of the thermal physical property of each oxide existing in iron ores could contribute to controlling the reaction kinetics, and pave the way to benefit the industrial-scale hydrogen reduction process. The current project aims to perform the thermodynamics, kinetics and machine learning modelling to investigate the mechanism of hydrogen metallurgy process.

Production engineering (Reg. No. 2350)

Type of position Visiting PhD student: 12 months	**Main supervisor** Xi (Vincent) Wang
KTH School ITM	**Co-supervisor(s)** Lihui Wang
KTH Department Production Engineering	**Main email contact** wangxi@kth.se

Specific subject area(s)

Human-robot collaboration

Title of project

Data-driven Human Robot Collaboration (HRC)

Number of available position

1

Earliest start date

2023-05-01

Short description of the project

Background: As pointed out by the European Union, Industry 5.0 calls for human-centric technologies for the factories of the future. In practice, Human-Robot Collaboration (HRC) provides a feasible and efficient method while combining the intelligence/flexibility of humans and the accuracy/repeatability of robots. Eventually, it forms a human-centric orking environment for the factories of the future.

Scope: In this project, the student will establish a human-robot collaboration method based on sensor data and digital twins. The research questions underneath will be answered.

· How to develop a pre-processing method for sensor data from multiple cameras, gesture sensors, microphones and robot controllers. Key information from sensors will be extracted respectively into a unified format.

· How to design a data fusion method, which fuses pre-processed data from various sensors.

· How to establish a decision method using HRC status classification, recognition and prediction algorithms for generating commands for the HRC system towards the safe operation.

· Finally, how to develop a digital twin system of the HRC by integrating the methods above and tested in the case study.

Time frame: 12 months

Expected background/experiences: Good skills in programming, machine learning and computer vision.

Transport Science (Reg. No. 2364)

Type of position Visiting PhD student: 12 months	**Main supervisor** Xiaoliang Ma
KTH School ABE	**Co-supervisor(s)**
KTH Department Civil and Architectural Engineering	**Main email contact** liang@kth.se

Specific subject area(s)

Intelligent Transport Systems

Title of project

MANEUVER - Modelling driver behaviour adaptation in evening using vehicle trajectory data

Number of available position

1

Earliest start date

2023-08-15

Short description of the project

"Driving during evening is a more challenging task than during day for vehicle drivers. Due to the change of light condition, driver may behave differently, perform less efficient in such condition, and may suffer from more severe consequence if accident happens. Therefore, an accurate understanding of driving behaviour in evening is essential for improving traffic safety and efficiency.

Trajectory data is always an important tool for studying driving behaviour because it contains rich spatial and temporal information of different running vehicles and drivers. Existing open trajectory datasets were mostly collected during the daytime. Due to the deficiency of vehicle trajectory data collected during evening, a nuanced understanding of driving behaviour in the dark condition has not been achieved in literature. To fill this gap, the objective of the project is to investigate the differences in main driving behaviour from the evidence of trajectory data collected during daytime and evening. For this purpose, trajectory data measured at a certain road during the morning peak and the evening peak will be applied to identify car-following and lane-changing models in different conditions. Since rear-end crashes and lane-changing crashes are the most frequent types of traffic accidents, the project will focus on the modelling and comparison of car-following events and lane-changing events in the daytime and evening.

More detailed tasks of the project are summarised as follows:

1. Investigating the differences of typical car-following characteristics including reaction time, speed-spacing relationship, and TTC between daytime and evening by combining with the traditional car-following models. Comparing the features of lane-changing events including speed, spacing, duration in the daytime and evening.

2. Exploring the different impacts of car-following/lane-changing features on rear-end crash risk/lane-changing crash risk between daytime and evening by dividing car-

following/lane-changing events into several crash risk levels according to the multiple traffic conflict indicators.

3. Making improvement on traditional car-following models to quantify the characteristics of driving behaviour in the evening.

4. Predicting and explaining lane-changing behaviour in the daytime and evening respectively. Carrying out comparison between the effects of driving features on lane-changing decisions in the daytime and evening.

Civil Engineering (Reg. No. 2365)

Type of position Visiting PhD student: 12 months	**Main supervisor** Denis Jelagin
KTH School ABE	**Co-supervisor(s)** Manfred N. Partl
KTH Department Byggvetenskap	**Main email contact** jelagin@kth.se

Specific subject area(s)
Infrastructure engineering
Title of project
Multiscale modelling of asphalt mixtures
Number of available position
1
Earliest start date
2023-05-01
Short description of the project

The project aims at development of new performance-oriented material design method for asphalt mixtures. Accordingly, under the project the digital specimen generation method will be developed and combined with multiscale mechanical modeling tools to evaluate the effect of material parameters on its performance. The project is planned for a visiting PhD student for 12 month and will be performed in coordination with other research projects on-going in the group. During the visit the student is expected to focus on the following sub tasks:

- Based on the asphalt mixture morphology establish a digital specimen generation algorithm to be used in mesopotamia-scale mechanical simulations.

- Using digital specimens, identify the morphological characteristics with most profound influence on mechanical properties of asphalt mixtures and their damage resistance. "

Sustainable development (Reg. No. 2366)

Type of position Visiting PhD student: 12 months	**Main supervisor** Miguel Mendonca Reis Brandão
KTH School ABE	**Co-supervisor(s)**
KTH Department SEED	**Main email contact** miguel.brandao@abe.kth.se

Specific subject area(s)
Poverty alleviation
Title of project
Sustainable economic-environmental development in poverty-stricken areas of China and Poverty Governance
Number of available position
1
Earliest start date
2023-05-01
Short description of the project

My research focuses on the study of China's poverty-stricken counties based on multi-source data such as remote sensing images, socio-economic and demographic data, and using multidisciplinary approaches such as geography and economics.

I am concerned that you are more interested in Environmental Economics and Poverty alleviation .I hope to work with you to conduct more in-depth research on Sustainable of China's poverty-stricken regions and, by summarizing China's experience in poverty eradication and objectively evaluating the effects of poverty eradication, I hope to provide a more realistic reference for other poverty-stricken countries and regions to eradicate poverty.

Material Science and Engineering (Reg. No. 2367)

Type of position Visiting PhD student: 12 months	Main supervisor Jinshan Pan
KTH School CBH	**Co-supervisor(s)**
KTH Department Chemistry	**Main email contact** jinshanp@kth.se

Specific subject area(s)
Corrosion Science
Title of project
Fundamental understanding of hydrogen-microstructure interactions in duplex stainless steel
Number of available position
1
Earliest start date
2023-05-01
Short description of the project

I have an ongoing VR project on this topic. The overall purpose of the project is to gain a fundamental understanding of hydrogen-microstructure interaction and initial stages of hydrogen-induced embrittlement (HE) of duplex stainless steel (DSS) to pave the way for development of stainless steel (SS) that are highly resistant to HE. Hydrogen can drastically reduce the strength of steel due to loss of ductility, which was observed a century ago but remains an important unsolved industrial challenge. High-strength steel is used in infrastructure, also for reducing weight in transport and for storage and usage of hydrogen. However, high-strength steel is particularly prone to HE, which limits its applications and hampers a 'hydrogen economy' that promises a low-carbon future. SS contain multiple alloying elements and exhibit high corrosion resistance due to formation of a barrier-type passive film on the surface. DSS consist of balanced ferrite and austenite phases in the microstructure and exhibit excellent mechanical strength and a high resistance to stress corrosion cracking (SCC). However, failures of components made of coarsely-grained DSS have been reported to be due to hydrogen-induced cracking. HE of high-strength steels (typically martensite type) has been studied extensively, and there are several proposed mechanisms, however, how crack initiation occurs is still an area of debate. For DSS, little is known about the hydrogen-microstructure interaction, and there are contradictory reports regarding which phase the hydrogen-induced crack initiates in DSS.

In this project, we will focus on a representative DSS and use multiple state-of-the-art analytical techniques including spatially-resolved operando synchrotron X-ray diffraction, neutron scattering, X-ray tomography, electron microscopy/diffraction, combined with electrochemical analysis and ab initio density functional theory calculation, to study the hydrogen-microstructure interactions and associated changes in the microstructure at micro-, nano- and atomic scales, in the surface and bulk. The specific aims are: i) to understand the hydrogen-induced degradation of the passive film; ii) to monitor the dynamic process of hydrogen-induced lattice change in the surface region and in the bulk; iii) to map and quantify the localization of strain and hydrogen in the microstructure; iv) to map the reversible and irreversible hydrogen traps, i.e., dislocations, phase/grain-boundaries, and precipitated particles; v) to clarify the ferrite-austenite interaction in response to hydrogen infusion in DSS; vi) to elucidate the mechanism of hydrogen-induced local elastic and plastic deformation leading to HE in DSS.

This project is an ambitious teamwork. The visiting student will join and contribute to the advanced experiments as well as the modelling work, and thus have the opportunity to learn the state-of-the-art techniques. "

Chemistry (Reg. No. 2368)

Type of position Visiting PhD student: 12 months	**Main supervisor** Qi Zhou
KTH School CBH	**Co-supervisor(s)** Lars Berglund
KTH Department Department of Chemistry	**Main email contact** qi@kth.se

Specific subject area(s)

Glycoscience

Title of project

Nanocellulose-based functional composites

Number of available position

1

Earliest start date

2023-05-01

Short description of the project

Nanocellulose-based materials have been increasingly studied due to their unique physical properties and various possible applications in automotive, aerospace, construction, composite, packaging, coating, paper making, personal care (cosmetics), textiles, food industry, environmental remediation, green electronics, energy devices, sensors, biological devices, and pharmaceuticals. The production of functional nanocelluloses and bioinspired materials combining lightweight, robust mechanical properties, multifunctionality, and structural control over multiple length scales are desired. In the context of materials design and engineering, the following aspects need to be addressed further for the development of cellulose-based nanocomposite materials: surface chemistry of nanocellulose, 3D structural design of nanocellulose, controlled assembly of nanocellulose, processing and manufacturing challenges, and integration of added functionalities. The main objective of this project is to design and fabricate cellulose nanofibers-based polymer composites for energy storage applications. we focus on the strategies for tailoring nanocellulose surfaces, controlled structural assembly and properties of nanocellulose based composite materials, particularly the fundamentals of the interfacial interactions at molecular level and the relationship between the structure and the electrochemical properties.

Computational mechanics (Reg. No. 2369)

Type of position Visiting PhD student: 12 months	**Main supervisor** Xiaogai Li
KTH School CBH	**Co-supervisor(s)**
KTH Department Biomedical Engineering and Health Systems	**Main email contact** xiaogai@kth.se

Specific subject area(s)
Computational mechanics, computer science
Title of project
Child human body model positioning and personalization
Number of available position
1
Earliest start date
2023-05-01
Short description of the project

Human body models (HBM) have become important numerical tools in understanding injury mechanisms and subsequently to aid the development of safety strategies, e.g. car seats [1,2]. For these purposes, one challenge is how to personalize and position HBMs. This project offers an opportunity for students to develop a new approach for positioning and personalization of child HBMs. Students with good math/physics skills are welcomed; programming skill is a merit but not necessary, and most important is you students think this a project that suits your interest.

References

[1] Giordano C, Li X, Kleiven S. Performances of the PIPER scalable child human body model in accident reconstruction. PloS one. 2017 Nov 14;12(11):e0187916.

[2] Bohman K, Östh J, Jakobsson L, Stockman I, Wimmerstedt M, Wallin H. Booster cushion design effects on child occupant kinematics and loading assessed using the PIPER 6-year-old HBM and the Q10 ATD in frontal impacts. Traffic injury prevention. 2020 Oct 12;21(sup1):S25-30."

Biotechnology (Reg. No. 2370)

Type of position Visiting PhD student: 12 months	**Main supervisor** Cristina Al-Khalili Szigyarto
KTH School CBH	**Co-supervisor(s)**
KTH Department Protein science	**Main email contact** caks@kth.se

Specific subject area(s)
Omics
Title of project
Development of cell models to explore genotype-phenotype correlation in rare neuromuscular diseases
Number of available position
1
Earliest start date
2023-05-01
Short description of the project

Cell models from induced pluripotent stem cells (iPSC) have during the past years held promise to elicit ground-breaking technologies to promote personalized medicine by better mimicking the patients true phenotype. While cell models are readily available to study the most common disorders such as metabolic disorders, the availability is scarce for rare disorders. This low availability is further complicated by the fact that several different genetic mutations can lead to the same diagnosis – in other words, one disorder may require a multitude of cell models to cover the mutational landscape of a patient group.

Muscular dystrophies eg. Duchenne and Limb-girdle Muscular Dystrophy are such rare genetic disorders that are incurable and life threatening. These disorders are characterised by increasing muscle deterioration, with loss of walking ability, difficulty to breath and ultimately heart failure. Having unique mutations and a low prevalence, of one per thousand individuals, capacity building within muscular dystrophies remains a challenge. Current efforts in developing and providing therapies are also hindered by challenges regarding the disease heterogeneity and the lack of tools for developing and testing novel therapies.

The main objective of the project is to develop in vitro biological systems to create patient representative cell models. The project will use novel methods to propagate iPSC, promote differentiation and create tissue models. High-throughput RNA-seq and protein array technology will be used to analyse in detail molecular features and reveal how the disease phenotypes vary in relation to the mutation. This strategy will generate well described disease models that if further developed could assist testing of emerging drugs as well as development of cell replacement therapies and regenerative medicine.

A visiting PhD student should have:

1. A background in biotechnology, molecular biology, biochemistry or similar,

2.. Knolwedge and hands-on experience of programming in eg. Python or R,

3. Interest in acquiring knowledge within high-throughput technologies for proteomics and transcriptomics profiling,

4. English communication skills, both written and oral.

The candidate will acquire:

1. Knowledge and experience in cell-cultivation and differentiation,

2. High-throughput antibody-based proteomics and RNA-sequencing,

3. Antibody validation.

This project is performed in an international context with opportunities to collaborate and develop a collaborative network."

Evolutionary genetics and genomics (Reg. No. 2371)

Type of position Visiting PhD student: 12 months	**Main supervisor** Peter Savolainen
KTH School CBH	**Co-supervisor(s)** Pelin Sahlen
KTH Department Gene Technology	**Main email contact** savo@kth.se

Specific subject area(s)
Origin and evolution of the domestic dog: Phylogeography and genome evolution
Title of project
Origin and Evolution of the domestic dog: identification of genes under selection and geographic region of origin
Number of available position
1
Earliest start date
2023-06-01
Short description of the project

This project is based on a long-established collaboration between Sweden and China, with the research groups of Professor Ya-ping Zhang and Professor Guo-Dong Wang at Kunming Institute of Zoology, Chinese Academy of Sciences. In a number of prominent papers, we have previously, based on large-scale genetics and genomics, indicated South China as the probable region of dog origins, and identified genes under selection in the first phase of dog evolution, affecting e.g. digestion and behaviour.

We have now increased sampling in South China and Southeast Asia, for refined phylogeographic analyses. We analyse all types of genetic markers: nuclear genomes as well as mitochondrial, Y-chromosomal and X-chromosomal DNA. Since most mutations are situated in regulating regions far from the affected genes, we also identify regulatory sequences under selection in the domestication, by mapping promoters and enhancers and their interactions in regulatory networks. Based on these analyses, we continue our studies of gene evolution and phylogeography, with the aim of describing how, when and where the wolf developed into the domestic dog.

Because of the broad aims of this study, students with different backgrounds are welcome to apply; molecular biology, bioinformatics or phylogeographic analysis.

Project website
https://www.kth.se/gte/evolutionary-biology-and-forensics-1.783359

Chemistry (Reg. No. 2372)

Type of position Visiting PhD student: 12 months	**Main supervisor** Istvan Furo
KTH School CBH	**Co-supervisor(s)** Sergey Dvinskikh
KTH Department Chemistry	**Main email contact** furo@kth.se

Specific subject area(s)
Physical Chemistry
Title of project
NMR/MRI studies of water and its transport in wood
Number of available position
1
Earliest start date
2023-09-01
Latest start date
2023-12-01
Short description of the project

The imbibition and transport of water in the complex architecture of natural and modified wood remains incompletely characterised and understood. The aim is to design and use advanced high-field magnetic resonance imaging methods to study the behaviour of wetting fronts in judiciously selected wood and other cellulosic materials. In addition, one would augment those experiments by other NMR observables that are sensitive to those local conditions of water that change during the process of the transport. In addition, we shall link high-field NMR observations to observables in low-field time-domain spectrometer where the latter type of instruments have the advantage of being portable and thereby applicable for in situ observation. The main and unparalleled advantage of NMR/MRI is that the same instrumentation and methodology it can provide both a macroscopic image and a detailed microscopic characterisation of both structure and dynamics. This study is intimately linked to and built upon previous advances in our laboratory (as representative examples, see Dvinskikh, Henriksson, Berglund, Furó, Holzforschung 65, 103 (2011); Lindh, Bergenstråhle-Wohlert, Terenzi, Salmén, Furó, Carbohydr. Res. 434, 136 (2016); Lindh, Terenzi, Salmén, Furó, Phys. Chem. Chem. Phys. 19, 4360 (2017); Chen, Wohlert, Berglund, Furó, J. Phys. Chem. Lett. 13, 5424 (2022).).

Mechatronics (Reg. No. 2373)

Type of position Visiting PhD student: 12 months	**Main supervisor** Lei Feng
KTH School ITM	**Co-supervisor(s)**
KTH Department Machine Design	**Main email contact** lfeng@kth.se

Specific subject area(s)
Image processing and measurement
Title of project
Accurate measurement method for deformation of 4D printed materials based on stripe projection
Number of available position
1
Earliest start date
2023-05-01
Latest start date
2023-10-01
Short description of the project

Four-dimensional printing (4DP) is defined as a prototyping technology that builds 3D printed structures with smart materials to enable the objects morphing under external stimuli. Moreover, 4DP requires closed-loop monitoring and control to achieve a high level of accuracy. We designed a closed-loop control strategy for the deformation process of 4D printed materials, where the accurate measurement of shape deformation provides a strong guarantee for closed-loop control.

In this project, the visiting PhD students will establish an accurate method for measuring the deformation of 4D printed materials based on either image processing methods. The following research questions will be answered.

- What measurement principles and modelling methods are suitable for measuring the deformation of 4d printed materials?

- How to process stripe maps generated by the computer, projected by the projector and photographed by the camera?

- How to perform phase extraction, system calibration and 3D surface reconstruction?

- How to calculate quantitative data on the deformation of 4d printed materials by integrating 3D point cloud coordinates?

Project website
https://www.kth.se/en/itm/forskning/iris/research/integrerad-mechanics/ongoing-projects/novel-mechatronic-systems-and-soft-robotics-enabled-by-4d-printing-and-machine-learning-1.1142457

Materials Science and Engineering (Reg. No. 2374)

Type of position Visiting PhD student: 12 months	**Main supervisor** Wangzhong Mu
KTH School ITM	**Co-supervisor(s)** Joakim Odqvist
KTH Department Materials Science and Engineering	**Main email contact** wmu@kth.se

Specific subject area(s)
Engineering Materials Science
Title of project
Designing and characterization of advanced high entropy alloys
Number of available position
1
Earliest start date
2023-09-01
Latest start date
2023-12-31
Short description of the project

High entropy alloy (HEA) is considered as a new alloying strategy which includes the combination of multiple principle elements with a high concentration during the past decade and a half. Initially, a conventional HEA strategy is developed for an equiatomic multicomponent alloy system and with a single phase structure which shows a single fcc phase. It shows an excellent strengthening property. However, the loss of ductility with the decreasing temperature in the tensile test for single fcc phase alloy has been widely noticed. Furthermore, dual phase HEA has been introduced, the formed martensite can contribute to a significant improvement in both strength, ductility and strain hardening, consequently tunes the strength and ductility balance at the cryogenic-temperature.

In this project, a sustainable solution to design and manufacture HEA is planned to do, CALPHAD based methodology in combination of machine learning (ML) will be used to design the correlation of composition, structure and the properties. Furthermore, an economic-friendly manufacturing solution is planned to provide. Furthermore, advanced characterization tools, e.g. different scales electron microscopies, atom probe tomography, in-situ characterization including synchrotron x-ray diffraction, thermal analysis will potentially use to characterize the microstructure evolution features. The obtained knowledge in this project will benefit for new insights for fundamental study of HEA manufacturing.

Material science, chemical engineering, mechanical engineering (Reg. No. 2375)

Type of position	Main supervisor
Visiting PhD student: 12 months	Weihong Yang
KTH School	**Co-supervisor(s)**
ITM	Pär Jönsson
KTH Department	**Main email contact**
Material Science and Engineering	weihong@kth.se

Specific subject area(s)
material science, chemical engineering, mechanical engineering
Title of project
Biomass gasfiication tar reforming
Number of available position
1
Earliest start date
2023-05-01
Short description of the project

Gasification of biomass and waste is one of promising process to convert solid fuel/waste into syntactical gas, which can be further convert into CH4, H2 or chemicals. Mainly challenge of such process is the tar in the syngas. Intensive works have been done to eliminate the tar during the gasification. process.

A solution is the use of a secondary catalytic reformer to convert tar components to useful permanent gases, before the end-user application.

Tar reforming is high endothermic reaction, which need supply energy. Typically Technologies for steam reforming are POX-partial oxidation, auto thermal reforming-ART or, catalytic crack, or combining of them. When POX is used, extra oxygen stream is needed, which leads to a complex system and cost. Meantime, the syngas is diluted by CO2 coming from partial combustion. Small syngas pipeline also makes the mixing of syngas and oxygen stream very hard.

In order to solve such problem, a novel electrical heating catalytic reforming process was developed at KTH. The reformer is heated directly by electricity, and the catalyst is prepared by 3D printing.

In this project, this technology will be tested in laboratory for tar reforming of biomass gasfication. Optimization the reformer design is the targeted.

Photonics (Reg. No. 2376)

Type of position Visiting PhD student: 12 months	**Main supervisor** Max Yan
KTH School SCI	**Co-supervisor(s)**
KTH Department Department of Applied Physics	**Main email contact** maxyan@kth.se

Specific subject area(s)
Nanofabrication, optical characterization, optical sensing, thermal emission, metamaterial, mid-infrared source, Si photonics
Title of project
Integrated Mid-Infrared Photonics
Number of available position
2
Earliest start date
2023-09-01
Short description of the project

Infrared photonics finds important applications in gas sensing, surveillance, and life science etc. In this project we investigate critical integration techniques for mid-infrared (MIR, 3-8 μm) radiation on silicon platform towards mainly gas sensing applications. Key components include thermal-emission based MIR sources, low-loss MIR waveguides, and even on-chip IR detection techniques. Knowledge to be developed/used: electromagnetic simulation, spectrally selective thermal emitter design, nanofabrication, infrared thermography, FTIR spectroscopy, system integration for gas sensing, etc. Depending on interest and specialty, the student can focus on either theoretical or experimental aspect of the project.

Project website
https://www.kth.se/profile/miya

Material Science - Energy Technology (Reg. No. 2377)

Type of position Visiting PhD student: 12 months	**Main supervisor** Muhammet Toprak
KTH School SCI	**Co-supervisor(s)** Björn Palm
KTH Department Applied Physics	**Main email contact** toprak@kth.se

Specific subject area(s)

Material Science

Title of project

Nanoengineered Heat Transfer Surfaces

Number of available position

1

Earliest start date

2023-05-01

Short description of the project

World energy crisis has triggered more attention to energy saving and energy conversion systems. Enhanced surfaces for boiling are among the applications of great interest since they can improve the energy efficiency of heat pumping equipment (i.e., air conditioners, heat pumps, refrigeration machines). Methods that are used to make the state-of-the-art enhanced surfaces are often based on complicated mechanical machine tools, are quite material-consuming and give limited enhancement of the boiling heat transfer. We present earlier a new approach to fabricate enhanced surfaces by using a simple electrodeposition method with in-situ grown dynamic gas bubble templates. As a result, a well-ordered 3D macro-porous metallic surface layer with nanostructured porosity is obtained. Since the structure is built based on the dynamic bubbles, it is perfect for the bubble generation applications such as nucleate boiling. At heat flux of 1W cm-2, the heat transfer coefficient is enhanced over 17 times compared to a plain reference surface. It's estimated that such an effective boiling surface would improve the energy efficiency of many heat pumping machines with 10–30%. The extraordinary boiling performance is explained based on the structure characteristics. In this project we plan to build further complex architectures using solution chemical methods and evaluate their heat transfer performance in real media.

Applied Mathematics (Reg. No. 2378)

Type of position Visiting PhD student: 12 months	**Main supervisor** Jan Kronqvist
KTH School SCI	**Co-supervisor(s)**
KTH Department Department of Mathematics	**Main email contact** jankr@kth.se

Specific subject area(s)
Optimization and Systems Theory
Title of project
Extensive pre-processing techniques and complexity reduction for mixed-integer optimization
Number of available position
1
Earliest start date
2023-08-01
Short description of the project

In the project we will develop algorithms and techniques for extensive pre-processing of mixed-integer optimization problems. The goal of these algorithms is to greatly reduce the computations needed to solve such a problem by automatically analyzing and modifying the given problem. We will focus on extensive and deterministic pre-processing techniques. Such pre-processing methods have many valuable real-world applications, for example, in some scheduling tasks where most of the problem is known well in advance (hours/days before the problem must be solved) but when the full problem is known then it must be solved very quickly. Other applications include robust verification of deep neural networks where the same problem.

In the project we will investigate and develop different techniques to strengthen the problem. For example, we will work with formulation strengthening techniques and methods to add strong valid inequalities. The methods we work with can improve and speed up the solution procedure by strengthening the continuous relaxation and excluding non-optimal/infeasible integer assignments, which can drastically reduce the size of the branch-and-bound tree.

For the project the PhD student needs to be familiar with mixed-integer optimization (studied the topic in some course or worked with this in their research), for example you should know what the idea behind so called cutting planes is (for example so-called Gomory cuts or similar). You also need to have some programming experience preferably in Python.

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Photonics (Reg. No. 2379)

Type of position Visiting PhD student: 12 months	Main supervisor Oskars Ozolins
KTH School SCI	**Co-supervisor(s)** Xiaodan Pang
KTH Department Applied Physics	**Main email contact** ozolins@kth.se

Specific subject area(s)

Sinfal procesing within Reservoir Computing

Title of project

NEURONS: Photonic-Assisted Signal Processing based on Reservoir Computing

Number of available position

1

Earliest start date

2023-03-01

Latest start date

2024-03-01

Short description of the project

We live in a complex world where we need to analyze and predict the evolution of large, nonlinear, dynamic systems; everything from the human brain to climate dynamics, the world economy, and the spread of diseases. Hence, in our information age, the ability to process large amounts of data is crucial; a development that is reinforced by the fact that more and more smart gadgets are being integrated into our daily lives. This will require the use of artificial intelligence even in the areas where humans today still have an advantage over digital computers. Advanced learning models, better algorithms, and higher available computing power need to be developed for applications such as self-driving cars, autonomous robotics, detection of fake news, prediction of pandemics, and so on.

The NEURONS project aims to develop optical neural networks where both hardware and software are tailored for machine learning. Such analog information processing with light has the potential to simultaneously achieve ultra-high computer speed and high energy efficiency, which will be required for future applications in artificial intelligence.

Project website

https://www.kth.se/profile/ozolins?l=en

Applied and computational mathematics (Reg. No. 2380)

Type of position Visiting PhD student: 12 months	**Main supervisor** Xiaoming Hu
KTH School SCI	**Co-supervisor(s)**
KTH Department Mathematics	**Main email contact** hu@kth.se

Specific subject area(s)
Optimization and systems theory
Title of project
Safety verification and control approaches for multi-agent systems
Number of available position
1
Earliest start date
2023-08-01
Short description of the project

The objective of this project is to develop safety verification and safety control approaches for multi-agent systems

with complex interconnection topology. Different from stability and robustness properties, safety is another core property of system that is used to ensure that the state stays in a safe region. However, traditional tools such as model checking and reachability analysis are hard to be applied to systems with large-scale or complex interconnection. To tackle such challenges, this project aims to establish a safety analysis tool for complex large-scale systems, and to develop safety control methods for multi-agent systems even with high-level safety constraints such as temporal logic type.

Visiting scholar: 3 - 12 months

Engineering Mechanics (Reg. No. 2351)

Type of position Visiting scholar: 12 months	**Main supervisor** Gunnar Tibert
KTH School SCI	**Co-supervisor(s)** Huina Mao
KTH Department Department of Engineering Mechanics	**Main email contact** tibert@kth.se

Specific subject area(s)
Mechanics
Title of project
Inverse Design of Metamaterials
Number of available position
1
Earliest start date
2023-08-01
Short description of the project

Metamaterials are rationally designed composites aiming at effective material parameters that go beyond those of the ingredient materials. The development of additive manufacturing techniques gives new possibilities for the fabrication of complex metamaterial structures, many of which cannot be realized through conventional fabrication methods. Our group has successfully developed an original inverse modeling approach for characterization of anisotropic cellular metamaterials. The project is aiming to extend the current method to design target-oriented multifunctional metamaterials and develop a systematic inverse design method by embedding machine learning methods. The developed novel multi-material additive manufacturing technology will be used for producing the complex meta-structures in the Lightweight Structures Laboratory (KTH). Moreover, this project will greatly promote the education and training of young researchers via scientific exchanges, cross-disciplinary workshops, and guest lectures. The goal of the visiting scholar is to form strong international collaborations in research, education, and the career development of young researchers.

Vehicle dynamics (Reg. No. 2352)

Type of position Visiting scholar: 12 months	**Main supervisor** Jenny Jerrelind
KTH School SCI	**Co-supervisor(s)** Lars Drugge
KTH Department Engineering Mechanics	**Main email contact** jennyj@kth.se

Specific subject area(s)
Modelling and simulation of vehicle behaviour, and its dynamic interaction with driver and environment.
Title of project
Energy efficient driving – tyre wear estimation and optimisation
Number of available position
1
Earliest start date
2023-05-01
Short description of the project

Due to increased environmental issues and for economic reasons energy efficient driving is of high interest for the future. By using path planning and thereby knowing which route the vehicle will drive, control strategies can be developed so that the vehicle can drive to its destination as energy efficient as possible while taking into account comfort and safety. In order to develop these energy efficient control strategies there is a need of a tyre model that models for example the losses related to the tyre such as the rolling resistance as well as the tyre wear. Tyre wear is costly for the vehicle owner but it is also an environmental issue. It results in larger waste of old tyres as well as particle emissions that are unhealthy for humanity as well as the ecological system.

The aim with this work is to develop a full vehicle model including a tyre model that can estimate tyre wear to evaluate how tyre wear as well as other energy consuming aspects such as cornering, acceleration, braking and rolling resistance are changing during different driving conditions and vehicle settings. Introduction of more advanced drive systems with multiple actuators, such as in wheel motors, active suspension, individual steering and camber control enable a higher number of control outputs than required to control a given number of degrees of freedom, i.e. over-actuation. The intention is to get an insight in how an over-actuated vehicle shall be controlled when driving to minimise wear, while taking into account energy efficiency, comfort and safety, since it is of major importance both for the consumers and the environment. This is an essential step towards development of safe and sustainable future vehicles.

Engineering Mechanics (Reg. No. 2353)

Type of position Visiting scholar: 12 months	Main supervisor Sebastian Stichel
KTH School SCI	**Co-supervisor(s)** Zhendong Liu
KTH Department Engineering mechanics	**Main email contact** stichel@kth.se

Specific subject area(s)

Railway engineering

Title of project

Modelling and fault diagnosis of railway pantograph-catenary system

Number of available position

1

Earliest start date

2023-10-01

Short description of the project

The pantograph-catenary system is the most important sub-system of electrified railways, which decides operational speed, maintenance cost and system reliability. The catenary is designed to be used for 30-40 years. During the long service life, the dynamic load together with many other factors e.g. wear, corrosion and environmental disturbances, eventually deteriorates the health condition of the system. In long-term operation, to keep the system in good condition, frequent inspections take place to ensure operational safety. However, the inspections are not only costly but also can not reveal the physical properties of invisible or undetectable positions of all parts of the system. Therefore, it is necessary to build a numerical model of the pantograph-catenary system to study the impact of different types of faults and develop the corresponding fault diagnosis methods. The proposed research work would mainly be performed by means of numerical studies with help of measurement data from previous inspections on the existing pantograph-catenary systems, e.g., contact force between pantograph and catenary, pantograph and carbody vibration, catenary geometry and track irregularity, etc.

Materials Science, Nanotechnology, Materials Engineering, Device Physics (Reg. No. 2354)

Type of position Visiting scholar: 10 months	Main supervisor Muhammet Toprak
KTH School SCI	**Co-supervisor(s)**
KTH Department Department of Applied Physics	**Main email contact** toprak@kth.se

Specific subject area(s)

Materials Science, Nanotechnology, Materials Engineering, Device Physics

Title of project

Tuning Charge transfer in printed hybrid thermoelectric materials

Number of available position

1

Earliest start date

2023-04-01

Short description of the project

The project focuses on the study and improvement, or tuning, of charge transport in polymer-inorganic hybrid thermoelectric materials.

The constituent materials are to be synthesized in-house and shall be used for ink formulation, which in turn will be used for printing active films. Transport properties of these films, and the underlying mechanisms, will be investigated using a wide library of tools and techniques.

Engineering (Reg. No. 2355)

Type of position Visiting scholar: 12 months	**Main supervisor** Liangchao Zou
KTH School ABE	**Co-supervisor(s)**
KTH Department Environmental Science and Engineering	**Main email contact** lzo@kth.se

Specific subject area(s)
Hydrogeology
Title of project
Analysis of non-Darcy flow in rock fractures
Number of available position
1
Earliest start date
2023-09-01
Short description of the project

Non-Darcy flow in rock fractures occurs in many geo-engineering projects, such as extraction and storage of geo-energy, oil, and gas, construction and maintenance of rock tunnels and dam foundations. The permeability of fractures in the non-Darcy flow regime is determined by both viscous permeability and inertial permeability. Determination of inertial permeability remains a challenge due to the coupling of strong heterogeneity of fracture structures and in situ hydromechanical conditions. This project aims to analyze the non-Darcy flow behaviors in rock fractures, focusing on the impact of dynamic loading on fracture permeability in the non-Darcy flow regime. A reliable model for predicting fracture permeability is expected to be established. It is planned for a visiting scholar (12 months).

Computer science (Reg. No. 2356)

Type of position Visiting scholar: 12 months	**Main supervisor** György Dán
KTH School EECS	**Co-supervisor(s)**
KTH Department Computer science	**Main email contact** gyuri@kth.se

Specific subject area(s)
Machine learning and game theory
Title of project
Resilient learning for serverless edge computing
Number of available position
1
Earliest start date
2023-09-01
Short description of the project

Serverless computing, based on the function-as-a-service paradigm, provides flexible access to computing resources with minimal need for manual system configuration. Due to its ease of use, serverless computing could become the dominant computing abstraction in edge environments, but for it to prevail, it is essential that it can guarantee SLAs for industrial use cases with potentially stringent requirements and that it be robust to adversarial input.

In this project we aim at developing novel algorithms for resilient learning in serverless edge computing environments. With a focus on multi-agent learning in the context of edge computing, we are particularly interested in addressing fundamental problems related to resource management, learning equilibria in games, and equilibrium performance potentially under adversarial behavior. Of interest are also approaches leveraging state-of-the-art neural architectures, including graphical models and federated learning. We will use the developed models for the design of topologies and learning algorithms that are resilient to noise and to adversarial behavior and allow to reach good system performance.

Wireless communications (Reg. No. 2357)

Type of position Visiting scholar: 12 months	**Main supervisor** Carlo Fischione
KTH School EECS	**Co-supervisor(s)**
KTH Department NSE	**Main email contact** carlofi@kth.se

Specific subject area(s)

Machine learning, applied optimization theory

Title of project

Machine Learning in Wireless Networks

Number of available position

1

Earliest start date

Short description of the project

One of the main characteristics of the IoT and 5-6G technological revolution is the huge data generation. Such wealth of data is motivating the development of data analysis methods, namely machine learning. Currently, machine learning needs big datasets and very huge computational and communication resources. However, in wireless networks, data sets of any size will be distributed among several nodes (people, devices, objects, or machines) that might not be able to perform the computations and to share data over bandwidth limited or energy limited links. Unfortunately, existing machine learning methods are mostly intended for proprietary and high performing networks as in data centres, and would greatly stress communication networks such as IoT and 5-6G wireless networks. In these wireless networks, machine learning methods will encounter new challenges in terms of computation, bandwidth, scalability, privacy, and security. Meanwhile, wireless communications methods are not yet intended to support Machine Learning services. Machine Learning over wireless networks face a lack of understanding of the fundamental methods. In this research project, we propose to contribute to investigate a new theory for wireless communications and machine learning.

Chemical Engineering (Reg. No. 2358)

Type of position Visiting scholar: 12 months	**Main supervisor** Kerstin Forsberg
KTH School CBH	**Co-supervisor(s)**
KTH Department Chemical Engineering	**Main email contact** kerstino@kth.se

Specific subject area(s)
Separation processes
Title of project
Industrial Crystallization for Resource Recovery
Number of available position
1
Earliest start date
2023-03-01
Short description of the project

The project concerns developing crystallization processes of relevance for resource recovery from waste streams, such as spent batteries or magnet scrap. The research will build on our previous and on-going work in this area (please see the website below). The work will be carried out in an international environment with strong links to industry in Sweden and Europe.

The aim will be to develop crystallization processes aiming at high purity and low energy consumption compared to conventional processes. The work will include developing both the fundamental understanding and industrial applicability. The work will consist of planning and performing laboratory experiments and evaluating the data in collaboration with the supervisors at KTH.

We seek a candidate with a background in chemical engineering or hydrometallurgy, having expertise in crystallization/ precipitation and with the ability to apply this knowledge to develop industrially applicable processes. The candidate is expected to be able to work both independently and together with colleagues. Furthermore, the candidate should have well-developed analytical and problem-solving skills, strong laboratory/ instrumental skills and good proficiency in written and spoken English.

Project website
https://www.kth.se/profile/kerstino?l=en

Chemistry (Reg. No. 2359)

Type of position Visiting scholar: 3-12 months	**Main supervisor** Markus Kärkäs
KTH School CBH	**Co-supervisor(s)** Prof. Peter Dinér
KTH Department Department of Chemistry	**Main email contact** karkas@kth.se

Specific subject area(s)
Organic chemistry
Title of project
Enabling Chemical Synthesis with Visible Light
Number of available position
1
Earliest start date
2023-03-01
Short description of the project

The application of visible light to promote chemical reactivity has far-reaching implications in minimizing the environmental impact and for the development of sustainable catalytic platforms. In this regard, photoredox catalysis has proven to be a sustainable and a powerful tool for promoting free-radical chemistry to access chemical reactivity that would otherwise be inaccessible using conventional two-electron processes.

The proposed research focuses on the development of methodologies for carbon–hydrogen (C–H) functionalization manifolds using hydrogen atom transfer (HAT) processes. The proposed projects are expected to promote numerous advances in carbon–carbon (C–C) cross-coupling technologies and can, for example, be extended to late-stage functionalization of drug candidates and biologically active target structures, for rapid drug discovery efforts. A key feature of the developed strategies is the use of abundant feedstocks, such as carboxylic acids and alcohols, as handles for controlled radical generation and subsequent bond formation.

Biomedical Engineering (Reg. No. 2360)

Type of position Visiting scholar: 10 months	**Main supervisor** Dmitry Grishenkov
KTH School CBH	**Co-supervisor(s)**
KTH Department Biomedical Engineering and Health Systems	**Main email contact** dmitryg@kth.se

Specific subject area(s)
Ultrasound, drug delivery, multimodal imaging
Title of project
Nano-engineered capsules for improved ultrasound imaging and controlled drug delivery
Number of available position
2
Earliest start date
2023-04-01
Short description of the project

A continuous development of new therapeutic agents has made novel drugs available for a variety of diseases. However, a wide spectrum of active molecules alone does not guarantee optimal therapeutic effect as other relevant factors, such as bioavailability and release mechanism, come into play. The "drug" has rather become a "complex" whose therapeutic efficacy is obtained with the collaborative action of a compound and a delivery system.

The current project introduces a new class of microdevices providing integrated diagnostic and therapeutic applications, i.e., theranostics using nano-engineered capsules. A gas core makes microbubbles to an efficient ultrasound contrast agent. Application of therapeutic compound or therapeutic gases opens new possibilities for local, specific drug delivery triggered by ultrasound. Incorporation of magnetic particles or Xenon gas makes capsules truly multimodal imaging devise where MRI and CT imaging can be combined with ultrasound.

The objective of the current project is to further improve existing and develop new contrast pulse sequences for diagnostic multimodal imaging and therapy using the preclinical ultrasound imaging platform Verasonics.

Depending on the applicant preferences specific tasks of the project might focus on:

1. Development and design new contrast pulse sequences using single crystal set-up and extend this knowledge towards programmable ultrasound system Verasonics.

2. Experimental work on multimodal imaging (CT, MRI and US) using the developed sequences.

3. Fabrication of the tissue mimicking phantom.

4. Design of the new experimental sep-up for demonstration of complex acoustic phenomenon.

5. Mathematical modelling of the wave propagation and capsules interaction.

Project website
https://www.kth.se/profile/dmitryg/page/projects

Materials Science and Engineering (Reg. No. 2361)

Type of position Visiting scholar: 12 months	**Main supervisor** Joakim Odqvist
KTH School ITM	**Co-supervisor(s)** Wangzhong Mu
KTH Department Materials Science and Engineering	**Main email contact** odqvist@kth.se

Specific subject area(s)

Computational Materials Science

Title of project

Advanced modelling of green steel manufacturing

Number of available position

1

Earliest start date

2023-08-01

Short description of the project

Sustainability is a common aim that involves almost all fields of human activities. Specifically, the global annual CO2 emission from the iron and steel industry contributes to a large percent. In this case, replacing carbon to use hydrogen as the reducing agent is urgently needed to offer a promising pathway for a green steel production towards fossil-free future. Among the plausible solutions for sustainable metallurgy, hydrogen-based direct reduction technology, e.g. Hydrogen plasma technique, etc. is one of the most promising methods with a high technology readiness considering the environmental impact.

It is known that the reduction of iron ores with hydrogen is a complex solid/gas reaction process, the underlying mechanisms governing this process are characterized by a complex interaction of several issues of physical, chemical, and mechanical principles, influencing issues such as mineralogy, phase transformations, transport phenomenon, stress between pellets are needed to consider. Quite some thermodynamic and kinetic issues are still unknown, for instance, the influence of nature of each mineral phase limits the understanding of this technique. A deep fundamental study of the thermal physical property of each oxide existing in iron ores could contribute to controlling the reaction kinetics, and pave the way to benefit the industrial-scale hydrogen reduction process. The current project aims to perform the thermodynamics, kinetics and machine learning modelling to investigate the mechanism of hydrogen metallurgy process. The obtained knowledge will in combination of experimental analysis to contribute to a sustainable future. This work will in combination of a running VINNOA project in collaboration with Max-Planck-Institut für Eisenforschung.

Computational Materialdesign (Reg. No. 2362)

Type of position Visiting scholar: 12 months	**Main supervisor** Levente Vitos
KTH School ITM	**Co-supervisor(s)** Stephan Schönecker
KTH Department Materials Science and Engineering	**Main email contact** levente@kth.se

Specific subject area(s)
Computational Materialdesign based on first principles quantum theory
Title of project
High-entropy magnetocaloric materials
Number of available position
2
Earliest start date
2023-09-01
Short description of the project

The magnetic refrigeration technique based on magnetocaloric effect (MCE) represents the most promising alternative to gas compression refrigeration. The MCE can generate substantial temperature changes around room-temperature, particularly in materials undergoing simultaneous both magnetic and structural transitions. In magnetocaloric materials (MCMs) the alignment of randomly oriented magnetic moments by external magnetic field at adiabatic conditions results in heating. This heat is removed by heat transfer. Then turning off the magnetic field, the magnetic moments randomize again, leading to cooling of the material below the ambient temperature.

Practical implementation of the magnetic refrigeration technique requires the development of innovative MCMs, having superior magnetic, chemical and mechanical properties and at the same time admissible cumulative cost and low environmental burden.

The richness of the magnetic properties of the multi-principal element alloys (MPEAs) offers unique possibility for magnetocaloric engineering. Today the magnetic MPEAs are among the most promising candidates for combined magneto-structural transitions at ambient and elevated pressures due to the outstanding mechanical characteristics. Revealing and understanding the atomistic mechanism behind the structural and magnetic properties, one will be able to tailor the magnetic transition temperature, the entropy and adiabatic temperature changes, and connect the magnetic transitions with structural changes in order to reach large MCE in new magnetocaloric materials.

The present project will use first-principles quantum mechanical tools to deliver high quality data in order to rigorously investigate specific magnetic MPEAs for magnetocaloric applications.

Computational Materialdesign (Reg. No. 2363)

Type of position Visiting scholar: 12 months	Main supervisor Levente Vitos
KTH School ITM	**Co-supervisor(s)** Song Lu
KTH Department Materials Science and Engineering (MSE)	**Main email contact** levente@kth.se

Specific subject area(s)

Computational Materialdesign based on first principles quantum theory

Title of project

Atomistic simulation of plasticity of complex alloys

Number of available position

2

Earliest start date

2023-09-01

Short description of the project

Plasticity is a fundamental property determining the mechanical behavior of materials. The complexity of plastic deformation and the lack of a unified theory have seriously limited the exploration of the full capacity of complex alloys, such as stainless steels or high entropy alloys. Elastic deformation involves small lattice distortions and is described by the well-known Hooke's law. However, the plastic deformation implies transitions over a series of unknown energy barriers. A phenomenological description of the plastic regime using the so called stacking fault energy (SFE) has been widely accepted in engineering sciences. However, the SFEs are very sensitive to a series of factors. For an effective optimization of the mechanical properties, a quantitative prediction of the SFEs and in-depth understanding of the stacking faults are important. Experimental techniques such as X-ray or TEM are commonly used to determine the SFE, but unfortunately the measured SFEs are often very scattered due to the failure of the conventional experimental techniques in systems with very small or negative SFE.

Another important aspect is that materials classification based merely on the SFE shows serious limitations the case of MPEAs. The reason is that an equilibrium property cannot capture the complexity of plastic deformation. However the generalized planar fault energy comprises several intrinsic energy barriers (IEBs) and thus provides information on the deformation process itself barriers. For a better understanding and prediction of the plastic deformation mechanism one requires as input both the SFEs and IEBs. This type of modeling has not been available for metallurgists because of the inherent difficulty of experimental determination of IEBs.

The present proposal focuses on assessing the composition and temperature dependence of the SFEs and IEBs using ab initio methods, establishing the composition regimes for various deformation mechanisms such as dislocation networks, twinning and martensite formation. A correlation between the theoretically predicted SFE and the deformation response will also be in the focus, through collaboration with experimentalists and industrial units.

Fiber and polymer science (Reg. No. 2381)

Type of position Visiting scholar: 3-12 months	**Main supervisor** Yuanyuan Li
KTH School CBH	**Co-supervisor(s)**
KTH Department Fibre and Polymer Technology	**Main email contact** yua@kth.se

Specific subject area(s)
Biocomposite
Title of project
Wood modification for gas separation
Number of available position
1
Earliest start date
2023-04-01
Short description of the project

Greenhouse gases (GHGs) emission, especially CO2, is pointed out as the main contributor to global warming, leading to an urgent requirement for efficient CO2 capture and storage. Physical adsorption is an attractive strategy. To fulfill industrial requirements, the adsorbent must have a high adsorption capacity, fast adsorption kinetics, and good stability (moisture, thermal, mechanical, and cyclic stabilities). Normally, the adsorbents are in the form of powder. A granulation process is always needed in the separation process, which leads to a decrease in CO2 adsorption capacity while increase in production costs. Porous mechanical support in the form of film and monolith is another strategy to increase the kinetic. However, the binding of the powder to the support is an issue. In this context, adsorbents with multi-scale hierarchical porous structures get great attention. Wood is biomass with natural complex hierarchical porous structure combing aligned micro-, meso-, and macropores, showing the potential as a monolith reactor for flow gases. Further modification could result in CO2 adsorbents with aligned pore structures from nano scale to tens of micrometer scale. The main focus of this project is wood modification with the purpose of CO2 adsorption.

Biotechnology (Reg. No. 2382)

Type of position Visiting scholar: 3-12 months	**Main supervisor** Cristina Al-Khalili Szigyarto
KTH School CBH	**Co-supervisor(s)**
KTH Department Protein sciences	**Main email contact** caks@kth.se

Specific subject area(s)
Systems biology
Title of project
Exploring genotype-phenotype correlation in rare neuromuscular diseases
Number of available position
1
Earliest start date
2023-09-01
Short description of the project

Tools and technological platforms for the analysis of the entire transcriptome and proteome are being increasingly used to decipher molecular alterations in tissues aiming to increase our understanding of different disease states. Molecular characterization of affected tissues can reveal genotype-phenotype correlations within eg. genetic disorders. Muscular dystrophies eg. Limb-girdle Muscular Dystrophy (LMGD) are such rare genetic disorders that are incurable and life threatening. These disorders are characterised by increasing muscle deterioration, with loss of walking ability, difficulty to breath and ultimately heart failure. Having unique mutations and a low prevalence, of one per thousand individuals, capacity building within muscular dystrophies remains a challenge. Current efforts in developing and providing therapies are also hindered by challenges regarding the disease heterogeneity and the lack of tools for developing and testing novel therapies.

The main objective of the project is to explore genotype-phenotype correlation by analysing and integrating RNA-seq and protein array data from the analysis of animal and cell models and affected patients. This strategy contributes to the capacity building within rare disorders and characterization of different phenotypes. The results can also facilitate classification of LGMD phenotypes as genetic mutations in single but different genes eg. Calpain 3, anoctamin 5, dysferlin, etc. lead to the same diagnosis.

A visiting scholar should have:

1. A background in biotechnology, biology, biochemistry or similar and bioinformatics,
2. Documented knowledge and hands-on experience of programming. Experience with R and Python is merituous,
3. Knowledge and hands-on experience with GitHub, Bioconductor, etc,
4. English communication skills, both written and oral.

This project is performed in collaboration with experimentalists and researchers from different universities. Ideal applicants are highly motivated scholars in the field of biotechnology with a strong interest in bioinformatics or in the field of bioinformatics with a strong interest in biotechnological applications.

Evolutionary genetics and genomics (Reg. No. 2383)

Type of position Visiting scholar: 3-12 months	**Main supervisor** Peter Savolainen
KTH School CBH	**Co-supervisor(s)** Pelin Sahlen
KTH Department Department of Gene Technology	**Main email contact** savo@kth.se

Specific subject area(s)
Origin and evolution of the domestic dog: Phylogeography and genome evolution
Title of project
Origin and Evolution of the domestic dog: identification of genes under selection and geographic region of origin
Number of available position
2
Earliest start date
2023-06-01
Short description of the project

This project is based on a long-established collaboration between Sweden and China, with the research groups of Professor Ya-ping Zhang and Professor Guo-Dong Wang at Kunming Institute of Zoology, Chinese Academy of Sciences. In a number of prominent papers, we have previously, based on large-scale genetics and genomics, indicated South China as the probable region of dog origins, and identified genes under selection in the first phase of dog evolution, affecting e.g. digestion and behaviour.

We have now increased sampling in South China and Southeast Asia, for refined phylogeographic analyses. We analyse all types of genetic markers: nuclear genomes as well as mitochondrial, Y-chromosomal and X-chromosomal DNA. Since most mutations are situated in regulating regions far from the affected genes, we also identify regulatory sequences under selection in the domestication, by mapping promoters and enhancers and their interactions in regulatory networks. Based on these analyses, we continue our studies of gene evolution and phylogeography, with the aim of describing how, when and where the wolf developed into the domestic dog.

Because of the broad aims of this study, students with different backgrounds are welcome to apply; molecular biology, bioinformatics or phylogeographic analysis.

Project website
https://www.kth.se/gte/evolutionary-biology-and-forensics-1.783359

Wireless Networks (Reg. No. 2384)

Type of position Visiting scholar: 3-12 months	**Main supervisor** Cicek Cavdar
KTH School EECS	**Co-supervisor(s)** Mustafa Ozger
KTH Department Communication Systems (COS)	**Main email contact** cavdar@kth.se

Specific subject area(s)
LEO-MEO Satellite, HAPS, UAV communications
Title of project
6G Non-terrestrial networks
Number of available position
1
Earliest start date
2023-08-01
Short description of the project

Satellites and high-altitude platforms (HAPs) are being deployed in large num- bers to provide connectivity to ground and aerial users. This project aims to provide integrated connectivity solutions and holistic network architecture by utilizing aerial and ground elements. Solutions will enable reliable and robust connectivity for aerial and ground users via flexible and adaptive network architecture adopting multiple technologies such as satellite and direct air-to-ground communications. The main focus will be challenges rising from the large LEO satellite constellations extending the solutions developed in an existing EU project 6G-SKY.

Project website
https://bscw.celticnext.eu/pub/bscw.cgi/d114062/6G-SKY-leaflet-start_lq.pdf

Mechatronics (Reg. No. 2385)

Type of position Visiting scholar: 3-12 months	**Main supervisor** Lei Feng
KTH School ITM	**Co-supervisor(s)**
KTH Department Machine Design	**Main email contact** lfeng@kth.se

Specific subject area(s)
Surgical Assistive Robots
Title of project
Design and prototype of a surgical robot for transurethral renal interventional diagnosis and treatment
Number of available position
1
Earliest start date
2023-05-01
Latest start date
2023-10-01
Short description of the project

Surgical robots significantly improve the productivity and success ratio of surgical operations and decrease patients' injuries. R&D on surgical robots directly contribute to the 3rd sustainable goal: Good Health and Well-being. Because of the huge varieties and complexities of surgical operations, a large number of dedicated robots need to be developed to assist the operations. This joint research project focuses on improving the diagnosis and treatment of kidney area through the ureteroscope. These operations require high skills of the operators, because the internal structure inside the kidney is difficult to identify, the endoscope is flexible and may be stuck in the urethra, the posture of the operator is tiresome, and the patients may be hurt.

The expected contribution of this project is to develop a robotic diagnosis and treatment system to assist the surgeon to manipulate the ureteroscope and diagnose and treat the disease. The robot system can remove kidney stones and even tumors. The prototype robot will be evaluated by professional surgeon in a big hospital.

Photonics (Reg. No. 2386)

Type of position	Main supervisor
Visiting scholar: 3-12 months	Max Yan
KTH School	**Co-supervisor(s)**
SCI	
KTH Department	**Main email contact**
Department of Applied Physics	maxyan@kth.se

Specific subject area(s)
Theoretical physics, thermodynamics, photonics, electromagnetic theory
Title of project
Revisit Kirchhoff's law of thermal radiation
Number of available position
1
Earliest start date
2023-09-01
Short description of the project

The Kirchhoff's law of thermal radiation states that an object's thermal emissivity is equal to its absorptivity, provided that material parameters are not affected at elevated temperatures. Both emissivity and absorptivity are scalar values. Information on "phase" is however missing. The information is vital for creating coherent thermal emitters, where one can possibly make directional beams via phase engineering. Would you be able to find the missing piece?

Project website
https://www.kth.se/profile/miya