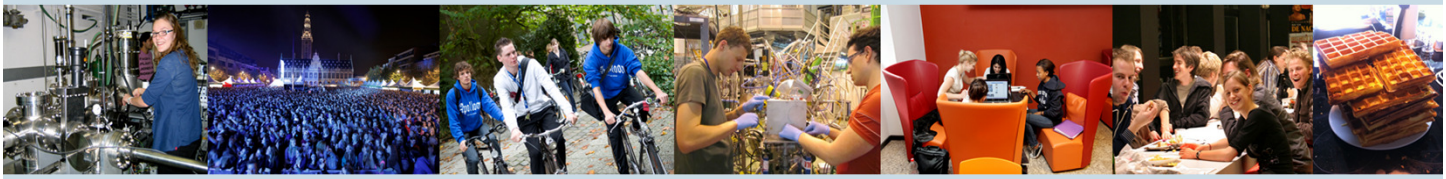
KU LEUVEN

Internships

Faculty of Science
KU Leuven



Leuven, Belgium

sc.kuleuven.be

We invite motivated and talented **undergraduate (Bachelor) and Master** students, interested in an **international research experience** at KU Leuven's science departments, to apply for an internship.

Applicants are required to submit:

- a one page CV (resume)
- a one page motivation letter, including a short statement of personal research interests
- 2 letters of recommendation

Duration: min. 3 – max. 6 months

Financial support: stipend or self-supporting

Deadline for application: 19th of January 2018

More information about the research internships topics can be found below

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Internships
sc.kuleuven.be/internships

research theme	research internship (ri) project title
Chemistry	Molecular Design and Synthetic-Organic chemistry
Mathematics	Technology and Mathematics for Finance
Physics, Mathematics	Computational tools to simulate realistic solar, astrophysical or plasma physics scenarios
physics	Functional Topogical Materials
Theoretical physics	Statistical Mechanics of interfacial Phenomena

Detailed descriptions of the research internships topics can be found below

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Molecular Design and Synthesis-Organic Chemistry

The division aims to be a knowledge centre for Molecular Design and Synthesis that focuses on a few strong, diverse research lines. The aim is to develop new synthetic methodologies and to create new molecules with different degrees of complexity and with different functionalities. Because of its expertise in different aspects of organic synthesis, the division is a knowledge center that is able to provide access to a wide variety of compounds of high importance to colleagues inside and outside the university. These different topics within the division do not stand alone but have many areas of overlap.

The current research lines include :

- Development and application of multicomponent reactions in heterocyclic and medicinal chemistry
- Process intensification including the use of flow chemistry and microwave enhancement
- Metal-catalyzed coupling/cyclization reactions
- Reactions with gaseous reagents in two chamber reactors (HCl, CO, SO_2F_2)
- Natural product analogs with interesting bioactivities
- Synthesis and applications of (bio)sensors and dyes, supramolecular chemistry, hydrogelators

Please when applying indicate your interest in one or more of these research lines.

Applicant's Current Degree Program (preferred):
Chemistry

Responsible scientist(s): prof. Wim Dehaen, Prof. Wim De Borggraeve, Prof; Erik Van der Eycken,

Duration: +/- 3 months (start and end date depend on the availability, possibly June to September

Stipend: +/- € 1000/month

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Technology and Mathematics for Finance

The internship will run in cooperation with the department of Mathematics and RiskConcile, a start-up in the domain of financial technology. The student will assist in the implementation of advanced models of financial derivatives in Python [3]. Most of the models are dealing with equity derivatives or hybrid financial instruments [2].

The documentation of the models, their inner workings, the assumptions to be taken, etc… will be provided by the supervisors of the internship. The student's role is to deliver a solution in Python capable to price the financial instrument and derive its corresponding hedge ratio's.

Further for each of the instruments a potential series of additional studies and analysis needs to be carried out:

- a global sensitivity analysis;
- using conic finance [1], the student will develop a liquidity-score of the different instruments;
- application of data mining techniques to acquire a wider understanding of the impact of the different model parameters on the value and embedded financial risk of the instruments.

Supportive literature:

- [1] Dilip Madan, Wim Schoutens (2016) Applied Conic Finance, Cambridge University Press
- [2] Jan De Spiegeleer, Wim Schoutens, Cynthia Van Hulle (2014) The Handbook of Hybrid Securities: Convertible Bonds, CoCo Bonds and Bail-In, Wiley
- [3] Robert Layton (2015) Learning Data Mining with Python

Applicant's Current Degree Program (preferred):
Mathematics

Responsible scientist(s): Prof. Wim Schoutens, Dr. Jan De Spiegeleer

Duration: +/- 3 months

Stipend: +/- €900/month

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Computational tools to simulate realistic solar, astrophysical or plasma physics scenarios

This type of research concentrates on the dynamical interaction between plasmas (the fourth and most abundant state of all known matter in our universe) and magnetic fields. This interaction gives rise to a wide range of fascinating and spectacular phenomena, including all aspects of our local **space weather related to coronal mass ejections** (see picture). Plasma dynamics also governs planetary and stellar magnetospheric physics, the turbulent motions in accretion disks, up to the jets observed wherever stars are born or die, or the relativistic jets emerging from entire galaxies, as seen on images taken by the Hubble space telescope.

We have developed unique expertise in all aspects of **plasma-physical modeling**, ranging from advanced analytical theories to the development, use and exploitation of state-of-the-art computational tools to simulate realistic solar, astrophysical or fundamental plasma physics scenarios. The Sun and the heliosphere are our favorite research objects and are regarded as a showcase for plasma behavior in other astrophysical objects.

The macroscopic behavior of most plasmas can be described by the magnetohydrodynamical (MHD) model. In this model formulas from fluid dynamics are combined with formulas describing the interacting of magnetic fields and fluids.

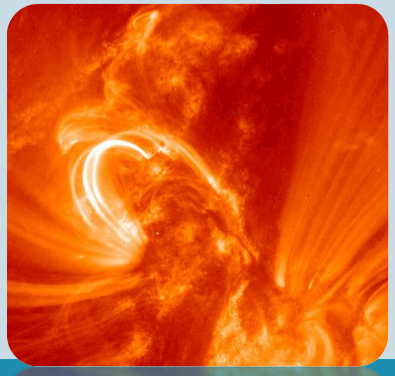
The topics of semester internships relate directly to the applications of the magnetohydrodynamical (MHD) model on solar astrophysics. The **mathematical modeling using MHD** is extremely varied and gives rise to a number of interesting mathematical analytical and numerical techniques and challenges.

Students doing an internship actively participate in current scientific research on the modeling of coronal mass ejections, MHD shock waves, seismology in coronal loops and in solar winds, magnetoseismology of magnetic accretion discs, astrophysical jets. (**only semester internships, no summer research**)

Applicant's Current Degree Program (Preferred):
Mathematics, Applied Mathematics, Physics, Computer Science and Engineering

Responsible scientist(s): Prof. Stefaan Poedts, Prof. Rony Keppens, Prof. Tom Van Doorsselaere

Duration: **3 months**



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Functional topological materials

For decades, the functionality of electronic devices has been based on the *charge* of electrons. By exploiting the additional degree of freedom of the electron *spin* (and the associated magnetic moment), *spintronics* promises a new generation of devices with superior performance and new functionalities. A new spintronics paradigm is emerging which is based on newly discovered topological materials and phenomena, instead of the conventional semiconductors (e.g. Si or GaAs) and magnetic metals (e.g. Co and Ni) that are currently used in electronics and spintronics. Although the physics underlying the functionality of these new materials is fundamentally different from that of conventional semiconductors and magnetic materials, the electronic and topological phenomena can be tuned using equivalent approaches, namely doping.

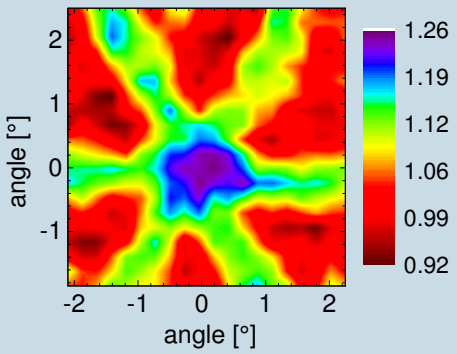
This internship is embedded in our group's ongoing research on functional properties induced or modified by doping. In particular, the intern will study the structure of doped topological materials (e.g. Mn doped $Ge_{1-x}Sn_xTe$ and Mn-doped Bi_2Se_3) using complementary experimental techniques such as *emission channeling* (at the ISOLDE facility at CERN, Switzerland) and *extended X-ray absorption fine structure* (at the European Synchrotron – ESRF, France). Concretely, the day-to-day activities may involve sample preparation (e.g. thin film growth), carrying out measurements (in our laboratories and eventually also at CERN and ESRF, depending on beam-time scheduling), analyzing the data, and performing numerical simulations. The exact work plan will be discussed at the start of the internship, taking into account the intern's own interests and background.

Applicant's Current Degree program (preferred):
Physics

Supervisor(s): Prof. Lino Pereira,
Prof. André Vantomme, Prof. Kristiaan Temst

Period + Duration: +/- 3 months (start and end date depend exclusively on the intern's availability)

Stipend: +/- €1000/month



Channeling spectrum of Mn-doped Bi_2Se_3

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Statistical mechanics of interfacial phenomena

The understanding of macroscopic cooperative phenomena from interactions taking place at the (sub-)microscopic molecular or atomic level has progressed impressively over the past few decades. Using density functional theory and renormalization group methods, as well as simulations (Monte Carlo, molecular dynamics), phase transitions and critical phenomena in and out of equilibrium have been unraveled by our research team, which is embedded in the Institute for Theoretical Physics of KU Leuven.

A recurrent theme in our research is the study of interfacial phenomena such as wetting and capillary waves in a large variety of systems ranging from molecular fluids to superconductors and Bose-Einstein condensates. Applications of our concepts and methods to complex (scale-free) networks and to active matter are currently under investigation. It is in this arena that we invite motivated applications for an internship. The interested scholar can find an overview of our research on the following page: http://itf.fys.kuleuven.be/~joi/

applicant's Current Degree program (preferred):
Master in Physics or Master in Engineering majoring in physics

Responsible scientist(s): Prof. Joseph Indekeu

Duration: +/- 3 months (start and end date depend on availability of applicant and supervisor

Stipend: To be negotiated