UNDERGRADUATE SUMMER RESEARCH INTERNSHIPS
National Center of Competence in Research for Bio-Inspired Materials

Research Projects Summer 2023

The National Center of Competence in Research (NCCR) Bio-Inspired Materials offers undergraduate students (from Switzerland and abroad) the opportunity to spend the summer break (8-12 weeks) participating in cutting-edge research within one of the Center's research groups. The undergraduate students have the opportunity to work on a research project and to interact with leading experts in their fields of interest and with fellow students from around the world. The students get a glimpse of advanced research work, gain desirable hands-on work experience, develop their transferable skills and have the unique opportunity to explore career options and network with professionals. Beyond conducting research in the hosting lab, undergraduates participate in scientific lectures, social and networking events. At the end of the summer, the students present the results of their research projects in a poster session followed by a summer party. The students have the opportunity to learn about Switzerland from an insider perspective, and to take the first steps toward learning or practicing French and/or German language skills.

Requirements

To apply to the program you need to fulfill the following conditions:

- Be a national of Switzerland, a member state of the European Union, or a country with a Visa exemption agreement with Switzerland for a maximum period of stay of 90 days;
- Be enrolled at a University as a full-time undergraduate student in a relevant field of natural sciences, such as medicine, biology, biochemistry, chemistry, physics or materials science;
- Be an undergraduate student having concluded a minimum of 2 years of a degree program by the start of the internship;
- Certify that you are and will be registered as an undergraduate at your University/College for the upcoming academic year;
- If you are studying in Switzerland, you cannot select a research project at the University where you are studying;
- Have very good (oral and written) English language skills (level B2/C1).

Terms of the research stay

Duration: 8-12 weeks; Only Period between June 15 – September 15

How to apply

Applicants must submit their applications online at www.bioinspired-materials.ch/

Applications are open from December 1, 2022 until January 20, 2023.

Project ID	Project title	Group	Field
P23-01_Acuna	Nanothermometers: Measuring temperature at the nanoscale using DNA origami and super resolution microscopy	Acuna	Biology, Chemistry, Physics
P23-02_Acuna	Enhancement of two photon excitation by DNA origami-based plasmonic nanoantennas	Acuna	Biology, Chemistry, Physics
P23-03_Acuna	Study of light matter interactions between plasmonic nanoparticles and fluorescent emitters using DNA origami	Acuna	Chemistry, Physics
P23-04_Mayer	Artificial electric organ development by using ion-selective membranes	Mayer	Biochemistry, Chemistry, Physics, Material Science & Engineering
P23-05_Mayer	Nanopores for bioanalytical sensing	Mayer	Biochemistry, Biology, Chemistry, Physics, Material Science & Engineering
P23-06_Rüegg	Detection of cancer-associated RNAs using DNA origami-based sensor system	Rüegg	Biology, Biochemistry, Physics, Material Science & Engineering
P23-07_Salentinig	Bio-inspired multifunctional antimicrobial nanomaterials	Salentinig	Chemistry, Material Science & Engineering
P23-08_Salentinig	Design and characterization of advanced food emulsions	Salentinig	Chemistry, Material Science & Engineering
P23-09_Steiner	Photochromic materials for bio-inspired hybrid photovoltaics	Steiner	Chemistry, Physics, Materials Science & Engineering
P23-10_Steiner	Bio-templating of 3D photonic crystals	Steiner	Physics, Materials Science & Engineering
P23-11_Studart	Dynamic morphing devices powered by chemically oscillating hydrogels	Studart	Chemistry, Materials Science & Engineering
P23-12_Vanni	Validation of molecular force fields for the investigation of phase-separation of intrinsically disordered proteins	Vanni	Biology, Biochemistry
P23-13_Weder	Bio-inspired compositionally graded membranes with directional water transport characteristics	Weder	Chemistry, Materials Science & Engineering
P23_14_Weder	Light-responsive polymeric material systems	Weder	Chemistry, Materials Science & Engineering
P23_15_Weder	Mechanochemistry in aqueous systems	Weder	Chemistry, Materials Science & Engineering
P23-16 Akrap	Optical spectroscopy of topological materials	Akrap	Physics
P23-17 Akrap	Topological materials in high magnetic fields	Akrap	Physics, Materials Science & Engineering

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Project ID	**URI P23-01_Acuna**
Project title	**Nanothermometers: Measuring temperature at the nanoscale using DNA origami and super resolution microscopy**
Research group	Prof. Guillermo Acuna https://www.unifr.ch/phys/en/research/groups/acuna/
Host Institution	Department of Physics, University of Fribourg
Duration	12 weeks
Possible period	**Period 15 June - 15 September**

Project summary

Plasmonic nanoparticles (NPs) are widely used in several fields of research because they efficiently convert light into heat. In some applications, such as for photothermal therapy, drug delivery and release, or solar steam generation, plasmon-assisted heating is the primary reason for using plasmonic NPs. Alternatively, heating can be an undesired side effect in many other applications such as ultrasensitive bio-sensing, nonlinear optics, or integrated optoelectronics. For instance, in biomedical applications, photothermal heating must be carefully controlled as it can affect the biomolecular interaction dynamics or even cause denaturation of the biomolecules. All these applications of plasmonic NPs have in common the necessity of a reliable method to measure temperature and heat dissipation at the nanoscale.

Currently, thermometry methods that rely on temperature-sensitive light-emitting probes collect their signal from a finite focal volume, measuring the emission of an ensamble of molecules which leads to an inaccurate temperature estimation. At the same time, they suffer from the diffraction limit of the optical system and thus have limited spatial resolution.

The present proposal aims to solve these problems by using a Super-Resolution Microscopy technique called DNA-PAINT (DNA-meadiated Points Accumulation for Imaging Nanoscale Topography) together with DNA Origami technology. The kinetics of DNA duplex hybridization is sensitive to temperature: by measuring the binding time of DNA complementary strands, a precise measurement of the temperature, at specific locations can be made. The project uses DNA Origami technology to build nanostructures that work as a breadboard where an arrangement of the nanothermometers, i.e. protruding single-stranded DNA, is placed around the heat source with nanometer precision. Plasmonic gold NPs are going to be used as heat sources.

The method to be developed will allow addressing several open questions about the role of temperature in both biomedical and plasmon-assisted applications, where nanostructures of arbitrary shapes and materials are present in complex matrixes and environments.
Keywords: plasmonics, DNA origami, super-resolution, thermal dissipation

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Research Projects Summer 2023

Project ID	**URI P23-02_Acuna**
Project title	**Enhancement of two photon excitation by DNA origami-based plasmonic nanoantennas**
Research group	Prof. Guillermo Acuna https://www.unifr.ch/phys/en/research/groups/acuna/
Host Institution	Department of Physics, University of Fribourg
Duration	12 weeks
Possible period	**Period 15 June - 15 September**

Project summary

Two-photon excitation is the electron transition in molecules during the absorption of two photons, usually of near-infrared wavelength. The use of NIR wavelengths makes two-photon excitation particularly useful in the study of biological samples, because of relatively low absorption in the 650-1350 nm, allowing deeper tissue penetration. For this reason, two-photon excitation microscopy has been involved in numerous fields, including: physiology, neuroscience and embryology. Although two-photon microscopy is a widely used technique, it relies on the measurement of large amounts of fluorophores. However, for a better understanding of biological processes or early detection of diseases, a high sensitivity measurement is needed, preferably down to a single molecule. This can be realised by using plasmonic nanoparticles as nanoantennas. In this project, we want to realise single molecule measurements under two-photon excitation using the signal amplification of plasmonic nanoparticles together with the nanometre precision of DNA origami structures. We anticipate that this will lead to much higher sensitivity enabling in-situ single molecule measurements in the future.

Keywords: two-photon excitation, plasmonic nanoparticles, DNA origami

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Project ID	**URI P23-03_Acuna**
Project title	**Study of light matter interactions between plasmonic nanoparticles and fluorescent emitters using DNA origami**
Research group	Prof. Guillermo Acuna https://www.unifr.ch/phys/en/research/groups/acuna/
Host Institution	Department of Physics, University of Fribourg
Duration	12 weeks
Possible period	**Period 15 June - 15 September**

Project summary

Interaction between light and matter can be strongly affected when using nanoscale plasmonic particles and structures. In particular, properties of fluorescent molecules such as lifetime, fluorescence intensity or spectrum are influenced by the presence of nanoparticles. Such effects have been shown to have applications in the fields of biosensing, fluorescence imaging and quantum optics, among others. However, precise study of these interactions requires accurate positioning and stoichiometry, something difficult to achieve with conventional nanofabrication techniques. In our group, we utilize DNA origami to precisely position individual fluorophores and nanoparticles under predefined geometries. Tuning the different geometrical parameters and using different types of nanoparticles, we will study how they influence emission properties of nearby fluorophores that have not been studied yet, like polarization or chirality, and investigate their possible applications for sensing or quantum optics.

Keywords: fluorescence microscopy, single-molecule emission, nanoparticles, DNA origami

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Project ID	**URI P23-04_Mayer**
Project title	**Artificial electric organ development by using ion-selective membranes**
Research group	Prof. Michael Mayer https://www.ami.swiss/biophysics/en/
Host Institution	Adolphe Merkle Institute, University of Fribourg
Duration	10 to 12 weeks
Possible period	**Period 15 June - 15 September**

Project summary

Electric power can be generated by reverse electrodialysis, using a gradient in concentration of ions. When the cations and anions in a salt solution can only travel in opposite directions, by using ion-selective membranes, currents can be generated. Using this concept, we aim to develop an artificial electric organ, which provides electric power needed to operate small implantable devices, using solely concentration gradients already present in the human body. Specifically, we want to use the gradient in concentration of protons (H+) from different fluids in the body. The proton concentration in the stomach acid is very high, while alkaline mucus has a very low proton concentration. Development of membranes which allow the selective transport of protons over other cations, such as sodium and potassium ions, is one of the main challenges we are tackling. In this project, you will fabricate different types of membranes, based on polymer networks and hydrogels, that can be used in a reverse electrodialysis setup with a proton gradient. Optimization of these membranes includes tuning parameters such as crosslink density and types of monomers/polymers used, as well as characterizing their effects on current and voltage we can generate with them.

Keywords: membranes, polymer network, hydrogel, electrophysiology, biophysics

UNDERGRADUATE SUMMER RESEARCH INTERNSHIPS

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Research Projects Summer 2023

Project ID	**URI P23-05_Mayer**
Project title	**Nanopores for bioanalytical sensing**
Research group	Prof. Michael Mayer https://www.ami.swiss/biophysics/en/
Host Institution	Adolphe Merkle Institute, University of Fribourg
Duration	10 to 12 weeks
Possible period	**Period 15 June - 15 September**

Project summary

Measurement of ionic current through nanopores permits the single-molecule level characterization of analytes in a label-free manner in solution. Recently, biological nanopores are emerging as powerful tools to detect unfolded proteins, DNA, and polymers. However, studying folded proteins through nanopores is challenging since the commonly used biological nanopores were too small in diameter to allow the entry of large and globular molecules. Known large diameter protein-based nanopores include cytolysin A (ClyA), fragaceatoxinC (FraC) and pleurotolysin AB (PlyAB). The folded proteins detected inside these nanopores range from 40 and 64.5 kDa. Expansion of the nanopore diameter via modifications such as site-directed mutagenesis usually compromises the structure and stability of proteins. We wish to explore the possibility of using new biological nanopores and fine-tuning the diameter to accommodate different analytes. The student will help us in our efforts to develop protocols for bioanalytical sensing.

Keywords: Proteins, single-channel measurements, biosensors

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Research Projects Summer 2023

Project ID	**URI P23-06_Rüegg**
Project title	**Detection of cancer-associated RNAs using DNA origami-based sensor system**
Research group	Prof. Curzio Rüegg https://www.unifr.ch/med/de/research/groups/ruegg/
Host Institution	Department of Medicine, University of Fribourg
Duration	8 weeks
Possible period	**Period 15 June - 15 September**

Project summary

Cancer is a genetic disease involving genomic, transcriptomic and phenotypical alterations. Detection of circulating tumor cells (CTC), tumor derived RNA (cfRNA) or micro RNA (miRNA) (a.k.a. liquid biopsy), can be used for cancer diagnostics and monitoring. DNA origami method allows the generation of nanoscale structures with precisely defined geometries and decoration of biomolecules at nanoscale resolution and therefore can be used as a nanoarray platform for multiplex detection of cancer-associated RNAs. During this internship, we will develop a DNA origami nanoarray system allowing distance-dependent detection of mRNAs and miRNAs using super resolution microscopy method, DNA-PAINT and flow cytometry. The experimental workflow is as following: 1) DNA origami structure design using caDNAno software. 2) Self-assembly and characterization of structures by gel electrophoresis and electron microscopy. 3) Preparation/isolation of RNAs from cancer cell lines (BT-474, MCF-7, MDA-MB-231) and human plasma 4) Detection of RNAs with super-resolution microscopy imaging and flow cytometry 5) Analysis of results with Picasso and Flowjo softwares.

Keywords: DNA-PAINT, biosensor, cancer biomarker detection, flow cytometry

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Project ID	**URI P23-07_Salentinig**
Project title	**Bio-inspired multifunctional antimicrobial nanomaterials**
Research group	Prof. Stefan Salentinig http://www3.unifr.ch/chem/en/research/groups/salentinig/
Host Institution	Department of Chemistry, University of Fribourg
Duration	12 weeks
Possible period	**Period 15 June - 15 September**

Project summary

The COVID-19 pandemic caused apprehension and concern around the thematic of microbial propagation. Antimicrobial nanomaterials may represent an “invisible” yet effective strategy among the available solutions. The goal of this project is the design and characterization of antimicrobial biopolymer materials that mimic the action of natural antimicrobial peptides in killing microbials. We recently discovered that certain biopolymer-lipid self-assemblies efficiently kill bacteria, including superbugs that are resistant to conventional antibiotics; and can inactivate enveloped viruses. The student will characterize the self-assembly of synthetic polymer amphiphiles in water and their interaction with bacteria and virus systems using i.e. light scattering, small angle X-ray scattering and cryo-TEM. Biological assays will provide the nanostructure - activity relationship in these materials. The project will be performed in collaboration with a second student focusing on polymer synthesis in the group of Prof. Kilbinger (see corresponding internship project). The student should have a strong background in physical chemistry related to polymers / materials.

Keywords: polymers, nanomaterials, antimicrobials, supramolecular structures

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Research Projects Summer 2023

Project ID	**URI P23-08_Salentinig**
Project title	**Design and characterization of advanced food emulsions**
Research group	Prof. Stefan Salentinig http://www3.unifr.ch/chem/en/research/groups/salentinig/
Host Institution	Department of Chemistry, University of Fribourg
Duration	12 weeks
Possible period	**Period 15 June - 15 September**

Project summary

Milk is the sole nutrient source for infants and responsible for their healthy development. It provides a vivid and seemingly infinite source of inspiration for the design of advanced functional food materials. Our team recently discovered the in-situ formation of hierarchically organized materials during the digestion of milk, and pioneered novel methods for emulsion design. Based on this, the global aim of this project is the design of nutrient loaded emulsions with tailor-made interfaces, and the in vitro study of their digestion. Towards this goal, colloid and interface chemistry will be combined with nanomaterial characterization and biochemical assays. Major characterization methods will include small angle X-ray scattering, static light scattering, confocal Raman microscopy and compositional assays. The student should have a strong background in one of the following fields: physical chemistry, materials chemistry, nanomaterials characterization.

Keywords: Nanomaterials, SAXS, DLS, digestion, cell culture, nutrient/drug delivery system

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Research Projects Summer 2023

Project ID	**URI P23-09_Steiner**
Project title	**Photochromic materials for bio-inspired hybrid photovoltaics**
Research group	Prof. Ullrich Steiner https://www.ami.swiss/physics/en/
Host Institution	Adolphe Merkle Institute, University of Fribourg
Duration	12 weeks
Possible period	**Period 15 June - 15 September**

Project summary

Hybrid organic-inorganic materials have emerged as one of the leading semiconductors for photovoltaics with extraordinary performances in solar-to-electric energy conversion. However, they feature instabilities that severely hinder their practical applications. Some of the underlying reasons are associated with detrimental ion migrations under operational conditions of voltage bias and light. While some of the ion migrations are reversible in the dark, others lead to irreversible degradation of hybrid materials as well as the resulting solar cells. It would thus be of interest to develop solar cells that respond to these conditions by adapting to the day-night cycles, thereby mimicking biological circadian rhythms.

This project aims to address this by using photochromic materials in hybrid perovskite solar cells that adapt to their operating conditions. This will be achieved by relying on an interdisciplinary approach involving material synthesis and characterization, as well as solar cell device fabrication and analysis towards more resilient bioinspired photovoltaics.

Keywords: smart bioinspired materials, supramolecular chemistry, hybrid photovoltaics

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Research Projects Summer 2023

Project ID	**URI P23-10_Steiner**
Project title	**Bio-templating of 3D photonic crystals**
Research group	Prof. Ullrich Steiner https://www.ami.swiss/physics/en/
Host Institution	Adolphe Merkle Institute, University of Fribourg
Duration	10-12 weeks
Possible period	**Period 15 June - 15 September**

Project summary

This project aims to create templates from biological photonic structures and to investigate their linear optical responses. The desired material of the templates is barium titanate (BTO). BTO is a nonlinear optical material and 3D nonlinear photonic crystals offer a lot of undiscovered and novel optical features e.g. entangled photon production, quantum optical node, Anderson localization etc.

Methodologies used in this project:

Bio-templating of sol-gels into scales of butterflies and beetles
SEM and FIB/SEM analysis together with supervisors
Optical characterization of photonic band gap
(FDTD Simulations on the obtained structures)

Keywords: Optics, Nanofabrication, Photonic Crystals, Insects, Nonlinear Photonics

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Research Projects Summer 2023

Project ID	**URI P23-11_Studart**
Project title	**Dynamic morphing devices powered by chemically oscillating hydrogels**
Research group	Prof. André Studart https://complex.mat.ethz.ch/people/person-detail.html?persid=97284
Host Institution	Department of Materials, ETH Zürich
Duration	12 weeks
Possible period	**Period 15 June - 15 September**

Project summary

The goal of this project is to design and fabricate active 2D hydrogel layers that can dynamically morph into 3D structures when submerged in solutions containing chemical fuels for an oscillating chemical reaction cascade. Dynamic morphing behavior is obtained by spatially programming different oscillatory swelling/shrinking waves within the molecular structure of the heterogeneous hydrogel network. To achieve this goal, we will first synthesize hydrogel copolymers containing varied concentrations of active monomers and characterize the kinetics of their swelling/shrinking transitions by exposing them to solutions containing specific chemical fuels. Dynamic morphing behavior will be obtained by combining hydrogel copolymers with different swelling/shrinking oscillatory kinetics in a predefined spatial configuration by multi-material 3D printing. The resulting 2D layered hydrogels are expected to exhibit programmed autonomous motions when integrated in an open reaction-diffusion system. Finally, we will demonstrate the use of the dynamic morphing behavior in autonomous materials by programming crawling/walking movements in 3D printed soft parts.

Keywords: organic synthesis, image analysis, 3D printing

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Research Projects Summer 2023

Project ID	**URI P23-12_Vanni**
Project title	**Validation of molecular force fields for the investigation of phase-separation of intrinsically disordered proteins**
Research group	Prof. Stefano Vanni https://www3.unifr.ch/bio/en/research/bioinformatics/vanni.html
Host Institution	Department of Biology, University of Fribourg
Duration	10-12 weeks
Possible period	**Period 15 June - 15 September**

Project summary

In the cell, it has been proposed that proteins can assemble in so-called membraneless organelles: highly concentrated protein assemblies that have liquid-like characteristic properties. The proteins that localize to these organelles are often enriched in intrinsically disordered motifs, which could potentially play a big role in determining the formation of membranes organelles by promoting liquid-liquid phase separation.

Yet, our understanding of the sequence-to-phase behaviour relationship of these proteins is still far from complete, in part because of limitations in the available computational methods to predict their biophyiscal and physicochemical behaviour.

In this project, the student will investigate several aspects of intrinsically disordered proteins using molecular dynamics simulations. To do so, the student will use currently available coarse-grain force field, and will investigate his/her ability to reproduce key properties of intrinsically disordered proteins, most notably his/her compactedness, membrane-binding propensity and protein-protein interaction behaviour.

We aim at a deep understanding of strenghts and limitations of current coarse-grain force-fields to describe phase separation by intrinsically disordered proteins to streamline future development efforts.

Keywords: molecular dynamics, computational soft matter, phase separation, intrinsically disordered proteins, bimolecular condensate

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Project ID	**URI P23-13_Weder**
Project title	**Bio-inspired compositionally graded membranes with directional water transport characteristics**
Research group	Prof. Christoph Weder https://www.ami.swiss/en/groups/polymer-chemistry-and-materials/
Host Institution	Adolphe Merkle Institute, University of Fribourg
Duration	10 weeks
Possible period	**Period 15 June - 15 September**

Project summary

Directional transport is exploited by several natural organisms as a strategy to retain water. Some species of plants achieved this property by developing a protective membrane called cuticle, whose main function is to regulate the water exchange with the environment. Cuticles consist of a polyester matrix mixed with polysaccharides that extend from the internal side and gradually fade in the transversal direction, and an external layer of hydrophobic waxes.

The aim of this project is to mimic the asymmetric structure of cuticles by combining a hydrophobic and a hydrophilic component into a dense nanocomposite membrane and to investigate the water permeability as a function of film orientation and of the relative humidity gradient.

The directionality can easily be tuned by varying the composition and the structure of these bio-inspired membranes, and this enables the development of a wide variety of new materials, whose properties may be useful for packaging applications.

Keywords: asymmetric design, nanocomposite membranes, water permeability

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Research Projects Summer 2023

Project ID	**URI P23-14_Weder**
Project title	**Light-responsive polymeric material systems**
Research group	Prof. Christoph Weder https://www.ami.swiss/en/groups/polymer-chemistry-and-materials/
Host Institution	Adolphe Merkle Institute, University of Fribourg
Duration	10 weeks
Possible period	**Period 15 June - 15 September**

Project summary

Nature abounds with examples of stimuli-responsive materials, which change their properties in response to external cues, for example exposure to light. In many plants, this effect is used to cause motion, such as bending of the plant towards or away from the light source, or the opening and closing of stomata - pores that control the transport of gases through the plant leaves. The aim of this project is to mimic such functions and to explore a new and simple approach to polymeric materials that change their mechanical or water-uptake properties upon exposure to light. For this purpose, a photoacid generator (PAG) will be incorporated into judiciously selected polymers. The PAG produces an acid when irradiated, thereby introducing ionic charges that affect the water affinity of water-swellable materials or the assembly, and hereby changing their mechanical properties, of supramolecular polymers.

Keywords: stimuli-responsive polymers, light-responsive polymers, mechanical characterization, water-uptake

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Research Projects Summer 2023

Project ID	**URI P23-15_Weder**
Project title	**Mechanochemistry in aqueous systems**
Research group	Prof. Christoph Weder https://www.ami.swiss/en/groups/polymer-chemistry-and-materials/
Host Institution	Adolphe Merkle Institute, University of Fribourg
Duration	10 weeks
Possible period	**Period 15 June - 15 September**

Project summary

Cells are able to sense and readapt to mechanical changes in their environment, however the quantification of the induced mechanical stress on such a small scale is challenging. A facile way of unraveling the response of materials and biological systems to the mechanical stresses on molecular levels is by incorporating of mechanophores into their structure. The focus lies on the non-covalent interactions of supramolecular mechanochromic mechanophores, as they offer reversible material responses. In that regard, a water-soluble mechanochromic system will be synthesized and characterized starting from a supramolecular mechanophore, which will be embed into a polymeric network. The thermal and mechanical properties of the material as well as its stability will be investigated by several characterization techniques including optical, fluorescence microscopy. Such stress-responsive materials can be developed as study models for various biological systems in order to understand and analyze their macroscopic behavior under load.

Keywords: mechanophores, supramolecular chemistry, polymers, fluorescence

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Project ID	**URI P23-16_Akrap**
Project title	**Optical spectroscopy of topological materials**
Research group	Prof. Ana Akrap https://www.unifr.ch/phys/en/research/groups/akrap/
Host Institution	Department of Physics, University of Fribourg
Duration	12 weeks
Possible period	**Period 15 June - 15 September**

Project summary

Topological materials—like graphene, topological insulators, or Weyl semimetals—are exciting because they can sometimes let us observe relativistic-like phenomena, in a piece of solid. These materials could in future be used as detectors, in opto-electronic devices, or in your future smartphones.

Their electronic properties are especially interesting at very low energies. Optical spectroscopy allows us to access this low-energy physics in topological materials. During this project, the student will learn how to do experiments in optical spectroscopy, how to analyze the data, and how to understand what we can learn from it about the electronic band structure.

Keywords: Solid state physics, Infrared Spectroscopy, Topological Materials, Data analysis

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Research Projects Summer 2023

Project ID	**URI P23-17_Akrap**
Project title	**Topological materials in high magnetic fields**
Research group	Prof. Ana Akrap https://www.unifr.ch/phys/en/research/groups/akrap/
Host Institution	Department of Physics, University of Fribourg
Duration	12 weeks
Possible period	**Period 15 June - 15 September**

Project summary

In a magnetic field, electrons become confined to so-called Landau levels, where many electrons (~ 1015) can coexist. These Landau levels have been tremendously useful to learn about semimetals and semiconductors. In modern experiments, we are able to extract very detailed information on topological materials – materials where sometimes electrons behave like relativistic particles. During this project, the student will learn how to do analyze experiments in magneto-optical spectroscopy, model the magneto-optical properties, and understand what we can learn from them about selected topological semimetals.

Keywords: Infrared spectroscopy, high magnetic field, topological materials, solid state physics, data analysis.