This year, we offer summer internship projects in both experimental and computational physics.

**Experimental**

**Imbibition of complex fluids**

Foams are an archetypal example of a shear thinning yield stress fluid with properties that can in the future be controlled by particle dopants. This proposal concentrates on two-dimensional particle-laden foams: their imbibition in a random porous media and rheology in cylindrical Couette geometry.

A complex fluid, foam, is flowing in a narrow two-dimensional channel in a preliminary experiment. The increase in channel height (inside green circle) reduces the bubble area and creates a disturbance that currently cannot be explained by any model or theory. The structure of the foam is different in each section illustrated by blue lines.

The behavior of yield stress fluids invading porous media is a novel and unexplored area. The length scales of pores, bubbles and particles are controllable and measurable over multiple decades from micro to centimeter scale controlling the intermittent dynamics seen imbibition experiments. The particle concentration also allows controlling the foam rheology that may be varied and measured directly as a time dependent stress-strain response in a Couette geometry.

In this work rheology and imbibition are connected by the same controllable material. The interdisciplinary nature of the topic has huge potential in explaining fundamental physics and behavior of complex fluids that recently have become the industrial solution for manufacturing lighter, greener materials.
The expected outcome(s) depending on applicant’s background and interests are Bachelor’s Thesis (or similar report), high impact publication, pitch in Slush and/or Masters Thesis. The applicant is expected to have keen interest in running, maintaining or designing an experiment. Experience with automated systems and complex machinery is a plus.

Contact person: Juha Koivisto

**Computational**

**Plastic deformation of crystalline solids**

Plastic deformation of crystalline solids, mediated by the stress-driven motion of topological defects of the crystal lattice called dislocations, has recently proven to be a more complex process than previously believed. Modern experimental techniques to study deformation of microscale crystals have revealed intermittent scale-free strain bursts with peculiar statistical properties, size effects of the sample strength, etc. In this project you will explore the complex nature of crystal plasticity by means of discrete dislocation dynamics simulations. The latter is a coarse-grained description where the dislocations are taken to be the basic degrees of freedom of the system, instead of the atoms of the underlying lattice.

A successful candidate should have basic programming skills (preferably in C), and be familiar with the Linux environment. In addition, some basic knowledge of the materials science behind plastic deformation of solids, as well as of parallel programming, would be appreciated.

Contact person: Lasse Laurson

**Micromagnetic simulations of magnetic domain wall dynamics**

The Aalto CECAM node (www.cecam.org) offers an Aalto CECAM internship in high-performance computational physics.

In this particular position, we investigate numerically domain wall dynamics in various ferromagnetic nanostructures (the specific problem may also be tailored according to the interest and background of the candidate), using a GPU-based micromagnetic simulation code. Possible problems to address include in particular magnetic field and electric current driven domain wall motion in nanowires and strips, which are also relevant for emerging domain wall based logic and memory devices.

The successful candidate is expected to possess basic skills in programming and data analysis, including familiarity with the standard Linux environment, and an undergraduate level understanding of basics of magnetism.

Contact person: Lasse Laurson

**Modeling confined low density particulate gels**

Low density attractive particulate gels are rheologically characterized as shear thinning, thixotropic yield stress fluids. It means that they posses properties of both solids and liquids depending on the surrounding conditions, whilst having significant time dependent behavior.
The material characteristics rise from the internal structures that are built from the particle networks that percolate through the whole material.

In this project, we study the evolution of structures formed of long range attractive soft particles using discrete element based methods developed at CSM group. The particles, confined in a Hele-Shaw shell, interact via long range van der Waals potential forming clusters. We analyze the evolution of the clusters under imposed shear flow to determine their mass to volume fractal dimension and lacunarity to learn the influence of shear to the geometry of the clusters. Furthermore, stagnated flow is studied to observe the structure changes due to structure relaxation.

The applicant should have experience in programming and have basic knowledge in soft matter physics. This project can be included in physics studies as either special assignment or Bachelor's thesis.

Contact person: **Antti Puisto**

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**Physics of curling**

Curling is an Olympic winter sport where two teams are competing against each other by shooting "stones" on icy surface towards a target area. As the name suggest, trajectory of the stone maybe curled, but there is no consensus about underlying physical phenomenon. The task would be to review competing proposals for curling-stone friction and design experiments for laboratory scale ice experiments or for real curling track. The measurements are then compared to predictions calculated by 2 different existing theories.

The work requires hands-on attitude on experimental devices and programming skills (Matlab, Python or C).

Contact person: **Mikko Alava**