16th Graduate Colloquium in Mathematics

Abstracts

Lucas Dahinden (UNINE), ***Open books and contact geometry***
It is often vital to decompose spaces (into factors, connected components, skeletons, etc.) to gain a better understanding of some of their aspects (metric, homology, dynamics etc). Open book decompositions are rather less known, but they play a surprising role in the understanding of contact structures, they can even be used for something close to a classification. We concentrate on the definition of open book decompositions, examples and a construction manual. Finally we try to sketch the connection to contact geometry.

Jonathan Rochat (EPFL), ***Numerical Approximation of Turbulent Flows in Electrolysis Cells***
Aluminium is a metal extracted from bauxite ore using electrolysis process, called Hall-Hroult process, and is done in a electrolytic bath within a huge cell. Observations and measurements are difficult to make in the cell and in this context numerical simulation can be very useful to optimize the production. The modeling of the electrolysis process is a two fluids system (liquid aluminium and electrolytic bath) with free moving interface. In this work we focus on the computation of the motion of the fluid and interface. Mixing length turbulent models and projection methods to solve the Navier-Stokes equations are presented.

Luc Pétiard (UNINE), ***Spectral inequalities and isoperimetric ratio***
In this talk we will place as part of hypersurfaces of $\mathbb{R}^{n+1}$, namely submanifolds of dimension n in $\mathbb{R}^{n+1}$ equipped with induced metric. We will consider smooth and compact hypersurfaces, with no boundary. As a consequence the associated spectrum of the laplacian operator $\Delta = -\mathrm{div}(\nabla)$, is discrete, positive, and denoted

$$0 = \lambda_0 < \lambda_1 \leqslant \lambda_2 \leqslant \dots$$

In general, an accurate estimation of the spectrum is difficult. In this context one can search for lower or upper bounds. However it seems that a control of geometry or topology is necessary. More precisely the inequality

$$\lambda_k(M,g)\mathrm{vol}(M,g)^{\frac{2}{n}} \leqslant K(n)k^{\frac{2}{n}}$$

is wrong for all constant $K(n)$. Thus one can work in a more restrictive geometric context in order to bound the spectrum from above, like N. Korevaar or A. Assannezhad who were interested in the conformal class. I will present some of these results, and why it is linked to what I do with the isoperimetric ratio $I(\Sigma) = \frac{\mathrm{vol}(\Sigma)}{\mathrm{vol}(\Omega)^{\frac{n}{n+1}}}$.

Jordane Granier (UNIFR), ***Hyperbolic geometry and moduli spaces of polyhedra***
Because of the world we live in, Euclidean and spherical geometries are familiar to everyone. Their hyperbolic counterpart, however, is more mysterious. I will present the basics of hyperbolic geometry and the object were interested in: discrete groups of hyperbolic isometries. I will show how some moduli spaces of polyhedra can be endowed with a hyperbolic structure, and thus give a way to construct examples of groups with interesting properties.

Thiebout Delabie (UNINE), ***Box spaces of the free group***
A box space is a metric space constructed using a set of quotients of a group. These spaces are often used in geometric group theory. We will consider two mutually exclusive properties of such a metric space. One is the coarse embeddability into a Hilbert space, the other one is the expander property. In most prevalent cases these properties depend on the properties of the group. However some groups, like the free group, have box spaces which are expanders, as well as box spaces that embed into a Hilbert space. We will explore the ongoing research to find a box space that does not have either of these properties.

Professor Marc Troyanov (EPFL), ***Mathematical literature: What does it takes to write a decent or even a good mathematical text and why it is important***

Elia Saini (UNIFR), ***Small hyperplane arrangements are isotopic***
To every matroid we associated a topological space called its *reduced realization space*. By means of symbolic computation we prove that for any matroid with ground set of up to 7 elements this topological space is either empty or connected. As an application we show that, in any rank, complex central hyperplane arrangements with up to 7 hyperplanes and same underlying matroid are isotopic. In particular, the diffeomorphism type of the complement manifold and the Milnor fiber and fibration of these arrangements are combinatorially determined (joint work with Matteo Gallet).

Alexandre Ramos (UNIBE), ***Symmetries of complex affine space and other complex manifolds***
Complex affine space $\mathbb{C}^n$ is one of the basic objects in algebraic geometry. It is therefore surprising that so little is known about its geometry and in particular about its symmetries. Following some fundamental results in the late 90's concerning the great abundance of (holomorphic) automorphisms in $\mathbb{C}^n$ for $n > 2$, there has been a renewed interest in understanding so-called vector fields in less trivial varieties. In this talk I will give a elementary overview of these ideas, and hopefully justify the notion which aims to generalize to a wider class of manifolds the concept of "having many automorphisms", both in the algebraic and holomorphic categories. Some very recent applications and examples will be given.