Plenary Lectures
Conférences plénières

FRÉDÉRIC GOURDEAU, Université Laval
Apprendre, comprendre, et quoi d'autre? Learning, understanding, and what else?

En 30 ans, j'ai passé des milliers d'heures à enseigner et des milliers d'heures à réfléchir à l'enseignement. Malgré tout ce temps et tous mes efforts, je me questionne encore sur ce qui peut avoir l'impact le plus positif possible pour les étudiantes et étudiants. Ma réflexion continue et avec elle, un enseignement vivant, en évolution. Je peux résumer mon objectif principal ainsi : je cherche à ce que les étudiantes et étudiants fassent des maths en étant pleinement engagés dans cette activité. Alors, qu'est-ce que cela veut dire au juste?

Je propose d'aborder cette réflexion pédagogique en m'appuyant sur des aspects de l'activité mathématique que je considère importants pour l'enseignement. Ces aspects ne sont pas nécessairement directement liés au contenu et objectifs spécifiques de chacun des cours, bien que leur importance relative puisse en dépendre fortement. J'aborderai des exemples tirés des cours que j'ai donnés et des activités de vulgarisation de l'AQJM (Association québécoise des jeux mathématiques), incluant des travaux d'équipe, des travaux de longue haleine et le « ungrading ».

Over 30 years, I have spent thousands of hours teaching, and thousands of hours thinking about teaching. Despite all this time and effort, every year I wonder about the best ways to maximize the positive impact for students engaged in any course that I teach. My reflection is ongoing, and with it a teaching which is alive, evolving. I can summarize my general goal by saying that I try to work so that students are fully invested in the doing of mathematics. What does that mean?

I propose to approach this pedagogical reflection by looking at aspects of mathematical activity that I consider important in relation to teaching. These aspects are not necessarily directly linked to the specific content and objectives of any given course, although their relative importance may well depend on it. I will look at concrete examples from courses I have taught and from outreach activities done by AQJM (Association québécoise des jeux mathématiques), including teamwork, long-term projects and ungrading.

JEAN-CHRISTOPHE NAVE, McGill University
Preserving Structure in the Numerical Simulation of PDEs

Differential equations are ubiquitous in modeling physical phenomenon and more generally in mathematics. On the one hand, studying the intrinsic properties of the operator or of their solutions has given rise to deep results and techniques in analysis and beyond. On the other hand, one may wish to have approximate solutions for the purpose of studying nature, engineering design, or provide some intuition to otherwise abstract objects.

The discretization of differential operators with respect to a small parameter h provides a discrete equation for the solution. Among other things we ask for convergence of the discrete solution to the actual solution as h–>0. However, in practice, h is finite. It turns out that preserving certain structures in the discretization provides great benefits for the approximated solution.

This talk will have two parts:

-1- I will give a short overview of what we mean by structure-preservation in the context of discretization of differential equations.

-2- I will look at the case of evolution PDEs which solutions develop a wide range of scales. I will show that by preserving the operator semi-group structure we may design a computationally efficient method with exceptional resolution properties. I will illustrate this technique with problems from fluid dynamics.

KATE STANGE, University of Colorado Boulder
Reciprocity obstructions in thin orbits (Apollonian circle packings and continued fractions)

Primitive integral Apollonian circle packings are fractal arrangements of tangent circles with integer curvatures. The curvatures form an orbit of a 'thin group,' a subgroup of an algebraic group having infinite index in its Zariski closure. The curvatures that appear must fall into a restricted class of residues modulo 24. The twenty-year-old local-global conjecture states that every sufficiently large integer in one of these residue classes will appear as a curvature in the packing. We prove that this conjecture is false for many packings, by proving that certain quadratic and quartic families are missed. The new obstructions are a property of the thin Apollonian group (and not its Zariski closure), and are a result of quadratic and quartic reciprocity, reminiscent of a Brauer-Manin obstruction. Based on computational evidence, we formulate a new conjecture. This is joint work with Summer Haag, Clyde Kertzer, and James Rickards. Time permitting, I will discuss some results, joint with Rickards, that extend these phenomena to certain settings in the study of continued fractions.