Plenary Speakers
Conférences plénières

JOSE CARRILLO, Imperial College London
Stability and Pattern formation in Nonlocal Interaction Models

I will review some recent results for first and second order models of swarming in terms of patterns, stationary states, and qualitative properties. I will discuss the stability of these patterns for the continuum and discrete particle cases.

These non-local models appear in collective behavior for animals, control engineering, and molecular structures among others. We first concentrate in the spatial shape of these patterns and the dynamics when inertia terms are neglected. The mathematical question behind consists in finding properties about local minimizers of the total interaction energy. Concerning 2nd order models, we will discuss particular properties of two patterns: flocks and mills. We will discuss the stability of these patterns in the discrete case. In both cases, we will describe the properties obtained for the continuum limits.

IRENA PEEVA, Cornell University
Matrix Factorizations for Complete Intersections

Hilbert introduced the approach to describe the structure of modules by free resolutions. Hilbert's Syzygy Theorem shows that minimal free resolutions over a polynomial ring are finite. By a result of Serre, it follows that most minimal free resolutions over quotient rings are infinite. We will discuss the structure of such resolutions. The concept of matrix factorization was introduced by Eisenbud 35 year ago, and it describes completely the asymptotic structure of minimal free resolutions over a hypersurface. Matrix factorizations have applications in many fields of mathematics: for the study of cluster algebras, Cohen-Macaulay modules, knot theory, moduli of curves, quiver and group representations, and singularity theory. Starting with Kapustin and Li, physicists discovered amazing connections with string theory. In a joint work with Eisenbud, we introduce the concept of matrix factorization for complete intersection rings and show that it suffices to describe the asymptotic structure of minimal free resolutions over complete intersections.

PAVEL WINTERNITZ, Universite de Montreal
Superintegrable systems in classical and quantum mechanics

A review is given of the present status of superintegrable systems, i.e. finite dimensional Hamiltonian systems with more integrals of motion than degrees of freedom. The emphasis is on conceptual questions and on recent developments such as the discovery of infinite families of superintegrable systems with integrals of motion of arbitrary order in the momenta. Quantum superintegrability is shown to be much richer than the classical one. In particular, Painleve transcendents appear as quantum superintegrable potentials. Connections with infinite dimensional integrable systems (the soliton equations) are stressed,in particular the existence of non-Abelian algebras of integrals of motion.