Differential Geometry and Mathematical Physics
Géométrie différentielle et physique mathématique
(Org: **Eric Bahuaud** (Seattle University) and/et **Frédéric Rochon** (UQÀM))

ARAM ALYOUSEF, University of Alberta

ABDOU OUSSAMA BENABIDA, UBC
Conical asymptotics for conformally balanced and HYM metrics

Motivated by the Chern-Strominger system and conifold transitions, we will discuss a conical asymptotics theorem for conformally balanced metrics near the vertex of a regular Calabi-Yau cone of complex dimension three. Under scale-invariant regularity bounds, and decay of $\partial\bar{\partial}\omega$, we obtain a unique asymptotic Calabi-Yau cone metric with a positive rate of convergence. For non-flat cones, we also establish compatible asymptotics for Hermitian-Yang-Mills metrics on the holomorphic tangent bundle.

MAURICIO BUSTAMANTE, Universidad Católica de Chile
Non-nullbordant aspherical manifolds

A manifold is called aspherical if its universal cover is contractible. Examples of aspherical manifolds are tori, hyperbolic manifolds and nonpositively curved manifolds. Hence the homotopy type of aspherical manifolds is encoded in their fundamental groups. It is therefore interesting to investigate the extent to which other topological properties of these manifolds are constrained by the fundamental group. In that regard, it was conjectured that closed aspherical manifolds whose fundamental group has nontrivial center were boundaries. In my talk I will show how using *hyperbolization* – a process to turn a triangulated manifold into an aspherical manifold– one can disprove this conjecture.

FACUNDO CAMANO, University of Waterloo
Monopolization of Tesserons

Monopolization is a conjecture by Sergey Cherkis that all tesserons (hyperkahler gravitational instantons) may be realized as monopole moduli spaces. In the first half of the talk, we will motivate the conjecture and cover some of the mentioned monopole moduli spaces and the Gromov-Hausdorff relations between them. In the second half of the talk, I will present recent work investigating a particular Gromov-Hausdorff limit of moduli spaces of singular monopoles on R3.

EMILY CLIFF, Université de Sherbrooke

BENJAMIN FRIEDMAN, UQÀM

CHRISTINE GUENTHER, Pacific University

ROBERT HARRIS, UQÀM

HARI KUNDURI, McMaster University

KUAN-HUI LEE, McGill University
Pluriclosed 3-folds with vanishing Bismut Ricci form

In this talk, we discuss complex 3-dimensional non-Kähler Bismut Ricci flat pluirclosed Hermitian manifolds (BHE) via their dimensional reduction to a special Kähler geometry in complex dimension 2. The reduced geometry satisfies a 6th order non-linear PDE which has infinite dimensional momentum map interpretation, similar to much-studied Kähler metrics of constant scalar curvature (cscK). We use this to associate to the reduced manifold or orbifold Mabuchi functional, as well as to obtain obstructions for the existence of solutions in terms of the automorphism group. Furthermore, we discuss explicit solutions of the PDE on orthotoric Kähler orbifold surfaces which construct some new BHE examples.

MAXENCE MAYRAND, University of Sherbrooke

RUXANDRA MORARU, University of Waterloo
Co-Higgs bundles and holomorphic Poisson structures

Co-Higgs bundles on a complex manifold M are pairs (E, ϕ), where E is a holomorphic vector bundle on M and $\phi \in H^0(M, \mathrm{End(E)} \otimes \mathrm{TM})$ is a Higgs field satisfying the integrability condition $\phi \wedge \phi = 0$. Such objects are equivalent to generalized holomorphic bundles on complex manifolds. Moreover, the Higgs field induces a distinguished class of holomorphic Poisson structures on the projectivization $\mathbb{P}(E)$, yielding numerous examples of compact holomorphic Poisson manifolds. This correspondence was first observed by A. Polishchuk, while moduli spaces of stable rank-2 co-Higgs bundles were constructed by S. Rayan on $\mathbb{P}^1$ and $\mathbb{P}^2$. In this talk, we examine the interplay between the algebraic properties of Higgs fields and the geometry of the associated Poisson manifolds, and we present new examples on curves and surfaces.

TRISTAN OZUCH, MIT
Positive Einstein metrics on infinitely many 4-manifolds

We construct Einstein metrics with positive scalar curvature on two infinite families of 4-manifolds. Via Wick rotation, we obtain static axisymmetric Lorentzian spacetimes with positive cosmological constant and arbitrarily many horizons of equal surface gravity. As the topology increases, the metrics collapse to an explicit 2-disk while bubbling off periodic gravitational instantons with Kasner asymptotics, one of which is new.

CRISTINA STOICA, Wilfrid Laurier University

ERIC WOOLGAR, University of Alberta
Spacetime conformal boundary causal rigidity

A well-known boundary rigidity problem for Riemannian geometry asks whether a manifold-with-boundary, such that all geodesic chords have the same length, is necessarily a round hemisphere. It is, and therefore any chord leaving a given boundary point passes through that point's antipode. For Lorentzian geometry, we pose the following conformal boundary rigidity problem. If all light rays leaving a point p in the distant past (Penrose's conformal infinity) refocus at the same point q in the distant future, and if the same is true for all such p, is the spacetime conformal to a maximally symmetric spacetime? For example, if the spacetime is also asymptotically anti-de Sitter, is it actually anti-de Sitter (up to conformal transformations that preserve the asymptotics)? I will answer this question, assuming that the spacetime is also stationary, based on joint work with Gabriel Paternain. Time permitting, I will discuss joint work with Alex Sandhu and Giulio Sanzeni on the positive cosmological constant version of this problem.

XUWEN ZHU, Northeastern University
Degenerations of gravitational instantons

Gravitational instantons are noncompact 4-dimensional Calabi-Yau manifolds, and there have been many recent developments in understanding their analytic and geometric properties. Depending on the end structure at infinity, gravitational instantons are divided into six types, ALE/F/G/G*/H*/H. In this talk I will talk about the connections among some of these types, showing that one type of gravitational instanton can degenerate into another type. In particular, I will talk about the following projects: (1) degenerations of ALG and ALH*, in joint work with Yu-Shen Lin and Sid Soundararajan; (2) degenerations of ALF, partly in joint work with Alia Yusaini. Several types of analysis techniques are used here, and all of these can be seen as a step towards building a global compactification of moduli spaces of all gravitational instantons.