Geometry and Physics: GAP 2013 — Horaire / Schedule

jeudi, le 30 mai, 2013 / Thursday, 30-May-2013

09h00 – 10h00	**Tamàs Hausel** (EPF Lausanne); *Arithmetic and physics of Higgs moduli spaces: Part 1 of 3*
10h00 – 10h30	Pause Café / Coffee Break
10h30 – 11h30	**Philip Boalch** (École Normale Supérieure & CNRS); *Connections on irregular curves: Part 1 of 3*
11h30 – 13h30	Lunch
13h30 – 14h30	**Lauren Williams** (UC Berkeley); *Cluster algebras: Part 1 of 3*
14h30 – 15h00	Pause Café / Coffee Break
15h00 – 16h00	**Lauren Williams** (UC Berkeley); *Cluster algebras: Part 2 of 3*
16h00 – 16h30	Pause Café / Coffee Break
16h30 – 17h30	**Andrew Neitzke** (UT Austin); *Spectral networks and their uses: Part 1 of 3*

vendredri, le 31 mai, 2013 / Friday, 31-May-2013

09h00 – 10h00	**Tamàs Hausel** (EPF Lausanne); *Arithmetic and physics of Higgs moduli spaces: Part 2 of 3*
10h00 – 10h30	Pause Café / Coffee Break
10h30 – 11h30	**Philip Boalch** (École Normale Supérieure & CNRS); *Connections on irregular curves: Part 2 of 3*
11h30 – 13h30	Lunch
13h30 – 14h30	**Lauren Williams** (UC Berkeley); *Cluster algebras: Part 3 of 3*
14h30 – 15h00	Pause Café / Coffee Break
15h00 – 16h00	**Andrew Neitzke** (UT Austin); *Spectral networks and their uses: Part 2 of 3*
16h00 – 16h30	Pause Café / Coffee Break
16h30 – 17h30	**Sergey Cherkis** (U of Arizona); *Self-dual gravitational instantons as moduli spaces: Part 1 of 3*

samedi, le 1er juin, 2013 / Saturday, 01-June-2013

09h00 – 10h00	**Tamàs Hausel** (EPF Lausanne); *Arithmetic and physics of Higgs moduli spaces: Part 3 of 3*
10h00 – 10h30	Pause Café / Coffee Break
10h30 – 11h30	**Philip Boalch** (École Normale Supérieure & CNRS); *Connections on irregular curves: Part 3 of 3*
11h30 – 13h30	Lunch
13h30 – 14h30	**Andrew Neitzke** (UT Austin); *Spectral networks and their uses: Part 3 of 3*
14h30 – 15h00	Pause Café / Coffee Break
15h00 – 16h00	**Sergey Cherkis** (U of Arizona); *Self-dual gravitational instantons as moduli spaces: Part 2 of 3*
16h00 – 16h30	Pause Café / Coffee Break
16h30 – 17h30	**Sergey Cherkis** (U of Arizona); *Self-dual gravitational instantons as moduli spaces: Part 3 of 3*

Geometry and Physics: GAP 2013 — Résumés / Abstracts

Conférencier/Speaker: **Boalch, Philip** (École Normale Supérieure & CNRS)
Titre/Title: **Connections on irregular curves**

Résumé/Abstract: Given a smooth compact complex curve X and a group G such as $\mathrm{GL}_n(\mathbb{C})$, work of Hitchin, Simpson and others gives us a hyperKähler manifold $M(X,G)$, which may be realised algebraically in three distinct ways: as a space of G-Higgs bundles on X, as a space of algebraic connections on G-bundles on X, or as a space of representations of the fundamental group of X into G.

If we then vary the curve X smoothly in a family over a base B the latter two descriptions of $M(X,G)$ each fit together into fibre bundles over B with natural flat (nonlinear) connections on them; the isomonodromy or nonabelian Gauss–Manin connections.

In this minicourse I will describe some aspects of what happens when X is not compact. A convenient perspective is to view this as generalizing the curve X above into an "irregular curve" (or "icurve"), by adding some data to control the behaviour at the punctures. In effect, work with Biquard from 2004 then says that there is a hyperKähler manifold $M(X,G)$ associated to an icurve X.

Our main goal will be to describe/define the irregular nonabelian Gauss–Manin connection, which occurs when the icurve is varied smoothly (in an admissible fashion). This leads to new types of nonlinear braid group actions generalizing the well-known braid/mapping class group actions on spaces of fundamental group representations of punctured curves. There are not many completely natural nonlinear flat connections so it is not surprising that this one appears in many places. The simplest case was used in 2001 to reveal the geometry underlying: 1) some old work of Soibelman and others on the quantum Weyl group, and 2) the braiding occurring in the theory of Frobenius manifolds, as will be explained. When written in certain coordinates considered by Loday–Richaud in 1994, the simplest case of this connection is reminiscent of the KS wall-crossing formula, and this finite dimensional setup seems to be a good model to help understand the cases considered by Kontsevich–Soibelman, upon replacing G by a pro-solvable group.

Some references:

- "Stokes Matrices, Poisson Lie Groups and Frobenius Manifolds", *Invent. Math. 146* (2001) 479–506.
- "G-bundles, Isomonodromy and Quantum Weyl Groups", *Int. Math. Res. Not. 22* (2002) 1129–1166.
- "Wild non-abelian Hodge theory on curves" (with O. Biquard); *Compos. Math. 140* (2004), 179–204.
- "Quasi-Hamiltonian geometry of meromorphic connections"; *Duke Math. J. 139* (2007), 369–405 (cf. arXiv 2002).
- "Geometry and braiding of Stokes data; Fission and wild character varieties"; *arXiv:1111.6228*, 61pp. (*Annals of Math.*, to appear).

Conférencier/Speaker: **Cherkis, Sergey** (University of Arizona)
Titre/Title: **Self-dual gravitational instantons as moduli spaces**

Résumé/Abstract: Self-dual gravitational Instantons are hyperKähler manifolds of real dimension four. The first lecture introduces these manifolds, describes their possible asymptotic metrics, and describes their significance in geometry, field theory, and string theory. In the remaining two lectures we identify gravitational instantons as moduli spaces of

1. classical self-dual Yang-Mills solutions,
2. quivers, bows, and slings,
3. local Calabi-Yau manifolds,
4. Quantum Field Theories in various dimensions.

Relations between these different realizations of the same space are used to establish isometries between gravitational instantons and to learn about their geometry. In the last lecture we focus on gravitational instantons of quadratic volume growth and obtain a classification of those that appear as moduli spaces of doubly periodic monopoles. This leads directly to combinatorial objects, such as plane arrangements and oriented matroids.

Conférencier/Speaker: **Hausel, Tamàs** (EPF Lausanne)
Titre/Title: **Arithmetic and physics of Higgs moduli spaces**

Résumé/Abstract: In these lectures we give an introduction to and discuss the connection between conjectures with Villegas on mixed Hodge polynomials of character varieties of Riemann surfaces achieved by arithmetic means and conjectures on the cohomology of Higgs moduli spaces derived by physicists Chuang-Diaconescu-Pan using refined BPS state counts.

Conférencier/Speaker: **Neitzke, Andrew** (University of Texas at Austin)
Titre/Title: **Spectral networks and their uses**

Résumé/Abstract: In joint work with Davide Gaiotto and Greg Moore we recently introduced some new geometric/combinatorial objects which we call "spectral networks." A spectral network is a collection of curves on a punctured Riemann surface, carrying some discrete decorations and obeying certain local rules. I aim to explain three things:

1. what spectral networks are;
2. how spectral networks lead to a procedure for "abelianizing" flat connections (closely related to the cluster variety structure on flat connections introduced by Fock and Goncharov);
3. how this procedure fits into a new strategy for getting geometric information about solutions of Hitchin's equations.

Conférencier/Speaker: **Williams, Lauren** (University of California at Berkeley)
Titre/Title: **Cluster algebras**

Résumé/Abstract: I will give an introduction to the theory of cluster algebras, which were introduced by Fomin and Zelevinsky in 2000. I will focus on examples coming from triangulations of surfaces, and Grassmannians.
