Geometry and Physics: GAP 2014 — Schedule

Unless otherwise indicated, all lectures are in ESB 2012.
All coffee breaks are just outside ESB 2012.

Thursday, 29-May-2014

09:00 – 10:00	**James Gates** (University of Maryland) *Introductory Lecture: A Showing Of How Physicists & Friends Are Driven To Discover New Mathematics*
10:00 – 10:30	Coffee Break
10:30 – 11:30	**José Figueroa-O'Farrill** (University of Edinburgh) *Lecture 1 of 3: Spinor equations and supersymmetry*
11:30 – 13:30	Lunch
13:30 – 14:30	**Chris Brav** (Institute for Advanced Study) *Lecture 1 of 3: Darboux theorem for symplectic derived stacks*
14:30 – 15:30	**Ron Donagi** (University of Pennsylvania) *Lecture 1 of 3: Moduli of super Riemann surfaces*
15:30 – 16:00	Reception: Just outside of ESB 1013
16:00 – 17:00	**James Gates** (University of Maryland) in **ESB 1013** *Public Lecture: From the Adinkras of Supersymmetry to the Music of Arnold Schoenberg*

Friday, 30-May-2014

09:00 – 10:00	**José Figueroa-O'Farrill** (University of Edinburgh) *Lecture 2 of 3: Spinor equations and supersymmetry*
10:00 – 10:30	Coffee Break
10:30 – 11:30	**Ron Donagi** (University of Pennsylvania) *Lecture 2 of 3: Moduli of super Riemann surfaces*
11:30 – 13:30	Lunch
13:30 – 14:30	**Dan Waldram** (Imperial College London) *Lecture 1 of 3: Supersymmetry, supergravity and generalised geometry*
14:30 – 15:30	**Chris Brav** (Institute for Advanced Study) *Lecture 2 of 3: Darboux theorem for symplectic derived stacks*
15:30 – 16:00	Coffee Break
16:00 – 17:00	**Ron Donagi** (University of Pennsylvania) *Lecture 3 of 3: Moduli of super Riemann surfaces*

Saturday, 31-May-2014

09:00 – 10:00	**Dan Waldram** (Imperial College London) *Lecture 2 of 3: Supersymmetry, supergravity and generalised geometry*
10:00 – 10:30	Coffee Break
10:30 – 11:30	**José Figueroa-O'Farrill** (University of Edinburgh) *Lecture 3 of 3: Spinor equations and supersymmetry*
11:30 – 13:30	Lunch
13:30 – 14:30	**Chris Brav** (Institute for Advanced Study) *Lecture 3 of 3: Darboux theorem for symplectic derived stacks*
14:30 – 15:30	**Dan Waldram** (Imperial College London) *Lecture 3 of 3: Supersymmetry, supergravity and generalised geometry*

Speaker: **Brav, Chris** (Institute for Advanced Study)

Title: **Darboux theorem for symplectic derived stacks**

Abstract: After giving some motivation for studying derived stacks (algebro-geometric and homotopy coherent analogues of Q-manifolds), we formulate a Darboux theorem for graded symplectic forms on derived stacks. As a particular case, we shall see that the moduli space of vector bundles on a Calabi-Yau threefold and the moduli space of local systems on a compact oriented three-manifold are locally critical loci of functions on smooth varieties. If time permits, we discuss applications to the categorification of Donaldson-Thomas theory.

These talks are based on joint work with Ben-Bassat, Bussi, and Joyce (arXiv:1305.6302,arXiv:1312.0090) and draws on work of Pantev-Toen-Vaquie-Vezzosi (arXiv:1111.3209).

Speaker: **Donagi, Ron** (University of Pennsylvania)

Title: **Moduli of super Riemann surfaces**

Abstract: In these talks we will explore various aspects of supergeometry and supersymmetry. The general notions will be applied to super Riemann surfaces and to their moduli spaces. In particular, we will study the obstruction, Atiyah, and super-Atiyah classes of a general (super)manifold, and will describe them explicitly in classical algebro-geometric terms for the moduli of super Riemann surfaces. For genus greater than or equal to 5, it turns out that this moduli space is not projected (and in particular it is not split): it cannot be holomorphically projected to its underlying reduced manifold. Physically, this means that certain approaches to superstring perturbation theory that are very powerful in low orders have no close analog in higher orders. Mathematically, it means that the moduli space of super Riemann surfaces cannot be constructed in an elementary way starting with the moduli space of ordinary Riemann surfaces. It has a life of its own.

Speaker: **Figueroa O'Farrill, José** (University of Edinburgh)

Title: **Spinor equations and supersymmetry**

Abstract: The geometric arena for these lectures is a (pseudo-)Riemannian spin manifold perhaps with some additional structure. There are some natural partial differential equations which spinor fields can satisfy: parallel spinors, Killing spinors and their generalisations. Such privileged spinors generate Lie (super)algebras which play an important rôle in supergravity and supersymmetric field theories. During these lectures I will give an overview of the different kinds of PDEs satisfied by spinor fields as well as their rôle in supersymmetry: both in supergravity and supersymmetric field theories (in curved space).

Speaker: **Gates, James** (University of Maryland)

Title: **A Showing Of How Physicists & Friends Are Driven To Discover New Mathematics**

Abstract: In this presentation, I will review how the struggle to understand mathematical properties of supersymmetry led to the uncovering new mathematical structures.

Title: **From the Adinkras of Supersymmetry to the Music of Arnold Schoenberg**

Abstract: The concept of supersymmetry, though never observed in Nature, has been one of the primary drivers of investigations in theoretical physics for several decades. Through all of this time, there have remained questions that are unsolved. This presentation will describe how looking at such questions one can be led to the 'Dodecaphony Technique' of Austrian composer Schoenberg.

Speaker: **Waldram, Dan** (Imperial College London)

Title: **Supersymmetry, supergravity and generalised geometry**

Abstract: Supersymmetry, that is the existence of a covariantly constant spinor, implies one has a manifold with special holonomy. This correspondence is central to the appearance of such manifolds in physics. However in the ten- or eleven-dimensional supergravity theories that arise in string theory, supersymmetry generically implies a more complicated set of differential conditions on the spinors, dependent on p-form "flux" degrees of freedom as well as the metric. These can be viewed as encoding natural extensions of conventional notions of integrable geometrical structures, such as Kähler-Einstein, Hyper-Kähler and Calabi-Yau geometries. A classic example is the generalised complex structure introduced by Hitchin and Gualtieri.

The goal of these lectures is to describe recent results on how these new differential operators, the corresponding structures, and in fact the supergravity theories themselves, can be described very naturally using the language of generalised geometry. There are different versions of generalised geometry appropriate to different supergravity theories, but in each case the metric and flux fields are unified as a generalised metric and there is an analogue of the Levi-Civita connection and the Ricci tensor. The condition of supersymmetry appears to be equivalent to an integrable (that is torsion-free) generalised structure.
