Workshop
Syzygies in Algebraic Geometry, with an exploration of a connection with String Theory
August 12-17, 2012

MEALS

Breakfast (Buffet): 7:00–9:30 am, Sally Borden Building, Monday–Friday
Lunch (Buffet): 11:30 am–1:30 pm, Sally Borden Building, Monday–Friday
Dinner (Buffet): 5:30–7:30 pm, Sally Borden Building, Sunday–Thursday
Please remember to scan your meal card at the host/hostess station in the dining room for each meal.
Coffee Breaks: As per daily schedule, in the foyer of the TransCanada Pipeline Pavilion (TCPL)

MEETING ROOMS

All lectures will be held in the new lecture theater in the TransCanada Pipelines Pavilion (TCPL).
All lecturers should be using ONLY blackboards.

SHORT COURSE

We will have a short course on **Matrix Factorizations and String Theory**. The following (mathematical) physicists are participating in the workshop: Paul S. Aspinwall, David Berenstein, Andrei Caldararu, Sheldon Katz, David R. Morrison, Stepan Paul, Eric Sharpe.

SCHEDULE

SUNDAY

16:00	Check-in begins (Front Desk - Professional Development Centre - open 24 hours)
17:30–19:30	Buffet Dinner, Sally Borden Building

MONDAY

7:00 − 8:45	Breakfast
8:45 − 9:00	Introduction and Welcome by BIRS Station Manager, TCPL
9:00 −10:00	Aldo Conca
10:00 −10:30	Coffee Break, TCPL
10:30 −11:30	Dale Cutkosky
11:30- -13:00	Lunch
13:00 −14:00	Guided Tour of The Banff Centre; meet in the 2nd floor lounge, Corbett Hall
14:00	Group Photo; meet in foyer of TCPL (photograph will be taken outdoors).
14:15 −14:45	Coffee Break, TCPL
14:45 −15:45	Short Course, Lecture 1, Ian Shipman
16:15 −17:15	Short Course, Lecture 2, Andrei Caldararu
17:30 −19:30	Dinner

TUESDAY

7:00 – 9:00	Breakfast
9:00 –10:00	Short Course, Lecture 3, David Berenstein
10:00 –10:30	Coffee Break, TCPL
10:30 –11:30	Short Course, Lecture 4, Paul Aspinwall
11:30 –13:30	Lunch
14:30 –15:00	Coffee Break, TCPL
15:00 –16:00	Short Course, Lecture 5, Eric Sharpe
16:30 –17:30	Short Course, Lecture 6, Dave Morrison
17:30 –19:30	Dinner

WEDNESDAY

7:00 – 9:00	Breakfast
9:00 –10:00	Short Course, Lecture 7, David Berenstein
10:00 –10:30	Coffee Break, TCPL
10:30 –11:30	Short Course, Lecture 8, Sheldon Katz
11:30 –13:30	Lunch
14:30 –15:00	Coffee Break, TCPL
15:00 –16:00	Short Course, Lecture 9, Paul Aspinwall
16:30 –17:30	Short Course, Lecture 10, Dave Morrison
17:30 –19:30	Dinner

THURSDAY

7:00 – 9:00	Breakfast
9:00 –10:00	Robert Lazarsfeld
10:00 –10:30	Coffee Break, TCPL
10:30 –11:30	Giorgio Ottaviani
11:30 –13:30	Lunch
	Break/Hike
17:30 –19:15	Dinner
19:15 – 20:15	Frank-Olaf Schreyer
20:30 –21:30	Marian Aprodu

FRIDAY

7:00 – 9:30	Breakfast
9:00 – 11:30	informal discussions
11:30 –13:30	Lunch

Checkout by 12 noon. Workshop participants are welcome to use BIRS Coffee Lounge, TCPL, and Reading Room until 3 pm on Friday, but are required to checkout of the guest rooms by 12 noon.

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ABSTRACTS
(in alphabetic order by speaker surname)

Speaker: **Marian Aprodu** (Inst. Math. Romanian Academy, Romania)
Title: *Vector bundles and syzygies*
Abstract: We discuss recent developments in the theory of syzygies using vector bundle techniques. The lecture is partly based on joint works with G. Farkas.

Speaker: **Paul Aspinwall** (Duke University)
Title: *The topological B-model and superpotentials*
Abstract: Lecture 4 in the Short Course on Matrix Factorizations and String Theory

Speaker: **Paul Aspinwall** (Duke University))
Title: *Matrix factorization on the quintic*
Abstract: Lecture 9 in the Short Course on Matrix Factorizations and String Theory

Speaker: **David Berenstein** (UC Santa Barbara)
Title: *From quivers and superpotentials to algebras and representation theory*
Abstract: Lecture 3 in the Short Course on Matrix Factorizations and String Theory

Speaker: **David Berenstein** (UC Santa Barbara)
Title: *Conjectures about superpotential algebras*
Abstract: Lecture 7 in the Short Course on Matrix Factorizations and String Theory

Speaker: **Andrei Caldararu** (University of Wisconsin)
Title: *Curved algebras*
Abstract: Lecture 2 in the Short Course on Matrix Factorizations and String Theory

Speaker: **Aldo Conca** (University of Genoa, Italy)
Title: *Koszul algebras and their syzygies*
Abstract: In a joint paper with Avramov and Iyengar it is shown that the syzygies of Koszul algebras behave very much as the syzygies of algebras with quadratic monomial relations. For example, it is shown that the highest degree of a i-th syzygy of a Koszul algebra is at most 2i. I will present new results concerning this analogy. I will also discuss some open problems concerning the syzygies of modules over a Koszul algebra.

Speaker: **Steven Cutkosky** (University of Missouri, USA)
Title: *Multiplicities Associated to Graded Families of Ideals*
Abstract: We prove that limits of multiplicities associated to graded families of ideals exist under very general conditions. Most of our results hold for reduced excellent equicharacteristic local rings, with perfect residue fields. We give a number of applications, including a "volume = multiplicity" formula, generalizing formulas of Lazarsfeld and Mustata and of Ein, Lazarsfeld and Smith, and a proof that the epsilon multiplicity of Ulrich and Validashti exists as a limit for ideals in rather general rings, including analytic local domains. We prove a generalization of this to generalized symbolic powers of ideals, proposed by Herzog, Puthenpurakal and Verma. We also prove an asymptotic "additivity formula" for limits of

multiplicities, and a formula on limiting growth of valuations, which answers a question posed by the author, Kia Dalili and Olga Kashcheyeva. Our proofs are inspired by a philosophy of Okounkov, for computing limits of multiplicities as the volume of a slice of an appropriate cone generated by a semigroup determined by an appropriate filtration on a family of algebraic objects.

Speaker: **Robert Lazarsfeld** (University of Michigan, USA)
Title: *Asymptotic syzygies of algebraic varieties*
Abstract: I'll discuss work with Ein and others concerning the asymptotic behavior of the syzygies of algebraic varieties as the positivity of the embedding line bundle increases.

Speaker: **Dave Morrison** (UC Santa Barbara)
Title: *D-brane algebras*
Abstract: Lecture 6 in the Short Course on Matrix Factorizations and String Theory

Speaker: **Dave Morrison** (UC Santa Barbara)
Title: *Matrix factorizations in physics (Summary talk)*
Abstract: Lecture 10 in the Short Course on Matrix Factorizations and String Theory

Speaker: **Sheldon Katz** (University of Illinois at Urbana-Champaign)
Title: *Computation of superpotentials for D-branes*
Abstract: Lecture 8 in the Short Course on Matrix Factorizations and String Theory

Speaker: **Giorgio Ottaviani** (University of Florence, Italy)
Title: *On the syzygies of Veronese embeddings*
Abstract: The resolution of the Veronese embedding of P^n is a basic algebraic object, not yet completely understood. It is a prototype for the behaviour of Betti numers of more general varieties, as shown by Ein and Lazarsfeld. It is well known that the resolution of the Veronese embedding can be in principle computed by the cohomology of certain homogeneous bundles. The category of homogeneous bundles on P^n is equivalent to the category of representations of a certain quiver with commutativity relations. This gives a combinatorial point of view for the computation of the cohomology of the relevant homogeneous bundles. We discuss these ideas having in mind the example of the Veronese embedding of P^2.

Speaker: **Frank-Olaf Schreyer** (Universittaet des Saarlandes, Germany)
Title: *Syzygies of torsion bundles and the geometry of the level ℓ modular variety over M_g*
Abstract: The talk is on joint work with Alessandro Chiodo, David Eisenbud, and Gavril Farkas. We formulate, and in some cases prove, three statements concerning the purity or, more generally, the naturallity of the resolution of various modules one can attach to a generic curve of genus g and a torsion point of ℓ in its Jacobian. These statements can be viewed an analogues of Greens Conjecture and we verify them computationally for bounded genus. I will focus on the unexpected failure of the Prym-Green conjecture in genus 8 and level 2, which we can establish probabilistically.

Speaker: **Eric Sharpe** (Virginia Tech)
Title: *Boundary terms in 2d theories and matrix factorization*
Abstract: Lecture 5 in the Short Course on Matrix Factorizations and String Theory

Speaker: **Ian Shipman** (MIT)
Title: *Orlov's theorem*
Abstract: Lecture 1 in the Short Course on Matrix Factorizations and String Theory