



# Banff International Research Station

for Mathematical Innovation and Discovery

## 08w5106 Hodge Theory

Arriving Sunday, April 6 and departing Friday, April 11, 2008

### 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

Coffee Breaks: As per daily schedule, 2nd floor lounge, Corbett Hall

**\*Please remember to scan your meal card at the host/hostess station in the dining room for each meal.**

### MEETING ROOMS

All lectures will be held in Max Bell 159 (Max Bell Building accessible by walkway on 2nd floor of Corbett Hall). LCD projector, overhead projectors and blackboards are available for presentations. Please note that the meeting space designated for BIRS is the lower level of Max Bell, Rooms 155–159. Please respect that all other space has been contracted to other Banff Centre guests, including any Food and Beverage in those areas.

### SCHEDULE

#### Sunday

- 16:00** Check-in begins (Front Desk - Professional Development Centre - open 24 hours)  
Lecture rooms available after 16:00 (if desired)
- 17:30–19:30** Buffet Dinner, Sally Borden Building
- 20:00** Informal gathering in 2nd floor lounge, Corbett Hall (if desired)  
Beverages and small assortment of snacks available on a cash honour-system.

#### Monday

- 7:00–8:45** Breakfast
- 8:45–9:00** Introduction and Welcome to BIRS by BIRS Station Manager, Max Bell 159
- 9:00 – 9:50** James Lewis: Residues of algebraic cycles
- 10:00 – 10:30** Coffee Break, 2nd floor lounge, Corbett Hall
- 10:30 – 11:20** Sabin Cautis: Abelian Monodromy Extension Property
- 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 – 14:20** Group Photo; meet on the front steps of Corbett Hall  
(can be scheduled for a different time or day if required)
- 14:30 – 15:20** Jozef Steenbrink: Ordinary quartic double solids
- 15:30 – 16:00** Coffee Break, 2nd floor lounge, Corbett Hall.
- 16:00 – 16:50** Morihiko Saito: Hausdorff property of the Zucker extension
- 17:30–19:30** Dinner

## Tuesday

- 7:00–9:00** Breakfast  
**9:00 – 9:50** Steven Zucker: The RBS motive for Shimura varieties  
**10 – 10:30** Coffee Break, 2nd floor lounge, Corbett Hall  
**10:30 – 11:20** Herb Clemens: Exploring the Hodge problem  
**11:30 – 13:30** Lunch  
**13:30 – 14:20** Christian Schnell: Residues and D-modules  
**14:30 – 15:20** Sampei Usui: Log Hodge structure and a geometric application  
**15:30 – 16:00** Coffee Break, 2nd floor lounge, Corbett Hall  
**16:00 – 16:50** Claire Voisin: Hodge Loci and absolute Hodge classes  
**17:30–19:30** Dinner

## Wednesday

- 7:00–9:00** Breakfast  
**9:00 – 9:50** Claude Sabbah: On Deligne’s irregular Hodge theory  
**10:00 – 10:30** Coffee Break, 2nd floor lounge, Corbett Hall  
**10:30 – 11:20** Fouad ElZein: On the decomposition theorem  
**11:30–13:30** Lunch  
Free Afternoon  
**17:30–19:30** Dinner

## Thursday

- 7:00–9:00** Breakfast  
**9:00 – 9:50** Mark Andrea de Cataldo: Filtrations in cohomology  
**10:00 – 10:30** Coffee Break, 2nd floor lounge, Corbett Hall  
**10:30 – 11:20** Elham Izadi  
**11:30 – 13:30** Lunch  
**13:30 – 14:20** Matt Kerr: Global Hodge theory of Calabi-Yau fibrations  
**14:30 – 15:20** Phillip Griffiths: Arakelov Equalities  
**15:30 – 16:00** Coffee Break, 2nd floor lounge, Corbett Hall  
**16:00 – 16:50** Claus Hertling: A generalization of Hodge structures from oscillating integrals  
**17:30–19:30** Dinner

## Friday

- 7:00–9:00** Breakfast  
**9:00 – 9:50** Zhaohu Nie: Singularities and admissible normal functions  
**10: 00 – 10:30** Coffee Break, 2nd floor lounge, Corbett Hall  
**10:30 – 11:30** Informal Discussions  
**11:30–13:30** Lunch

**Checkout by 12 noon.**

\*\* 5-day workshops are welcome to use the BIRS facilities (2nd Floor Lounge, Max Bell Meeting Rooms, Reading Room) until 3 pm on Friday, although participants are still required to checkout of the guest rooms by 12 noon. \*\*



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### ABSTRACTS

(in alphabetical order by speaker surname)

Speaker: **Sabin Cautis** (Rice University)

Title: *Abelian monodromy extension property*

Abstract: I will describe necessary and sufficient conditions for extending a family of smooth curves over an open subset  $U$  of  $S$  to a family of stable curves over  $S$ . More precisely, I'll introduce the abelian monodromy extension (AME) property and show that the standard Deligne-Mumford compactification is the unique, maximal AME compactification of the moduli space of curves. Other examples of AME compactifications as well as some conjectures will be mentioned.

Speaker: **Herb Clemens** (Ohio State University)

Title: *Exploring the Hodge problem*

Abstract: We will propose a template for attacking the Hodge problem on an even-dimensional complex projective manifold  $W$  by induction on (even) dimension. A rough outline is as follows:

1. Extend intermediate Jacobians  $J(X)$  of sufficiently ample hypersurfaces  $X$  of  $W$  to somewhat larger abelian topological groups, denoted  $K(X)$ ;
2. extend Voisin's version of the Abel-Jacobi map on Noether-Lefschetz loci to a map from topological cycles into  $K(X)$ ;
3. define a 'generalized' normal function associated to a 'strongly primitive' Hodge class on  $W$ , also taking values in  $K(X)$ ;
4. solve, almost everywhere, a topological version of Jacobi inversion for the generalized normal function'
5. use 4) to find a Noether-Lefschetz locus where topological Jacobi inversion breaks down.

(Joint work with Christian Schnell.)

Speaker: **Marc Andrea de Cataldo** (SUNY Stony Brook)

Title: *Filtrations in cohomology*

Abstract: I will report on joint work with L. Migliorini on a new characterization of the perverse filtration on the cohomology of a constructible complex on a quasi projective variety using hyperplane sections.

Speaker: **Fouad ElZein** (Université de Nantes)

Title: *Decomposition theorem*

Abstract: The speaker proposes to give a proof of the decomposition theorem without the use of differential modules and in line with a proof of Gabber in positive characteristic.

Speaker: **Phillip Griffiths** (IAS)

Title: *Arakelov equalities*

Abstract: See <http://www.math.ubc.ca/~brosnan/Pages/BanffHodge08/Griffiths.pdf>.

Speaker: **Claus Hertling** (Universität Mannheim)

Title: *A generalization of Hodge structures from oscillating integrals*

Abstract: The physicists Cecotti and Vafa studied already '91 a generalization of variation of Hodge structure which puts together meromorphic connections with irregular poles of order 2 and real structure. It is related to, but richer than harmonic bundles. A favorable situation where it turns up are holomorphic functions which have isolated singularities and except from that good topological behaviour (tame). There the oscillating integrals play a key role. One can formulate (partially still a conjecture) a correspondence between nilpotent orbits of pure structures and (limit) mixed structures. In the special case of regular singularities there are classifying spaces with negative holomorphic sectional curvature, but in order to make them complete one has to glue in smaller classifying spaces and allow for singularities. Also, several recent results of Sabbah and of Mochizuki concern these generalizations directly or indirectly.

Speaker: **Elham Izadi** (University of Georgia)

Title: *TBA*

Abstract: TBA

Speaker: **Ludmil Katzarkov** (University of Miami)

Title: *Generalized homological mirror symmetry and Hodge structures*

Abstract: TBA

Speaker: **Matthew Kerr** (University of Durham)

Title: *Global Hodge theory of Calabi-Yau fibrations (joint work with P. Griffiths and M. Green)*

Abstract: This talk is about 1-parameter families of elliptic curves, K3 surfaces, and CY 3-folds – objects which arise, for example, in the theory of modular forms and in mirror symmetry – with particular attention to the role played by singular fibers. Instead of looking at the geometry of the family directly, one often studies the associated VHS, and the degrees of related vector bundles on the parameter space are a tool for studying global behavior.

In his classic study of minimal elliptic fibrations, Kodaira described all possible singular fibers and their relation to the A-D-E classification (from Lie/singularity theory). We will first recall this and how one can relate fiber types to the Euler characteristic of the total space and the degree of the Hodge bundles.

What is interesting is how these relations generalize (or fail to generalize) to higher dimensions (K3, CY 3-fold), and the related nonexistence (or existence) of non-isotrivial families with no singular fibers. We will describe some results along these (global) lines, and suggest how this should fit with our earlier classification of (local) degenerations of CY 3-fold VHS's related to mirror symmetry.

Speaker: **James Lewis** (University of Alberta)

Title: *Residues of algebraic cycles*

Abstract: It is common knowledge among experts on algebraic cycles that there are counterexamples to Beilinson's formulation of the Hodge conjecture for the higher K-groups of smooth complex quasiprojective varieties. We will present an amended version of this conjecture, and show how it relates to other conjectures due to Jannsen, Voisin and Bloch-Kato.

Speaker: **Zhaohu Nie** (Texas A & M)

Title: *Singularities of admissible normal functions*

Abstract: I will talk on recent work with P. Brosnan, H. Fang and G. Pearlstein on the program for studying the Hodge conjecture via singularities of admissible normal functions.

Speaker: **Claude Sabbah** (Ecole Polytechnique)

Title: *On Deligne's irregular Hodge Theory*

Abstract: In 1984, then 2006, Deligne proposed the construction of a Hodge filtration in the case of a variation of polarized Hodge structure on a curve, twisted by the exponential of a function (cf. Correspondance Deligne-Malgrange-Ramis, Documents mathématiques, SMF, 2007). In the talk, I shall recall (and

generalize) Deligne's construction and I shall indicate the relation with the Fourier-Laplace transform of variations of polarizable twistor structures.

Speaker: **Morihiro Saito** (RIMS Kyoto)

Title: *Hausdorff property of the Zucker extension at the monodromy invariant subspace*

Abstract: We prove the Hausdorff property at the monodromy invariant subspace of the Zucker extension of the family of intermediate Jacobians if the divisor at infinity is smooth. Using a recent theorem of Green, Griffiths and Kerr, it implies in this case the analyticity of the closure of the zero locus of an admissible normal function. The last assertion is also obtained by Brosnan and Pearlstein generalizing their method in the curve case.

For a detailed abstract, see <http://www.math.ubc.ca/~brosnan/Pages/BanffHodge08/MSaito.pdf>.

Speaker: **Christian Schnell** (Ohio State University)

Title: *Residues and D-modules*

Abstract: Residues of meromorphic differential forms give a way to describe the interesting part of the cohomology of a smooth hypersurface. Using Saito's theory of mixed Hodge modules, and results from the recent preprint by Brosnan, Fang, Nie, and Pearlstein, we apply this idea to the study of normal functions associated to Hodge classes. We obtain a slightly different point of view on singularities of such normal functions. (Note: This is a continuation of Clemens' talk, in a way.)

Speaker: **Joseph Steenbrink** (Radboud University)

Title: *Ordinary quartic double solids*

Abstract: The talk will be about the third homology group of an ordinary quartic double solid and how its mixed Hodge structure reflects the geometry of the threefold.

Speaker: **Sampei Usui** (Osaka University)

Title: *Log Hodge structure and a geometric application*

Abstract: TBA.

Speaker: **Claire Voisin** (Jussieu)

Title: *Hodge loci and absolute Hodge classes*

Abstract: The general motivation for this work is a question asked by Maillot and Soulé: can one reduce the Hodge conjecture to the case of varieties defined over a number field? We observe that this is the case for absolute Hodge classes, and more generally for those Hodge classes for which the corresponding Hodge locus is defined over a number field. We also give a local criterion (which can be checked at finite order) for a Hodge locus to be defined over a number field.

Speaker: **Steven Zucker** (Johns Hopkins University)

Title: *The RBS motive for Shimura varieties*

Abstract: We will indicate the construction of the motive representing the **non-complex** reductive Borel-Serre compactification of a modular variety.