Workshop Alpbach 2026

Hotel Böglerhof, Alpbach/Austria
June 14 - 19, 2026

Organizers: J. Ayoub, C. Fuchs, P. Habegger, D. Löffler, S. Zerbes
Supported by: ETH Zurich, University of Zurich, University of Salzburg

This, the 19th in a series of workshops in Alpbach, will feature minicourses given by world class researchers and invited talks by younger researchers, covering a spectrum of in arithmetic geometry related to Galois representations and heights. The emphasis includes not only deep theoretical developments, but also applications of a more concrete/computational nature. Minicourses presenting a broad overview of these topics, delivered by top international experts, will be complemented by invited talks highlighting recent progress.

Minicourses given by:
Pierre Colmez and Wieslawa Niziol (IMJ-PRG)
Shabnam Akhtari (Penn State U.)
Florian Herzig (U. Toronto)

Talks given by:
Simone Coccia (U. Basel)
Hymn Chan (U. Toronto)
Gabriel Ribeiro (ETH Zurich)
Janine Roshardt (ETH Zurich)
Linli Shi (ETH Zurich & FernUni Schweiz)

Program

All lectures take place in the seminar room at Hotel Böglerhof.

Sunday, June 14, 2026:

17:00 - 17:15: Opening
Welcome words and organizational matters

17:15 - 18:45: **Pierre Colmez and Wieslawa Niziol** (IMJ-PRG)
Hodge theory of p-adic varieties. I

Monday, June 15, 2026:

09:00 - 10:30: **Shabnam Akhtari** (Penn State U.)
Reduction theory of integral binary forms and counting in number fields. I

11:00 - 12:30: **Florian Herzig** (U. Toronto)
Mod-p cohomology for GL_2*. I*

13:45 - 14:45: **Simone Coccia** (U. Basel)
Density of integral points on character varieties

15:00 - 16:00: **Janine Roshardt** (ETH Zurich)
Wach modules of crystalline (φ, Γ)*-modules over the Robba ring*

Tuesday, June 16, 2026:

09:00 - 10:30: **Pierre Colmez and Wieslawa Niziol** (IMJ-PRG)
Hodge theory of p-adic varieties. II

11:00 - 12:30: **Shabnam Akhtari** (Penn State U.)
Reduction theory of integral binary forms and counting in number fields. II

13:45 - 14:45: **Linli Shi** (ETH Zurich & FernUni Schweiz)
Modularity in Higher Chow Groups and Beilinson's Conjectures

Wednesday, June 17, 2026:

09:00 - 10:30: **Florian Herzig** (U. Toronto)
Mod-p cohomology for GL_2*. II*

11:00 - 12:30: **Pierre Colmez and Wieslawa Niziol** (IMJ-PRG)
Hodge theory of p-adic varieties. III

Thursday, June 18, 2026:

09:00 - 10:30: **Shabnam Akhtari** (Penn State U.)
Reduction theory of integral binary forms and counting in number fields. III

11:00 - 12:30: **Florian Herzig** (U. Toronto)
Mod-p cohomology for GL_2*. III*

13:45 - 15:15: **Pierre Colmez and Wieslawa Niziol** (IMJ-PRG)
Hodge theory of p-adic varieties. IV

Friday, June 19, 2026:

09:00 - 10:00: **Hymn Chan** (U. Toronto)
On Breuil's Lattice Conjecture for GL_2

10:30 - 11:30: **Gabriel Ribeiro** (ETH Zurich)
Smooth coefficient systems

Abstracts

Pierre Colmez and Wieslawa Niziol (IMJ-PRG)
Title: *Hodge theory of p-adic varieties*
Abstract: We will give an overview of our results concerning the p-adic proétale cohomology of p-adic varieties: comparison with differential forms, duality, ...

Shabnam Akhtari (Penn State U.)
Title: *Reduction theory of integral binary forms and counting in number fields*
Abstract: We start with a general overview and a brief history of the reduction theory of integral polynomials. Then we will discuss how some important objects, such as rings, orders, and ideals in number fields, can be parametrized by binary forms. This will lead us to present some results and make some conjectures about counting specific arithmetic objects using classical reduction theory.

Florian Herzig (U. Toronto)
Title: *Mod-p cohomology for* GL_2
Abstract: The classical local Langlands correspondence of a p-adic group, say $\mathrm{GL}_n(K)$, is realized in the ℓ-adic cohomology of suitable Shimura varieties for any prime $\ell \neq p$ (most classically, $n = 2$, $K = \mathbb{Q}_p$ and the Shimura varieties are modular curves). Roughly speaking, it relates n-dimensional representations of the Galois group of K to representations of $\mathrm{GL}_n(K)$, both over an ℓ-adic coefficient field. In our talks we will replace the coefficient field by a field of characteristic p, with the aim of investigating a mod-p Langlands correspondence for GL_2. In this setting, much is known when $K = \mathbb{Q}_p$, but much less for other p-adic fields K. We will introduce some of the basic objects involved, such as modular representations of p-adic groups, spaces of algebraic modular forms, Serre-weight conjectures, ... We will also survey some recent developments, based on joint work with Breuil, Hu, Morra, Schraen.

Hymn Chan (U. Toronto)
Title: *On Breuil's Lattice Conjecture for* GL_2
Abstract: Let K be an extension of $\mathbb{Q}_p$ and E be a finite extension of $\mathbb{Q}_p$ which is sufficiently large. We seek a p-adic Langlands correspondence between Galois representations $\rho : \mathrm{Gal}(\overline{K}/K) \to \mathrm{GL}_2(E)$ and admissible unitary Banach space representations of $\mathrm{GL}_2(K)$ over E. This correspondence is known when $K = \mathbb{Q}_p$, but remains unknown even for $K/\mathbb{Q}_p$ unramified.

To construct a candidate for such a correspondence, given a global automorphic representation $r : G_F \to \mathrm{GL}_2(E)$ where F is a number field with p inert, one can construct an admissible unitary Banach space representation $\pi(r)$ of $\mathrm{GL}_2(K)$. However, it is unclear whether this representation is local, that it depends only on $r|_{G_{F_p}}$. Breuil's lattice conjecture provides evidence for such a claim. Proving the conjecture shows local-global compatibility at the integral level. In the talk, I will explain the motivation behind the conjecture and briefly sketch the proof.

Simone Coccia (U. Basel)
Title: *Density of integral points on character varieties*
Abstract: Given a smooth quasi-projective complex variety Y with a simple normal crossings compactification, a (relative) SL_2-character variety of Y is a moduli space parametrizing SL_2-representations of the fundamental group of Y with fixed traces along the boundary components of the compactification. Well-known examples of SL_2-character varieties are Markoff-type cubic surfaces, and in recent years the study of their integral points has attracted much attention, notably with the work of Bourgain, Gamburd and Sarnak. In this talk I will present joint work with Daniel Litt where we prove that integral points are potentially Zariski dense in every SL_2-character variety (provided the fixed traces along the boundary components are algebraic integers). The proof uses work of Corlette and Simpson to reduce to the case of Y a Riemann surface, where we produce an integral point whose orbit under the mapping class group action is Zariski dense.

Gabriel Ribeiro (ETH Zurich)
Title: *Smooth coefficient systems*
Abstract: Grothendieck's yoga of six operations organizes the many compatibilities between cohomology theories into a coherent system of functorial identities. These identities interact in highly non-trivial ways, and for a long time it was unclear how to formulate a definition of a six-functor formalism that captures all the required coherence. This problem was solved independently by Liu–Zheng and by Gaitsgory–Rozenblyum, building on an idea of Lurie.
The resulting definition is, in some sense, maximal: it encodes all the coherence data present in a six-functor formalism. As a consequence, constructing such a formalism directly is unfeasible. A more workable approach is provided by results of Ayoub and, more recently, of Liu–Zheng and Cnossen–Lenz–Linskens, which identify minimal collections of axioms sufficient to generate a six-functor formalism.
In settings involving differential operators, such as $\mathcal{D}$-modules or mixed Hodge modules, these axioms are often much easier to verify on smooth schemes than on arbitrary schemes. In this talk, I will explain joint work

in progress with M. Gallauer proving that this loss of generality is only apparent: we establish an equivalence between six-functor formalisms on all schemes and six-functor formalisms defined only on smooth schemes.

Janine Roshardt (ETH Zurich)
Title: *Wach modules of crystalline (φ, Γ)-modules over the Robba ring*
Abstract: By works of Nathalie Wach and Laurent Berger there is an equivalence of Wach modules over $\mathbb{B}^+_{\mathbb{Q}_p}$ and crystalline p-adic representations of the absolute Galois group over $\mathbb{Q}_p$. Jonathan Pottharst has stated a generalization of this equivalence to crystalline (φ, Γ)-modules over the Robba ring, but no proof has appeared in the literature. In this talk, I will explain the ideas underlying this generalization and the construction of Wach modules over the positive Robba ring.

Linli Shi (ETH Zurich & FernUni Schweiz)
Title: *Modularity in Higher Chow Groups and Beilinson's Conjectures*
Abstract: In the Kudla program, one constructs generating series with values in Chow groups and proves that they are automorphic forms. Such modularity theorems play a central role in the proof of arithmetic inner product formulas, which may be viewed as higher-dimensional generalizations of the Gross–Zagier formula. In this talk, we propose a cohomological framework, together with a slight generalization of Borcherds products, which can be used to:

1. give a new proof of modularity theorems in the Kudla program, including convergence;
2. construct automorphic forms with values in higher Chow groups;
3. construct a sequence of motivic classes in higher Chow groups, with potential applications to new cases of Beilinson's conjectures.

This is joint work in progress with Wenxuan Qi, Liang Xiao, and Yichao Zhang.