Workshop on F-isocrystals and rigid cohomology

Announcement of the second session

Organizers : F. Baldassarri, P. Berthelot

As part of a series of mini-conferences planned by the european network "Arithmetic Algebraic Geometry" for the training of young researchers, the Padova and Rennes nodes of the network are organizing during the academic year 2004-2005 a workshop on F-isocrystals and rigid cohomology of algebraic varieties over a field of characteristic p. The purpose of the workshop is to offer both an up-to-date introduction to the subject, which has been making rapid progress over the last years, and an exposition of some of the most recent results obtained in this direction. In particular, Kiran Kedlaya has given, in a series of articles and preprints, many results which are fundamental for the development of this p-adic cohomology theory. One main goal of the workshop is to provide a detailed presentation of his work.

The workshop consists in two sessions. The first one has taken place in Padova on December 11-12, 2004. It was of a more introductory nature, and has covered topics ranging from basic constructions in rigid cohomology to the p-adic monodromy theorem for overconvergent F-isocrystals. The second one will be held in Rennes on June 1-3, 2005. The main topics will include finiteness theorems, Poincaré duality and Künneth formula in rigid cohomology, cohomological descent for rigid cohomology, the p-adic approach to Deligne's theorems on weights, and questions related to the semi-stable reduction theorem for overconvergent F-isocrystals in higher dimension. This second session will begin with a survey of the results on the p-adic monodromy theorem exposed in detail during the first session, so that it will not be necessary to have attended the first session to be able to participate in the second one.

The general principle of the workshop is that a list of topics for lectures is released, with some relevant references. A more extensive bibliography is also provided. Participants are asked to choose among these topics to volunteer to give one of the lectures. In view of the educational nature of the workshop, young researchers are particularly encouraged to do so. Some of these lectures may also be given by more advanced researchers, particularly on questions for which references are still scarce.

In addition, there will also be a few invited talks dedicated to some related topics.

Details of the programme of the regular lectures for the second session are provided below (the programme of the first one is given in an appendix). To volunteer for one of these lectures, please contact Pierre Berthelot (`pierre.berthelot@univ-rennes1.fr`) or Francesco Baldassarri (`baldassa@math.unipd.it`) before April 15, 2005. Instructions for accomodation and registration will be given on the web page of the workshop:

`htt://www.arithgeom-network.univ-rennes1.fr/miniconfA/`

Members of the "Arithmetic Algebraic Geometry" network attending the workshop are expected to get support from their node's budget.

Programme of the second session (June 1-3, 2005)

Lecture 1. – *Slope filtrations and the p-adic monodromy theorem, revisited.*

The purpose of the talk is to give a survey of the main results about σ-modules over Robba rings and their slope filtrations, leading to the proof of the p-adic monodromy theorem. It will present some recent improvements exposed in [Ke05e], using the analogies with the theory of semistable vector bundles, and the classification of σ-modules over a punctured unit-disc in the equicharacteristic case (due to Hartl and Pink).

Ref. : [Co03], [HN75], [HP04], [Ke04a], [Ke05e], [Man63], [Sha77].

Lecture 2. – *Finiteness, Poincaré duality and Künneth isomorphism for rigid cohomology with coefficients.*

Construction of local finite étale maps to the affine space in characteristic p. Construction and properties of generic pushforwards. Rigid cohomology with compact supports and Poincaré duality on the affine space. Finiteness, Poincaré duality and Künneth isomorphism in the general case.

Ref. : [Be97a], [Be97b], [Cr98], [Ke02], [Ke03b], [Ke04a], [Ke05a], [Ke05d], [Ts99].

Lecture 3. – *Proper cohomological descent in rigid cohomology.*

Proper hypercoverings of pairs and triples, associated Čech complexes. Universally cohomological descendability, universally de Rham descendability. Proper cohomological descent theorem: reduction steps, basic cases. Spectral sequences defined by hypercoverings, and applications.

Ref. : [De75], [CT03], [S-D72], [Ts03], [Ts04].

Lecture 4. – *Radius of convergence, ramification filtration and the Euler characteristic formula.*

Monodromy representation of a quasi-unipotent connection on an annulus. Relation between the generic radii of convergence of a unipotent connection and the breaks of its monodromy representation. Interpretation in terms of irregularity and Swan conductor. Euler characteristic formula.

Ref. : [An02b], [CD94], [CM93], [CM01], [Cr00], [Ka87], [Ke04b], [Ke05c], [Mat97], [Mat02], [Me02], [Ts98c].

Lecture 5. – *A p-adic proof of Weil II. Part 1: Overconvergent F-isocrystals on the affine line and the Fourier transform.*

Cohomology of families of overconvergent F-isocrystals. The p-adic Fourier transform. Application of the Euler characteristic formula to the cohomology of twisted overconvergent F-isocrystals on the affine line.

Ref. : [Cr98], [De80], [Hu95a], [Hu95b], [Hu03], [Ka01], [Ke03b], [Ke04b], [Lau87].

Lecture 6. – *A p-adic proof of Weil II. Part2: Monodromy and weights.*

The Lefschetz trace formula. Weights and determinantal weights on an overconvergent F-isocrystal, interpretation through the action of the global monodromy group. Proof of the Weil conjecture for overconvergent F-isocrystals.

Ref. : [Cr92], [Cr98], [De80], [ELS93], [Ka01], [Ke02], [Ke04b], [Lau87], [Mo71].

Lecture 7. – *Semi-stable reduction for overconvergent F-isocrystals. Part 1: Logarithmic extensions.*

Logarithmic connections, Shiho's conjecture. The case of curves. Isocrystals with unipotent monodromy along a divisor. Caracterization of the extendability and log-extendability of an overconvergent isocrystal in terms of its monodromy along the boundary.

Ref. : [Cr98], [Ke03a], [Ke05b], [Shi00], [Shi02].

Lecture 8. – *Semi-stable reduction for overconvergent F-isocrystals. Part 2: Towards the semi-stable reduction theorem.*

How to control the local monodromy along exceptional branches in a blowing-up. The strategy for a proof of the semi-stable reduction theorem.

Ref. : [Ke05b], [Ke05f], [Ke05g].

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Appendix: Programme of the first session (December 11-12, 2004)

Lecture 1. – P. Berthelot (Rennes): *The category of overconvergent F-isocrystals.*

Basic geometric constructions on the generic fiber of a formal scheme. Construction of the category of overconvergent F-isocrystals on an algebraic variety over a field of characteristic p. Interpretation in terms of dagger algebras in the smooth affine case. Examples (Dwork isocrystals, Bessel isocrystals, etc).

Ref. : [Be82], [Be84], [Be91], [Be97a], [Dw74], [Dw82], [MW68], [Ts98a], [vdP86].

Lecture 2. – F. Andreatta (Padova): *Rigid cohomology and rigid cohomology with compact supports.*

Construction of rigid cohomology with coefficients in an overconvergent isocrystal. Excision properties. Relation with Monsky-Washnitzer cohomology for smooth affine varieties. Rigid cohomology with compact supports, trace morphism and duality pairing.

Ref. : [Be82], [Be91], [Be97a], [Be97b], [Cr98], [Ke03b], [MW68], [vdP86].

Lecture 3. – M. Hien (Regensburg): *Rigid cohomology of curves and Crew's conjecture.*

Localization at a point of an overconvergent isocrystal on a curve, interpretation in terms of modules over the Robba ring, local duality. Strict connections, unipotent and quasi-unipotent connections. Crew's conjecture. Applications to the finiteness of rigid cohomology and to Poincaré duality.

Ref. : [Be91], [Be97a], [Be97b], [Cr87], [Cr98], [dJ98b], [Ts98a].

Lecture 4. – A. Marmora (Paris 13): *The p-adic local monodromy theorem for unit-root F-isocrystals on curves.*

Standard rings associated with the classical Robba ring. Étale (σ, ∇)-modules. Overconvergent étale (σ, ∇)-modules associated to p-adic representations with finite monodromy. Existence of horizontal sections when the Frobenius matrix is close enough to I. Proof of Crew's conjecture in the unit-root case.

Ref. : [Cr87], [Cr98], [Fo90], [Ke04a], [Ts96], [Ts98b].

Lecture 5. – O. Brinon (Padova): *Analytic rings and their algebraic properties.*

Cohen rings of valued extensions of $k((t))$. Kedlaya's generalizations to such extensions of the Robba ring and other related rings of analytic functions. Algebraic properties of these rings, and of modules over these rings.

Ref. : [Cr98], [dJ98a], [Ke04a], [Laz62], [Ts98b].

Lecture 6. – J. Poineau (Rennes): *The special Newton polygon of a σ-module over a Robba ring.*

Eigenvectors of σ-modules over Robba rings. Construction of a basis of eigenvectors. Slope decomposition and special Newton polygon.

Ref. : [Ke04a].

Lecture 7. – F. Oort (Utrecht): *Proof of the local p-adic monodromy theorem in dimension 1.*

Dieudonné-Manin classification, generic Newton polygon. Ascending and descending filtrations. Comparison of the Newton polygons. Descent of the special filtration. Proof of the p-adic local monodromy theorem.

Ref. : [dJ98a], [dJ98b], [Ka79], [Ke04a], [Man63].

Lecture 8. – G. Chatel (Rennes): *The relative local p-adic monodromy theorem.*

Dagger algebras and fringe algebras. The Robba ring over a dagger algebra, (σ, ∇)-modules over Robba rings. Unipotent (σ, ∇)-modules. Generic quasi-unipotency of (σ, ∇)-modules over the Robba ring of a dagger algebra.

Ref. : [Be91], [BGR84], [Gr00a], [Ke04a], [Ke03b], [MW68], [vdP86].