

C.I.M.E. Session on "Topological methods in the theory of
ordinary differential equations in finite and infinite dimensions"

Montecatini Terme, June 24-July 2, 1991

LIST OF PARTICIPANTS

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- P. SANTORO, Dip. Mat. Appl., Fac. Ing., v. S. Marta 3, 50139 Firenze
- G. SAVARE', IAN-CNR, Palazzo Univ., Corso Carlo Alberto 5, 27100 Pavia
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- F. ZANOLIN, Dip. Mat., Univ. Udine, v. Zanon 6, 33100 Udine

FONDAZIONE C.I.M.E.
CENTRO INTERNAZIONALE MATEMATICO ESTIVO
INTERNATIONAL MATHEMATICAL SUMMER CENTER

“Arithmetic Algebraic Geometry”

is the subject of the Second 1991 C.I.M.E. Session.

The Session, sponsored by the Consiglio Nazionale delle Ricerche and by the Ministero dell'Università e della Ricerca Scientifica e Tecnologica, will take place under the scientific direction of Prof. Edoardo BALLICO (Università di Trento) at Villa Madruzzo (Cognola di Trento) from June 24 to July 2, 1991.

C o u r s e s

- a) **Torsion Algebraic Cycles and Algebraic K-Theory.** (6 lectures in English).
Prof. Jean-Louis COLLIOT-THELENE (CNRS, Université de Paris-Sud, Orsay).

Outline

The Bloch/Ogus theory.

Some key facts from Quillen's 1973 K-theory paper.

Some more recent developments: known cases of the Gersten conjecture.

Etale cohomology of varieties defined over arithmetic fields: a summary.

Summary of some results of Merkur'ev and Suslin. Applications to K-cohomology.

Algebraically closed ground fields: Roitman's theorem.

Finite ground fields: codimension two cycles; the unramified class field theory of Kato and Saito.

Arbitrary ground fields: cycle class maps for torsion cycles via Galois action over an algebraic closure.

Varieties over p-adic or number fields: finiteness results for torsion codimension two cycles, via the Galois method.

Varieties over p-adic or number fields: finiteness results for torsion codimension two cycles, via the localization method.

Local-to-global conjectures for the torsion in the codimension two Chow groups of varieties defined over number fields.

References

- S. Bloch, Torsion algebraic cycles and a theorem of Roitman, *Comp. Math.* 39 (1979), 107-127.
S. Bloch, Lectures on algebraic cycles, *Duke Univ. Math. Ser.* 4, Durham, 1980.
S. Bloch, Torsion algebraic cycles. K2 and Brauer groups of function fields, in *Springer L.N.M.* 844 (1981)
S. Bloch, On the Chow groups of certain rational surfaces, *Ann. Ec. Norm. Sup.* (1981), 41-59.
S. Bloch, Algebraic K-theory and class field theory for arithmetic surfaces, *Ann. of Math.* 114 (1981), 229-266.
S. Bloch and A. Ogus, Gersten's conjecture and the homology of schemes, *Ann. Sc. Ec. Norm. Sup.* 4 (1974), 181-202.
S. Bloch, A. Kas and D. Lieberman, Zero-cycles on surfaces with $pg = 0$, *Comp. Math.* 33 (1976), 135-145.
S. Bloch and V. Srinivas, Remarks on correspondences and algebraic cycles, *Amer. J. Math.* 105 (1983), 1235-1253.
J.-L. Colliot-Thélène, Hilbert's theorem 90 for K2, with applications to the Chow groups of rational surfaces, *Inventiones Math.* 71 (1983), 1-20.
J.-L. Colliot-Thélène and W. Raskind, K2-cohomology and the second Chow group, *Math. Annalen* 270 (1985), 165-199.
J.-L. Colliot-Thélène and W. Raskind, On the reciprocity law for surfaces over a finite field, *J. of the Faculty of Science, University of Tokio*, 33 (1986), 282-294.

- J.-L. Colliot-Thélène and W. Raskind, Groupe de Chow de codimension deux des variétés définies sur un corps de nombres: un théorème de finitude pour la torsion, to appear in *Inventiones Math.*
- J.-L. Colliot-Thélène et J.-J. Sansuc, On the Chow groups of certain rational surfaces: a sequel to a paper of S. Bloch, *Duke Math. J.* 48 (1981), 421-447.
- J.-L. Colliot-Thélène, J.-J. Sansuc et C. Soulé, Torsion dans le groupe de Chow de codimension deux, *Duke Math. J.* 48 (1983), 763-801.
- K. Coombes, The arithmetic of zero cycles on surfaces with geometric genus zero and irregularity zero, preprint.
- M. Gros, O-cycles de degré zéro sur les surfaces fibrées en coniques, *J. reine und ang. Math.* 373 (1987), 166-184.
- U. Jannsen, On the ℓ -adic cohomology of varieties over number fields and its Galois cohomology, in: *Galois groups over \mathbb{Q}* , MSRI Publications.
- K. Kato and S. Saito, Unramified class field theory of arithmetical surfaces, *Ann. of Math.* 118 (1983), 241-275.
- A.S. Merkur'ev and A.A. Suslin, K-cohomology of Severi-Brauer varieties and norm residue homomorphism, *Izv. Akad. Nauk SSSR* 46 (1982), 1011-1046 = *Math. USSR Izv.* 21 (1983), 307-341.
- D. Quillen, Higher algebraic K-theory I, in *Springer L.N.M.* 341.
- W. Raskind, Algebraic K-theory, étale cohomology and torsion algebraic cycles, *Contemporary Mathematics* 83 (1989), 311-341.
- W. Raskind, Torsion algebraic cycles on varieties over local fields, in *Algebraic K-theory: Connection with geometry and varieties over local fields*, in *Algebraic K-theory: Connection with geometry and topology*, 343-388, (1989), Kluwer Academic Publishers.
- C. Schoen, Some examples of torsion in the Griffiths Group, preprint.
- C. Schoen, On the computation of the cycle class map for nullhomologous cycles over the algebraic closure of a finite field, preprint.
- S. Saito, A conjecture of Bloch and Brauer groups of surfaces over p -adic fields, preprint, May 1990.
- S. Saito, Cycle map on torsion algebraic cycles of codimension two, preprint, October 1990.
- P. Salberger, Zero-cycles on rational surfaces over number fields, *Inventiones Math.* 91 (1988), 505-524.
- A.A. Suslin, Torsion in K_2 of fields, *Journal of K-Theory*, 1 (1987), 5-29.

b) Values of L-functions, Explicit Reciprocity Laws, and p -adic Hodge Theory. (6 lectures in English).

Prof. Kazuya KATO (University of Tokyo).

Outline

The main theme is the p -adic property of special values of Hasse-Weil L-functions of algebraic varieties over number fields. By using the p -adic Hodge theory developed by J. Tate, J.M. Fontaine, W. Messing, G. Faltings, and other people, we generalize the classical explicit reciprocity law in local class field theory to more general varieties, and relate it to values of L-functions. Related conjectures on Iwasawa theory of varieties over number fields are proposed and discussed.

References

- S. Bloch and K. Kato, L-functions and Tamagawa numbers of motives, in the *Grothendieck Festschrift*, Vol. I, Birkhäuser 1990, 333-400.
- G. Faltings, Crystalline cohomology and p -adic Galois representation, in *Algebraic Analysis, Geometry, and Number Theory*, The Johns Hopkins Univ. Press, 1989, 25-80.
- J.M. Fontaine and W. Messing, p -adic periods and p -adic étale cohomology, in *Current Trends in Arithmetical Algebraic Geometry*, *Contemporary Math.* 67, 1987, 179-207.

c) Arakelov Geometry. (6 lectures in English).

Prof. Christophe SOULE' (IHES).

Outline

This course will present an overview of joint work with Henri Gillet, extending to arbitrary dimensions the Arakelov theory of arithmetic surfaces. The main result is a Riemann-Roch type theorem for hermitian bundles on arithmetic varieties (generalizing previous work of Faltings and Deligne). Its proof uses recent analytical work of Bismut and others on the determinant of Laplace operators. In this survey we shall also try to indicate the possible links between this geometry and different aspects of number theory.

References

Some familiarity with the basic notions of the algebraic geometry of schemes (Hartshorne's book, Chapters 1 and 2) and complex geometry (Griffiths and Harris, chapters 0, 1, 3) will be useful.

Original papers:

- C. Soulé, H. Gillet: Intersection theory using Adams operations, *Inventiones Math.* 90 (1987), 243-277.
 C. Soulé, H. Gillet, Direct images of Hermitian holomorphic bundles, *Bull. AMS* 15 (1986), 209-212.
 J.-M. Bismut, H. Gillet, C. Soulé, Analytic torsion and holomorphic determinant bundles I: Bott-Chern forms and analytic torsion, *Comm. in math. Physics* 115 (1988), 49-78.
 J.-M. Bismut, H. Gillet, C. Soulé, Analytic torsion and holomorphic determinant bundles II: Direct images and Bott-Chern forms, *Comm. in Math. Physics* 115 (1988), 79-126.
 J.-M. Bismut, H. Gillet, C. Soulé, Analytic torsion and holomorphic determinant bundles III: Quillen metrics on holomorphic determinants, *Comm. Math. Physics* 115 (1988), 301-351.
 H. Gillet, C. Soulé, Intersection on arithmetic varieties, *Publications IHES*, à paraître.
 H. Gillet, C. Soulé, Characteristic classes for algebraic vector bundles with hermitian metric, *Annals of Math.* 131 (1990), 163-203.
 H. Gillet, C. Soulé, Analytic torsion and the arithmetic Todd genus, *Topology*, à paraître.
 H. Gillet, C. Soulé, Arithmetic amplitude, note aux CRAS, 307, 1988, 887-890.
 H. Gillet, C. Soulé, Un théorème de Riemann-Roch arithmétique, *CRAS Paris*, 309, 1989, 929-932.
 J.-M. Bismut, H. Gillet, C. Soulé, Bott-Chern currents and complex immersions, *Duke Math. J.* 60 (1990), 255-284.
 J.-M. Bismut, H. Gillet, C. Soulé, Complex immersions and Arakelov geometry, *Grothendieck Festschrift*, Birkhäuser, 1990.

Survey papers:

- C. Soulé, Théorie d'Arakelov et théorie de Nevanlinna, *Astérisque* 183 (1990), 127-135.
 C. Soulé, Géométrie d'Arakelov et théorie des nombres transcendants, *Astérisque*, à paraître.
 C. Soulé, Géométrie d'Arakelov des surfaces arithmétiques, exposé au séminaire Bourbaki, Juin 1989, 15 p.

Especially:

- J.B. Bost, Théorie de l'intersection et théorème de Riemann-Roch arithmétiques, *Séminaire Bourbaki*, Novembre 1990, 37 p.

d) Applications of Arithmetic Geometry to Diophantine Approximations. (6 lectures in English).

Prof. Paul VOJTA (University of California, Berkeley).

Outline

1. Thue's method
2. Mordell's conjecture over function fields (Manin's theorem)
3. A proof for number field
4. Enhancements due to Faltings
5. Enhancements due to Bombieri.

References

- W.M. Schmidt, Application of Thue's method in various branches of number theory. *Proceedings of the International Congress of Mathematicians*, R.P. James, ed., Canadian Mathematical Congress, Vancouver, 1975, pp. 177-186.
 P. Vojta, Mordell's conjecture over function fields, *Invent. Math.* 98 (1989), 115-138.
 P. Vojta, Siegel's theorem in the compact case, *Ann. Math.* (to appear).
 G. Faltings, Diophantine approximation on abelian varieties, *Ann. Math.* (to appear).
 E. Bombieri, The Mordell conjecture revisited. (to appear)

FONDAZIONE C.I.M.E.
CENTRO INTERNAZIONALE MATEMATICO ESTIVO
INTERNATIONAL MATHEMATICAL SUMMER CENTER

**“Transition to Chaos
in Classical and Quantum Mechanics”**

is the subject of the Third 1991 C.I.M.E. Session.

The Session, sponsored by the Consiglio Nazionale delle Ricerche and by the Ministero dell'Università e della Ricerca Scientifica e Tecnologica, will take place under the scientific direction of Prof. Sandro GRAFFI (Università di Bologna, Dipartimento di Matematica, Piazza di Porta S. Donato, 40126 Bologna, E-mail: MK7BOG73 at ICINECA; graffi at dm.unibo.it.) at Villa “La Querceta”, Montecatini (Pistoia), from July 6 to July 13, 1991.

C o u r s e s

a) Non Commutative Method in Semi Classical Analysis. (8 lectures in English).

Prof. Jean BELLISSARD (Wissenschaftskolleg zu Berlin).

Outline

- 1) Quantum phase space ad groupoid
- 2) Perturbation theory: Birkhoff versus Rayleigh Schrödinger in the semi classical limit
- 3) Semi classical expansion and tunneling effects
- 4) Analysis of resonances: KAM theory and quantum localization
- 5) Spectrum in the classically chaotic region

References

1. J. Bellissard, C^* algebras in solid state physics, in “Operator algebras and applications”, D.E. Evans and M. Takesuki Eds., Cambridge Univ. Press 1988.
2. J. Bellissard, M. Vittot, Heisenberg's picture and non commutative geometry of the semi classical limit in quantum mechanics, Ann. Inst. H. Poincaré 52 (1990), 175-235.
3. J. Bellissard, R. Rammal, An algebraic semi-classical approach to Bloch electrons in a magnetic field, J. de Physique Paris, (March 1990).
4. J. Bellissard, Stability and instability in quantum mechanics, in “Trends and developments in the eighties”, Alberverio, Blanchard, Eds, World Sc. Publ., 1985, 1-106.
5. O. Bohigas, M.J. Giannoni, C. Schmit, Spectral properties of the Laplacian and random matrix theory, Lecture notes in physics, vol. 209 (1984), p. 1.

b) Stochastic Properties of Classical Dynamical Systems. (8 lectures in English).

Prof. Anatole KATOK (Pennsylvania State University).

Outline

1. Review of stochastic properties of dynamical systems. Ergodicity, mixing, eigenfunctions. Entropy and asymptotic independence. K-property, Bernoulli property.

2. Hyperbolic systems with examples exhibiting stochastic properties and complicate dynamical behaviour.
3. Smooth hyperbolic systems. The Pesin theory. Lyapunov exponents, stable and unstable manifolds, stochastic behaviour. The Pesin entropy formula, local ergodicity and local Bernoulli property.
4. Application of Pesin's theory to specific systems. Invariant cone families and Lyapunov characteristic exponents. Wojtkowski's theorem. Symplectic cones.
5. From local to global ergodicity. Criteria of openness of ergodic components and ergodicity based on existence of virtually strictly invariant family of symplectic cones.
6. Dynamical systems with singularities. Billiards, collisions, elastic balls in a volume and multidimensional billiard. Generalization of the Pesin theory to include billiards.
7. Cone families for various special classes of classical dynamical systems, both smooth and with singularities.
8. Criteria of ergodicity for dynamical systems with singularities.

References

1. Walters, P.: An introduction to ergodic theory, Springer Verlag, 1981.
2. Katok, A.: Dynamical systems with hyperbolic structure, in: Three papers in dynamical systems, AMS Translations (2) Vol. 116, 1981.
3. Pesin, Ya. B.: Characteristic Lyapunov exponents and smooth ergodic theory, Russian Math. Surveys, Vol. 32 (1977), 54-114.
4. Katok, A.: Lyapunov exponents, entropy and periodic points of diffeomorphisms, Publ. Math. IHES, Vol. 51 (1980), 137-173.
5. Wojtkowski, M.: Invariant families of cones and Lyapunov exponents, Ergodic Theory and Dynamical Systems, Vol. 5 (1985), 145-161.

- c) **Dynamics of Area Preserving Maps.** (8 lectures in English).
 Prof. John N. MATHER (Princeton University).

Outline

1. Hyperbolic and elliptic fixed points, Birkhoff normal form
2. A brief discussion of KAM theory (no proofs)
3. A brief discussion on the "last invariant circle" with reference to the numerical results of Greene, Percival, McKay (no proofs)
4. An outline of Aubry's theory and of its generalization by Barget
- 5.6. Herman's method and the author's method of destroying invariant circles (with an outline of the proofs)
- 7.8. Orbits which pass close to a succession of Aubry-Mather sets (with an outline of the proofs)

References

- Herman, M.R.: Sur les courbes invariantes par les difféomorphismes de l'anneau. Vol. 1, Astérisque, 103-104.
 Bangert, V.: Mather sets for twist maps and geodesics on tori, Dynamics reported, Vol. 1, pp. 1-56.
 Salamon, S. And Zehnder, E.: The Kolmogorov-Arnold-Moser theory in configuration space, Comm. Math. Helv., Vol. 64, pp. 84-132.
 Mather, J.N.: Destruction of invariant circles, Ergodic Theory and Dynamical Systems, 8, 199-214.
 Mather, J.N.: Variational construction of orbits of twist diffeomorphisms, Journal of the American Mathematical Society, to appear.

LIST OF C.I.M.E. SEMINARS

Publisher

1954 -	1. Analisi funzionale	C.I.M.E.
	2. Quadratura delle superficie e questioni connesse	"
	3. Equazioni differenziali non lineari	"
1955 -	4. Teorema di Riemann-Roch e questioni connesse	"
	5. Teoria dei numeri	"
	6. Topologia	"
	7. Teorie non linearizzate in elasticità, idrodinamica, aerodinamica	"
	8. Geometria proiettivo-differenziale	"
1956 -	9. Equazioni alle derivate parziali a caratteristiche reali	"
	10. Propagazione delle onde elettromagnetiche	"
	11. Teoria della funzioni di più variabili complesse e delle funzioni automorfe	"
1957 -	12. Geometria aritmetica e algebrica (2 vol.)	"
	13. Integrali singolari e questioni connesse	"
	14. Teoria della turbolenza (2 vol.)	"
1958 -	15. Vedute e problemi attuali in relatività generale	"
	16. Problemi di geometria differenziale in grande	"
	17. Il principio di minimo e le sue applicazioni alle equazioni funzionali	"
1959 -	18. Induzione e statistica	"
	19. Teoria algebrica dei meccanismi automatici (2 vol.)	"
	20. Gruppi, anelli di Lie e teoria della coomologia	"
1960 -	21. Sistemi dinamici e teoremi ergodici	"
	22. Forme differenziali e loro integrali	"
1961 -	23. Geometria del calcolo delle variazioni (2 vol.)	"
	24. Teoria delle distribuzioni	"
	25. Onde superficiali	"
1962 -	26. Topologia differenziale	"
	27. Autovalori e autosoluzioni	"
	28. Magnetofluidodinamica	"

1963 -	29. Equazioni differenziali astratte	"
	30. Funzioni e varietà complesse	"
	31. Proprietà di media e teoremi di confronto in Fisica Matematica	"
1964 -	32. Relatività generale	"
	33. Dinamica dei gas rarefatti	"
	34. Alcune questioni di analisi numerica	"
	35. Equazioni differenziali non lineari	"
1965 -	36. Non-linear continuum theories	"
	37. Some aspects of ring theory	"
	38. Mathematical optimization in economics	"
1966 -	39. Calculus of variations	Ed. Cremonese, Firenze
	40. Economia matematica	"
	41. Classi caratteristiche e questioni connesse	"
	42. Some aspects of diffusion theory	"
1967 -	43. Modern questions of celestial mechanics	"
	44. Numerical analysis of partial differential equations	"
	45. Geometry of homogeneous bounded domains	"
1968 -	46. Controllability and observability	"
	47. Pseudo-differential operators	"
	48. Aspects of mathematical logic	"
1969 -	49. Potential theory	"
	50. Non-linear continuum theories in mechanics and physics and their applications	"
	51. Questions of algebraic varieties	"
1970 -	52. Relativistic fluid dynamics	"
	53. Theory of group representations and Fourier analysis	"
	54. Functional equations and inequalities	"
	55. Problems in non-linear analysis	"
1971 -	56. Stereodynamics	"
	57. Constructive aspects of functional analysis (2 vol.)	"
	58. Categories and commutative algebra	"

1972 -	59. Non-linear mechanics		"
	60. Finite geometric structures and their applications		"
	61. Geometric measure theory and minimal surfaces		"
1973 -	62. Complex analysis		"
	63. New variational techniques in mathematical physics		"
	64. Spectral analysis		"
1974 -	65. Stability problems		"
	66. Singularities of analytic spaces		"
	67. Eigenvalues of non linear problems		"
1975 -	68. Theoretical computer sciences		"
	69. Model theory and applications		"
	70. Differential operators and manifolds		"
1976 -	71. Statistical Mechanics	Ed Liguori, Napoli	
	72. Hyperbolicity		"
	73. Differential topology		"
1977 -	74. Materials with memory		"
	75. Pseudodifferential operators with applications		"
	76. Algebraic surfaces		"
1978 -	77. Stochastic differential equations		"
	78. Dynamical systems	Ed Liguori, Napoli and Birkhäuser Verlag	
1979 -	79. Recursion theory and computational complexity		"
	80. Mathematics of biology		"
1980 -	81. Wave propagation		"
	82. Harmonic analysis and group representations		"
	83. Matroid theory and its applications		"
1981 -	84. Kinetic Theories and the Boltzmann Equation	(LNM 1048) Springer-Verlag	
	85. Algebraic Threefolds	(LNM 947)	"
	86. Nonlinear Filtering and Stochastic Control	(LNM 972)	"
1982 -	87. Invariant Theory	(LNM 996)	"
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