

An arithmetic Riemann–Roch theorem

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Introduction

We prove in this paper an arithmetic analog of the Riemann–Roch–Grothendieck theorem for the determinant of the cohomology of an Hermitian vector bundle of arbitrary rank on a family of arithmetic varieties of arbitrary dimension. We also show that high powers of ample line bundles on arithmetic varieties have small sections.

Let X and Y be regular quasi-projective flat schemes over $\mathbb{Z}$. Consider an Hermitian vector bundle $\bar{E} = (E, h)$ on X : E is an algebraic vector bundle on X and h is an Hermitian metric on the associated holomorphic vector bundle on $X(\mathbb{C})$, which is invariant under complex conjugation. In [GS2] we defined arithmetic Chow groups $\widehat{CH}^p(X)$, $p \geq 0$, and in [GS3] we attached to (E, h) arithmetic characteristic classes such as the Chern character $\widehat{ch}(E, h) \in \widehat{CH}^*(X)_{\mathbb{Q}} = \bigoplus_{p \geq 0} \widehat{CH}^p(X) \otimes_{\mathbb{Z}} \mathbb{Q}$, and the Todd class $\widehat{Td}(E, h)$. Assume now that $f: X \rightarrow Y$ is a smooth projective morphism from X to Y . The determinant of cohomology $\lambda(E) = \det Rf_*(E)$ is an algebraic (graded) line bundle on Y . Choose an Hermitian metric h_f , invariant by conjugation, on the relative tangent space Tf , whose restriction to each fiber of f over $Y(\mathbb{C})$ is Kähler. The line bundle $\lambda(E)$ can then be equipped with the Quillen metric h_Q ([Q2], [BGS1] or 4.1.1 below).

Our main result (Theorem 7) computes the first arithmetic Chern class of $(\lambda(E), h_Q)$ in the $\mathbb{Q}$ -vector space $\widehat{CH}^1(Y) \otimes_{\mathbb{Z}} \mathbb{Q}$. It reads

$$(1) \quad \widehat{c}_1(\lambda(E), h_Q) = f_*(\widehat{ch}(E, h) \widehat{Td}(Tf, h_f) - \alpha(ch(E_{\mathbb{C}}) Td(Tf_{\mathbb{C}}) R(Tf_{\mathbb{C}})))^{(1)}.$$

Here $\alpha^{(1)}$ is the component of degree one of $\alpha \in \widehat{CH}^*(Y)_{\mathbb{Q}}$, α is the map from the real cohomology of $Y(\mathbb{C})$ to $\widehat{CH}^*(Y)_{\mathbb{Q}}$ defined in [GS2, 3.3.4] and in 2.2.1 below, and R is the additive characteristic class (in real cohomology) attached to the power series

$$R(x) = \sum_{\substack{m \text{ odd} \\ m \geq 1}} \left(2\zeta'(-m) + \left(1 + \frac{1}{2} + \dots + \frac{1}{m} \right) \zeta(-m) \right) \frac{x^m}{m!}$$

* Supported by a grant from the NSF

Arithmetic Riemann Roch Theorem For Singular Arithmetic Surfaces

Ambar Sengupta



Arithmetic Riemann Roch Theorem For Singular Arithmetic Surfaces:

An Arithmetic Riemann-Roch Theorem for Singular Arithmetic Surfaces Wayne Aitken, 1996 The following gives a development of Arakelov theory general enough to handle not only regular arithmetic surfaces but also a large class of arithmetic surfaces whose generic fiber has singularities This development culminates in an arithmetic Riemann Roch theorem for such arithmetic surfaces The first part of the memoir gives a treatment of Deligne's functorial intersection theory and the second develops a class of intersection functions for singular curves which behaves analogously to the canonical Green's functions introduced by Arakelov for smooth curves

Gauge Theory on Compact Surfaces Ambar Sengupta, 1997 In this paper we develop a concrete description of connections on principal bundles possibly non trivial over compact surfaces and use this description to construct the Yang Mills measure which underlies the Euclidean quantum theory of gauge fields involving compact gauge groups on compact connected two dimensional Riemannian manifolds possibly with boundary Using this measure we compute expectation values of important random variables the Wilson loops variables corresponding to a broad class of configurations of loops on the surface

Two Classes of Riemannian Manifolds Whose Geodesic Flows Are Integrable Kazuyoshi Kiyohara, 1997 Two classes of manifolds whose geodesic flows are integrable are defined and their global structures are investigated They are called Liouville manifolds and Kahler Liouville manifolds respectively In each case the author finds several invariants with which they are partly classified The classification indicates in particular that these classes contain many new examples of manifolds with integrable geodesic flow

Hodge Theory in the Sobolev Topology for the de Rham Complex Luigi Fontana, Steven George Krantz, Marco M. Peloso, 1998 In this book the authors treat the full Hodge theory for the de Rham complex when calculated in the Sobolev topology rather than in the L^2 topology The use of the Sobolev topology strikingly alters the problem from the classical setup and gives rise to a new class of elliptic boundary value problems The study takes place on both the upper half space and on a smoothly bounded domain It features a good introduction to elliptic theory pseudo differential operators and boundary value problems theorems completely explained and proved and new geometric tools for differential analysis on domains and manifolds

The Operator Hilbert Space $\mathcal{OH}_\infty$, Complex Interpolation and Tensor Norms Gilles Pisier, 1996 In the recently developed duality theory of operator spaces bounded operators are replaced by completely bounded ones isomorphism by complete isomorphisms and Banach spaces by operator spaces This allows for distinguishing between the various ways in which a given Banach space can be embedded isometrically into $\mathcal{B}$ $\mathcal{H}$ with $\mathcal{H}$ being Hilbert One of the main results is the observation that there is a central object in this class there is a unique self dual Hilbertian operator space which we denote by $\mathcal{OH}_\infty$ which seems to play the same central role in the category of operator spaces that Hilbert spaces play in the category of Banach spaces

CR-Geometry and Deformations of Isolated Singularities Ragnar-Olaf Buchweitz, John James Millson, 1997 In this paper we show how to compute the

parameter space X for the versal deformation of an isolated singularity V_0 under the assumptions $\dim V \geq 4$ $\text{depth } V \geq 3$ from the CR structure on a link M of the singularity We do this by showing that the space X is isomorphic to the space denoted here by K_M associated to M by Kuranishi in 1977 In fact we produce isomorphisms of the associated complete local rings by producing quasi isomorphisms of the controlling differential graded Lie algebras for the corresponding formal deformation theories

The Classification of Countable Homogeneous Directed Graphs and Countable Homogeneous n -tournaments Gregory L. Cherlin, 1998 In this book Ramsey theoretic methods introduced by Lachlan are applied to classify the countable homogeneous directed graphs This is an uncountable collection and this book presents the first explicit classification result covering an uncountable family The author's aim is to demonstrate the potential of Lachlan's method for systematic use

Abelian Galois Cohomology of Reductive Groups Mikhail Borovoi, 1998 In this volume a new function $H^2_{\text{ab}}(K, G)$ of abelian Galois cohomology is introduced from the category of connected reductive groups G over a field K of characteristic 0 to the category of abelian groups The abelian Galois cohomology and the abelianization map $\text{ab}_1: H^1(K, G) \rightarrow H^2_{\text{ab}}(K, G)$ are used to give a functorial almost explicit description of the usual Galois cohomology set $H^1(K, G)$ when K is a number field

Model Theory and Linear Extreme Points in the Numerical Radius Unit Ball Michael A. Dritschel, Hugo Jan Woerdeman, 1997 This memoir initiates a model theory based study of the numerical radius norm Guided by the abstract model theory of Jim Agler the authors propose a decomposition for operators that is particularly useful in understanding their properties with respect to the numerical radius norm Of the topics amenable to investigation with these tools the following are presented a complete description of the linear extreme points of the non matrix numerical radius unit ball several equivalent characterizations of matricial extremals in the unit ball that is those members which do not allow a nontrivial extension remaining in the unit ball and applications to numerical ranges of matrices including a complete parameterization of all matrices whose numerical ranges are closed disks

The Study of Minimax Inequalities and Applications to Economies and Variational Inequalities George Xian-Zhi Yuan, 1998 This book provides a unified treatment for the study of the existence of equilibria of abstract economics in topological vector spaces from the viewpoint of Ky Fan minimax inequalities which strongly depend on his infinite dimensional version of the classical Knaster Kuratowski and Mazurkiewicz Lemma KKM Lemma in 1961 Studied are applications of general system versions of minimax inequalities and generalized quasi variational inequalities and random abstract economies and its applications to the system of random quasi variational inequalities are given

Factorizing the Classical Inequalities Grahame Bennett, 1996 This memoir describes a new way of looking at the classical inequalities The most famous such results those of Hilbert Hardy and Copson may be interpreted as inclusion relationships $l^p \subset l^q$ between certain Banach sequence spaces the norm of the injection being the best

constant of the particular inequality The inequalities of Hilbert Hardy and Copson all share the same space italic capital Y That space alias italic ces italic p is central to many celebrated inequalities and thus is studied here in considerable detail

Stratifying Endomorphism Algebras Edward Cline,Brian Parshall,Leonard L. Scott,1996 This paper presents a systematic study of the relationships between the representation theories of italic capital R and italic capital A especially those involving actual or potential quasi hereditary structures on the latter algebra Our original motivation comes from the theory of Schur algebras work of Soergel on the Bernstein Gelfand Gelfand category script capital O and recent results of Dlab Heath Marko realizing certain endomorphism algebras as quasi hereditary algebras We synthesize common features of all these examples and go beyond them in a number of new directions *The Integral Manifolds of the Three Body Problem*

Christopher Keil McCord,Kenneth Ray Meyer,Quidong Wang,1998 The phase space of the spatial three body problem is an open subset in R^{18} Holding the ten classical integrals of energy center of mass linear and angular momentum fixed defines an eight dimensional manifold For fixed nonzero angular momentum the topology of this manifold depends only on the energy This volume computes the homology of this manifold for all energy values This table of homology shows that for negative energy the integral manifolds undergo seven bifurcations Four of these are the well known bifurcations due to central configurations and three are due to critical points at infinity This disproves Birkhoffs conjecture that the bifurcations occur only at central configurations *Axiomatic Stable Homotopy Theory* Mark Hovey,John Harold Palmieri,Neil P.

Strickland,1997 We define and investigate a class of categories with formal properties similar to those of the homotopy category of spectra This class includes suitable versions of the derived category of modules over a commutative ring or of comodules over a commutative Hopf algebra and is closed under Bousfield localization We study various notions of smallness questions about representability of co homology functors and various kinds of localization We prove theorems analogous to those of Hopkins and Smith about detection of nilpotence and classification of thick subcategories We define the class of Noetherian stable homotopy categories and investigate their special properties Finally we prove that a number of categories occurring in nature including those mentioned above satisfy our axioms **Reductive Subgroups of Exceptional**

Algebraic Groups Martin W. Liebeck,Gary M. Seitz,1996 The theory of simple algebraic groups is important in many areas of mathematics The authors of this book investigate the subgroups of certain types of simple algebraic groups and obtain a complete description of all those subgroups which are themselves simple This description is particularly useful in understanding centralizers of subgroups and restrictions of representations Some Connections between Isoperimetric

and Sobolev-type Inequalities Serguei Germanovich Bobkov,Christian Houdré,1997 For Borel probability measures on metric spaces this text studies the interplay between isoperimetric and Sobolev type inequalities In particular the question of finding optimal constants via isoperimetric quantities is explored Also given are necessary and sufficient conditions for the equivalence between the extremality of some sets in the isoperimetric problem and the validity of some analytic inequalities

The book devotes much attention to the probability distributions on the real line the normalized Lebesgue measure on the Euclidean spheres and the canonical Gaussian measure on the Euclidean space

Geometry of Loop Spaces and the Cobar Construction Hans J. Baues, 1980 The homology of iterated loop spaces capital Greek Omega superscript n italic X has always been a problem of major interest because it gives some insight into the homotopy of italic X among other things Therefore if italic X is a CW complex one has been interested in small CW models for capital Greek Omega superscript n italic X in order to compute the cellular chain complex The author proves a very general model theorem from which he can derive models in addition to very technical proofs of the model theorem for several other models Lebesgue Theory in the Bidual of $C(X)$ Samuel Kaplan, 1996 The present work is based upon our monograph The Bidual of italic capital C italic capital X italic capital X being compact We generalize to the bidual the theory of Lebesgue integration with respect to Radon measures on italic capital X of bounded functions The bidual of italic capital C italic capital X contains this space of bounded functions but is much more spacious so the body of results can be expected to be richer Finally we show that by projection onto the space of bounded functions the standard theory is obtained The Finite Irreducible Linear 2-Groups of Degree 4 Dane Laurence Flannery, 1997 This memoir contains a complete classification of the finite irreducible 2 subgroups of $GL(4, \mathbb{C})$ Specifically the author provides a parametrized list of representatives for the conjugacy classes of such groups where each representative is defined by generating a set of monomial matrices The problem is treated by a variety of techniques including elementary character theory a method for describing Hasse diagrams of submodule lattices and calculation of 2 cohomology by means of the Lyndon Hochschild Serre spectral sequence Related questions concerning isomorphism between the listed groups and Schur indices of their defining characters are also considered

Crossed Products of von Neumann Algebras by Equivalence Relations and Their Subalgebras Igor Fulman, 1997 In this book the author introduces and studies the construction of the crossed product of a von Neumann algebra This construction is the generalization of the construction of the crossed product of an abelian von Neumann algebra by an equivalence relation introduced by J Feldman and C C Moore Many properties of this construction are proved in the general case In addition the generalizations of the Spectral Theorem on Bimodules and of the theorem on dilations are proved

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