




# Cyclic Homology In Noncommutative Geometry

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## **Cyclic Homology In Noncommutative Geometry:**

Cyclic Homology in Non-Commutative Geometry Joachim Cuntz, Georges Skandalis, Boris Tsygan, 2013-03-14 Cyclic homology was introduced in the early eighties independently by Connes and Tsygan. They came from different directions. Connes wanted to associate homological invariants to  $K$  homology classes and to describe the index pairing with  $K$  theory in that way while Tsygan was motivated by algebraic  $K$  theory and Lie algebra cohomology. At the same time Karoubi had done work on characteristic classes that led him to study related structures without however arriving at cyclic homology properly speaking. Many of the principal properties of cyclic homology were already developed in the fundamental article of Connes and in the long paper by Feigin Tsygan. In the sequel cyclic homology was recognized quickly by many specialists as a new intriguing structure in homological algebra with unusual features. In a first phase it was tried to treat this structure as well as possible within the traditional framework of homological algebra. The cyclic homology groups were computed in many examples and new important properties such as product structures, excision for  $H$  unital ideals or connections with cyclic objects and simplicial topology were established. An excellent account of the state of the theory after that phase is given in the book of Loday.

Cyclic Homology in Non-Commutative Geometry Joachim Cuntz, Georges Skandalis, Boris Tsygan, 2014-01-15 Contributions by three authors treat aspects of noncommutative geometry that are related to cyclic homology. The authors give rather complete accounts of cyclic theory from different points of view. The connections between bivariant  $K$  theory and cyclic theory via generalized Chern characters are discussed in detail. Cyclic theory is the natural setting for a variety of general abstract index theorems. A survey of such index theorems is given and the concepts and ideas involved in these theorems are explained.

Cyclic Cohomology at 40: Achievements and Future Prospects A. Connes, C. Consani, B. I. Dundas, M. Khalkhali, H. Moscovici, 2023-02-23 This volume contains the proceedings of the virtual conference on Cyclic Cohomology at 40: Achievements and Future Prospects held from September 27 to October 1, 2021 and hosted by the Fields Institute for Research in Mathematical Sciences, Toronto, ON, Canada. Cyclic cohomology, since its discovery forty years ago in noncommutative differential geometry, has become a fundamental mathematical tool with applications in domains as diverse as analysis, algebraic  $K$  theory, algebraic geometry, arithmetic geometry, solid state physics, and quantum field theory. The reader will find survey articles providing a user-friendly introduction to applications of cyclic cohomology in such areas as higher categorical algebra, Hopf algebra symmetries, de Rham-Witt complex, quantum physics, etc., in which cyclic homology plays the role of a unifying theme. The researcher will find frontier research articles in which the cyclic theory provides a computational tool of great relevance. In particular, in analysis, cyclic cohomology index formulas capture the higher invariants of manifolds where the group symmetries are extended to Hopf algebra actions, and where Lie algebra cohomology is greatly extended to the cyclic cohomology of Hopf algebras, which becomes the natural receptacle for characteristic classes. In algebraic topology, the cyclotomic structure obtained using the cyclic subgroups of the circle action on topological Hochschild

homology gives rise to remarkably significant arithmetic structures intimately related to crystalline cohomology through the de Rham Witt complex Fontaine's theory and the Fargues Fontaine curve

**K-theory and Noncommutative Geometry** Guillermo Cortiñas, 2008 Since its inception 50 years ago K theory has been a tool for understanding a wide ranging family of mathematical structures and their invariants topological spaces rings algebraic varieties and operator algebras are the dominant examples The invariants range from characteristic classes in cohomology determinants of matrices Chow groups of varieties as well as traces and indices of elliptic operators Thus K theory is notable for its connections with other branches of mathematics Noncommutative geometry develops tools which allow one to think of noncommutative algebras in the same footing as commutative ones as algebras of functions on noncommutative spaces The algebras in question come from problems in various areas of mathematics and mathematical physics typical examples include algebras of pseudodifferential operators group algebras and other algebras arising from quantum field theory To study noncommutative geometric problems one considers invariants of the relevant noncommutative algebras These invariants include algebraic and topological K theory and also cyclic homology discovered independently by Alain Connes and Boris Tsygan which can be regarded both as a noncommutative version of de Rham cohomology and as an additive version of K theory There are primary and secondary Chern characters which pass from K theory to cyclic homology These characters are relevant both to noncommutative and commutative problems and have applications ranging from index theorems to the detection of singularities of commutative algebraic varieties The contributions to this volume represent this range of connections between K theory noncommutative geometry and other branches of mathematics

*Cyclic Cohomology and Noncommutative Geometry* Joachim J. R. Cuntz, Masoud Khalkhali, 1997-01-01 Noncommutative geometry is a new field that is among the great challenges of present day mathematics Its methods allow one to treat noncommutative algebras such as algebras of pseudodifferential operators group algebras or algebras arising from quantum field theory on the same footing as commutative algebras that is as spaces Applications range over many fields of mathematics and mathematical physics This volume contains the proceedings of the workshop on Cyclic Cohomology and Noncommutative Geometry held at The Fields Institute Waterloo ON in June 1995 The workshop was part of the program for the special year on operator algebras and its applications

**Cyclic Homology** Jean-Louis Loday, 2013-06-29 This book is a comprehensive study of cyclic homology theory together with its relationship with Hochschild homology de Rham cohomology  $S^1$  equivariant homology the Chern character Lie algebra homology algebraic K theory and non commutative differential geometry Though conceived as a basic reference on the subject many parts of this book are accessible to graduate students

**Noncommutative Geometry and Number Theory** Caterina Consani, Matilde Marcolli, 2007-12-18 In recent years number theory and arithmetic geometry have been enriched by new techniques from noncommutative geometry operator algebras dynamical systems and K Theory This volume collects and presents up to date research topics in arithmetic and noncommutative geometry and ideas from

physics that point to possible new connections between the fields of number theory algebraic geometry and noncommutative geometry The articles collected in this volume present new noncommutative geometry perspectives on classical topics of number theory and arithmetic such as modular forms class field theory the theory of reductive  $p$ -adic groups Shimura varieties the local  $L$ -factors of arithmetic varieties They also show how arithmetic appears naturally in noncommutative geometry and in physics in the residues of Feynman graphs in the properties of noncommutative tori and in the quantum Hall effect

**Basic Noncommutative Geometry** Masoud Khalkhali, 2009 Basic Noncommutative Geometry provides an introduction to noncommutative geometry and some of its applications The book can be used either as a textbook for a graduate course on the subject or for self study It will be useful for graduate students and researchers in mathematics and theoretical physics and all those who are interested in gaining an understanding of the subject One feature of this book is the wealth of examples and exercises that help the reader to navigate through the subject While background material is provided in the text and in several appendices some familiarity with basic notions of functional analysis algebraic topology differential geometry and homological algebra at a first year graduate level is helpful Developed by Alain Connes since the late 1970s noncommutative geometry has found many applications to long standing conjectures in topology and geometry and has recently made headways in theoretical physics and number theory The book starts with a detailed description of some of the most pertinent algebra geometry correspondences by casting geometric notions in algebraic terms then proceeds in the second chapter to the idea of a noncommutative space and how it is constructed The last two chapters deal with homological tools cyclic cohomology and Connes Chern characters in  $K$ -theory and  $K$ -homology culminating in one commutative diagram expressing the equality of topological and analytic index in a noncommutative setting Applications to integrality of noncommutative topological invariants are given as well Publisher's description

**Topics in Non-Commutative Geometry** Yuri I. Manin, 2014-07-14 There is a well known correspondence between the objects of algebra and geometry a space gives rise to a function algebra a vector bundle over the space corresponds to a projective module over this algebra cohomology can be read off the de Rham complex and so on In this book Yuri Manin addresses a variety of instances in which the application of commutative algebra cannot be used to describe geometric objects emphasizing the recent upsurge of activity in studying noncommutative rings as if they were function rings on noncommutative spaces Manin begins by summarizing and giving examples of some of the ideas that led to the new concepts of noncommutative geometry such as Connes noncommutative de Rham complex supergeometry and quantum groups He then discusses supersymmetric algebraic curves that arose in connection with superstring theory examines superhomogeneous spaces their Schubert cells and superanalogues of Weyl groups and provides an introduction to quantum groups This book is intended for mathematicians and physicists with some background in Lie groups and complex geometry Originally published in 1991 The Princeton Legacy Library uses the latest print on demand technology to again make available previously out of print books from the

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**Noncommutative Geometry, Arithmetic, and Related Topics** Caterina Consani, Alain Connes, 2011 Mathematics Institute these essays collectively provide mathematicians and physicists with a comprehensive resource on the topic

Local and Analytic Cyclic Homology Ralf Meyer, 2007 Periodic cyclic homology is a homology theory for non commutative algebras that plays a similar role in non commutative geometry as de Rham cohomology for smooth manifolds While it produces good results for algebras of smooth or polynomial functions it fails for bigger algebras such as most Banach algebras or C algebras Analytic and local cyclic homology are variants of periodic cyclic homology that work better for such algebras In this book the author develops and compares these theories emphasizing their homological properties This includes the excision theorem invariance under passage to certain dense subalgebras a Universal Coefficient Theorem that relates them to K theory and the Chern Connes character for K theory and K homology The cyclic homology theories studied in this text require a good deal of functional analysis in bornological vector spaces which is supplied in the first chapters The focal points here are the relationship with inductive systems and the functional calculus in non commutative bornological algebras Some chapters are more elementary and independent of the rest of the book and will be of interest to researchers and students working on functional analysis and its applications

Advances in Noncommutative Geometry Ali Chamseddine, Caterina Consani, Nigel Higson, Masoud Khalkhali, Henri Moscovici, Guoliang Yu, 2020-01-13 This authoritative volume in honor of Alain Connes the foremost architect of Noncommutative Geometry presents the state of the art in the subject The book features an amalgam of invited survey and research papers that will no doubt be accessed read and referred to for several decades to come The pertinence and potency of new concepts and methods are concretely illustrated in each contribution Much of the content is a direct outgrowth of the Noncommutative Geometry conference held March 23 April 7 2017 in Shanghai China The conference covered the latest research and future areas of potential exploration surrounding topology and physics number theory as well as index theory and its ramifications in geometry

**Cyclic Cohomology and Noncommutative Geometry**, 2012

**Noncommutative Geometry** Alain Connes, 1994-11-22 This English version of the path breaking French book on this subject gives the definitive treatment of the revolutionary approach to measure theory geometry and mathematical physics developed by Alain Connes Profusely illustrated and invitingly written this book is ideal for anyone who wants to know what noncommutative geometry is what it can do or how it can be used in various areas of mathematics quantization and elementary particles and fields First full treatment of the subject and its applications Written by the pioneer of this field Broad applications in mathematics Of interest across most fields Ideal as an introduction and survey Examples treated include the space of Penrose tilings the space of leaves of a foliation the space of

irreducible unitary representations of a discrete group the phase space in quantum mechanics the Brillouin zone in the quantum Hall effect A model of space time

**Noncommutative Geometry, Quantum Fields and Motives** Alain Connes, Matilde Marcolli, 2019-03-13 The unifying theme of this book is the interplay among noncommutative geometry physics and number theory The two main objects of investigation are spaces where both the noncommutative and the motivic aspects come to play a role space time where the guiding principle is the problem of developing a quantum theory of gravity and the space of primes where one can regard the Riemann Hypothesis as a long standing problem motivating the development of new geometric tools The book stresses the relevance of noncommutative geometry in dealing with these two spaces The first part of the book deals with quantum field theory and the geometric structure of renormalization as a Riemann Hilbert correspondence It also presents a model of elementary particle physics based on noncommutative geometry The main result is a complete derivation of the full Standard Model Lagrangian from a very simple mathematical input Other topics covered in the first part of the book are a noncommutative geometry model of dimensional regularization and its role in anomaly computations and a brief introduction to motives and their conjectural relation to quantum field theory The second part of the book gives an interpretation of the Weil explicit formula as a trace formula and a spectral realization of the zeros of the Riemann zeta function This is based on the noncommutative geometry of the ad le class space which is also described as the space of commensurability classes of  $\mathbb{Q}$  lattices and is dual to a noncommutative motive endomotive whose cyclic homology provides a general setting for spectral realizations of zeros of  $L$  functions The quantum statistical mechanics of the space of  $\mathbb{Q}$  lattices in one and two dimensions exhibits spontaneous symmetry breaking In the low temperature regime the equilibrium states of the corresponding systems are related to points of classical moduli spaces and the symmetries to the class field theory of the field of rational numbers and of imaginary quadratic fields as well as to the automorphisms of the field of modular functions The book ends with a set of analogies between the noncommutative geometries underlying the mathematical formulation of the Standard Model minimally coupled to gravity and the moduli spaces of  $\mathbb{Q}$  lattices used in the study of the zeta function

*From Differential Geometry to Non-commutative Geometry and Topology* Neculai S. Teleman, 2019-11-10 This book aims to provide a friendly introduction to non commutative geometry It studies index theory from a classical differential geometry perspective up to the point where classical differential geometry methods become insufficient It then presents non commutative geometry as a natural continuation of classical differential geometry It thereby aims to provide a natural link between classical differential geometry and non commutative geometry The book shows that the index formula is a topological statement and ends with non commutative topology

On the (co)homology of Non-commutative Toroidal Orbifolds Safdar Qudus, 2013 Noncommutative torus algebra was studied in the early 80 s as a fundamental example of noncommutative geometry Connes calculated its cyclic and Hochschild cohomology In this thesis we study noncommutative toroidal orbifolds generated by actions of finite subgroups of  $SL(2, \mathbb{Z})$  on a noncommutative

torus algebra In the first part we calculate the Hochschild and cyclic homology of special characters omitted for all finite subgroups special characters omitted In the second part we analyse the cohomology of these algebras and compute the Chern Connes pairing between the  $K_0$  elements of special characters omitted and explicit cocycles discovered in our calculations In the third part we discuss some partial results and conjectures about the corresponding smooth orbifolds

**Elements of Noncommutative Geometry** José M. Gracia-Bondía, Joseph C. Varilly, Hector Figueroa, 2000-10-23 This book is an introduction to the language and techniques of noncommutative geometry at a level suitable for graduate students and also provides sufficient detail to be useful to physicists and mathematicians wishing to enter this rapidly growing field It may also serve as a reference text on several topics that are relevant to noncommutative geometry BOOK JACKET

*Asymptotic Cyclic Cohomology* Michael Puschnigg, 2006-11-14 The aim of cyclic cohomology theories is the approximation of  $K$  theory by cohomology theories defined by natural chain complexes The basic example is the approximation of topological  $K$  theory by de Rham cohomology via the classical Chern character A cyclic cohomology theory for operator algebras is developed in the book based on Connes work on noncommutative geometry Asymptotic cyclic cohomology faithfully reflects the basic properties and features of operator  $K$  theory It thus becomes a natural target for a Chern character The central result of the book is a general Grothendieck Riemann Roch theorem in noncommutative geometry with values in asymptotic cyclic homology Besides this the book contains numerous examples and calculations of asymptotic cyclic cohomology groups

Elliptic Theory and Noncommutative Geometry Vladimir E. Nazaykinskiy, A. Yu. Savin, B. Yu. Sternin, 2008-06-30 This comprehensive yet concise book deals with nonlocal elliptic differential operators These are operators whose coefficients involve shifts generated by diffeomorphisms of the manifold on which the operators are defined This is the first book featuring a consistent application of methods of noncommutative geometry to the index problem in the theory of nonlocal elliptic operators To make the book self contained the authors have included necessary geometric material

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