

Background Lecture: Grothendieck Existence Theorem for coherent sheaves.

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The topic of this lecture is the Grothendieck Existence theorem (EGA, Chapter III, Theorem 5.1.4). The statement there is rather technical so I propose that in your presentation you try to keep it as down to earth as possible. To this end, I suggest presenting the above theorem without using formal schemes, and assuming that $f : X \rightarrow Y$ is proper and that A is complete local. The statement then becomes the following.

Let $\mathfrak{m} \subset A$ be the maximal ideal and for an integer n let A_n denote A/\mathfrak{m}^{n+1} , and let X_n denote $X \times_{\mathrm{Spec}(A)} \mathrm{Spec}(A_n)$. Let $\varprojlim \mathrm{Coh}(X_n)$ denote the category of data $(F_n, \iota_n)_{n \geq 0}$, where F_n is a coherent sheaf on X_n and $\iota_n : F_{n+1}|_{X_n} \rightarrow F_n$ is an isomorphism of coherent sheaves on X_n .

The most commonly used version of the Grothendieck Existence Theorem is then the following:

Theorem 1. *The reduction functor*

$$(\text{coherent sheaves on } X) \rightarrow \varprojlim \mathrm{Coh}(X_n)$$

is an equivalence of categories.

In the context of the workshop, an important consequence of this theorem is the following (please try to fit this in if possible):

Theorem 2. *Let A , A_n , etc. be as above. Suppose given for every n a closed subscheme $Z_n \subset \mathbb{P}_{A_n}^r$ (for some fixed r) flat over $\mathrm{Spec}(A_n)$ such that $Z_{n+1} \times_{\mathrm{Spec}(A_{n+1})} \mathrm{Spec}(A_n) \subset \mathbb{P}_{A_n}^r$ is equal to Z_n for all $n \geq 0$. Then there exists a unique closed subscheme $Z \subset \mathbb{P}_A^r$ inducing the Z_n .*

This theorem is obtained by applying the preceding theorem to the ideal sheaves defining the Z_n .

Grauert's Theorem On Direct Images Of Coherent Sheaves

Birger Iversen



Grauert's Theorem On Direct Images Of Coherent Sheaves:

Grauert's Theorem on Direct Images of Coherent Sheaves Raghavan Narasimhan, 1971 **Complex Manifolds** Steven Bell, J.-L. Brylinski, A.T. Huckleberry, R. Narasimhan, C. Okonek, Georg Schumacher, A. Van de Ven, S. Zucker, 1997-12-11 The articles in this volume were written to commemorate Reinhold Remmert's 60th birthday in June 1990. They are surveys meant to facilitate access to some of the many aspects of the theory of complex manifolds and demonstrate the interplay between complex analysis and many other branches of mathematics: algebraic geometry, differential topology, representations of Lie groups and mathematical physics being only the most obvious of these branches. Each of these articles should serve not only to describe the particular circle of ideas in complex analysis with which it deals but also as a guide to the many mathematical ideas related to its theme.

Coherent Analytic Sheaves H. Grauert, R. Remmert, 2012-12-06 Je mehr ich über die Prinzipien der Funktionentheorie nachdenke und ich tue dies unablässig, um so fester wird meine Überzeugung, dass diese auf dem Fundamente algebraischer Wahrheiten aufgebaut werden muss. WEIERSTRASS Glaubensbekenntnis 1875 Math Werke II p 235 1. Sheaf Theory is a general tool for handling questions which involve local solutions and global patching. La notion de faisceau s'introduit parce qu'il s'agit de passer de données locales à l'étude de propriétés globales. CAR p 622 The methods of sheaf theory are algebraic. The notion of a sheaf was first introduced in 1946 by J. LERAY in a short note *Année de l'homologie d'une représentation* C. R. Acad. Sci. 222 1366-68. Of course sheaves had occurred implicitly much earlier in mathematics. The Monogene analytische Functionen which K. WEIERSTRASS glued together from Functionelemente durch analytische Fortsetzung are simply the connected components of the sheaf of germs of holomorphic functions on a RIEMANN surface and the *idéaux de domaines indéterminés* basic in the work of K. OKA since 1948. cf. OKA p 84-107 are just sheaves of ideals of germs of holomorphic functions. Highly original contributions to mathematics are usually not appreciated at first. Fortunately H. CARTAN immediately realized the great importance of LERAY's new abstract concept of a sheaf. In the polycopied notes of his Seminaire at the ENS.

The Riemann Legacy Krzysztof Maurin, 2013-04-17 very small domain environment affects through analytic continuation the whole of Riemann surface or analytic manifold. Riemann was a master at applying this principle and also the first who noticed and emphasized that a meromorphic function is determined by its singularities. Therefore he is rightly regarded as the father of the huge theory of singularities which is developing so quickly and whose importance also for physics can hardly be overestimated. Amazing and mysterious for our cognition is the role of Euclidean space. Even today many philosophers believe following Kant that real space is Euclidean and other spaces being abstract constructs of mathematicians should not be called spaces. The thesis is no longer tenable: the whole of physics testifies to that. Nevertheless there is a grain of truth in the 3rd prejudice: 3-dimensional Euclidean space is special in a particular way, pleasantly familiar to us in it. We also we mathematicians feel particularly confident and move with a sense of greater safety than in non-Euclidean spaces. For this reason perhaps Riemann space M stands out among the multitude of

interesting geometries For it is 1 Locally Euclidean i e M is a differentiable manifold whose tangent spaces $T_x M$ are equipped with Euclidean metric U_x 2 Every submanifold M of Euclidean space E is equipped with Riemann natural metric inherited from the metric of E and it is well known how often such submanifolds are used in mechanics e g the spherical pendulum

Several Complex Variables VII H. Grauert, Thomas Peternell, R. Remmert, 2013-03-09 Of making many books there is no end and much study is a weariness of the flesh Eccl 12 12 1 In the beginning Riemann created the surfaces The periods of integrals of abelian differentials on a compact surface of genus g immediately attach a g dimensional complex torus to X If $g \geq 2$ the moduli space of X depends on $3g - 3$ complex parameters Thus problems in one complex variable lead from the very beginning to studies in several complex variables Complex tori and moduli spaces are complex manifolds i e Hausdorff spaces with local complex coordinates $Z^1 \times \dots \times Z^n$ holomorphic functions are locally those functions which are holomorphic in these coordinates th In the second half of the 19 century classical algebraic geometry was born in Italy The objects are sets of common zeros of polynomials Such sets are of finite dimension but may have singularities forming a closed subset of lower dimension outside of the singular locus these zero sets are complex manifolds **Applications of Sheaves** M. P.

Fourman, C. J. Mulvey, D. S. Scott, 2006-11-15 **Analytic Functions of Several Complex Variables** Robert Clifford Gunning, Hugo Rossi, 2009 The theory of analytic functions of several complex variables enjoyed a period of remarkable development in the middle part of the twentieth century This title intends to provide an extensive introduction to the Oka Cartan theory and some of its applications and to the general theory of analytic spaces **Spectral Decompositions and Analytic Sheaves** Jörg Eschmeier, Mihai Putinar, 1996 Rapid developments in multivariable spectral theory have led to important and fascinating results which also have applications in other mathematical disciplines In this book classical results from the cohomology theory of Banach algebras multidimensional spectral theory and complex analytic geometry have been freshly interpreted using the language of homological algebra It has also been used to give in sights into new developments in the spectral theory of linear operators Various concepts from function theory and complex analytic geometry are drawn together and used to give a new approach to concrete spectral computations The advantages of this approach are illustrated by a variety of examples unexpected applications and conceptually new ideas which should stimulate further research

Complex Analysis F. Gherardelli, 2011-06-04 A Andreotti Nine lectures on complex analysis J J Kohn Propagations of singularities for the Cauchy Riemann equations Yum Tong Siu The mixed case of the direct image theorem and its applications *A Panorama of Pure Mathematics, As Seen by N. Bourbaki*, 1982-08-18 A Panorama of Pure Mathematics As Seen by N Bourbaki *Introduction to Hodge Theory* José Bertin, 2002 Hodge theory originated as an application of harmonic theory to the study of the geometry of compact complex manifolds The ideas have proved to be quite powerful leading to fundamentally important results throughout algebraic geometry This book consists of expositions of various aspects of modern Hodge theory Its purpose is to provide the nonexpert reader with a precise idea of the current status of

the subject The three chapters develop distinct but closely related subjects L 2 Hodge theory and vanishing theorems Frobenius and Hodge degeneration variations of Hodge structures and mirror symmetry The techniques employed cover a wide range of methods borrowed from the heart of mathematics elliptic PDE theory complex differential geometry algebraic geometry in characteristic p cohomological and sheaf theoretic methods deformation theory of complex varieties Calabi Yau manifolds singularity theory etc A special effort has been made to approach the various themes from their most natural starting points Each of the three chapters is supplemented with a detailed introduction and numerous references The reader will find precise statements of quite a number of open problems that have been the subject of active research in recent years The reader should have some familiarity with differential and algebraic geometry with other prerequisites varying by chapter The book is suitable as an accompaniment to a second course in algebraic geometry

Steady Gradient Kähler-Ricci Solitons on Crepant Resolutions of Calabi-Yau Cones Ronan J. Conlon, Alix Deruelle, 2025-04-02 View the abstract

Hodge Theory Eduardo Cattani, Fouad El Zein, Phillip A. Griffiths, Lê Dũng Tráng, 2014-07-21 This book provides a comprehensive and up to date introduction to Hodge theory one of the central and most vibrant areas of contemporary mathematics from leading specialists on the subject The topics range from the basic topology of algebraic varieties to the study of variations of mixed Hodge structure and the Hodge theory of maps Of particular interest is the study of algebraic cycles including the Hodge and Bloch Beilinson Conjectures Based on lectures delivered at the 2010 Summer School on Hodge Theory at the ICTP in Trieste Italy the book is intended for a broad group of students and researchers The exposition is as accessible as possible and doesn't require a deep background At the same time the book presents some topics at the forefront of current research The book is divided between introductory and advanced lectures The introductory lectures address Kähler manifolds variations of Hodge structure mixed Hodge structures the Hodge theory of maps period domains and period mappings algebraic cycles up to and including the Bloch Beilinson conjecture and Chow groups sheaf cohomology and a new treatment of Grothendieck's algebraic de Rham theorem The advanced lectures address a Hodge theoretic perspective on Shimura varieties the spread philosophy in the study of algebraic cycles absolute Hodge classes including a new self contained proof of Deligne's theorem on absolute Hodge cycles and variation of mixed Hodge structures The contributors include Patrick Brosnan James Carlson Eduardo Cattani François Charles Mark Andrea de Cataldo Fouad El Zein Mark L Green Phillip A Griffiths Matt Kerr Lê Dũng Tráng Luca Migliorini Jacob P Murre Christian Schnell and Loring W Tu

Commutative Harmonic Analysis III V.P. Havin, N.K. Nikol'skij, 2012-12-06 The theory of generalized functions is a general method that makes it possible to consider and compute divergent integrals sum divergent series differentiate discontinuous functions perform the operation of integration to any complex power and carry out other such operations that are impossible in classical analysis Such operations are widely used in mathematical physics and the theory of differential equations where the ideas of generalized functions first arose in other areas of analysis and beyond The point of departure for this theory is to

regard a function not as a mapping of point sets but as a linear functional defined on smooth densities. This route leads to the loss of the concept of the value of function at a point and also the possibility of multiplying functions but it makes it possible to perform differentiation an unlimited number of times. The space of generalized functions of finite order is the minimal extension of the space of continuous functions in which coordinate differentiations are defined everywhere. In this sense the theory of generalized functions is a development of all of classical analysis in particular harmonic analysis and is to some extent the perfection of it. The more general theories of ultradistributions or generalized functions of infinite order make it possible to consider infinite series of generalized derivatives of continuous functions.

Cohomology of Sheaves Birger Iversen, 2012-12-06 This text exposes the basic features of cohomology of sheaves and its applications. The general theory of sheaves is very limited and no essential result is obtainable without turning to particular classes of topological spaces. The most satisfactory general class is that of locally compact spaces and it is the study of such spaces which occupies the central part of this text. The fundamental concepts in the study of locally compact spaces is cohomology with compact support and a particular class of sheaves the so called soft sheaves. This class plays a double role as the basic vehicle for the internal theory and is the key to applications in analysis. The basic example of a soft sheaf is the sheaf of smooth functions on n or more generally on any smooth manifold. A rather large effort has been made to demonstrate the relevance of sheaf theory in even the most elementary analysis. This process has been reversed in order to base the fundamental calculations in sheaf theory on elementary analysis.

Multivariable Operator Theory Ernst Albrecht, Raúl Curto, Michael Hartz, Mihai Putinar, 2023-12-21 Over the course of his distinguished career Jörg Eschmeier made a number of fundamental contributions to the development of operator theory and related topics. The chapters in this volume compiled in his memory are written by distinguished mathematicians and pay tribute to his many significant and lasting achievements.

Proceedings Of The International Congress Of Mathematicians 2018 (Icm 2018) (In 4 Volumes) Boyan Sirakov, Paulo Ney De Souza, Marcelo Viana, 2019-02-27 The Proceedings of the ICM publishes the talks by invited speakers at the conference organized by the International Mathematical Union every 4 years. It covers several areas of Mathematics and it includes the Fields Medal and Nevanlinna Gauss and Leelavati Prizes and the Chern Medal laudations.

Higher Multiplicities and Almost Free Divisors and Complete Intersections James Damon, 1996 Almost free divisors and complete intersections form a general class of nonisolated hypersurface and complete intersection singularities. They also include discriminants of mappings, bifurcation sets and certain types of arrangements of hyperplanes such as Coxeter arrangements and generic arrangements. Associated to the singularities of this class is a singular Milnor fibration which has the same homotopy properties as the Milnor fibration for isolated singularities. This memoir deduces topological properties of singularities in a number of situations including complements of hyperplane arrangements, various nonisolated complete intersections, nonlinear arrangements of hypersurfaces, functions on discriminants, singularities defined by compositions of functions and bifurcation sets.

Encyclopedic Dictionary of Mathematics Nihon Sūgakkai, 1993 V 1 A N v 2 O Z Apendices and indexes *Complex Analytic Cycles I* Daniel Barlet, Jón Magnússon, 2020-01-03 The book consists of a presentation from scratch of cycle space methodology in complex geometry Applications in various contexts are given A significant portion of the book is devoted to material which is important in the general area of complex analysis In this regard a geometric approach is used to obtain fundamental results such as the local parameterization theorem Lelong's Theorem and Remmert's direct image theorem Methods involving cycle spaces have been used in complex geometry for some forty years The purpose of the book is to systematically explain these methods in a way which is accessible to graduate students in mathematics as well as to research mathematicians After the background material which is presented in the initial chapters families of cycles are treated in the last most important part of the book Their topological aspects are developed in a systematic way and some basic important applications of analytic families of cycles are given The construction of the cycle space as a complex space along with numerous important applications is given in the second volume The present book is a translation of the French version that was published in 2014 by the French Mathematical Society

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