



# Deformation Theory

**Murray Gerstenhaber**



## **Deformation Theory:**

*Deformation Theory* Robin Hartshorne, 2009-11-12 In the fall semester of 1979 I gave a course on deformation theory at Berkeley My goal was to understand completely Grothendieck's local study of the Hilbert scheme using the cohomology of the normal bundle to characterize the Zariski tangent space and the obstructions to deformations At the same time I started writing lecture notes for the course However the writing project soon foundered as the subject became more intricate and the result was no more than one of a projected thirteen sections corresponding roughly to sections 1 2 3 5 6 of the present book These handwritten notes circulated quietly for many years until David Eisenbud urged me to complete them and at the same time without consulting me mentioned to an editor at Springer You know Robin has these notes on deformation theory which could easily become a book When asked by Springer if I would write such a book I immediately refused since I was then planning another book on space curves But on second thought I decided this was after all a worthy project and that by writing I might finally understand the subject myself So during 2004 I expanded the old notes into a rough draft which I used to teach a course during the spring semester of 2005 Those notes rewritten once more with the addition of exercises form the book you are now reading My goal in this book is to introduce the main ideas of deformation theory in algebraic geometry and to illustrate their use in a number of typical situations

**Deformations of Algebraic Schemes** Edoardo Sernesi, 2007-04-20 In one sense deformation theory is as old as algebraic geometry itself this is because all algebraic geometric objects can be deformed by suitably varying the coefficients of their defining equations and this has of course always been known by the classical geometers Nevertheless a correct understanding of what deforming means leads into the technically most difficult parts of our discipline It is fair to say that such technical obstacles have had a vast impact on the crisis of the classical language and on the development of the modern one based on the theory of schemes and on cohomological methods The modern point of view originates from the seminal work of Kodaira and Spencer on small deformations of complex analytic manifolds and from its formalization and translation into the language of schemes given by Grothendieck I will not recount the history of the subject here since good surveys already exist e.g. [27, 138, 145, 168] Today while this area is rapidly developing a self-contained text covering the basic results of what we can call classical deformation theory seems to be missing Moreover a number of technicalities and well known facts are scattered in a vast literature as folklore sometimes with proofs available only in the complex analytic category This book is an attempt to fill such a gap at least partially

*Deformation Theory* Robin Hartshorne, 2009-11-13 **Deformation Theory of Algebras and Their Diagrams** Martin Markl, 2012 This book brings together both the classical and current aspects of deformation theory The presentation is mostly self-contained assuming only basic knowledge of commutative algebra homological algebra and category theory In the interest of readability some technically complicated proofs have been omitted when a suitable reference was available The relation between the uniform continuity of algebraic maps and topologized tensor products is

explained in detail however as this subject does not seem to be commonly known and the literature is scarce The exposition begins by recalling Gerstenhaber's classical theory for associative algebras The focus then shifts to a homotopy invariant setup of Maurer Cartan moduli spaces As an application Kontsevich's approach to deformation quantization of Poisson manifolds is reviewed Then after a brief introduction to operads a strongly homotopy Lie algebra governing deformations of diagrams of algebras of a given type is described followed by examples and generalizations

**Deformation Theory of Algebras and Structures and Applications** Michiel Hazewinkel, Murray Gerstenhaber, 2012-12-06 This volume is a result of a meeting which took place in June 1986 at Il Ciocco in Italy entitled Deformation theory of algebras and structures and applications It appears somewhat later than is perhaps desirable for a volume resulting from a summer school In return it contains a good many results which were not yet available at the time of the meeting In particular it is now abundantly clear that the Deformation theory of algebras is indeed central to the whole philosophy of deformations perturbations stability This is one of the main results of the 254 page paper below practically a book in itself by Gerstenhaber and Shack entitled Algebraic cohomology and deformation theory Two of the main philosophical methodological pillars on which deformation theory rests are the following Pure To study a highly complicated object it is fruitful to study the ways in which it can arise as a limit of a family of simpler objects the unraveling of complicated structures Applied If a mathematical model is to be applied to the real world there will usually be such things as coefficients which are imperfectly known Thus it is important to know how the behaviour of a model changes as it is perturbed deformed

**Introduction to Singularities and Deformations** Gert-Martin Greuel, Christoph Lossen, Eugenio I. Shustin, 2007-02-23 Singularity theory is a young rapidly growing topic with connections to algebraic geometry complex analysis commutative algebra representations theory Lie groups theory and topology and many applications in the natural and technical sciences This book presents the basic singularity theory of analytic spaces including local deformation theory and the theory of plane curve singularities It includes complete proofs

Deformation Theory Robin Hartshorne, 2009-12-10 The basic problem of deformation theory in algebraic geometry involves watching a small deformation of one member of a family of objects such as varieties or subschemes in a fixed space or vector bundles on a fixed scheme In this new book Robin Hartshorne studies first what happens over small infinitesimal deformations and then gradually builds up to more global situations using methods pioneered by Kodaira and Spencer in the complex analytic case and adapted and expanded in algebraic geometry by Grothendieck The author includes numerous exercises as well as important examples illustrating various aspects of the theory This text is based on a graduate course taught by the author at the University of California Berkeley

**Global Logarithmic Deformation Theory** Simon Felten, 2025-09-26 This monograph provides the first systematic treatment of the logarithmic Bogomolov Tian Todorov theorem Providing a new perspective on classical results this theorem guarantees that logarithmic Calabi Yau spaces have unobstructed deformations Part I develops the deformation theory of curved Batalin-Vilkovisky calculi and the abstract

unobstructedness theorems which hold in quasi perfect curved Batalin Vilkovisky calculi Part II presents background material on logarithmic geometry families of singular log schemes and toroidal crossing spaces Part III establishes the connection between the geometric deformation theory of log schemes and the purely algebraic deformation theory of curved Batalin Vilkovisky calculi The last Part IV explores applications to the Gross Siebert program to deformation problems of log smooth and log toroidal log Calabi Yau spaces as well as to deformations of line bundles and deformations of log Fano spaces Along the way a comprehensive introduction to the logarithmic geometry used in the Gross Siebert program is given This monograph will be useful for graduate students and researchers working in algebraic and complex geometry in particular in the study of deformation theory degenerations moduli spaces and mirror symmetry

**Deformation Theory of Plasticity** Robert Millard Jones,2009 **Lie Methods in Deformation Theory** Marco Manetti,2022-08-01 This book furnishes a comprehensive treatment of differential graded Lie algebras L infinity algebras and their use in deformation theory We believe it is the first textbook devoted to this subject although the first chapters are also covered in other sources with a different perspective Deformation theory is an important subject in algebra and algebraic geometry with an origin that dates back to Kodaira Spencer Kuranishi Gerstenhaber and Grothendieck In the last 30 years a new approach based on ideas from rational homotopy theory has made it possible not only to solve long standing open problems but also to clarify the general theory and to relate apparently different features This approach works over a field of characteristic 0 and the central role is played by the notions of differential graded Lie algebra L infinity algebra and Maurer Cartan equations The book is written keeping in mind graduate students with a basic knowledge of homological algebra and complex algebraic geometry as utilized for instance in the book by K Kodaira Complex Manifolds and Deformation of Complex Structures Although the main applications in this book concern deformation theory of complex manifolds vector bundles and holomorphic maps the underlying algebraic theory also applies to a wider class of deformation problems and it is a prerequisite for anyone interested in derived deformation theory Researchers in algebra algebraic geometry algebraic topology deformation theory and noncommutative geometry are the major targets for the book

**Noncommutative Deformation Theory** Eivind Eriksen,Olav Arnfinn Laudal,Arvid Siqveland,2017-09-19 Noncommutative Deformation Theory is aimed at mathematicians and physicists studying the local structure of moduli spaces in algebraic geometry This book introduces a general theory of noncommutative deformations with applications to the study of moduli spaces of representations of associative algebras and to quantum theory in physics An essential part of this theory is the study of obstructions of liftings of representations using generalised matrix Massey products Suitable for researchers in algebraic geometry and mathematical physics interested in the workings of noncommutative algebraic geometry it may also be useful for advanced graduate students in these fields

Deformation Theory of Pseudogroup Structures Victor Guillemin,Shlomo Sternberg,1966 Algebraic and Analytic Deformation Theory William Stephen Piper,1966 Deformation Theory and Symplectic Geometry Daniel Sternheimer,John

Rawnsley, Simone Gutt, 1997-07-31 Proceedings of the Ascona Meeting June 1996 Deformation Theory and Quantum Groups with Applications to Mathematical Physics Murray Gerstenhaber, 1992 Quantum groups are not groups at all but special kinds of Hopf algebras of which the most important are closely related to Lie groups and play a central role in the statistical and wave mechanics of Baxter and Yang Those occurring physically can be studied as essentially algebraic and closely related to the deformation theory of algebras commutative Lie Hopf and so on One of the oldest forms of algebraic quantization amounts to the study of deformations of a commutative algebra  $A$  of classical observables to a noncommutative algebra  $A_h$  of operators with the infinitesimal deformation given by a Poisson bracket on the original algebra  $A$  This volume grew out of an AMS IMS SIAM Joint Summer Research Conference held in June 1990 at the University of Massachusetts at Amherst The conference brought together leading researchers in the several areas mentioned and in areas such as  $q$  special functions which have their origins in the last century but whose relevance to modern physics has only recently been understood Among the advances taking place during the conference was Majid's reconstruction theorem for Drinfeld's quasi-Hopf algebras Readers will appreciate this snapshot of some of the latest developments in the mathematics of quantum groups and deformation theory *Maurer-Cartan Methods in Deformation Theory* Vladimir Dotsenko, Sergey Shadrin, Bruno Vallette, 2023-09-07 A unique overview of the Maurer Cartan methods in algebra geometry topology and mathematical physics **A Refined Shear Deformation Theory for the Analysis of Laminated Plates** Junuthula Narasimha Reddy, 1986 *Deformations of Singularities* Jan Stevens, 2003-01-01 These notes deal with deformation theory of complex analytic singularities and related objects The first part treats general theory The central notion is that of versal deformation in several variants The theory is developed both in an abstract way and in a concrete way suitable for computations The second part deals with more specific problems specially on curves and surfaces Smoothings of singularities are the main concern Examples are spread throughout the text *Deformation Theory and the Fundamental Group in Algebraic Geometry* David Harbater, 1978 **Kinetic Theory of Engineering Structures Dealing with Stresses, Deformations and Work for the Use of Students and Practitioners in Civil Engineering** David Albert Molitor, 1910

## Adopting the Song of Phrase: An Mental Symphony within **Deformation Theory**

In a world eaten by screens and the ceaseless chatter of instantaneous communication, the melodic elegance and emotional symphony developed by the written word usually diminish into the backdrop, eclipsed by the relentless sound and interruptions that permeate our lives. But, set within the pages of **Deformation Theory** a charming fictional prize brimming with organic emotions, lies an immersive symphony waiting to be embraced. Constructed by a wonderful musician of language, that fascinating masterpiece conducts readers on a psychological trip, skillfully unraveling the concealed melodies and profound affect resonating within each cautiously crafted phrase. Within the depths of the poignant examination, we can explore the book is key harmonies, analyze their enthralling writing model, and submit ourselves to the profound resonance that echoes in the depths of readers souls.

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