

## Curves And Singularities A Geometrical Introduction To Singularity Theory

Differential Geometry from a Singularity Theory Viewpoint provides a new look at the fascinating and classical subject of the differential geometry of surfaces in Euclidean spaces. The book uses singularity theory to capture some key geometric features of surfaces. It describes the theory of contact and its link with the theory of caustics and wavefronts. It then uses the powerful techniques of these theories to deduce geometric information about surfaces embedded in 3, 4 and 5-dimensional Euclidean spaces. The book also includes recent work of the authors and their collaborators on the geometry of sub-manifolds in Minkowski spaces. Contents: The Case for the Singularity Theory Approach Submanifolds of the Euclidean Space Singularities of Germs of Smooth Mappings Contact Between Submanifolds of  $n$ -Lagrangian and Legendrian Singularities Surfaces in the Euclidean 3-Space Surfaces in the Euclidean 4-Space Surfaces in the Euclidean 5-Space Spacelike Surfaces in the Minkowski Space-Time Global Viewpoint Readership: Advanced undergraduates and post-graduate students, and researchers in the fields of differential geometry and singularity theory. Key Features: The book is unique in its nature. It provides a coherent approach for studying the geometry of sub-manifolds of various ambient spaces from the singularity theory point of view. The book informs the reader about the progress in the field of extrinsic differential geometry and singularity theory. The information is new and has not been treated in previous textbooks. The book gathers scattered work from various research articles, most of which are recent, and describes techniques that could be used to tackle problems in other areas of mathematics. Keywords: Contact; Extrinsic Geometry; Genericity; Caustics; Singularities; Surfaces; Transversality; Wave Fronts

This book addresses the global study of finite and infinite singularities of planar polynomial differential systems, with special emphasis on quadratic systems. While results covering the degenerate cases of singularities of quadratic systems have been published elsewhere, the proofs for the remaining harder cases were lengthier. This book covers all cases, with half of the content focusing on the last non-degenerate ones. The book contains the complete bifurcation diagram, in the 12-parameter space, of global geometrical configurations of singularities of quadratic systems. The authors' results provide - for the first time - global information on all singularities of quadratic systems in invariant form and their bifurcations. In addition, a link to a very helpful software package is included. With the help of this software, the study of the algebraic bifurcations becomes much more efficient and less time-consuming. Given its scope, the book will appeal to specialists on polynomial differential systems, pure and applied mathematicians who need to study bifurcation diagrams of families of such systems, Ph.D. students, and postdoctoral fellows.

In image processing, "motions by curvature" provide an efficient way to smooth curves representing the boundaries of objects. In such a motion, each point of the curve moves, at any instant, with a normal velocity equal to a function of the curvature at this point. This book is a rigorous and self-contained exposition of the techniques of "motion by curvature". The approach is axiomatic and formulated in terms of geometric invariance with respect to the position of the observer. This is translated into mathematical terms, and the author develops the approach of Olver, Sapiro and Tannenbaum, which classifies all curve evolution equations. He then draws a complete parallel with another axiomatic approach using level-set methods: this leads to generalized curvature motions. Finally, novel, and very accurate, numerical schemes are proposed allowing one to compute the solution of highly degenerate evolution equations in a completely invariant way. The convergence of this scheme is also proved.

By virtue of their special algebraic structures, Pythagorean-hodograph (PH) curves offer unique advantages for computer-aided design and manufacturing, robotics, motion control, path planning, computer graphics, animation, and related fields. This book offers a comprehensive and self-contained treatment of the mathematical theory of PH curves, including algorithms for their construction and examples of their practical applications. It emphasizes the interplay of ideas from algebra and geometry and their historical origins and includes many figures, worked examples, and detailed algorithm descriptions.

Singularity theory appears in numerous branches of mathematics, as well as in many emerging areas such as robotics, control theory, imaging, and various evolving areas in physics. The purpose of this proceedings volume is to cover recent developments in singularity theory and to introduce young researchers from developing countries to singularities in geometry and topology. The contributions discuss singularities in both complex and real geometry. As such, they provide a natural continuation of the previous school on singularities held at ICTP (1991), which is recognized as having had a major influence in the field.

This proceedings book brings selected works from two conferences, the 2nd Brazil-Mexico Meeting on Singularity and the 3rd Northeastern Brazilian Meeting on Singularities, that were held in Salvador, in July 2015. All contributions were carefully peer-reviewed and revised, and cover topics like Equisingularity, Topology and Geometry of Singularities, Topological Classification of Singularities of Mappings, and more. They were written by mathematicians from several countries, including Brazil, Spain, Mexico, Japan and the USA, on relevant topics on Theory of Singularity, such as studies on deformations, Milnor fibration, foliations, Catastrophe theory, and myriad applications. Open problems are also introduced, making this volume a must-read both for graduate students and active researchers in this field.

This volume constitutes the thoroughly refereed post-conference proceedings of the 8th International Conference on Curves and Surfaces, held in Paris, France, in June 2014. The conference had the overall theme: "Representation and Approximation of Curves and Surfaces and Applications". The 32 revised full papers presented were carefully reviewed and selected from 39 submissions. The scope of the conference was on following topics: approximation theory, computer-aided geometric design, computer graphics and visualization, computational geometry and topology, geometry processing, image and signal processing, interpolation and smoothing, mesh generation, finite elements and splines, scattered data processing and learning theory, sparse and high-dimensional approximation, subdivision, wavelets and multi-resolution method.

A collection of articles giving overviews and open questions in singularities and their computational aspects.

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The differential geometry of curves and surfaces in Euclidean space has fascinated mathematicians since the time of Newton. Here the authors take a novel approach by casting the theory into a new light, that of singularity theory. The second edition of this successful textbook has been thoroughly revised throughout and includes a multitude of new exercises and examples. A new final chapter has been added that covers recently developed techniques in the classification of functions of several variables, a subject central to many applications of singularity theory. Also in this second edition are new sections on the Morse lemma and the classification of plane curve singularities. The only prerequisites for students to follow this textbook are a familiarity with linear algebra and advanced calculus. Thus it will be invaluable for anyone who would like an introduction to the modern theories of catastrophes and singularities.

This volume contains the proceedings of an AMS special session held at the 1999 Joint Mathematics Meetings in San Antonio. The participants were an international group of researchers studying singularities from algebraic and analytic viewpoints. The contributed papers contain original results as well as some expository and historical material. This

volume is dedicated to Oscar Zariski, on the one hundredth anniversary of his birth. The topics include the role of valuation theory in algebraic geometry with recent applications to the structure of morphisms; algorithmic approaches to resolution of equisingular surface singularities and locally toric varieties; weak subintegral closures of ideals and Rees valuations; constructions of universal weakly subintegral extensions of rings; direct-sum decompositions of finitely generated modules; construction and examples of resolution graphs of surface singularities; Jacobians of meromorphic curves; investigation of spectral numbers of curve singularities using Puiseux pairs; Grobner basis calculations of Hochschild homology for hypersurfaces with isolated singularities; and the theory of characteristic classes of singular spaces - a brief history with conjectures and open problems.

Geometry, this very ancient field of study of mathematics, frequently remains too little familiar to students. Michle Audin, professor at the University of Strasbourg, has written a book allowing them to remedy this situation and, starting from linear algebra, extend their knowledge of affine, Euclidean and projective geometry, conic sections and quadrics, curves and surfaces. It includes many nice theorems like the nine-point circle, Feuerbach's theorem, and so on. Everything is presented clearly and rigorously. Each property is proved, examples and exercises illustrate the course content perfectly. Precise hints for most of the exercises are provided at the end of the book. This very comprehensive text is addressed to students at upper undergraduate and Master's level to discover geometry and deepen their knowledge and understanding.

"Presents the structure of algebras appearing in representation theory of groups and algebras with general ring theoretic methods related to representation theory. Covers affine algebraic sets and the nullstellensatz, polynomial and rational functions, projective algebraic sets. Groebner basis, dimension of algebraic sets, local theory, curves and elliptic curves, and more."

This volume contains invited expository and research papers from the conference Topology of Algebraic Varieties, in honor of Anatoly Libgober's 60th birthday, held June 22-26, 2009, in Jaca, Spain. The volume contains four parts corresponding to the four main focal points of the conference: algebraic geometry and fundamental groups, braids and knots, hyperplane arrangements, and singularities. Together, the papers provide an overview of the current status of a broad range of topological questions in Algebraic Geometry.

This book contains expository papers that give an up-to-date account of recent developments and open problems in the geometry and topology of manifolds, along with several research articles that present new results appearing in published form for the first time. The unifying theme is the problem of understanding manifolds in low dimensions, notably in dimensions three and four, and the techniques include algebraic topology, surgery theory, Donaldson and Seiberg-Witten gauge theory, Heegaard Floer homology, contact and symplectic geometry, and Gromov-Witten invariants. The articles collected for this volume were contributed by participants of the Conference "Geometry and Topology of Manifolds" held at McMaster University on May 14-18, 2004 and are representative of the many excellent talks delivered at the conference.

Geometric Modeling and Algebraic Geometry, though closely related, are traditionally represented by two almost disjoint scientific communities. Both fields deal with objects defined by algebraic equations, but the objects are studied in different ways. In 12 chapters written by leading experts, this book presents recent results which rely on the interaction of both fields. Some of these results have been obtained from a major European project in geometric modeling.

This volume brings together recent, original research and survey articles by leading experts in several fields that include singularity theory, algebraic geometry and commutative algebra. The motivation for this collection comes from the wide-ranging research of the distinguished mathematician, Antonio Campillo, in these and related fields. Besides his influence in the mathematical community stemming from his research, Campillo has also endeavored to promote mathematics and mathematicians' networking everywhere, especially in Spain, Latin America and Europe. Because of his impressive achievements throughout his career, we dedicate this book to Campillo in honor of his 65th birthday. Researchers and students from the world-wide, and in particular Latin American and European, communities in singularities, algebraic geometry, commutative algebra, coding theory, and other fields covered in the volume, will have interest in this book.

Comprehensive and self-contained exposition of singularities of plane curves, including new, previously unpublished results.

This book describes recent progress in the topological study of plane curves. The theory of plane curves is much richer than knot theory, which may be considered the commutative version of the theory of plane curves. This study is based on singularity theory: the infinite-dimensional space of curves is subdivided by the discriminant hypersurfaces into parts consisting of generic curves of the same type. The invariants distinguishing the types are defined by their jumps at the crossings of these hypersurfaces. Arnold describes applications to the geometry of caustics and of wavefronts in symplectic and contact geometry. These applications extend the classical four-vertex theorem of elementary plane geometry to estimates on the minimal number of cusps necessary for the reversion of a wavefront and to generalizations of the last geometrical theorem of Jacobi on conjugated points on convex surfaces. These estimates open a new chapter in symplectic and contact topology: the theory of Lagrangian and Legendrian collapses, providing an unusual and far-reaching higher-dimensional extension of Sturm theory of the oscillations of linear combinations of eigenfunctions.

This volume is a collection of papers presented at the XIII International Workshop on Real and Complex Singularities, held from July 27–August 8, 2014, in São Carlos, Brazil, in honor of María del Carmen Romero Fuster's 60th birthday. The volume contains the notes from two mini-courses taught during the workshop: on intersection homology by J.-P. Brasselet, and on non-isolated hypersurface singularities and Lê cycles by D. Massey. The remaining contributions are research articles which cover topics from the foundations of singularity theory (including classification theory and invariants) to topology of singular spaces (links of singularities and semi-algebraic sets), as well as applications to topology (cobordism and Lefschetz fibrations), dynamical systems (Morse-Bott functions) and differential geometry (affine geometry, Gauss-maps, caustics, frontals and non-Euclidean geometries). This book is published in cooperation with Real Sociedad Matemática Española (RSME)

Since the beginning of human history we have had a communication network that is identical with the physical distribution network. In the late 19th century we established the energy network to distribute electric and thermal energy, launching the modern society. The analog communication network became popular in the middle of the 20th century. And now, at the end of the 20th century, we have global digital information networks. Along with the advancement of the communication network, the progress of the information processing technology can be classified into three historical

phases. The first phase technology is physical information processing, treating physical data from the real world. This technology is often called "signal processing" and is based on the physical law of nature. The second phase is free from the physical constraints. It is logical information processing, dealing with knowledge and rules. The most important aspect of this phase is consistency. "Provable" is employed to confirm the reality of the system. Based on the advanced computer and network technology, we are entering the third phase of information processing, which is "Kansei" information processing. ("Kansei" is a Japanese word expressing some subjective ability referred to as "sensitivity", "intuition", "affection" or "emotion"). Emotional resonance or consent is important in the pursuit of reality in this phase. Multimedia modeling to harmonize different media and systems is one of the key technologies in the third phase of information processing. It will provide a next generation framework to construct a human-centered information environment that is more comfortable and more productive. This volume is devoted to a discussion on effective modeling of multimedia information and systems for a wide range of applications. It contains 30 technical articles, all of which were selected, after vigorous peer reviews, for presentation at the International Conference on Multimedia Modeling held in Nagano, Japan, on 13-15 November 2000.

This second edition is an invaluable textbook for anyone who would like an introduction to the modern theories of catastrophes and singularities.

This book presents the proceedings of two conferences, Resolution des singularites et geometrie non commutative and the Annapolis Algebraic Geometry Conference. Research articles in the volume cover various topics of algebraic geometry, including the theory of Jacobians, singularities, applications to cryptography, and more. The book is suitable for graduate students and research mathematicians interested in algebraic geometry.

This development of the theory of complex algebraic curves was one of the peaks of nineteenth century mathematics. They have many fascinating properties and arise in various areas of mathematics, from number theory to theoretical physics, and are the subject of much research. By using only the basic techniques acquired in most undergraduate courses in mathematics, Dr. Kirwan introduces the theory, observes the algebraic and topological properties of complex algebraic curves, and shows how they are related to complex analysis.

Richly detailed survey of the evolution of geometrical ideas and development of concepts of modern geometry: projective, Euclidean, and non-Euclidean geometry; role of geometry in Newtonian physics, calculus, relativity. Over 100 exercises with answers. 1966 edition.

This is the second part of the Proceedings of the meeting 'School and Workshop on the Geometry and Topology of Singularities', held in Cuernavaca, Mexico, from January 8th to 26th of 2007, in celebration of the 60th Birthday of Le Dung Trang. This volume contains fourteen cutting-edge research articles on geometric and topological aspects of singularities of spaces and maps. By reading this volume, and the accompanying volume on algebraic and analytic aspects of singularities, the reader should gain an appreciation for the depth, breadth, and beauty of the subject, and also find a rich source of questions and problems for future study.

The first monograph on singularities of mappings for many years, this book provides an introduction to the subject and an account of recent developments concerning the local structure of complex analytic mappings. Part I of the book develops the now classical real  $\mathbb{C}^n$  and complex analytic theories jointly. Standard topics such as stability, deformation theory and finite determinacy, are covered in this part. In Part II of the book, the authors focus on the complex case. The treatment is centred around the idea of the "nearby stable object" associated to an unstable map-germ, which includes in particular the images and discriminants of stable perturbations of unstable singularities. This part includes recent research results, bringing the reader up to date on the topic. By focusing on singularities of mappings, rather than spaces, this book provides a necessary addition to the literature. Many examples and exercises, as well as appendices on background material, make it an invaluable guide for graduate students and a key reference for researchers. A number of graduate level courses on singularities of mappings could be based on the material it contains.

Interest in the study of geometry is currently enjoying a resurgence—understandably so, as the study of curves was once the playground of some very great mathematicians. However, many of the subject's more exciting aspects require a somewhat advanced mathematics background. For the "fun stuff" to be accessible, we need to offer students an introduction with modest prerequisites, one that stimulates their interest and focuses on problem solving. Integrating parametric, algebraic, and projective curves into a single text, *Geometry of Curves* offers students a unique approach that provides a mathematical structure for solving problems, not just a catalog of theorems. The author begins with the basics, then takes students on a fascinating journey from conics, higher algebraic and transcendental curves, through the properties of parametric curves, the classification of limaçons, envelopes, and finally to projective curves, their relationship to algebraic curves, and their application to asymptotes and boundedness. The uniqueness of this treatment lies in its integration of the different types of curves, its use of analytic methods, and its generous number of examples, exercises, and illustrations. The result is a practical text, almost entirely self-contained, that not only imparts a deeper understanding of the theory, but inspires a heightened appreciation of geometry and interest in more advanced studies.

The volume contains both general and research papers. Among the first ones are papers showing recent and original developments or methods in subjects such as resolution of singularities, D-module theory, singularities of maps and geometry of curves. The research papers deal on topics related to, or close to, those listed above. The contributions are organized in three parts according to their contents. Part I presents a set of papers on resolution of singularities, a topic of renewed activity. It deals with important topics of current interest, such as canonical, algorithmic, combinatorial and graphical procedures (Villamayor, Oka, Marijmin), as well as special results on desingularization in characteristic  $p$  (Cossart, Moh), and connections between resolution and structure of the space of arcs through a singularity (González-Sprinberg-Lejeune-Jalabert). Part II contains a series of papers on the study of singularities and its connections with differential systems and deformation or perturbation theories. Two expository papers (Maisonobe-Briamson, Viebkhout) describe, in an algebro-geometric way, the interaction between singularities and D-module theory including recent progress on Bernstein polynomials and Newton polygon techniques. Geometry of foliations (Henaut, Garcia-Reguera), polar varieties and stratifications (Hajto) are also topics treated here. Two other papers (Wall, Greuel-Pfister) deal with quasihomogeneous singularities in the contexts of perturbations and moduli spaces. Globalization of deformations of singularities (de Jong) and determination of complex topology from the real one (~10nd) complete this series of papers. Part III consists of papers on algebraic geometry of curves and surfaces.

The Advances in Architectural Geometry (AAG) symposia serve as a unique forum where developments in the design, analysis and fabrication of building geometry are presented. With participation of both academics and professionals, each symposium aims to gather and present practical work and theoretical research that responds to contemporary design challenges and expands the opportunities for architectural form. The fifth edition of the AAG symposia was hosted by the National Centre for Competence in Research Digital Fabrication at ETH Zurich, Switzerland, in September 2016. This book contains the proceedings from the AAG2016 conference and offers detailed

insight into current and novel geometrical developments in architecture. The 22 diverse, peer-reviewed papers present cutting-edge innovations in the fields of mathematics, computer graphics, software design, structural engineering, and the design and construction of architecture.

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