

# **Symplectic Geometry and Mirror Symmetry**

Proceedings of the 4th KIAS Annual International Conference



**Editors**

**K. Fukaya, Y.-G. Oh, K. Ono, G. Tian**

**World Scientific**

# Symplectic Geometry Mirror Symmetry

**Ron Donagi, Katrin Wendland**



## **Symplectic Geometry Mirror Symmetry:**

Symplectic Geometry and Mirror Symmetry Kodŭng Kwahagwŏn (Korea). International Conference, 2001 In 1993 M Kontsevich proposed a conceptual framework for explaining the phenomenon of mirror symmetry Mirror symmetry had been discovered by physicists in string theory as a duality between families of three dimensional Calabi Yau manifolds Kontsevich's proposal uses Fukaya's construction of the A category of Lagrangian submanifolds on the symplectic side and the derived category of coherent sheaves on the complex side The theory of mirror symmetry was further enhanced by physicists in the language of D branes and also by Strominger Yau Zaslow in the geometric set up of special Lagrangian torus fibrations It rapidly expanded its scope across from geometry topology algebra to physics In this volume leading experts in the field explore recent developments in relation to homological mirror symmetry Floer theory D branes and Gromov Witten invariants Kontsevich Soibelman describe their solution to the mirror conjecture on the abelian variety based on the deformation theory of A categories and Ohta describes recent work on the Lagrangian intersection Floer theory by Fukaya Oh Ohta Ono which takes an important step towards a rigorous construction of the A category There follow a number of contributions on the homological mirror symmetry D branes and the Gromov Witten invariants e g Getzler shows how the Toda conjecture follows from recent work of Givental Okounkov and Pandharipande This volume provides a timely presentation of the important developments of recent years in this rapidly growing field *Symplectic Geometry And Mirror Symmetry - Proceedings Of The 4th Kias Annual International Conference* Kenji Fukaya, Yong Geun Oh, K Ono, Gang Tian, 2001-11-19 In 1993 M Kontsevich proposed a conceptual framework for explaining the phenomenon of mirror symmetry Mirror symmetry had been discovered by physicists in string theory as a duality between families of three dimensional Calabi Yau manifolds Kontsevich's proposal uses Fukaya's construction of the A category of Lagrangian submanifolds on the symplectic side and the derived category of coherent sheaves on the complex side The theory of mirror symmetry was further enhanced by physicists in the language of D branes and also by Strominger Yau Zaslow in the geometric set up of special Lagrangian torus fibrations It rapidly expanded its scope across from geometry topology algebra to physics In this volume leading experts in the field explore recent developments in relation to homological mirror symmetry Floer theory D branes and Gromov Witten invariants Kontsevich Soibelman describe their solution to the mirror conjecture on the abelian variety based on the deformation theory of A categories and Ohta describes recent work on the Lagrangian intersection Floer theory by Fukaya Oh Ohta Ono which takes an important step towards a rigorous construction of the A category There follow a number of contributions on the homological mirror symmetry D branes and the Gromov Witten invariants e g Getzler shows how the Toda conjecture follows from recent work of Givental Okounkov and Pandharipande This volume provides a timely presentation of the important developments of recent years in this rapidly growing field *Symplectic Geometry and Mirror Symmetry* Korea Institute for Advanced Study, 0 K. Fukaya, 2001 *Mirror Symmetry IV* Eric D'Hoker, 2002 This book presents contributions of

participants of a workshop held at the Centre de Recherches Mathématiques CRM University of Montreal It can be viewed as a sequel to Mirror Symmetry I 1998 Mirror Symmetry II 1996 and Mirror Symmetry III 1999 copublished by the AMS and International Press The volume presents a broad survey of many of the noteworthy developments that have taken place in string theory geometry and duality since the mid 1990s Some of the topics emphasized include the following Integrable models and supersymmetric gauge theories theory of M and D branes and noncommutative geometry duality between strings and gauge theories and elliptic genera and automorphic forms Several introductory articles present an overview of the geometric and physical aspects of mirror symmetry and of corresponding developments in symplectic geometry The book provides an efficient way for a very broad audience of mathematicians and physicists to explore the frontiers of research into this rapidly expanding area

**Tropical Geometry and Mirror Symmetry** Mark Gross, 2011-01-20 Tropical geometry provides an explanation for the remarkable power of mirror symmetry to connect complex and symplectic geometry The main theme of this book is the interplay between tropical geometry and mirror symmetry culminating in a description of the recent work of Gross and Siebert using log geometry to understand how the tropical world relates the A and B models in mirror symmetry The text starts with a detailed introduction to the notions of tropical curves and manifolds and then gives a thorough description of both sides of mirror symmetry for projective space bringing together material which so far can only be found scattered throughout the literature Next follows an introduction to the log geometry of Fontaine Illusie and Kato as needed for Nishinoue and Siebert's proof of Mikhalkin's tropical curve counting formulas This latter proof is given in the fourth chapter The fifth chapter considers the mirror B model side giving recent results of the author showing how tropical geometry can be used to evaluate the oscillatory integrals appearing The final chapter surveys reconstruction results of the author and Siebert for integral tropical manifolds A complete version of the argument is given in two dimensions

**Mirror Symmetry and Tropical Geometry** Ricardo Castaño-Bernard, Yan S. Soibelman, Ilia Zharkov, 2010 This volume contains contributions from the NSF CBMS Conference on Tropical Geometry and Mirror Symmetry which was held from December 13-17 2008 at Kansas State University in Manhattan Kansas It gives an excellent picture of numerous connections of mirror symmetry with other areas of mathematics especially with algebraic and symplectic geometry as well as with other areas of mathematical physics The techniques and methods used by the authors of the volume are at the frontier of this very active area of research

*Homological Mirror Symmetry and Tropical Geometry* Ricardo Castano-Bernard, Fabrizio Catanese, Maxim Kontsevich, Tony Pantev, Yan Soibelman, Ilia Zharkov, 2014-10-07 The relationship between Tropical Geometry and Mirror Symmetry goes back to the work of Kontsevich and Y Soibelman 2000 who applied methods of non archimedean geometry in particular tropical curves to Homological Mirror Symmetry In combination with the subsequent work of Mikhalkin on the tropical approach to Gromov Witten theory and the work of Gross and Siebert Tropical Geometry has now become a powerful tool Homological Mirror Symmetry is the area of mathematics concentrated around several

categorical equivalences connecting symplectic and holomorphic or algebraic geometry The central ideas first appeared in the work of Maxim Kontsevich 1993 Roughly speaking the subject can be approached in two ways either one uses Lagrangian torus fibrations of Calabi Yau manifolds the so called Strominger Yau Zaslow picture further developed by Kontsevich and Soibelman or one uses Lefschetz fibrations of symplectic manifolds suggested by Kontsevich and further developed by Seidel Tropical Geometry studies piecewise linear objects which appear as degenerations of the corresponding algebro geometric objects

**Homological Mirror Symmetry for the Quartic Surface** Paul Seidel, 2015 We prove Kontsevich's form of the mirror symmetry conjecture for on the symplectic geometry side a quartic surface in  $CP^3$

**Mirror Symmetry and Algebraic Geometry** David A. Cox, Sheldon Katz, 1999 Mirror symmetry began when theoretical physicists made some astonishing predictions about rational curves on quintic hypersurfaces in four dimensional projective space Understanding the mathematics behind these predictions has been a substantial challenge This book is the first completely comprehensive monograph on mirror symmetry covering the original observations by the physicists through the most recent progress made to date Subjects discussed include toric varieties Hodge theory Kahler geometry moduli of stable maps Calabi Yau manifolds quantum cohomology Gromov Witten invariants and the mirror theorem This title features numerous examples worked out in detail an appendix on mathematical physics an exposition of the algebraic theory of Gromov Witten invariants and quantum cohomology and a proof of the mirror theorem for the quintic threefold

**Homological Mirror Symmetry** Anton Kapustin, Maximilian Kreuzer, Karl-Georg Schlesinger, 2008-12-15 Homological Mirror Symmetry the study of dualities of certain quantum field theories in a mathematically rigorous form has developed into a flourishing subject on its own over the past years The present volume bridges a gap in the literature by providing a set of lectures and reviews that both introduce and representatively review the state of the art in the field from different perspectives With contributions by K Fukaya M Herbst K Hori M Huang A Kapustin L Katzarkov A Klemm M Kontsevich D Page S Quackenbush E Sharpe P Seidel I Smith and Y Soibelman this volume will be a reference on the topic for everyone starting to work or actively working on mathematical aspects of quantum field theory

**Mirror Symmetry III** Duong H. Phong, Luc Vinet, Shing-Tung Yau, 1998 This volume presents surveys from a workshop held during the theme year in geometry and topology at the Centre de recherches mathématiques CRM University of Montreal Canada The volume is in some senses a sequel to Mirror Symmetry I 1998 and Mirror Symmetry II 1996 co published by the AMS and International Press It is intended for graduate students research mathematicians and physicists working in mathematics and theoretical physics especially in algebraic or complex geometry or conformal field theory

**Geometry and Physics of Branes** U Bruzzo, V. Gorini, U. Moschella, 2002-11-05 Branes are solitonic configurations of a string theory that are represented by extended objects in a higher dimensional space time They are essential for a comprehension of the non perturbative aspects of string theory in particular in connection with string dualities From the mathematical viewpoint branes are related to several important theo

**Mirror Symmetry I**

Shing-Tung Yau, 1998 Vol 1 represents a new ed of papers which were originally published in Essays on mirror manifolds 1992 supplemented by the additional volume Mirror symmetry 2 which presents papers by both physicists and mathematicians Mirror symmetry 1 the 1st volume constitutes the proceedings of the Mathematical Sciences Research Institute Workshop of 1991 *AN INTRODUCTION TO DIFFERENTIAL GEOMETRY* DR MANJULA T, 2025-10-18

Differential geometry is an area of mathematics that uses calculus linear algebra and geometry to investigate curves surfaces and higher dimensional objects It is an important field of research in mathematics with far reaching ramifications for physics engineering and computing From Hodge Theory to Integrability and TQFT Ron Donagi, Katrin Wendland, 2008 Ideas from quantum field theory and string theory have had an enormous impact on geometry over the last two decades One extremely fruitful source of new mathematical ideas goes back to the works of Cecotti Vafa et al around 1991 on the geometry of topological field theory Their tt geometry tt stands for topological antitopological was motivated by physics but it turned out to unify ideas from such separate branches of mathematics as singularity theory Hodge theory integrable systems matrix models and Hurwitz spaces The interaction among these fields suggested by tt geometry has become a fast moving and exciting research area This book loosely based on the 2007 Augsburg Germany workshop From tQFT to tt and Integrability is the perfect introduction to the range of mathematical topics relevant to tt geometry It begins with several surveys of the main features of tt geometry Frobenius manifolds twistors and related structures in algebraic and differential geometry each starting from basic definitions and leading to current research The volume moves on to explorations of current foundational issues in Hodge theory higher weight phenomena in twistor theory and non commutative Hodge structures and their relation to mirror symmetry The book concludes with a series of applications to integrable systems and enumerative geometry exploring further extensions and connections to physics With its progression through introductory foundational and exploratory material this book is an indispensable companion for anyone working in the subject or wishing to enter it Publisher's website

**Minimal Surfaces, Geometric Analysis and Symplectic Geometry** Kenji Fukaya, Seiki Nishikawa, Joel Spruck, 2002 The 1998 1999 programme year of the Japan U S Mathematics Institute at the Johns Hopkins University USA was devoted to minimal surfaces geometric analysis and symplectic geometry The programme culminated in a week long workshop and conference to discuss developments This volume is a collection of articles written by the speakers It presents extended or modified versions of the lectures delivered at the meeting Each article provides a vivid account of contemporary research with the information given ranging from introductory level to the most up to date results Of special interest is a long survey article by K Fukaya on applications of Floer homology to mirror symmetry Also discussed are developments on the geometry of constant mean curvature one surfaces in hyperbolic 3 spaces of finite total curvature The range of topics covered in the volume provides direction for further research in these rapidly developing areas The book should be suitable for graduate students and researchers interested in differential and symplectic geometry Foundations

of Mathematics and Physics One Century After Hilbert Joseph Kouneiher, 2018-05-26 This book explores the rich and deep interplay between mathematics and physics one century after David Hilbert's works from 1891 to 1933 published by Springer in six volumes. The most prominent scientists in various domains of these disciplines contribute to this volume providing insight to their works and analyzing the impact of the breakthrough and the perspectives of their own contributions. The result is a broad journey through the most recent developments in mathematical physics such as string theory, quantum gravity, noncommutative geometry, twistor theory, Gauge and Quantum fields theories, just to mention a few. The reader accompanied on this journey by some of the fathers of these theories explores some far reaching interfaces where mathematics and theoretical physics interact profoundly and gets a broad and deep understanding of subjects which are at the core of recent developments in mathematical physics. The journey is not confined to the present state of the art but sheds light on future developments of the field highlighting a list of open problems. Graduate students and researchers working in physics, mathematics and mathematical physics will find this journey extremely fascinating. All those who want to benefit from a comprehensive description of all the latest advances in mathematics and mathematical physics will find this book very useful too.

*Perturbed Gradient Flow Trees and  $A_\infty$ -algebra Structures in Morse Cohomology* Stephan Mescher, 2018-04-25 This book elaborates on an idea put forward by M. Abouzaid on equipping the Morse cochain complex of a smooth Morse function on a closed oriented manifold with the structure of an  $A_\infty$  algebra by means of perturbed gradient flow trajectories. This approach is a variation on K. Fukaya's definition of Morse  $A_\infty$  categories for closed oriented manifolds involving families of Morse functions. To make  $A_\infty$  structures in Morse theory accessible to a broader audience, this book provides a coherent and detailed treatment of Abouzaid's approach including a discussion of all relevant analytic notions and results requiring only a basic grasp of Morse theory. In particular, no advanced algebra skills are required and the perturbation theory for Morse trajectories is completely self-contained. In addition to its relevance for finite dimensional Morse homology, this book may be used as a preparation for the study of Fukaya categories in symplectic geometry. It will be of interest to researchers in mathematics, geometry and topology and to graduate students in mathematics with a basic command of the Morse theory.

Singularities, Mirror Symmetry, and the Gauged Linear Sigma Model Tyler J. Jarvis, Nathan Priddis, 2021-02-26 This volume contains the proceedings of the workshop Crossing the Walls in Enumerative Geometry held in May 2018 at Snowbird, Utah. It features a collection of both expository and research articles about mirror symmetry, quantized singularity theory, FJRW theory and the gauged linear sigma model. Most of the expository works are based on introductory lecture series given at the workshop and provide an approachable introduction for graduate students to some fundamental topics in mirror symmetry and singularity theory including quasimaps, localization, the gauged linear sigma model, GLSM, virtual classes, cosection localization,  $p$ -fields and Saito's primitive forms. These articles help readers bridge the gap from the standard graduate curriculum in algebraic geometry to exciting cutting edge research in the field. The volume also contains several

research articles by leading researchers showcasing new developments in the field      *Modular Forms and String Duality*  
Noriko Yui, Helena Verrill, and Charles F. Doran, This book is a testimony to the BIRS Workshop and it covers a wide range  
of topics at the interface of number theory and string theory with special emphasis on modular forms and string duality They  
include the recent advances as well as introductory expositions on various aspects of modular forms motives differential  
equations conformal field theory topological strings and Gromov Witten invariants mirror symmetry and homological mirror  
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