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S.-T. Yau, Series Editor

Mirror Symmetry II

B. Greene and S.-T. Yau, Editors

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Foreword

Mirror symmetry has undergone dramatic progress since the Mathematical Sciences Research Institute workshop in 1991 whose proceedings constitute volume I of this continuing collection. Tremendous insight has been gained on a number of key issues, and it is the purpose of the present volume to survey some of these results. Some of the contributions are reprints of papers which have appeared elsewhere while others were written specifically for this collection.

The areas covered are organized into four sections, and each presents papers by both physicists and mathematicians. Section I focuses on the present understanding of explicit constructions of mirror manifolds. Paper 1 briefly reviews the notion of path integration to assist those less familiar with this physical tool. Paper 2 reviews the first, and at present, only known construction of mirror manifolds, at the level of conformal field theory. Paper 3 discusses a more general construction of mirror pairs, which as yet has not been established in conformal field theory, and paper 4 reviews this and other conjectured constructions. Paper 5 discusses mirror symmetry in the context of Landau-Ginsburg theories and paper 6 reviews properties of the orbifolding operation, from a mathematical perspective.

Section II focuses on work that has honed our understanding of both Calabi-Yau and conformal field theory moduli spaces. Papers 7 and 8 discuss properties of the enlarged Kähler moduli space required by conformal field theory, and in particular, establish the first concrete arena for physically smooth spacetime topology change. Paper 9 discusses aspects of geometrical structure of such moduli spaces and, in paper 10, some of the newfound understanding of moduli space is applied to the case of orbifold theories. In paper 11, the classification problem for Calabi-Yau's is discussed; in paper 12 Witten's notion of thickening the moduli space is described from a mathematical perspective and in paper 13 an example of an obstructed moduli space is discussed. Paper 14 presents an introductory discussion of duality properties of moduli space, paper 15 embarks on the issue of non-compact Calabi-Yau spaces while paper 16 discusses some interesting Calabi-Yau numerology.

Section III focuses on developments in using mirror symmetry to solve difficult counting problems, i.e. problems in enumerative geometry. Papers 18 and 19 discuss the methods for counting rational curves for examples whose parameter space is larger than one, while paper 17 presents a review of the multi-parameter case in general. Paper 20 places the physical approach to these enumerative problems on more firm mathematical foundation, as well as applying such methods to a variety of counting problems. Paper 21 resolves a number of key issues in mirror symmetry such as the form of the mirror map, in addition to providing a means of extending the domain of accessible counting problems to higher genus curves. In paper 22, some aspects of the methods used in applying mirror symmetry to enumerative problems

are placed in an appropriate mathematical framework.

Section IV focuses on the extension of mirror symmetry away from the familiar case of complex dimension three to both lower and higher dimension. Papers 23 and 24 discuss mirror symmetry for complex dimension 2 and papers 24 and 25 discuss various aspects of mirror symmetry in dimension greater than 3.

Due to space limitations, there are a number of equally interesting and important developments that have not been included. The papers of this volume, though, will undoubtedly allow the reader to gain much insight into both the physics and the mathematics of the remarkable structure of mirror symmetry.

The editors wish to thank Arthur Greenspoon and Misha Verbitsky, whose tremendous work and dedication has greatly improved the technical quality of this volume.

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