

# Proceedings of Symposia in PURE MATHEMATICS

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Volume 85

## String-Math 2011

Jonathan Block  
Jacques Distler  
Ron Donagi  
Eric Sharpe  
Editors



**American Mathematical Society**

# String-Math 2011

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**American Mathematical Society**  
Providence, Rhode Island

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UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA, PA,  
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## Preface

The conference ‘String-Math 2011’ was held June 6-11, 2011 at the University of Pennsylvania, as the first in a new annual series of large meetings exploring the interface of mathematics and string theory. This volume presents the proceedings of that conference.

The nature of interactions between mathematicians and physicists has been thoroughly transformed in recent years. String theory and quantum field theory have contributed a series of profound ideas which gave rise to entirely new mathematical fields and revitalized older ones. The influence flows in both directions, with mathematical techniques and ideas contributing crucially to major advances in string theory. By now there is a large and rapidly growing number of both mathematicians and physicists working at the string-theoretic interface between the two academic fields.

For mathematics, string theory has been a source of many significant inspirations, ranging from Seiberg-Witten theory in four-manifolds, to enumerative geometry and Gromov-Witten theory in algebraic geometry, to work on the Jones polynomial in knot theory, to recent progress in the geometric Langlands program and the development of derived algebraic geometry and n-category theory. In the other direction, mathematics has provided physicists with powerful tools, ranging from powerful differential geometric techniques for solving or analyzing key partial differential equations, to toric geometry, to K-theory and derived categories in D-branes, to the analysis of Calabi-Yau manifolds and string compactifications, to the use of modular forms and other arithmetic techniques. The depth, power and novelty of the results obtained in both fields thanks to their interaction is truly mind-boggling.

Despite these profound and wide-ranging interactions, there was no major conference bringing together the leading mathematicians and mathematically-minded physicists working in this interface. We initiated the String-Math series of conferences and organized String-Math 2011 to fill this gap. Our intention was that this conference would be a vehicle for promoting such interactions, giving attendees greater opportunities to cross cultural boundaries, learn aspects of other fields relevant for their research, and advertise important developments to audiences that might not otherwise hear of them or appreciate their importance.

The conference covered a wide array of topics at the interface of mathematics and high energy physics, including, in no particular order,

- Homological mirror symmetry
- Categorical constructions of topological field theories
- Mathematical string phenomenology
- F-theory



- Wall crossing formulas
- Geometric Langlands
- Arithmetic of strings
- Gromov-Witten theory and related enumerative geometry
- A-twisted Landau-Ginzburg models
- String topology
- Elliptic cohomology
- Heterotic mirror symmetry
- Topological T duality
- String measures
- Chiral de Rham complexes
- Noncommutative geometry

Altogether, this conference brought together approximately 140 mathematicians and physicists. There were 28 invited plenary talks given by leaders in both fields. Additionally, there were 36 contributed talks given in parallel sessions on the Wednesday of the meeting. All the talks are available at the conference web site: <http://www.math.upenn.edu/StringMath2011/>.

The conference also included a public lecture on ‘Strings and Geometry’, by Cumrun Vafa. There were three satellite and affiliated conferences:

- FRG Workshop on Holomorphic Symplectic Varieties, Courant Institute for Mathematical Science, NY, June 4-8, 2011, <http://www.math.nyu.edu/~tschinke/.nyu/FRG11.html>.
- Topological Heterotic Strings and (0,2) Mirror Symmetry, Schrödinger Institute for Mathematical Physics, Vienna, Austria, June 20-24, 2011, <http://www.aei.mpg.de/~ilarion/ESIhet/ESIhet.html>.
- Connections in Geometry and Physics: 2011, Fields Institute, Toronto, Canada, May 13-15, 2011. <http://www.math.uwaterloo.ca/~gap/>.

The math/strings collaboration is clearly here to stay, and we expect this conference series to continue as long the subject remains active and exciting. The venues and years of the first five conferences of the String-Math series were agreed in advance:

- String-Math 2011, Penn, June 6-11, 2011
- String-Math 2012, Bonn (Hausdorff Center for Mathematics), July 16 - 21, 2012
- String-Math 2013, Stony Brook (Simons Center for Geometry and Physics)
- String-Math 2014, Alberta (Pacific Institute of Mathematical Sciences)
- String-Math 2015, China (Sanya Conference Center)

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- University of Pennsylvania School of Arts and Sciences,
- US Department of Energy.

We are also very grateful to Sergei Gelfand and Chris Thivierge of AMS for their help in various stages of preparing this volume, and to Arthur Greenspoon for his help in proofreading and improving many of the articles included here.

The organizers of String-Math 2011:

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