Introduction

A NOTE FROM OUR DIRECTOR, JOHN MORGAN

As Director of the Simons Center for Geometry and Physics, I am pleased to introduce the first newsletter from the Center. Its purpose is to describe the range of the Center’s many activities, and to introduce the people at the Center. For more detailed information on any aspect of the Center and its activities please see our website: www.scgp.stonybrook.edu.

During the last 30 years there has been much activity at the interface of mathematics, especially geometry, and physics. The motivation for creating the Simons Center was the conviction that significant further progress in each field can be achieved by bringing researchers from the two disciplines together in an environment where they are encouraged to exchange ideas and work across the divide separating their disciplines. As these pages indicate, our lectures, programs and workshops are in areas where the interaction between geometry and physics is the most vibrant and where the questions are the deepest. This vibrancy is also echoed in the arts, culture and cuisine of the Center each of which is a celebration of exploration, innovation, and collaboration.

A NOTE FROM OUR FOUNDERS, JIM AND MARILYN SIMONS

From its beginnings as a research university, Stony Brook has had a special strength in mathematics and in physics and has long been known for fostering an environment where researchers in these fields can come together to exchange information and share ideas. Given the Simons Foundation’s own mission of advancing knowledge in mathematics and the basic sciences, it seemed highly appropriate and desirable for us to build upon those strengths by endowing and sustaining a new center designed to bring together mathematicians and physicists around problems and questions of common interest. Much of the most profound work in physics has been deeply intertwined with the geometric side of mathematics, including that of Archimedes, Newton and Einstein. And recently, particularly with the rise in importance of quantum field theory and string theory, developments in geometry and physics have become even more interrelated.

With that in mind, the Center gives many of the world’s best mathematicians and physicists the opportunity to work and interact in an environment and architecture carefully designed to foster and enhance scientific progress. We believe there is a good chance that work accomplished at the Center will significantly change and deepen our understanding of the physical universe and its basic mathematical structure.

We are gratified to see that in the three years since the building’s opening, the Center has attracted top-level international talent to serve on its permanent faculty, along with the numerous world-renowned visiting scholars who come to here to lead special programs. The Center is now truly a hub of activity at the interface of geometry and physics, involving graduate students, postdocs, visitors and senior faculty from all over the world. Activity to date has produced many papers now available in the math and physics archives, and many recorded talks, available on the Center’s website. We are also proud that the Center has hosted many events bridging the worlds of science, art, and music of general interest to the Stony Brook community as a whole.

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http://scgp.stonybrook.edu/newsletter
Sasha Abanov was appointed Deputy Director of the Simons Center in the fall of 2012. Currently Sasha’s research interests include theoretical condensed matter and mathematical physics; more broadly the interplay between condensed matter physics, quantum field theory, and mathematics. As Deputy Director, Dr. Abanov’s main role is to oversee the scientific activities of the Center, which are organized into research programs that typically run for one semester, and more concentrated workshops, which typically last a week. Each of these has a focused topic and an organizing committee. These committees are responsible for selecting the participants to their programs with the goal of bringing to the Center mathematicians and physicists from around the world, who are doing the most influential and exciting work in the field. Visitors to a program come for a period of one month, and workshop participants come for the entire period of the workshop. The Center aims to have 20 programmatic visitors in residence at any time, and the workshops bring an additional 25 to 40 participants to the Center.

2013-2014 PROGRAMS

PHYSICS AND MATHEMATICS OF SCATTERING AMPLITUDES
Organized by Zvi Bern, Lance Dixon, Michael Douglas, Alexander Goncharov, and Lionel Mason
FALL 2013

MOCK MODULAR FORMS, MOONSHINE, AND STRING THEORY
Organized by Miranda Cheng, Matthias Gaberdiel, and Terry Gannon
AUGUST 26 – SEPTEMBER 27, 2013

QUIVER VARIETIES
Organized by Nikita Nekrasov, Alexander Kirillov, Olivier Schiffmann, and Ljudmila Kamenova
SEPTEMBER 30 – NOVEMBER 8, 2013

MODULI SPACES OF PSEUDO-HOLOMORPHIC CURVES AND THEIR APPLICATIONS TO SYMPLECTIC TOPOLOGY
Organized by Kenji Fukaya, Dusa McDuff, and John Morgan
JANUARY 2 – JUNE 30, 2014

QUANTUM ANOMALIES, TOPOLOGY, AND HYDRODYNAMICS
Organized by Alexandre Abanov, Dmitri Kharzeev, Boris Khesin, Dam Son, and Paul Wiegmann
FEBRUARY 17–JUNE 13, 2014
The SCGP has been delighted to host a series of engaging public lectures made possible by a generous donation from brothers Stephen and Vincent Della Pietra. The Della Pietra Lecture Series brings world-renowned scientists to the Simons Center for Geometry and Physics to enhance the intellectual activity of the Center, and also bring greater awareness of recent and impactful discoveries in Physics and Mathematics to the Long Island community.

Each Della Pietra Lecturer gives a series of talks, including public talks aimed towards the general community and local high school students, as well as a technical seminar to advanced graduate students and faculty. On more than one occasion, these public talks have filled to capacity, illustrating a strong local passion to learn more about cutting edge science and discovery!

The Center has partnered with local high schools to bus students in for talks and meetings with the lecturers as well as tours of the Center’s gallery and art exhibitions. Public receptions accompanying each lecture also provide students and interested researchers the opportunity to network with Stony Brook University’s top faculty and the Center’s world-renowned visiting scholars.

To date, lecturers have included: William Bialek of Princeton University; Brian Greene of Columbia University; Robert Kirshner of Harvard University; Jon Kleinberg of Cornell University; Andrei Linde of Stanford University; and Jeffrey Weeks.

For more information about the Della Pietra Lecture series as well as recent public lectures and events, such as the May 2013 talk by LSST’s Tony Tyson or the March 2013 talk by Pixar’s Tony DeRose, visit: http://scgp.stonybrook.edu/scientific/public-lectures

Video of these talks and more are also available on the SCGP website at: http://scgp.stonybrook.edu/multimedia/videos
Sir Simon Donaldson will become a permanent member of the Simons Center on January 1, 2014. He received his B.A. from Pembroke College of Cambridge University in 1979 and his Ph.D. from Oxford University in 1983, studying first under the supervision of Dr. Nigel Hitchin and later under Sir Michael Atiyah. His thesis was The Yang-Mills Equations on Kähler Manifolds, written in 1983, where he showed the equivalence of anti-self-dual connections and stable holomorphic structures on bundles over algebraic surfaces. Donaldson’s most renowned work is his study of the topology of smooth (differentiable) four-dimensional manifolds. Among his most noted achievements are his proof of the diagonalizability theorem, sometimes referred to as Donaldson’s theorem, and his algebraic invariants of four-manifolds codified into what is now called the Donaldson polynomial invariant. His more recent work includes the introduction of pencils of curves in a symplectic four-manifold and his study of extremal metrics, including Kahler-Einstein metrics, and the relation of these to algebro-geometric stability. In 1986 he was awarded the Fields Medal for his work in the geometry and topology of 4-dimensional manifolds, and was elected a Fellow of the Royal Society. In 2009, he was awarded the Shaw Prize in Mathematical Sciences for his work in conjunction with Clifford Taubes “for their many contributions to geometry in three and four dimensions”. He is currently a Professor in the Department of Mathematics, Imperial College, London.

Michael R. Douglas received his Bachelor’s degree in Physics from Harvard University in 1983 and his Ph.D. from Caltech in 1988 under the supervision of John Schwarz. Douglas is a string theorist, best known for his part in the development of matrix models, and for his work on noncommutative geometry in string theory, on Dirichlet branes and their relation to derived categories, and on the statistical approach to string phenomenology. Before coming to help start the Simons Center in 2008, Douglas was at Rutgers University where he was Professor of Physics and Director of the New High Energy Theory Center. He was awarded the Sackler Prize in Physical Sciences, and was a Louis Michel Visiting Professor at the IHES and a Clay Mathematical Institute Mathematical Emissary. He is a fellow of the American Mathematical Society and a member of the American Physical Society, and has served as the editor of the Journal of High Energy Physics and of Communications in Mathematical Physics. Douglas has organized many workshops at the Simons Center including “String Theory for Mathematicians”, “Mathematical Foundations of Quantum Field Theory” and “String Phenomenology.”
Kenji Fukaya became a permanent member of the Simons Center on April 1, 2013. He received his B.A. in Mathematics at the University of Tokyo in 1981, and continued his graduate studies at the University of Tokyo, receiving his Ph.D. in 1986. He was at the University of Tokyo from 1983 through 1990, where he was first a Research Assistant and then an Associate Professor. He was a Professor of Mathematics at Kyoto University from 1994 until coming to the Simons Center. Fukaya’s recent work has been in symplectic geometry and in particular has centered around the study of Lagrangian submanifolds and the Floer homology related to intersections of these submanifolds. Fukaya developed and has studied extensively a theory in which the Lagrangian submanifolds of a given symplectic manifold are the objects of a generalized category, now called the Fukaya category, and the morphisms are the Floer homology groups. This work is closely related to Kontsevich’s homological mirror symmetry conjecture. This is now formulated as the conjecture that the derived category of coherent sheaves on a Kahler manifold should be isomorphic to the Fukaya category of a ‘mirror’ symplectic manifold. His earlier work was in Riemannian geometry and especially dealt with collapsing results in this context. Fukaya was awarded the Japan Academy Award in 2003, Asahi prize in 2009, and Fujiwara prize in 2012. He is a member of the Japanese National Academy of Sciences.

Nikita Nekrasov was a visiting professor at the Simons Center in 2009 -2010, and will soon become a permanent member of the Center. He earned his Ph.D. at Princeton University in 1996 under the supervision of David Gross. His dissertation was on Four Dimensional Holomorphic Theories. Nekrasov was a postdoc in physics at Harvard University, a Junior Fellow at the Harvard Society of Fellows in 1996-1999, and the Dicke Fellow at Princeton University in 1999-2000, before becoming a permanent Professor at the Institut des Hautes Études Scientifiques. He is a leading mathematical physicist, and the world expert in non-pertubative calculations in supersymmetric gauge theory. Among his best-known achievements is the proof of the Seiberg-Witten solution of Donaldson theory in 2002, which had been one of the major unsolved problems in Quantum Field theory since 1994. He is also well known for his work on non-commutative geometry, topological string theory and ADHM construction, for which he received the Hermann Weyl Prize in 2004. While at the Center, Nikita has co-organized many programs and workshops including the Fall 2012 program ‘Integrability in Modern Theoretical and Mathematical Physics’, along with Samson Shatashvili, and the workshops ‘Gauge Theory Angle at Intergrability’ in 2012 and ‘Branes and Bethe Ansatz in Supersymmetric Gauge Theories’ in 2011.
UPCOMING WORKSHOPS

2013

GRADUATE WORKSHOP ON KAHLER GEOMETRY
JUNE 24-JULY 5

SIMONS SUMMER WORKSHOP
JULY 22-AUGUST 16

SEARCH
AUGUST 20-22

QUIVER VARIETIES
OCTOBER 14-18

THE GEOMETRY AND PHYSICS OF SCATTERING AMPLITUDE
DECEMBER 9-13

SPRING 2014

ASPECTS OF SUPERGRAVITY
JANUARY 6-10

QUANTUM ANOMALIES AND HYDRODYNAMICS
FEBRUARY 17-21

STRONGLY COUPLED SYSTEMS AWAY FROM EQUILIBRIUM
FEBRUARY 24-28

MODULI SPACES OF PSEUDO-HOLOMORPHIC CURVES I
MARCH 17-21

GEOMETRICAL ASPECTS OF HYDRODYNAMICS
MAY 19-23

EQUIVARIANT GROMOV-WITTEN THEORY AND APPLICATIONS
MAY 26-30

MODULI SPACES OF PSEUDO-HOLOMORPHIC CURVES II JUNE 2-6
The week of June 17 – June 21, the Simons Center for Geometry and Physics hosted the 3rd annual String-Math Conference. First organized by Ron Donagi, Eric Sharpe, Jonathan Block, Mirjam Cvetiˇc, Jacques Distler and Tony Pantev, the String-Math conference originated at the University of Pennsylvania in June of 2011 with the purpose of bringing together mathematicians and physicists from around the world, to conduct collaborative research on ideas related to string theory. It was held last year at the Max Planck Institute in Bonn, Germany and will be held next year at the University of Alberta in Edmonton, Alberta. Recently, string theory has given rise to entirely new mathematical fields and revitalized older ones. By now there is a large and rapidly growing number of 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 recent progress in the geometric Langlands program and the development of derived algebraic geometry and theory of n-categories. The influence flows in both directions, with mathematical techniques and ideas contributing crucially to major advances in string theory. The String-Math Conferences have become the main annual opportunity for researchers in all branches of the strings/math interaction to meet, learn, collaborate, and discuss their research with colleagues. The Simons Center’s goal of bridging the gap between mathematicians and physicists is a natural match for the goals of the conference. The center’s members were excited to host this year’s meeting.

This year’s conference organizing committee included Alexandre Abanov, Ron Donagi, Michael Douglas, Ljudmila Kamenova, Claude LeBrun, John Morgan, Nikita Nekrasov, Leonardo Rastelli and Martin Rocek. The organizing committee was assisted by an international advisory board consisting of leading mathematicians and physicists with interests in the math/physics interface. This board was formed by the steering committee of the series, and helped to determine the most promising topics for the lectures, as well as the individual speakers best equipped to present developments related to each topics. The conference covered a variety of topics in string theory and mathematics; many of the talks concerned aspects of supersymmetric gauge theories–knot invariants and category theory, aspects of BPS states (including their role in studying manifolds with G2 holonomy), integrability and the relation to two-dimensional models, the mathematical structure of amplitudes in such theories, and the structure of their embeddings in string theory and the implications for real world physics. Related themes that played a major role were Floer and Khovanov cohomology as well as sporadic groups and moonshine.
The Art Program at the Simons Center for Geometry and Physics is an outreach program connecting artists and scientists; with the overarching goal of enhancing the intellectual life of the Center, the broader University and local community while also drawing on the cultural and creative strengths of the University’s Fine Arts and Humanities faculty and students.

The Center's Art Gallery has presented a multiplicity of exhibits by established and emerging artists that have featured such varied media as kinetic sculpture, live 3D printing, woven grass, and blown-glass origami. Public workshop series offered by Math teacher and origamist Christine Edison in 2012 and 3D sculptor Phil Webster this spring offered many members of the Stony Brook community the opportunity to blend their creative and scientific instincts. Other Artists-in-Residence have included Melissa Clarke, Nina Douglas, and Saya Woolfalk.

Collaborative music concerts, lectures, and workshops as well as a unique mix of cross-disciplinary performances beginning with Differential Cohomology: A Dance in 2011 are the mark of the Center’s cultural program. The Center has also hosted costumed staged readings of the plays Galileo and QED produced and directed by Steve Marsh of the SBU Department of Theater Arts. Mr. Marsh most recently teamed with Dr. Christopher Herzog of the Yang Institute for Theoretical Physics on a science playwriting contest that awarded prizes from Dr. Herzog’s NSF grant to five different students and faculty members who crafted original ten minute plays with a strong science component that were then staged at the Center.

In Spring 2010, Nina Douglas and Tony Phillips conceived of a limestone wall for the Center carved with significant mathematical and physical equations and diagrams – a design was born and printed on the Center’s lobby wall. Christian White has been charged with completing this vision by cementing the Iconic Wall in stone. His process includes creating a mold of the wall, carving the pieces into limestone and casting in a lightweight polymer to apply to the Center’s central wall.

Visit the Center’s art program website at: http://scgp.stonybrook.edu/art for more information about exhibits and events including the current Paths exhibit curated by Alastair Noble and the upcoming Science and Poetry workshop by Alice Major in September.
CHRISTIAN WHITE
CARVING AN ICONIC WALL

Q The Center’s interior wall cannot support real limestone, how did you develop your material to mimic the look and feel of limestone?
A I did many experiments with various products that have been developed for this kind of application. The architects insisted that the final product be fireproof, leading me ultimately to the combination of materials that I am using, which has a variety of stone elements added to it to recreate the very specific look of the originals. The entire surface of each panel will be re-cut and finished by hand, to make the crispness, feel and texture more convincing.

Q You’ve been a stuntman in your career, how does stunt coordination compare with working with large blocks of stone?
A Surprisingly, many of the odd skills I have picked up over my life have proved valuable on this project. There has been a lot of rigging of pulley systems to move around these 300 lb. slabs of stone, not unlike the safety and twisting harnesses we use in gymnastics and stunt work. Also, finding people with very specialized and esoteric skills is similar in both fields. There is an extreme element of creative problem solving and coordination, also, in both occupations.

Q What has been the most challenging aspect of this project?
A The matter of solving details of design and production is always the hardest part of a project like this because it cannot be delegated. By far the greatest, most unpredictable cost in time has been nailing down the details of the appearance in three dimensions of each particular element and carving detail, especially since the design was conceived by someone else, and consisted only of a 2-D, graphic image. As my knowledge of things like Quantum Mechanics and Knot Theory is quite limited, every design decision needs to be run by the faculty of SCGP, to make sure that the meaning is not lost, obscured, or made less accurate.

Q Which has been your favorite theorem or icon to carve?
A That is hard to say; I am particular fond of the visual proof of the Pythagorean Theorem, as it is described in a short story by my uncle, Aldous Huxley, called “Young Archimedes”, in which it is drawn in the sand by a young Italian boy who came upon it on his own, but favorite to carve? I made two different plaster models of the Fibonacci diagram, both of which I like quite a lot, and maybe that will be the most fun, as it is geometry that is very dear to the heart of many artists, what we call “sacred geometry,” since it describes proportions that are common in logarithmic growth that we see everywhere in nature. Artists have been drawn to the golden section proportion for thousands of years.
It's a place where you can view the conjunction of Jupiter and Venus, with a glass of Spanish grenache in hand, carefully paired with artisanal cheeses from local purveyors. Like the Center it’s named for, the SCGP Café crosses boundaries to stimulate, exhilarate, and inspire its guests.

The menu of soups, salads and entrees, crafted daily by Chef Paolo Fontana, focuses on organically inspired French, Italian, and American cuisines. Chef Paolo’s farm to table philosophy was born out of love of his grandparents’ farm in Sicily where he learned to cook from the warm summer’s harvest. Chef Paolo studied in Avellino (Italy), The Culinary Institute of America in New York, Stony Brook University, and NYU, and has worked as an apprentice to world-renowned chef Mario Batali and as sous chef for one of his personal favorites, Chef Michael Romano. He has cooked for New York City culinary landmarks such as the Union Square Café, Babbo, Gramercy Tavern, Craft, as well as Chez Panisse in Berkeley, California and most recently, Mirabelle, under award winning and La Toque d’Argent recipient, Chef Guy Reuge.

Most recently Chef Paolo led a master class on traditional Italian cuisines for the members of the Center, preparing a scrumptious tasting of homemade dishes including hand crafted cheese and pasta. The Café is preparing series of master classes for the public with a focus on a different cuisine each month giving Chef Paolo the opportunity to explore diverse locally sourced ingredients with the changing seasons.

Café team member Chris Ciccone also cooked his signature dishes including lamb- and eggplant-stuffed ravioli in a goat cheese and dill alfredo sauce, at the Center’s viewing of the premier of MasterChef on May 22nd. Chef Chris is keeping quiet about his placement on the Fox network cooking competition show, but based on his yummy recipes, it could just be that his mouth is full.

Chef Paolo prepares for another fascinating culinary master class at the café
TRY THIS REFRESHING SUMMER RECIPE FROM CHEF PAOLO!

ORGANIC WATERMELON, FETA, AND CORIANDER SALAD

1 Seedless Organic Watermelon
1 Pound Feta, removed from Brine
1 Tablespoon Coriander Seed
1 Cup dry White Wine
Extra Virgin Olive Oil
Sea Salt

In a heavy bottom sauce-pan, heat wine and coriander. Reduce until almost all of the wine has evaporated. Meanwhile, cut rind off watermelon, and cut into desired shape. We use a full mouth sized square piece, 2”x2”. Crumble feta, coriander, sea salt and olive oil over watermelon. Serve immediately. Best enjoyed outside under the hot sun!

AS THE WEATHER WARMS, GUESTS AT THE SCGP CAFÉ CAN DINE AL FRESCO ON THE OUTDOOR TERRACE. FROM THERE THEY CAN ALSO ENJOY THE AROMATHERAPY PROVIDED BY CHEF PAOLO’S LIVING GARDEN. YOU MIGHT EVEN NOTICE THE HOMEGROWN GOODNESS UTILIZED IN THE CAFÉ’S FRESH MEALS.
Overseeing all activities at the Simons Center for Geometry and Physics is a Board of Trustees comprised of members of the Stony Brook and peer academic communities. Scientific programs and workshops held at the Simons Center for Geometry and Physics are selected by a Scientific Advisory Committee comprised of faculty members from peer institutions around the world, for information on how to submit a proposal to the Center for a workshop, program or visit, please see: http://scgp.stonybrook.edu.

For more information about the SCGP Staff, please visit us at http://scgp.stonybrook.edu/people/staff