QGM HIGHLIGHTS 2015

Selected scientific results


J.E. Andersen & **Kenji Ueno** published a paper in the top international journal Inventiones Mathematicae, where they provided an explicit isomorphism from the modular functor underlying the skein-theoretic model for the Witten–Reshetikhin–Turaev TQFT due to Blanchet, Habbeger, Masbaum and Vogel to the vacua modular functor coming from the conformal field theory. This thus provides a geometric construction of the TQFT first proposed by Witten and constructed first by Reshetikhin–Turaev from the quantum group $U_q(sl(N))$.


J.E. Andersen & **Rinat Kashaev** proved a version of the volume conjecture for the Teichmüller TQFT, together with S. Garoufalidis, for the case of one cusp hyperbolic three-manifolds and a paper with this result is under preparation. J.E. Andersen and R. Kashaev took initial steps towards extending the Teichmüller TQFT to a four-dimensional theory based on the Neumann-Zagier symplectic structure and the gluing equations of Thurston.


J.E. Andersen & **Leonid Chekhov** proved combinatorically the explicit relation between genus filtrated s-loop means of the Gaussian matrix model and terms of the genus expansion of the Kontsevich-Penner matrix model, which is the generating function for volumes of discretized (open) moduli spaces. It was proved that this generating function is also the generating function for ancestor invariants of a cohomological field theory thus enjoying the Givental decomposition, which provides a proof of (quasi)-polynomiality of the discrete volumes.

Henning Haahr Andersen concentrated his research on the study of tilting modules for quantum groups at arbitrary roots of unity. Together with QGM postdoc D. Tubbenhauer and Professor C. Stroppel he first proved a surprisingly general connection between tilting modules and cellular algebras. This theorem gives a way of producing cellular bases for endomorphism algebras of any such tilting module. As a first application they obtain in this way the cellularity of many important classes of finite dimensional algebras. As a next step they established criteria for when such algebras - for instance the much studied Brauer algebras - are semisimple. This generalises and significantly simplifies several known results on semisimplicity.

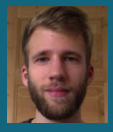
One of **Hirosi Ooguri's** current projects is to derive robust predictions from superstring theory on its low energy effective theory using methods developed in quantum information theory. Ooguri proved that any consistent gravitational theory whose spacetime is asymptotic to the anti-de Sitter space must satisfy a certain set of positivity conditions on its local matter energy density. This result was published in Physical Review Letters and selected for the Editors' Suggestion.

With Soibelman, **Maxim Kontsevich** established an algebraic wall-crossing structure (applicable e.g. to cluster algebras). Kontsevich further found a resurgence structure in the path integral for the free particle on the sphere. Together with F. Haiden, L. Katzarkov and P. Pandit he worked out many details in their ongoing project on Kähler stability in triangulated categories over local fields.

Qiongling Li, joint with Daniele Alessandrini found, using Higgs bundes, a new way to construct AdS structures, which illuminate many of their properties explicitly, including the very recent volume formula by Tholozan. Li further understood the asymptotics of Hitchin representations along certain Higgs bundles rays.

Yang Huang constructed, in a joint work in progress with Prof. K. Honda, a contact Morse function in the critical level, which may play a fundamental role in the intrinsic understanding of contact manifolds in any dimension. Another work in progress by Huang is the construction of a Floer-type theory for foliations using contact topology.

Jens Kristian's research focused on the identification of the Hitchin connection with the KZ connection in ongoing joint work with J.E. Andersen.



Willam Petersen adapted, in joint work with J.E. Andersen, Turaev's construction of modular functors from modular tensor category, so as to obtain modular functors in the sense of Kevin Walker.

Dominic Joyce wrote papers with postdocs D. Borisov on virtual cycles for -2-shifted symplectic derived schemes, leading to new Donaldson-Thomas type invariants "counting" (semi)stable coherent sheaves on Calabi-Yau 4-folds, and with Pavel Safronov on a "Lagrangian neighbourhood theorem" for Lagrangians in k-shifted symplectic derived schemes.

Indranil Biswas computed the automorphism group of moduli of Higgs line bundles on a compact Riemann surface.

Nitin Nitsure research during 2015 focused on Moduli theory for bundles and application of ideas inspired by geometry to experimental soft condensed matter physics.

Travis Mandel posted a paper in which he shows how to define the Gross-Hacking-Keel-Kontsevich theta functions in terms of counts of tropical curves and tropical disks. He also defines quantum deformations of these theta functions, and he expresses these in terms of refined counts of tropical curves, analogously to the refined tropical counts recently defined by Block and Goettsche.

Alexander Shapiro & **Gus Schrader** constructed an embedding of the quantum group $U_q(g)$ into the quantized algebra of functions on the big symplectic leaf of the group G. As a corollary, they obtain a presentation of $U_q(g)$ in terms of q-commuting generators, which has immediate applications to the Gelfand-Kirillov conjecture.

Together with J.E. Andersen, **Kenneth Rasmussen** has constructed a Hitchin connection with weaker criterion on the family of complex structures.

Statistics

Publications: 92 journal articles, 1 conf. proc., 1 book, 7 theses, 4 qualifying dissertations & 55 preprints
QGM activities: 1 conference, 3 masterclasses, 31 seminars, 2 retreats.
QGM members gave 105 invited talks around the world during 2015.

New staff

Alessandro Malusà
PhD student

Qiongling Li
Postdoc
(joint position with Caltech)

Satoshi Nawata
Postdoc
(joint position with Caltech)

Special events

Masterclass: 23-27 Mar 2015: by Ivan Losev (Northeastern)
Conference: 27-31 Jul 2015: New developments in TQFT
Masterclass: 3-12 Aug 2015: by Dominic Joyce & Lino Amorim (Oxford)
PhD Retreat: 12-14 Aug 2015: QGM PhD retreat 2015
Masterclass: 9-13 Nov 2015: by Nicolai Reshetikhin (UC Berkeley)
Retreat: 13-17 Nov 2015: QGM Nielsen Retreat 2015 at Sandbjerg Estate

The Danish-Indian collaboration continued in 2015: The total no. of exchanges ultimo 2015 was 47 man-months. Three joint events were conducted. Six of the involved Danish and one of the involved Indian PhD students have ultimo 2015 obtained their PhD degrees. In 2015 one co-authored paper was published and further 46 journal papers, 1 conf. proceeding and 24 preprints associated with the collaboration was published.

Danmarks Grundforskningsfond
Danish National Research Foundation

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