Changrim Ahn
Ehwa Womans University

Jordan blocks in Strongly twisted SYM

Abstract: t.b.a.

Hidetoshi Awata
Nagoya University

On the quantum toroidal gl_1 algebra and the AGT correspondence

Abstract: We discuss on recent developments of the representation theory of the quantum toroidal gl_1 algebra and its relation with the AGT correspondence.

Pascal Baseilhac
University of Tours

Diagonalization of the Heun-Askey-Wilson operator, Leonard pairs and the algebraic Bethe ansatz

Abstract: The Heun-Askey-Wilson (HAW) operator arises in different context, such as the theory of Leonard pairs, the theory of special functions related with the q-analog of the Heun operator or the time-band limiting problem in signal processing. In the first part, I will show how the HAW operator can be derived from Sklyanin's framework in terms of the elements of the Askey-Wilson algebra triple $A, A*$ and $A^\diamond$. Using this setup, for different specializations and the generic case, the HAW operator is diagonalized within the framework of the algebraic Bethe ansatz using the theory of Leonard pairs. Eigenstates are constructed in the form of Bethe states whose Bethe roots satisfy Bethe ansatz equations of homogeneous or inhomogenous type. In particular, the inhomogeneous term is determined by the characteristic polynomial of $A^\diamond$. For each set of Bethe equations, an alternative presentation is given in terms of 'symmetrized' Bethe roots. In a second part, realizations of the HAW operator as second q-difference operators are introduced. It will be explained how the TQ-relations are derived from that point of view. In a third part, we will give some examples of integrable models that are solved using this approach: for instance, various types of three-sites Heisenberg spin chains in a magnetic field with inhomogeneous couplings, three-body and boundary interactions. Work done in collaboration with R. Pimenta (Sao Carlos and IDP).

Murray Batchelor
Australian National University

Wrestling with free parafermions

Abstract: In this talk I will give an update on our recent calculations on the properties of the free parafermion Z(N) spin chain. For N = 2 this model reduces to the familiar quantum Ising chain in a transverse field described by free fermions. The more general model was discovered in 1989 by Rodney Baxter. Then not much at all happened until 2014 when Paul Fendley showed that the eigenvalue structure corresponds to free parafermions. The model has some interesting if not peculiar properties due to it being non-Hermitian for N > 2.

Vladimir Bazhanov
Australian National University

On the scaling behaviour of an alternating spin chain

Abstract: In this talk I will report the results of the study of a 1D integrable alternating spin chain whose critical behaviour is governed by a CFT possessing a continuous spectrum of scaling dimensions. I will review both analytical and numerical approaches to analyzing the spectrum of low energy excitations of the model. It turns out that the computation of the density of Bethe states of the continuous theory can be reduced to the calculation of the connection coefficients for a certain class of differential equations whose monodromy properties are similar to those of the conventional confluent hypergeometric equation. The finite size corrections to the scaling are also discussed.

Jean-Emile Bourgine
KIAS

New quantum toroidal algebras from supersymmetric gauge theories

Abstract: Quantum affine algebras describe the symmetries of quantum integrable systems, and provide essential tools to solve them. Recently, a method has been obtained to associate an algebra (the Cohomological Hall algebra) to a quiver

representation. In many cases, the algebra defined in this way is a deformation of a quantum affine algebra. Exploiting the coalgebraic structure, an intertwining operator can be derived, and then used to compute various physical quantities through a diagrammatic technique. In this talk, I will present a concrete realization of this general program, and consider the quiver representation describing the non-perturbative sector of 4D N=2 super-symmetric gauge theories defined on a particular space-time. This space-time is an orbifold obtained from the action of the Abelian group Z/pZon the Euclidean space C^2, and the relevant algebra is a deformation of the quantum toroidal gl(p) algebra. Then, two different representations of this algebra will be constructed, namely a vertex (or level one) representation, and a highest weight representation acting on states parameterized by colored Young diagrams. Finally, the intertwining operator between these representations will be derived, and used to reconstruct the partition function and the qq-characters of the gauge theory.

Jan de Gier
University of Melbourne

KPZ universality in a two-species exclusion process

Abstract: We discuss a derivation from first principles of a joint current probability distribution function in the two-species Arndt-Heinzel-Rittenberg model. Our result is based on a Bethe ansatz approach for the Green's function, and an asymptotic analysis confirms the heuristic prediction of non-linear fluctuation hydrodynamics. This is the first rigorous proof for a Tracy-Widom type distribution function in a multi-species model, and is joint work with Zeying Chen, Iori Hiki and Tomorhiro Sasamoto.

Patrick Dorey
University of Durham

t.b.a

Abstract: t.b.a

Benjamin Doyon
King's College London

Large deviations in transport and twist field correlation functions from hydrodynamics

Abstract: Hydrodynamics is a powerful framework for large-wavelength phenomena in many-body systems. It was extended recently to include integrable models, giving "generalised hydrodynamics" . In this talk, I will first review fundamental aspects of the hydrodynamic of integrable systems. I will then explain how hydrodynamics gives access to the exact large-time fluctuations in the transport of quantities in one dimension such as particles or energy - their so-called full counting statistics. Applied to integrable systems, this generalises the free-fermion Levitov-Lesovik formulae to a very large family of interacting theories. This works in Gibbs and generalised Gibbs ensembles, including in nonequilibrium steady states. Interestingly, I will explain how the same framework gives exact exponential decays of "twist field" correlation functions, such as the exponential field in the sine-Gordon model.

Fabian Essler
University of Oxford

Quantum mechanical probability distributions in integrable models in and out of equilibrium

Abstract: I consider the quantum mechanical probability distributions of observables defined in large, finite subsystems for the spin-1/2 Heisenberg XXZ chain and the transverse field Ising model. I first review the equilibrium case in the quantum critical regime. I then turn to the time evolution of these quantities after quantum quenches.

Frank Göhmann
University of Wuppertal

Finite temperature dynamical correlation functions of the XX chain

Abstract: A series representation of the dynamical two-point correlation functions of Yang-Baxter integrable quantum chains involving the form factors of an associated quantum transfer matrix is used to analyse the transverse correlation function of the XX chain. Starting from the series we obtain new results for the long-time, large-distance asymptotic behaviour in the spacelike regime and a novel Fredholm determinant representation that allows us to efficiently analyse the model numerically and asymptotically in the high-temperature limit.

Katsushi Ito
Tokyo Institute of Technology

Generalized ODE/IM correspondence

Abstract: We derive TBA systems govering the exact WKB periods in 1-dimensional quantum mechanics with arbitrary polinomial potentials. The TBA systems provide a generalization of the ODE/IM correspondence proposed by Dorey and Tateo in 1999. It also gives the solution of a analytic bootstrap program of resurgent quantum mechanics formulated by Voros. This talk is based on the joint work with Marcos Marino and Hongfei Shu (arXiv:1811.04812[hep-th]).

Michio Jimbo
Rikkyo University

Remarks on deformed W algebras and integrals of motion

Abstract: We revisit the deformed W algebras introduced by Frenkel and Reshetikhin in 1997. Using a certain comodule algebra over the quantum toroidal gl(1) algebra, we construct a large class of deformed W algebras (slightly different from those of FR), and commuting family of operators thereof. (Joint work with B. Feigin, E. Mukhin and I. Vilkovisky.)

Ivan Kostov
Saclay

Quantum Field Theory for the Thermodynamic Bethe Ansatz

Abstract: On this talk I formulate an effective QFT in the rapidity space, involving a pair of bosons and fermions, which computes the finite-size effects in 1+1 dimensional models of factorised scattering. The perturbative expansion of the path integral for this effective QFT matches the recently obtained graph expansions for the free energy in TBA. The theory is one-loop exact and the path integral localizes to the critical point of the action, which is determined by the TBA equation. For simplicity, I consider a scattering matrix for a single neutral particle and no bound states, as the one for the sinh-Gordon model. Both periodic and open boundary conditions are considered. In case of periodic boundary conditions, the loop effects due to bosons and fermions compensate completely while for open boundary conditions the one-loop contribution gives the universal part of the boundary free energy.

Andreas Klümper
University of Wuppertal

Exact solution of the spin $\frac{1}{2}$ XXX chain with off-diagonal boundary fields

Abstract: The spin-1/2 Heisenberg chain with periodic boundary conditions is a seminal model of integrable resp. exactly solvable systems. It is known that the Heisenberg chain with arbitrary boundary fields is still integrable, but so far defied an explicit solution for the case of off-diagonal fields which break the $U(1)$ symmetry. As the magnetization is no longer a good quantum number, the direct application of the Bethe ansatz fails.

Here we show how the problem can be solved by a set of non-linear integral equations (NLIEs). Instead of two NLIEs as in the case of the periodically closed chain, we find a set of three NLIEs from which the eigenvalues of the Hamiltonian can be obtained.

Jules Lamers
University of Melbourne

The q-deformed Haldane-Shastry spin chain: from the affine Hecke algebra, via 'freezing', to exact eigenvectors

Abstract: The Haldane-Shastry model is an exactly-solvable long-range spin chain whose remarkable properties include Yangian symmetry already at finite system size. Its q-deformation was found by D. Uglov in '95 in an e-print that seems to have gone by unnoticed. We give a direct derivation, starting from the affine Hecke algebra via 'freezing', of the pairwise form of the 'chiral' Hamiltonian obtained by one of us. We further obtain its 'antichiral' and 'full' counterparts, the latter of which has real spectrum also for the root of unity case. Our main new result is an exact closed-form expression for the (highest-weight) eigen-vectors at finite size. It has a simple component that involves the symmetric square of the q-Vandermonde times a Macdonald polynomial (q-deformed zonal polynomial). This is ongoing work together with Vincent Pasquier and Didina Serban.

Pierre Le Dousaal
ENS, Paris

Large deviations for the KPZ equation and the edge of random matrices

Abstract: Using the exact results valid at all time for the KPZ equation for various initial conditions, we show how to obtain the tails of the one point distribution of the height. We identify the large deviation regimes at short time and at large time, and calculate the rate functions. The results agree very well with numerical simulations. We explain and exploit the connections of the problem with the eigenvalues of random matrices at the edge of the spectrum, which leads to study the

problem of a 1D Coulomb gas perturbed at its edge.

Andrei Mironov
ITEP

CFT, Painleve and matrix models

Abstract: The modern version of conformal matrix model describes conformal blocks in the Dijkgraaf-Vafa phase. Therefore it possesses a determinant representation and becomes a Toda chain tau-function only after a peculiar Fourier transform in internal dimensions. In this case, the Hirota equations arise in a peculiar discrete form (when the couplings are actually Miwa time-variables). Instead, this integrability property is actually independent on the measure in the original hypergeometric integral. To get hypergeometric functions, one needs to pick up a very special tau-function satisfying an additional "string equation". Usually, its role is played by the lowest Virasoro constraint, but, in the Miwa variables, it turns into a finite-difference equation w.r.t. the Miwa variables. One can get rid of these differences by rewriting the string equation in terms of some double ratios of the shifted τ -functions, and then these ratios satisfy more sophisticated equations equivalent to the discrete Painleve equations by M. Jimbo and H. Sakai (q-PVI equation). They look much simpler in the q-deformed ("5d") matrix model, while in the "continuous" limit q->1 to 4d one should consider the Miwa variables with non-unit multiplicities, what finally converts the simple discrete Painleve q-PVI into sophisticated differential Painleve VI equations.

Sanefumi Moriyama
Osaka City University

Hanany-Witten Transition in Quantum Curves

Abstract: It was known that the $U(N)^4$ super Chern-Simons matrix model describing the worldvolume theory of D3-branes with two NS5-branes and two (1,k)5-branes in IIB brane configuration (dual to M2-branes after taking the T-duality and the M-theory lift) corresponds to the D_5 quantum curve. By combining both the viewpoints of the brane configurations and the quantum curves, we obtain a larger picture for supersymmetric M2-branes. In clarifying the M2-brane physics it is important to cut the compact T-duality circle (or the circular quiver diagram) open, which is similar to the concept of "fixing a reference frame" or "fixing a local chart". In my talk I will explain these recent ideas on the M2-brane physics.

Hisayoshi Muraki
Sogang University

From minimal gravity to intersection theory

Abstract: We investigate the relation between the two-dimensional minimal gravity on a surface with boundaries and the open intersection theory in arXiv:1904.06885. It is noted that the gravity is described in terms of the boundary cosmological constant while the open intersection theory is in terms of the boundary marked point generating parameter. Based on the idea that the two different descriptions are related by the Laplace transform (arXiv:1808.07304), we reproduce the known results in the open intersection theory from the minimal gravity, and provide a compact expression for the generating function on a disk.

Takeshi Oota
Osaka City University

Unitary matrix model, supersymmetric gauge theory, and Painleve system

Abstract: There is a close connection between certain types of matrix models and supersymmetric gauge theories. In the case of N=2 supersymmetric SU(2) $N_f = 2$ gauge theory (in the self-dual omega background), a generating function of the instanton partition functions is described by a unitary matrix model. The unitary matrix model is an extension of the Gross-Witten-Wadia model by a logarithmic potential. Its partition function is a tau-function of the Painleve III' equation. The double scaling limit of this matrix model corresponds to the limit to the Argyres-Douglas conformal fixed point of the gauge theory.

(References: 1805.05057 [hep-th], 1812.00811 [hep-th])

Vincent Pasquier
Saclay

Q matrix and Bäcklund for quantizing integrable models

Abstract: I shall review the method of Q matrix to quantize lattice models as an alternative to the Algebraic Bethe Ansatz. This method is the only available for the Toda chain, Ablowits Ladik chain etc... The Q matrix is a sort of quantized version of the Bäcklund transform. One possibility to make further progres is to introduce a nonlinear integral

equation which in first approximation coincides with the assymptotic Bethe Ansatz of Sutherland. I will discuss some difficulties and I hope some applications.

Paul Pearce
University of Melbourne

Extended T-Systems, Q Matrices and T-Q Relations for $s\ell(2)$ Models at Roots of Unity

Abstract: The mutually commuting $1 \times n$ fused single-row transfer matrices $T^n(u)$ of the critical six-vertex model are considered at roots of unity $q = e^{i\lambda}$ with crossing parameter $\lambda = \frac{(p'-p)\pi}{p'}$ a rational fraction of π. For diagonal twisted boundary conditions, we find explicit closure relations for the T-system functional equations and obtain extended sets of bilinear T-system identities. We also define extended Q matrices as linear combinations of the fused transfer matrices and obtain extended matrix T-Q relations. Using our extended T-system and extended T-Q relations for eigenvalues, we deduce the usual scalar Baxter T-Q relation and the Bazhanov-Lukyanov-Zamolodchikov decomposition of the fused transfer matrix $T^{p-1}(u+\lambda)$ in terms of the product $Q^+(u)Q^-(u)$ or $Q(u)^2$. It follows that the zeros of $T^{p-1}(u+\lambda)$ are comprised of the Bethe roots and complete p' strings. We also clarify the formal observations of Pronko and Yang-Nepomechie-Zhang and establish, under favourable conditions, the existence of an infinite fusion limit $n \to \infty$ in the auxiliary space of the fused transfer matrices. Similar results hold for $U_q(s\ell(2))$ invariant and off-diagonal vacuum boundary conditions on the strip.

Leonid Petrov
University of Virginia

Mapping TASEP back in time

Abstract: We obtain a new relation between the distributions μ_t at different times $t \geq 0$ of the continuous-time TASEP (Totally Asymmetric Simple Exclusion Process) started from the step initial configuration. Namely, we present a continuous-time Markov process with local interactions and particle-dependent rates which maps the TASEP distributions μ_t backwards in time. Under the backwards process, particles jump to the left, and the dynamics can be viewed as a version of the discrete-space Hammersley process. Combined with the forward TASEP evolution, this leads to a stationary Markov dynamics preserving μ_t which in turn brings new identities for expectations with respect to μ_t. Based on a joint work with Axel Saenz.

Tomaz Prosen
University of Ljubljana

The Rule 54: Completely Solvable Statistical Mechanics Model of Deterministic Interacting Dynamics

Abstract:
Derivation of macroscopic statistical laws, such as Fourier's, Ohm's or Fick's laws, from reversible microscopic equations of motion is one of the central fundamental problems of statistical physics. In recent years we have witnessed a remarkable progress in understanding the dynamics and nonequilibrium statistical physics of integrable systems. This encourages us to attempt to understand the aforementioned connection at least in specific classes of nontrivial integrable systems with strong interactions. In my talk I will introduce a family of reversible cellular automata, which model systems of interacting particles, and for which we can prove the existence of diffusion and exactly solve several interesting paradigms of statistical physics, e.g.: nonequilibrium steady states of the system between two stochastic reservoirs, the problem of relaxation to the nonequilibrium steady state, or even the problem of explicit time evolution of macroscopic states, for instance, the solution of inhomogeneous quench problems and the calculation of dynamical structure factor in highly entropic equilibrium states.

Francesco Ravanini
University of Bologna

On the Generalized Hydrodynamics of Unstable Excitations

Abstract: We apply the theory of Generalized Hydrodynamics (GHD) to the study of an integrable quantum field theory that possesses both stable and unstable particles, namely to a Homogeneous Sine-Gordon (HSG) model. Explicit TBA calculations are done in the case of the $SU(3)_2$ HSG, in the partition protocol setup. Features of the stationary currents in this framework are investigated.

Didina Serban
Saclay

Exact results for the simplest four-point function in N=4 SYM

Abstract:
In the last two decades integrability has found an unexpected application to describe the planar limit of conformal, higher dimensional gauge theories. The most outstanding example is that of the supersymmetric $\mathcal{N} = \triangle$ gauge theory in four dimensions, known to be dual to string theory on $AdS^5 \times S_5$ background. In this talk, I will explain how the computation of a particularly simple example of the correlation function of four gauge-invariant operators can be done by using a geometrical decomposition in terms of non-local form factors.

Junichi Shiraishi
Univeristy of Tokyo

Affine Screening Operators, Affine Laumon Spaces, and Conjectures Concerning Non-Stationary Ruijsenaars Functions

Abstract:
Based on the screened vertex operators associated with the affine screening operators, we introduce the formal power series $f^{\widehat{\mathfrak{gl}}_N}(x,p|s,\kappa|q,t)$ which we call the *non-stationary Ruijsenaars function*. We identify it with the generating function for the Euler characteristics of the affine Laumon spaces. When the parameters s and κ are suitably chosen, the limit $t\ rightarrowq$ of $f^{\widehat{\mathfrak{gl}}_N}(x,p|s,\kappa|q,q/t)$ gives us the dominant integrable characters of $\widehat{\mathfrak{sl}}_N$ multiplied by $1/(p^N;p^N)_\infty$ (*i.e.* the $\widehat{\mathfrak{gl}}_1$ character). Several conjectures are presented for $f^{\widehat{\mathfrak{gl}}_N}(x,p|s,\kappa|q,t)$, including the bispectral and the Poincaré dualities, and the evaluation formula. The main conjecture asserts that (i) one can normalize $f^{\widehat{\mathfrak{gl}}_N}(x,p|s,\kappa|q,t)$ in such a way that the limit $\kappa \to 1$ exists, and (ii) the limit $f^{\mathrm{st.}\,\widehat{\mathfrak{gl}}_N}(x,p|s|q,t)$ gives us the eigenfunction of the elliptic Ruijsenaars operator. The non-stationary affine q-difference Toda operator $\mathcal{T}^{\widehat{\mathfrak{gl}}_N}(\kappa)$ is introduced, which comes as an outcome of the study of the Poincaré duality conjecture in the affine Toda limit $t \to 0$. The main conjecture is examined also in the limiting cases of the affine q-difference Toda ($t \to 0$), and the elliptic Calogero-Sutherland ($q, t \to 1$) equations.

Naoto Shiraishi
Gakushuin University

Proof of absence of local conserved quantity in S=$\frac{1}{2}$ XYZ chain with a magnetic field

Abstract: The integrable system is one of the most important subjects in mathematical physics, and various models have been revealed to be integrable. Integrable systems possess sufficiently many local conserved quantities, which lies behind the solvability of integrable systems.

Although vast literature is devoted to integrability, very few studies have addressed non-integrability of concrete models. Here, we used the word non-integrable in the sense that the model has no local conserved quantity. The absence of local conserved quantities is necessary for thermalization and mixing, which is relevant to broad research fields from the application of the Kubo formula [1] to the scrambling in a black hole [2]. In spite of this necessity, the non-integrability of a certain model is usually not proven but only expected, and very few theoretical works have tackled to prove it. In fact, a rigorous proof of non-integrability in a concrete model has been completely elusive.

To break this impasse, in this presentation, we rigorously prove that a particular quantum many-body system, the spin-1/2 XYZ chain with a magnetic field, is indeed non-integrable in the sense that this system has no nontrivial local conserved quantity [3]. The proof of non-integrability exploits a bottom-up approach: We first list up all the candidates of local conserved quantities, and then prove that all of them cannot be conserved. Any nontrivial conserved quantity in this model turns out to be a sum of operators supported by at least half of the entire system. Our approach can apply to other S=1/2 systems including the Heisenberg model with the next nearest-neighbor interaction.

[1] A. Shimizu and K. Fujikura, J. Stat. Mech. 024004 (2017). [2] S. H. Shenker and D. Stanford, J. High Energ. Phys. 2014:67 (2014). [3] N. Shiraishi, arXiv:1803.02637

Jean-Marie Stéphan
University of Lyon 1

free fermions at the edge of interacting systems

Abstract:
The Tracy-Widom (T-W) law governs the fluctuations of the largest eigenvalue of a random hermitian matrix. Its appearance is not limited to random matrix theory: since its discovery, it has been found to describe, after non trivial rescaling, the edge behavior of out of equilibrium classical exclusion processes such as ASEP, quantum out of equilibrium problems, or 'arctic circle' type setups in equilibrium statistical mechanics. This distribution can be understood –from a physicist perspective– using a simple 1d free fermions model in a linear potential. In this talk I will discuss a few examples of interacting quantum systems with inhomogeneous couplings were T-W naturally appears in the ground state, and give a simple argument why this occurs. In the case of Lieb-Liniger models in trapping potentials or XXZ spin chain in varying magnetic field, Bethe Ansatz considerations allow us to compute the appropriate rescaling exactly. I will also discuss interacting quantum out of equilibrium setups where T-W scaling can break down, leading to more complicated

edge universality classes.

Roberto Tateo
University of Turin

Irrelevant perturbations of 2D integrable models

Abstract: Two-dimensional quantum field theories deformed by Zamolodchikov's TTbar operator have recently attracted the attention of theoretical physicists due to the many important links with string theory and AdS/CFT. The introduction of this perturbation induces coupling between the stress-energy tensor and spacetime and the resulting models can be interpreted as the undeformed theories coupled to topological Jackiw-Teitelboim gravity.

In this talk, I will argue that there exist infinite families of generalised gravity-type models corresponding to specific irrelevant deformations of integrable quantum field theories. In these models, the geometry couples instead to generic combinations of the local conserved currents, labelled by the Lorentz spin. These natural generalisations of the TTbar perturbation are, in spirit, similar to the JTbar model as the associated scattering phase factors explicitly break Lorentz symmetry.

Dinh-Long Vu
Saclay

From the product of conserved charges to counting statistics of currents in GHD: a diagrammatic approach

Abstract: I propose a diagrammatic formulation to compute the expectation value of the products of con- served charges in Generalized Gibbs Ensemble (GGE). The diagrams are similar in appearance to tree Feynman diagrams. The weight of their vertices and propagators are readily obtained from Thermodynamic Bethe Ansatz (TBA). The main idea of this approach follows the same line of recent works [1?3], namely to derive thermodynamic quantities directly from their matrix elements and form factors. I also conjecture that the counting statistics of transport currents in Generalized Hydrodynamics (GHD) admit a similar diagrammatic expansion, with only minor modifications. I show that this conjecture is in agreement with the result of [4?6] (obtained by hydrodynamic projection) up to the fourth cumulant.
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Micheal Wheeler
University of Melbourne

Coloured vertex models and non-symmetric Macdonald polynomials

Abstract: In recent years, the higher-spin six-vertex model has seen a very rich interaction with one-dimensional stochastic processes and the theory of symmetric functions. This talk will be about some recent works in collaboration with A. Borodin, which extend the above topics to the setting of higher-rank algebras

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Masahito Yamazaki
IPMU

Four-Dimensional Origin of Integrability

Abstract: It has been a long-standing problem to explain the origin of spectral parameters of integrable models in a suitable modification of the three-dimensional Chern-Simons theory. Recently it has been found that the answer is provided by a four-dimensional analogue of the Chern-Simons theory, and this has lead to a number of new results and insights, both in integrable lattice models and two-dimensional integrable field theories. In this talk I will give an overview of these fascinating developments, based on my papers with Kevin Costello and Edward Witten.