FRG Workshop
Special Holonomy Geometry, Mirror, and Supersymmetry
May 9-10, 2016
Harvard University Science Center Room 507

Monday May 9, 2016

9:00am - 9:15am	*Welcome remarks*	
9:15am - 10:15am	Ron Donagi	Super Riemann surfaces and superstring perturbation theory
10:15am - 10:30am	*Coffee break*	
10:30am - 11:30am	Mauricio Romo	B-brane transport on (non-) abelian gauged linear sigma models
11:30am – 1:00pm	*Lunch*	
1:00pm - 2:00pm	An Huang	Zeros of derivatives of generalized hypergeometric functions
2:00pm - 2:15pm	*Coffee break*	
2:15pm - 3:15pm	Jie Zhou	Phase transition in moduli space of elliptic curves and Cayley transform
3:15pm - 3:30pm	*Coffee break*	
3:30pm - 4:30pm	Melissa Liu	MSP fields, GW theory of the quintic threefold, and FJRW theory of the Fermat quintic

Tuesday May 10, 2016

9:00am - 10:00am	Tony Pantev	Enhanced moduli of D-branes and superpotentials
10:00am - 10:15am	*Coffee break*	
10:15am - 11:15am	Jim Halverson	Gauge Enhancement and Landscaping in G2 Compactifications of M-theory
11:15am - 11:30pm	*Coffee break*	
11:30pm - 12:30pm	Masahito Yamazaki	Mirror Symmetry, Integrability and Quivers
12:30pm - 2:00pm	*Lunch*	
2:00pm - 3:00pm	Daniel Robbins	G-structures and the alpha' expansion on compact special holonomy manifolds
3:00pm - 3:15pm	*Coffee break*	
3:15pm - 4:15pm	William Linch	Supergeometry of Gauged p-Form Hierarchies
4:15pm - 4:30pm	*Coffee break*	
4:30pm - 5:30pm	Paul Seidel	Second order ODEs and the mirror map

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Talk titles and abstracts (in order of presenting):

Monday, May 9th, 2016

Ron Donagi
Title: Super Riemann surfaces and superstring perturbation theory.
Abstract: Super Riemann surfaces exhibit many of the familiar features of ordinary Riemann surfaces, and some novelties. They have moduli spaces and Deligne-Mumford compactifications. One can integrate and construct measures on moduli spaces. The punctures one can insert come in two varieties: Ramond and Neveu-Schwarz.

I will survey some of the expected and unexpected features, including some aspects of non splitness: for genus g \geq 5, the moduli space of super Riemann surfaces is not projected (and in particular is not split); it cannot be holomorphically projected to its underlying reduced manifold. Physically, this means that certain approaches to superstring perturbation theory that are very powerful in low orders have no close analog in higher orders. Mathematically, it means that the moduli space of super Riemann surfaces cannot be constructed in an elementary way starting with the moduli space of ordinary Riemann surfaces. It has a life of its own.

When we examine the Deligne-Mumford compactification of moduli space, and especially the Ramond boundary divisors, we find that the interesting new phenomena start already genus one. This is interpreted as the mechanism that allows supersymmetry to remain unbroken at tree level in certain models of superstring perturbation theory, but to be spontaneously broken at one loop.

Mauricio Romo
Title: B-brane transport on (non-) abelian gauged linear sigma models.
Abstract: I will define the hemisphere partition function for B-brane boundary conditions in GLSMs and describe some applications to B-brane transport on spacial classes of (non-) abelian GLSMs.

An Huang
Title: Chain integral solutions to the GKZ system.
Abstract: I will describe an explicit geometric description, of all solutions to the GKZ system, arising from Calabi-Yau hypersurface family in an ambient Fano toric variety. The existence of such a description in general was conjectured by physicists in the 90's.

Jie Zhou
Title: Phase transition in moduli space of elliptic curves and Cayley transform.
Abstract: I will report a recent joint work with Y. Shen on the CY/LG correspondence for elliptic orbifold curves via modular forms. We show that the generating series in the Gromov-Witten theory of each elliptic orbifold curve and those in the corresponding Landau-Ginzburg A-model, mathematically known as the Fan-Jarvis-Ruan-Witten theory,

are different representations of the same set of underlying quasi-modular forms, but expanded around different points in the moduli space.

From the singularity in the Calabi-Yau phase around which the Gromov-Witten theory is defined, to the singularity in the Landau-Ginzburg phase around which the other enumerative theory - the Fan-Jarvis-Ruan-Witten theory - is defined, the transition is realized by the Cayley transform in a simple way. The proof is established using the machinery of modular forms and does not reply on techniques from mirror symmetry.

Melissa Liu
Title: MSP fields, GW theory of the quintic threefold, and FJRW theory of the Fermat quantic.
Abstract: Motivated by Witten's vision, we develop a theory of Mixed-Spin-P (MSP) fields to interpolate the Gromov-Witten (GW) theory of the quintic Calabi-Yau threefold and the Fan-Jarvis-Ruan-Witten (FJRW) theory of the Fermat quintic polynomial, at all genera. By virtual localization, the equivariant theory of MSP fields can be expressed in terms of GW theory of the quintic threefold, FJRW theory of the Fermat quintic polynomial, and GW theory of a point (which is known). Each vanishing MSP invariant gives rise to a polynomial relation among GW invariants of the quintic threefold and FJRW invariants of the Fermat quintic. This talk is based on joint work with Huai-Liang Chang, Jun Li, and Wei-Ping Li.

Tuesday, May 10th, 2016

Tony Pantev
Title: Enhanced moduli of D-branes and superpotentials.
Abstract: Moduli of D-branes on to Calabi-Yau manifolds are naturally equipped with enhanced geometric structures which play important role in classical field theory and are an essential input for the quantization problem. I will explain how one can recognize when such enhanced structures arise from a local or global superpotential. I will discuss applications to higher dimensional Chern-Simons functionals, to non-abelian Hodge theory, to the moduli spaces of framed sheaves on log Calabi-Yau geometries, and to the moduli of monopoles. This is based on joint works with Calaque, Katzarkov, Toen, Vaquie, and Vezzosi.

Jim Halverson
Title: Gauge Enhancement and Landscaping in G2 Compactifications of M-theory.
Abstract: M-theory compactifications on seven-manifolds with G_2 holonomy give rise to N=1 theories in four dimensions, which may be relevant for particle physics. However, such compactifications have historically been limited by a relative lack of physical and mathematical control, and also a relative scarcity of compact G2 manifolds. The latter has changed in recent years due to Kovalev's twisted connected sum construction. In this talk I will present work with Dave Morrison on the landscape of M-theory compactifications on twisted connected sum G2 manifolds, studying the physics broadly and in a concrete example, making use of recent mathematical results, mostly topological. This also

motivated us to study gauge enhancement and singular limits in a global context, leading to a proposal to study gauge enhancement via collapsing calibrated submanifolds.

Masahito Yamazaki
Title: Mirror Symmetry, Integrability and Quivers.
Abstract: I will discuss brane configurations corresponding to the geometry of toric Calabi-Yau manifolds (and their base Sasaki-Einstein manifolds) and hypersurface singularities. We find that the quivers as derived from the branes have connections to a number of interesting topics in mathematics and physics, such as mirror symmetry, integrability, cluster algebras and wall crossing phenomena.

Daniel Robbins
Title: G-structures and the alpha' expansion on compact special holonomy manifolds.
Abstract: Supergravity (the low-energy approximation to string or M-theory) admits supersymmetric backgrounds which correspond to products of flat space with compact manifolds of special holonomy. In order to study the fate of these background solutions once string or M-theory corrections are included, it is natural to use the language of G-structures. Correcting the solution then amounts to solving certain differential equations for the G-structure. Alternatively, one can formulate the issues in the context of an effective theory on Minkowski space (but keeping the Kaluza-Klein modes arising from the compact manifold), and use standard tricks from supersymmetric field theory to obtain the same results. In this talk I will present both approaches: the connections between them, and the puzzles yet to be resolved.

William Linch
Title: Supergeometry of Gauged p-Form Hierarchies.
Abstract: Compactifications of supersymmetric gauge/gravity theories generally give rise to "non-abelian/gravitational tensor hierarchies": double complices of differential superforms with values in representations of some non-abelian Lie algebra. I will describe the structure of such hierarchies in four-dimensional superspace and use it to construct manifestly supersymmetric Chern-Simons-like invariants of the resulting complices.

Paul Seidel
Title: Second order ODEs and the mirror map.
Abstract: The complements of anticanonical divisors carry holomorphic volume forms. We will consider the dependence of these on the divisor (within a fixed pencil), and the corresponding mirror question.