# ABSTRACTS

**Moduli Spaces in Symplectic Topology and in Gauge Theory**
**June 1 - 5, 2015**

**Mohammed Abouzaid: Nearby Lagrangians are simply homotopic.**

I will describe joint work with Thomas Kragh proving that closed exact Lagrangians in cotangent bundles are simply homotopy equivalent to the base. The main two ideas are (i) a Floer theoretic model for the Whitehead torsion of the projection from the Lagrangian to the base, and (ii) a large scale deformation of the Lagrangian which allows a computation of this torsion.

**Matthew Strom Borman: Quantum cohomology via symplectic cohomology.**
Consider a monotone closed symplectic manifold $M$ together with an ample normal crossings divisor $D$ such that $M \setminus D$ is a Liouville manifold. In this talk I will describe how in some cases the quantum cohomology of $M$ is recovered by deforming the symplectic cohomology of $M \setminus D$ via a Maurer-Cartan element in the $L_\infty$ structure of the symplectic cohomology of $M \setminus D$. This is joint work in progress with Nick Sheridan.

**Kai Cieliebak: On a question by Michele Audin.**

This talk is about joint work with Klaus Mohnke, in which we give an affirmative answer to a question by Michele Audin: Each (not necessarily monotone) Lagrangian torus in linear symplectic space has minimal Maslov number two. The main ingredient in the proof is a transversality result for punctured holomorphic curves, which is established using domain-dependent perturbations and Donaldson's symplectic hypersurfaces.

**Octav Cornea: Two tales from the frontier..**
I will discuss two phenomena that touch upon the frontier separating rigidity from flexibility in Lagrangian topology. The first one, based on joint work with Egor Schelukhin, is an extension of the Hofer metric for Lagrangian submanifolds that is well defined and finite for some non-isotopic Lagrangians. The second, more speculative, has to to with the putative existence of a morphism relating the Grothendieck group of the derived Fukaya category and the immersed Lagrangian cobordism group. Both constructions rely on the Lagrangian cobordism machinery set up in previous joint work with Paul Biran.

**Michael Entov: Unobstructed symplectic packing for tori.**

I will discuss why any finite collection of disjoint (not necessarily equal) standard symplectic balls admits a symplectic embedding to an even-dimensional torus T equipped with a Kahler form, as long as their total volume is less than the volume of T. The proof uses a number of powerful rigidity results from complex geometry. If the cohomology class of the Kahler form on T is not proportional to a rational one, a similar claim holds also for symplectic embeddings of any number of equal polydisks. The proof of the latter result involves

Ratner's orbit closure theorem. This is a joint work with M.Verbitsky.

**Joel W. Fish: Feral $J$-curves and minimal subsets.**
I will discuss some current joint work with Helmut Hofer, in which we define and establish properties of a new class of pseudoholomorphic curves (feral J-curves) to study certain divergence free flows in dimension three. In particular, we show that if $H$ is a smooth, proper, Hamiltonian on $\mathbb{R}^4$, then no energy level of $H$ is minimal; that is, the flow of the associated Hamiltonian vector field has a trajectory which is not dense.

**Kenji Fukaya: Floer homology of 3 manifolds with boundary.**
Gauge theory (Yang-Mills) Floer homology for 3 manifold with boundary is a problem where moduli spaces of Gauge theory and pseudo-holomorphic curve are both related. I will explain a proof of various conjectures (+ alpha) which I proposed in 1990's on this subject.

**Sheel Ganatra: The Floer theory of a cotangent bundle, the string topology of the base, and Calabi-Yau categories.**
We construct, and prove an equivalence between, two chain-level topological conformal field theories: one associated to the wrapped (or "large growth?) Floer theory for a cotangent bundle and the other associated to the string topology of its base (with suitable twists if the base is not spin). On the level of homology, this equivalence produces another proof of the relationship between the symplectic cohomology and free loop space homology BV algebra structures. The method of proof relies on a recent classification result for field theories due to Kontsevich-Vlassopoulous (and in a different formulation, to Hopkins-Lurie), in terms of certain types of (non-compact) Calabi-Yau categories or algebras. This is joint work (in progress) with Ralph Cohen.

**Michael Hutchings: Symplectic embedding obstructions from Seiberg-Witten theory via ECH.**
We discuss some of the latest results on obstructions to symplectically embedding one four-dimensional symplectic manifold with boundary into another. The obstructions are obtained by using Seiberg-Witten theory to deduce that certain cobordism maps on embedded contact homology are nontrivial, and then using a carefuly study of holomorphic curves to draw geometric conclusions.

**Kei Irie: Chain level operations in string topology via de Rham chains.**
We propose a chain model of the free loop space of a differentiable manifold, on which one can define string topology operations in chain level. In particular, we define a chain level Batalin-Vilkovisky (BV) structure on the chain model, reproducing the Chas-Sullivan BV structure in homology level. Key ingredients in our construction are notion of de Rham chains (hybrid of singular chains and differential forms) and a geometric analogue of Hochschild complex (which involves loops with marked points). Conjectural relations between our result and higher products in symplectic homology will be also discussed.

**Ailsa Keating: Homological Mirror Symmetry for singularities of type $T_{p,q,r}$..**
We present work-in-progress on mirror symmetry for the singularities of type $T_{p,q,r}$. Loosely, these are one level of complexity up from so-called 'simple' singularities, of type A, D and E. We will consider some symplectic invariants of the real four-dimensional Milnor fibres of these singularities, and explain how they correspond to coherent sheaves on certain blow-ups of the projective space $\mathbb{P}^2$. Time allowing, we hope to emphasize how the relations between different "flavours" of invariants (e.g., versions of the Fukaya category) match up on both sides.

**Emmy Murphy: Existence of Liouville structures on cobordisms.**
Given a smooth cobordism with an almost complex structure, one can ask whether it is realized as a Liouville cobordism, that is, an exact symplectic manifold whose primitive induces a contact structure on the boundary. We show that this is always the case, as long as the positive and negative boundaries are both nonempty. The contact structure on the negative boundary will always be overtwisted in this construction, but for dimensions larger than 4 we show that the positive boundary can be chosen to have any given contact structure. In dimension 4 we show that this cannot always be the case, due to obstructions from gauge theory.

**John Pardon: Virtual fundamental cycles and contact homology.**
I will discuss work in progress aimed towards defining contact homology using "virtual" holomorphic curve counting techniques.

**Tim Perutz: From categories to curve-counts in mirror symmetry.**
I will report on aspects of work with Sheridan and Ganatra in which we show how homological mirror symmetry for Calabi-Yau manifolds implies equality of Yukawa couplings on the A- and B-sides. On the A-side, these couplings are generating functions for genus-zero GW invariants. On the B-side, one has a degenerating family of CY manifolds, and the couplings are fiberwise integrals involving a holomorphic volume form. We show that the Fukaya category implicitly ?knows" the correct normalization of this volume form, as well as the mirror map.

**Egor Shelukhin: Autonomous Hamiltonian flows and persistence modules.**
We discuss obstructions to including a Hamiltonian diffeomorphism into an autonomous flow that are robust in Hofer's metric. This is an application of symmetry and multiplicity in filtered Floer homology considered as a persistence module. Joint work with Leonid Polterovich.

**Nick Sheridan: Counting curves using the Fukaya category.**
In 1991, string theorists Candelas, de la Ossa, Green and Parkes made a startling prediction for the number of curves in each degree on a generic quintic threefold, in terms of periods of a holomorphic volume form on a 'mirror manifold'. Givental and Lian, Liu and Yau gave a mathematical proof of this version of mirror symmetry for the quintic threefold (and many

more examples) in 1996. In the meantime (1994), Kontsevich had introduced his 'homological mirror symmetry' conjecture and stated that it would 'unveil the mystery of mirror symmetry'. I will explain how to prove that the number of curves on the quintic threefold matches up with the periods of the mirror via homological mirror symmetry. I will also attempt to explain in what sense this is 'less mysterious' than the previous proof. This is based on joint work with Sheel Ganatra and Tim Perutz.

**Jake Solomon: The degenerate special Lagrangian equation**

The degenerate special Lagrangian equation governs geodesics in the space of positive Lagrangians. Existence of such geodesics has implications for uniqueness and existence of special Lagrangians. It also yields lower bounds on the cardinality of Lagrangian intersections related to the strong Arnold conjecture. An overview of what is known about the existence problem will be given. The talk is based on joint work with A. Yuval and with Y. Rubinstein.

**Claude Viterbo: TBA.**
TBA

**Chris Wendl: Spine removal surgery and its applications.**
Spine removal surgery is a topological operation that can be performed on contact manifolds presented as spinal open books, a generalized notion of open books which arise naturally on boundaries of Lefschetz fibrations over Liouville domains. The original example (though it was not expressed in these terms) was Eliashberg's construction of symplectic caps for contact 3-manifolds, and I will explain two more recent examples, proving: (1) the existence of tight but nonfillable contact structures in all dimensions, and (2) a uniform bound on the topology of Stein fillings for a wide class of contact 3-manifolds. The latter argument also hints at the conjecture that every planar contact 3-manifold should have only finitely many distinct Stein fillings, and I will provide some evidence for this based on considering finite energy J-holomorphic planes in spine removal cobordisms.