Bay Area Differential Geometry Seminar
Saturday October 19, 2013
MSRI, Berkeley

Seminar participants and their significant others are invited to dinner at the home of David Hoffman, 37 Hill Road, Berkeley, CA 94708 (tel: 510 649-1641). Directions will be provided at the meeting. Please use the **signup list** *to indicate your participation and dietary restrictions if any. (Click on the boldfaced text in the previous sentence to get to the list.)*

- 10:00–11:00 **Reception, Morning Coffee**
- 11:00-12:00 **Robert McCann, U. Toronto**: *Optimal transport: old and new.*

The Monge-Kantorovich optimal transportation problem is to pair producers with consumers so as to minimize a given transportation cost. When the producers and consumers are modeled by probability densities on two given manifolds or subdomains, it is interesting to try to understand the analytical, geometric and topological features of the optimal pairing as a subset of the product manifold. This subset may or may not be the graph of a map.

This lecture describes recent developments concerning Monge's original version of this problem, and contrasts them with a capacity constrained variant in which a bound is imposed on the quantity transported between each given producer and consumer. In particular, we give a new perspective on Kantorovich's linear programming duality and expose how more subtle questions relating the structure of the solution are intimately connected to the differential topology and geometry of the chosen transportation cost.

- 12:00–2:00 **Lunch**

  Lunch will be available for purchase at MSRI. Orders will be taken before the first talk. There will be a brief organizational meeting at 1:45.

- 2:00–3:00 **James Isenberg, U. Oregon**: *Asymptotic Behavior of Neckpinches in Ricci Flow*

Neckpinch singularities are a prevalent feature of Ricci flow, and recent work has given us a good picture of their asymptotic behavior, so long as the geometries are rotationally symmetric. We discuss this asymptotic behavior, both for degenerate and non-degenerate neckpinches. It has been conjectured that neckpinch singularities which develop in non-rotationally symmetric Ricci flows do asymptotically approach roundness, and consequently have very similar asymptotic behavior to those which are rotationally symmetric. We discuss very recent work which supports this conjecture.

- 3:00–4:00 **Afternoon Tea**
- 4:00–5:00 **Vincent Moncrief, Yale**: *Hamiltonian reduction for Einstein's equations*

For the model problem of $2+1$ dimensional 'cosmological' spacetimes with Cauchy surfaces diffeomorphic to a compact, connected, orientable, higher genus surface Σ one can fully reduce the vacuum Einstein equations, in a suitable gauge fixed setting, to a (time dependent) Hamiltonian system over the cotangent bundle of the Teichmüller space, $\mathcal{T}(\Sigma)$, of Σ and characterize the global behavior of solutions in a satisfactory way. This includes a statement of global existence and asymptotics (in the direction of cosmological expansion) and a characterization of the (big bang like) singularities that arise (generically) in the direction of cosmological collapse.

For the corresponding problem in $3+1$ dimensions formulated on Cauchy surfaces diffeomorphic to a (compact, connected, orientable) manifold M of negative Yamabe type one can reduce the vacuum field equations, again in a suitable gauge, to an (infinite dimensional) Hamiltonian system defined over the cotangent bundle of a certain Teichmller-like space of conformal structures of M. In certain cases this reduced configuration space is smooth and contractible but, more generally, it will admit orbifold type singularities or consist of a stratified union of smooth manifolds corresponding to the different conformal isometry classes of Riemannian metrics admitted by M.

Much less is known, of course, about the global evolution properties of solutions in this case but the reduced Hamiltonian can nevertheless be shown to be universally monotonically decreasing (in the direction of cosmological expansion) and to have its infimum given in terms of the σ constant (or Yamabe invariant) of M. There are also quasi local generalizations of this Hamiltonian which also evolve monotonically.

- 6:00 **Dinner** *Please see the invitation and signup link at the top of this announcement.*