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Mini-Workshop on Differential Geometry

Tuesday, 9 December 2014
Rm. 222, Lady Shaw Building, CUHK

Time	Speaker & Title
1:30-2:30pm	**Shear-Free Asymptotically Hyperboloidal Initial Data in General Relativity** by **Professor John Lee** **University of Washington** **Abstract**: One of the most useful tools for studying isolated gravitational systems is conformal compactification, which transforms "infinity" into a finite boundary by multiplying the metric by a suitable smooth function. For studying outgoing radiation effects, an effective approach is to set up an initial-value problem on an asymptotically hyperboloidal spacelike hypersurface that intersects future conformal null infinity transversely. The initial data for the Einstein equations consists of a Riemannian metric and a second fundamental form on the initial hypersurface, together with some matter and energy fields. These data are not freely specifiable, but instead must satisfy the Einstein constraint equations, which boil down to a nonlinear elliptic system on the chosen initial hypersurface. In Roger Penrose's original conception of this approach, he assumed that the space-time had a smooth conformal compactification. But we now know that this is generally impossible because of intrinsic properties of the constraint equations, so the best regularity one can expect for asymptotically hyperboloidal initial data is polyhomogeneity at the boundary, meaning there is an asymptotic expansion in powers of the distance to the boundary and its logarithm. Moreover, in order for the conformal compactifiability to persist under the forward evolution of the system, the initial data must satisfy a nontrivial boundary condition called the "shear-free" condition. I will talk about joint work with Jim Isenberg, Paul Allen, and Iva Stavrov, in which we construct a complete parametrization of the constant-mean-curvature, polyhomogeneous, shear-free, asymptotically hyperboloidal solutions to the constraint equations. Some interesting aspects of the proof are a useful extension of known polyhomogeneity results for elliptic equations, and the discovery of an apparently new conformally invariant nonlinear differential operator.
2:45-3:45pm	**Introduction to Nonlinear Harmonic Forms** by **Professor Mark Stern** **Duke University** **Abstract**: We motivate and introduce nonlinear harmonic forms. These are de Rham representatives z of cohomology classes which minimize the energy $\|z\|_{L_2}^2$ subject to a nonlinear constraint. We give basic existence results for quadratic constraints, discuss the rich Euler Lagrange equations, and ask many regularity questions.
4:00-5:00pm	**New Characterizations of the Catenoid and Helicoid** by **Professor Jaigyoung Choe** **Korea Institute for Advanced Study** **Abstract**: Bernstein and Breiner found a characterization of the catenoid that the area of a minimal annulus in a slab is bigger than that of the maximally stable catenoid. We give a simpler proof of their theorem and extend the theorem to some minimal surfaces with genus (joint work with Benoit Daniel). New characterizations of the helicoid recently proved by Eunjoo Lee will be also presented.

All are Welcome!