

# Department of Mathematics

University of Toronto



Fourteenth Annual  
R. A. Blyth Lectures in Mathematics

Professor Scott Sheffield, Massachusetts Institute of Technology

## Quantum Gravity and Randomized Space-Time Geometry



In general relativity the space-time geometry is not a flat four dimensional space. It is curved ("warped") by the presence of matter and energy in a manner described by Einstein. In quantum mechanics, the density of matter and energy is, in a sense, random. A central goal of modern physics is unify these theories into a single coherent framework. This requires addressing the randomness of space-time itself.

This is no simple task. How does one even describe a universe in which basic geometric properties (lengths, areas, directions of "straight" lines, etc.) are uncertain? Put mathematically, what are the most natural measures on the space of all geometries? And to what extent can these measures be precisely understood in a mathematical way?

These lectures will address (with copious illustrations) a two-dimensional version of these problems and a particular family of random geometries called "Liouville quantum gravity", which have been a starting point for more complicated constructions in string theory. These lectures will not unify general relativity and quantum mechanics, but they will least illustrate how mathematically subtle --yet beautiful-- random geometry can be.

The first talk will be accessible to a general scientific audience. The second and third will be at the level of a colloquium for mathematicians and physicists.

**Mathematical keywords:** Schramm-Loewner evolution, Riemann uniformization, random planar maps, conformal welding, conformal field theory, Gaussian free field.

LECTURE 1  
Wednesday April 1, 2009, 4:10 p.m.  
Room: BA1170, Bahen Centre for Information Technology,  
40 St George Street

LECTURES 2 AND 3  
Thursday April 2 and Friday April 3, 2009, 4:10 p.m.  
Room: 1130, Bahen Centre for Information Technology,  
40 St George Street

The Blyth Lecture Reception will follow the first lecture in the Department of Mathematics lounge, 40 St. George St. 6<sup>th</sup> floor.  
For more information, please visit the website <http://www.math.utoronto.ca/events/blyth/blyth2009.htm>