



# WPI

# HAROLD J GAY LECTURE SERIES

## PDEs and Fractals

## Louis H. Kauffman

Professor  
Department of Mathematics,  
Statistics, and Computer Science  
University of Illinois at Chicago



## Topological Quantum Information and the Jones Polynomial

Friday, March 25, 2011

3:00pm, Olin Hall, Room 107

**ABSTRACT** We give a quantum statistical interpretation for the Jones polynomial in terms of the Kauffman bracket polynomial state sum. The Jones polynomial is a well-known topological invariant of knots in three-dimensional space that is closely related to structures in statistical mechanics and quantum field theory. We use this interpretation to give a new quantum algorithm for computing the Jones polynomial. This algorithm is useful for its conceptual simplicity, and it applies to all values of the polynomial variable that lie on the unit circle in the complex plane. Letting  $H(K)$  denote the Hilbert space for this model, there is a natural unitary transformation  $U$  from  $H(K)$  to itself such that  $\langle K \rangle = \text{Trace}(U)$  where  $\langle K \rangle$  is the bracket polynomial for the knot  $K$ . The quantum algorithm for  $\langle K \rangle$  arises directly from this formula via the Hadamard Test. We also review how we have implemented quantum algorithms for the Jones polynomial in NMR experiments and we show how the framework of the present model is related to recent work in knot theory such as Khovanov homology. This talk does not assume any background in either quantum computing or in the theory of knots and their invariants.

Geometry with its applications has been at the heart of the development of partial differential equations and boundary value problems since the very beginning. In physics, biology, economics, and other applied fields, a variety of new problems are now emerging that display unusual geometrical, analytical and scaling features, possibly of fractal type. The objective of these lectures is to acquire the view of outstanding mathematicians on the subject of differential equations and fractals, and their developments and applications, in a broad perspective encompassing both classical highlights and contemporary trends.

Sponsored by WPI and hosted by the Department of Mathematical Sciences

Coffee and tea available before lecture time in Olin Hall 107

Participation of faculty and students is most welcome

[wpi.edu/+Math/News/lectureseries.html](http://wpi.edu/+Math/News/lectureseries.html)

