**Title: The complexity of Brownian processes run with nonlinear clocks**

**Moongyu Park**

Department of Mathematical Sciences University of Alabama in Huntsville

 Anomalous diffusion occurs in many branches of physics. Examples include diffusion in confined nano-films, Richardson turbulence in the atmosphere, near-surface ocean currents, fracture flow in porous formations and vortex arrays in rotating flows. Classically, anomalous diffusion is characterized by a power law exponent related to the mean-square displacement of a particle or squared separation of pairs of particles: < $|X(t)|^{2}>\~ t^{r}.$ The exponent, r, is often thought to relate to the fractal dimension of the underlying process. If r = 1 it is classical, if r > 1 the flow is super-diffusive, otherwise it is sub-diffusive. In this talk we illustrate how time-changed Brownian position processes can be employed to model sub-, super-, and classical diffusion, while time-changed Brownian velocity processes can be used to model super-diffusion alone. Specific examples presented include transport in turbulent fluids and renormalized transport in porous media. Intuitively, a time-changed Brownian process is a classical Brownian motion running with a nonlinear clock (Bm-nlc). The major difference between classical and Bm-nlc is that the time-changed case has nonstationary increments. An important novelty of this approach is that, unlike fractional Brownian motion, the fractal dimension of the process driving anomalous diffusion as modeled by Bm-nlc positions or velocities does not change with the scaling exponent, $r.$