String theory and quantum gravity

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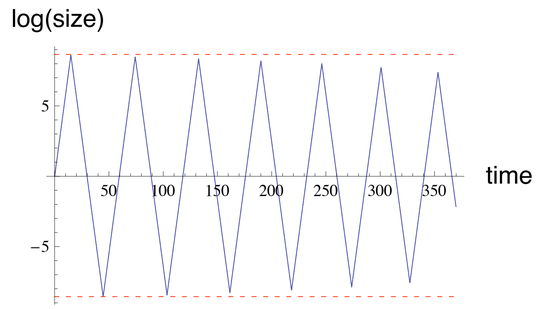
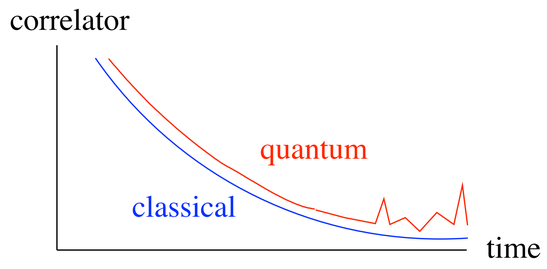
My main interests are in gravitational physics. I'm particularly interested in non-perturbative quantum gravity and its applications to cosmology and black holes. String theory, our best-developed approach to quantum gravity, has been the main focus of my research.

Bouncing and cyclic cosmologies



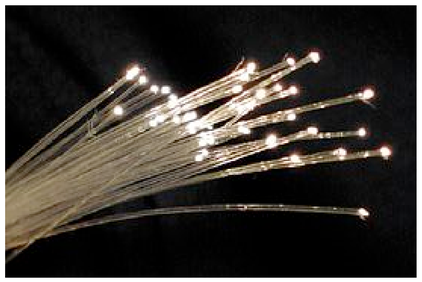
With plausible modifications to Einstein gravity a network of strings can make the size of the early universe oscillate: winding modes keep it from expanding while momentum modes keep it from shrinking. This gives the universe time to come to thermal equilibrium and provides a novel alternative to conventional inflationary cosmology. (Work in progress with Brian Greene and Stefanos Marnerides.)

Quantum black holes



In the classical limit a black hole has infinite information storage capacity; correlators decay exponentially as information is dissipated into an infinite heat bath. Quantum effects make the entropy finite and lead to deviations from purely thermal behavior. These deviations should be visible in multi-point correlators in a dual non-gravitational description of the black hole. (Work in progress with Nori Iizuka.)

Gravitational waveguides



Okay, this doesn't have much to do with string theory. In ordinary fiber optics light is confined to a waveguide by total internal reflection. Gravitational waves can likewise be confined to a fiber-like defect in the spacetime geometry where the local speed of light is reduced. Maybe we're living on a 3+1 dimensional waveguide? (Work in progress with K. Hintebichler, L. Hui and A. Nicolis. We're hoping this helps with the cosmological constant; the idea is that long-wavelength modes can leak off the waveguide.)