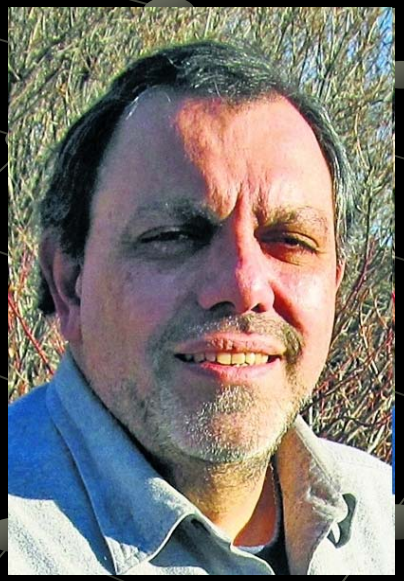
Theory Seminar

Monday, September 26, 2011 2:10 PM 831 Pupin Hall

New Horizons in Gravity: The Trace Anomaly and Its Macroscopic Quantum Effects in 'Black Holes' and Cosmology

Anomalies are classical symmetries that cannot be maintained at the quantum level. In the familiar axial anomaly in QED and QCD, massless poles necessarily arise from anomalous Ward identities. These massless poles in two-particle intermediate states are non-local quantum pair correlated states, described by an effective local Lagrangian containing additional pseudoscalar degrees of freedom, not present in the classical theory. The stress tensor contains a similar anomaly in its trace, which leads to additional scalar degrees of freedom not present in the classical Einstein theory. Thus General Relativity receives quantum corrections from Standard Model fields which can become significant in macroscopic systems and in particular near black hole and cosmological event horizons. The region near the classical event horizon of a fully collapsed star may then be instead a quantum boundary layer where the effective value of the gravitational vacuum energy density can change. By taking a positive value in the interior, the vacuum energy removes any singularity, replacing it with a smooth dark energy interior. The observed dark energy of our universe likewise may be a macroscopic finite size effect whose value depends not on microphysics but on the cosmological horizon itself.



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