DOE Research Report 2008-2009

Theory Group, UOCHEP, University of Oregon

January, 2009

UO Theory Group

Professors: Nilendra Deshpande, Davison Soper, Steve Hsu, Graham Kribs

Postdocs: Tuhin Roy

Students: Wei Gong, Ricky Fok, David Reeb

Congratulations to Dave Soper: 2009 APS Sakurai Prize Winner!

2009 J. J. Sakurai Prize for Theoretical Particle Physics Recipient

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Davison E. Soper
University of Oregon

Citation:

"*For work in perturbative Quantum Chromodynamics, including applications to problems pivotal to the interpretation of high energy particle collisions.*"

Background:
Davison E. Soper graduated from Amherst College in 1965 and received his Ph.D. from Stanford University in 1971. He taught at Princeton University from 1971 to 1977. He has been at the University of Oregon since 1977. He was Head of the Physics Department from 2004 to 2007.

Soper's thesis work, with J. Kogut and directed by J. Bjorken, concerned null-plane quantum field theory. He worked with J. Collins on the definition of parton distribution functions and with Collins and G. Sterman on summing logarithmically enhanced contributions to observables and on the factorization property that enables one to make reliable predictions for hadron colliders. Z. Kunszt and S. Ellis, and Soper calculated cross sections to make jets of hadrons in hadron- hadron collisions, using matrix elements from R. K. Ellis and J. Sexton.

Soper's most recent work, with Zoltan Nagy, concerns the parton showers produced in high energy collisions.

Soper is a member of the CTEQ collaboration and was its co-spokesperson from 2001 to 2004. He has served as a Divisional Associate Editor of Physical Review Letters and as a member of the Editorial Board of Physical Review D. He is a member of the APS and is a Fellow of the AAAS.

UO Theory Group

Recent Postdocs:

Xavier Calmet (Service de Physique Theorique, Brussels, Belgium)

Roman Buniy (Postdoc, Indiana University)

Dilip Ghosh (Professor, National Physical Laboratory, Ahamadabad, India)

Zoltan Nagy (Staff Scientist, DESY)

Kaustubh Agashe (Asst. Professor, University of Maryland)

Francesco Hautmann (Scientist, LAPP Annecy)

Bhaskar Dutta (Associate Professor, Texas A & M University)

Xiao-Gang He (Professor, National Taiwan University)

Steve Hsu – recent collaborators

Xavier Calmet (Service de Physique Theorique, Brussels, Belgium)

David Reeb (UO PhD student), Wei Gong (UO PhD student)

Tom Kephart (Vanderbilt)

Paul Frampton (UNC Chapel Hill)

N.G. Deshpande (UO), X.G. He (Taiwan National University)

Papers (2008)

[100] **Invisible Higgs boson, continuous mass fields and unHiggs mechanism.** with X. Calmet, N.G. Deshpande, X.G. He, arXiv:0810.2155. BSM model; Higgs physics

[99] **On the sign problem in QCD**, with D. Reeb, arXiv:0808.2987. Lattice QCD

[98] **Colorful quantum black holes at the LHC**, with X. Calmet, and W. Gong, Phys.Lett.B668:20-23,2008, arXiv:0806.4605. BSM; phenomenology

[97] **Grand unification and enhanced quantum gravitational effects**, with X. Calmet and D. Reeb, Phys.Rev.Lett.101:171802,2008, arXiv:0805.0145. BSM; GUTs

Papers (2008)

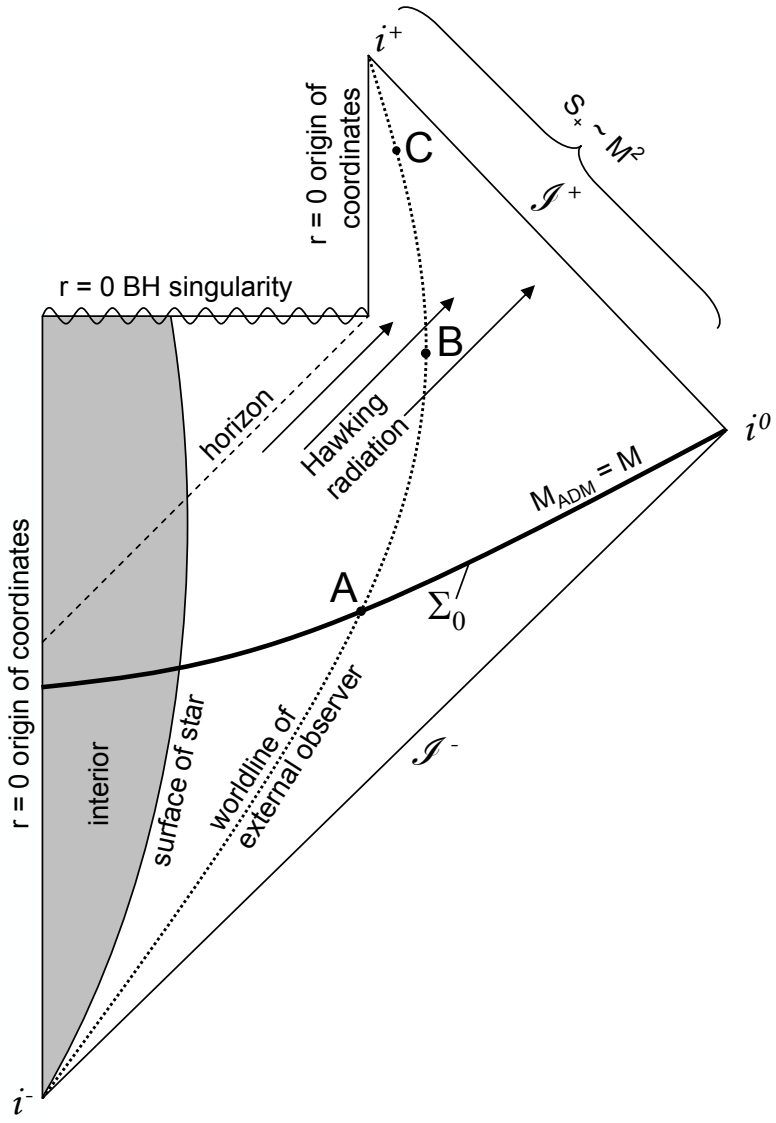
[96] **Unitarity and the Hilbert space of quantum gravity**, with D. Reeb, Class.Quant.Grav.25:235007,2008, arXiv:0803.4212. Quantum gravity; entropy bounds

[95] **Quantum gravity at a TeV and the renormalization of Newton's constant**, with X. Calmet and D. Reeb Phys.Rev.D77:125015, 2008, arXiv:0803.1836. BSM; solution of hierarchy problem

[94] **What is the entropy of the universe?**, with P. Frampton, T. Kephart and D. Reeb, arXiv:0801.1847. Black holes; entropy

[93] **TeV gravity in four dimensions?**, with X. Calmet, Phys.Lett.B663:95-98, 2008, arXiv:0711.2306. BSM; solution of hierarchy problem

Black hole information: Penrose diagram



Does information that falls into the hole re-emerge in the Hawking evaporation?

String theory says yes! – AdS/CFT duality, counting of microstates, etc.

Hilbert space of quantum gravity

If black hole evaporation is unitary, then we can exclude many exotic configurations of classical general relativity from the Hilbert space of the quantum theory.

Note this is quite unusual: typically, there are many distinct quantum states that correspond to a particular macroscopic or semiclassical configuration. Classical arrangements of matter are (more than) faithfully reproduced in the quantum theory.

Example: a rock. Many possible arrangements of electrons and nucleons correspond to the same macroscopic rock. Any classical rock is well approximated by numerous quantum states.

Hilbert space of quantum gravity

Ordinary objects are not excluded from the quantum theory by this black hole entropy argument.

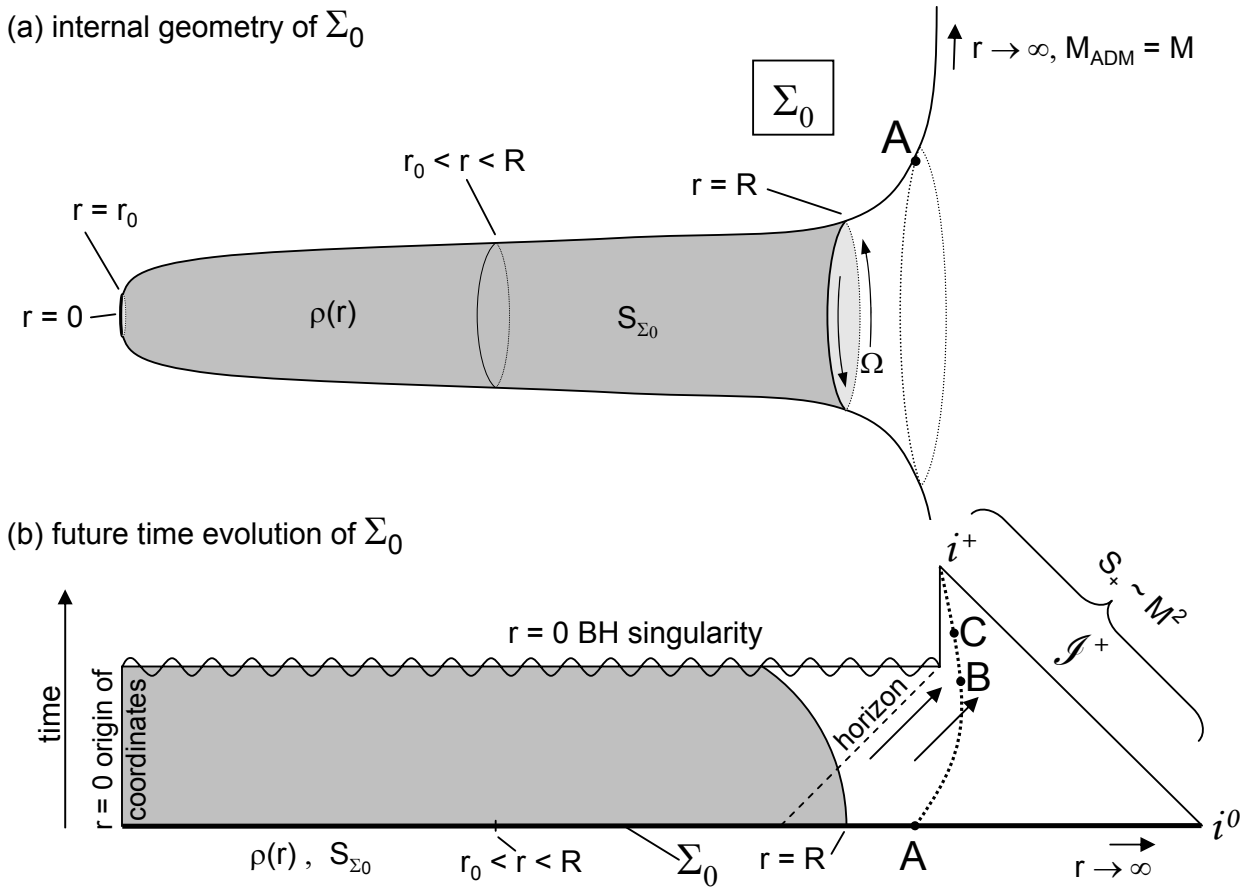
$$S_{\text{ordinary}} \sim M^{3/2}$$

$$S_{\text{blackhole}} = S_{\text{Hawking radiation}} \sim \text{Area} \sim M^2$$

Only highly entropic objects are excluded.

Example 1: "monster" states in curved space

Black hole entropy, curved space and monsters, Phys. Lett. B 658:244-248 (2008), arXiv:0706.3239v2



Example 2: glued Einstein-Rosen bridges