Curriculum vitae of Prof. Karyn Renée Jeannine LE HUR

1 Present Position

Associate Professor at Yale University
Department of Physics and Applied Physics
Member of Yale Center for Quantum Information Physics

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2 Positions

July 2006-present	:**Associate professor** at Yale University
2005-2006	:**Tenured Associate professor** at Sherbrooke University (Canada)
2004	:Member of the Canadian Institute for Advanced Research
	:Now, as an external member (http://www2.cifar.ca)
2002-2005	:**Assistant professor** at Sherbrooke University
October 2000-July 2002	:**Maitre-Assistant position** at Genève University
November 1998-October 2000	:**Postdoctoral fellow** at E.T.H Zürich with *Professor T.M. Rice*
	:Theoretische Physik, E.T.H. Hönggerberg, Switzerland.

3 Education

05th October 1998	:**Doctorate award in Theoretical Physics**,
	:obtained with distinction (Jury: P. Nozières, H. Schulz, M. Fabrizio
	:B. Douçot, T. Jolicoeur, B. Coqblin)
1995-05th October 1998	:PhD. in Theoretical Physics,
	:Laboratoire Pysique des Solides, Orsay, France,
	:*on Strongly Correlated Electron Systems*,
	:under the supervision of B. Coqblin.
1995	:D.E.A. of Theoretical Physics with Honors, M.Sc in Physics
	:École Normale Supérieure (ENS), Paris (France).
	:Directors, É. Brézin and J. Illiopoulos.

4 Scientific Profile

I am a theorist aiming to answer fundamental questions in physics-related interdisciplinary research areas engaging many-body quantum systems, condensed matter, quantum information theory, quantum field theory, nanoelectronics, cold atoms and light.

5 Research Overview

5a) Novel Phenomena in Quantum Matter

The matter consists of positive and negative electricity: partly heavy positive elementary particles gathered in atomic nuclei, partly light negative elementary particles - electrons - which move in wonderful patterns around the nuclei - always attracted to them but difficult to catch because of their own movement. This electron dance results in fascinating properties of matter. I am particularly interested in exotic phases of matter such as superfluidity, superconductivity, Luttinger liquids and heavy-fermion systems... . Recently I have made progress in the theoretical understanding of the Hubbard model close to the Mott state, in relation to the emergence of high-Tc superconductivity. Another important progress is the phenomenon of charge fractionalization occurring in low-dimensional conductors described by a Luttinger theory. Although the unit of charge in nature is a fundamental constant, the charge of individual quasiparticles in these low-dimensional systems are fractionalized. Those quasiparticles carry charge in units smaller than the electron charge e. I have also predicted the emergence of Majorana fermions in superconducting graphene; a Majorana fermion is a fermion which is its own anti-particle. Heavy fermions correspond to electron systems having effective masses that are several hundred times the electron mass; I have studied the intriguing heavy-fermion character of LiV_2O_4.

Related publications:

• Hubbard model and High-temperature superconductivity

Survey, *Superconductivity close to the Mott state: From condensed-matter systems to superfluidity in optical lattices*, Karyn Le Hur and T. Maurice Rice, Annals of Physics **324**, 1452-1515 (2009), Special Issue July; arXiv:0812.1581, 98 pages[1].

Enhancement of T_c in cuprate heterostructures,
C.-H. Chung, D. L. Bergman, I. Paul, T. M. Rice and K. Le Hur, in progress.

Successive opening of the Fermi surface in doped N-leg Hubbard ladders,
U. Ledermann, K. Le Hur and T. M. Rice, Phys. Rev. B **62**, 16383 (2000).

• Charge Fractionalization in low-dimensional electrons systems[2]

Experiment: *Charge Fractionalization in quantum wires*, Hadar Steinberg, Gilad Barak, Amir Yacoby, Loren N. Pfeiffer, Ken W. West, Bertrand I. Halperin and Karyn Le Hur, Nature Physics **4**, 116-119 (2008) and Supplementary information

Theory: *Charge Fractionalization in nonchiral Luttinger liquids*, Karyn Le Hur, Bertrand I. Halperin and Amir Yacoby, Annals of Physics **323**, 3037-3058 (2008).

See also: *Dephasing of Mesoscopic Interferences from Electron Fractionalization*, Karyn Le Hur Phys. Rev. Lett. **95**, 076801-076803 (2005); *Electron lifetime in Luttinger liquids*, Karyn Le Hur Phys. Rev. B **74**, 165104 (2006), 17 pages; *Electron fractionalization induced dephasing in Luttinger liquids*, Karyn Le Hur, Phys. Rev. B **65**, 233314 (2002).

[1] In particular, we have developed a Renormalization Group approach for quasi-one-dimensional and two-dimensional systems. See also the survey by my colleague Prof. R. Shankar: *Renormalization-group approach to interacting fermions*, R. Shankar Rev. Mod. Phys. **66**, 129-192 (1994).

[2] See also *Fractional excitations in the Luttinger liquid*, K.-V. Pham, M. Gabay, and P. Lederer, Phys. Rev. B **61**, 16397-16422 (2000).

• New collective behavior for one-dimensional electron systems in the low-density limit
Transport in a spin-incoherent Luttinger liquid, G. A. Fiete, K. Le Hur and L. Balents, Phys. Rev. B **72**, 125416 (2005); *Coulomb drag between two spin-incoherent Luttinger liquids*, G. Fiete, K. Le Hur and L. Balents, Phys. Rev. B **73**, 165104 (2006), 18 pages.

• Superconducting Dirac fermions in graphene and Majorana fermions[3]
Near-zero modes in condensate phases of the Dirac theory on the honeycomb lattice, D. L. Bergman and K. Le Hur, Phys. Rev. B **79**, 184520 (2009), 25 pages.
See also the related paper by P. Ghaemi and F. Wilczek: *Near-Zero Modes in Superconducting Graphene*, http://arxiv.org/pdf/0709.2626.

• Intriguing heavy-fermion behavior of LiV_2O_4
Electronic Structure of the Heavy Fermion Metal LiV_2O_4, V. I. Anisimov, M. A. Korotin, M. Zölfl, T. Pruschke, K. Le Hur and T. M. Rice, Phys. Rev. Lett. **83**, 364 (1999).

5b) Condensed matter and Quantum Information

In the last few years it has become evident that quantum information may lead to further insight into other areas of physics as statistical mechanics and quantum field theory. The attention of the quantum information community to systems intensively studied in condensed matter has stimulated an exciting cross-fertilization betweeen the two areas[4]. Methods developed in quantum information has proved to be extremely useful in the analysis of many-body systems. A central task of quantum information theory has been to characterize and quantify the entanglement of multiparticle systems; quantum entanglement is a quantum mechanical phenomenon in which the quantum states of two or more objects have to be described with reference to each other, even though the individual objects may be spatially separated. In particular, understanding entanglement between a qubit (spin) and its environment constitutes an important class of problems; any realization of a quantum computer has a dissipative environment which is entangled, to some extent with the qubits. I and collaborators have made a breakthrough in the understanding of entanglement between a qubit coupled to a collection of harmonic oscillators — the dissipative environment — resulting in the spin-boson model.

Entanglement properties of a (two-state system) qubit coupled to an environment:
Universal and Measurable Entanglement Entropy in the Spin-Boson Model, A. Kopp and K. Le Hur, Phys. Rev. Lett. **98**, 220401-220403 (2007).

Entanglement and Criticality in Quantum Impurity Systems, K. Le Hur, Ph. Doucet-Beaupré and W. Hofstetter, Phys. Rev. Lett. **99**, 126801 (2007).

For a survey, *Entanglement entropy, decoherence, and quantum phase transitions of a dissipative two-level system*, Karyn Le Hur, Annals of Physics **323**, 2208-2240 (2008).

For an Introduction, *Entanglement, decoherence, and dynamics of a two-state system*, Karyn Le Hur, Proceedings of PQE conference 2009, Snowbird, to appear in Journal of Modern Optics

[3]Majorana fermions also appear in other superconducting ground states; Best example is the $p_x + ip_y$ superconducting state studied by my colleague Prof. N. Read: *Paired states of fermions in two dimensions with breaking of parity and time-reversal symmetries and the fractional quantum Hall effect*, N. Read and D. Green, Phys. Rev. B **61**, 10267 (2000).

[4]The Center for Quantum Information Physics at Yale perfectly examplifies this cross-fertilization.

(accessible at http://www.yale.edu/lehurgroup).

This work has also been summarized in recent reviews: *Entanglement entropy in quantum impurity systems and systems with boundaries*, I. Affleck, N. Laflorencie, and E. Sorensen, 40 pages, special issue "Entanglement entropy in extended systems" in J. Phys. A; arXiv:0906.1809. *Entanglement in Many-Body Systems*, Luigi Amico, Rosario Fazio, Andreas Osterloh, and Vlatko Vedral, Rev. Mod. Phys. **80**, 517-526 (2008).

Many-Body Spin dynamics and Landau-Zener problem (in progress):
The damping of Rabi oscillations in the presence of a many-body environment is a challenging theoretical problem. In the case of a bosonic environment (a collection of harmonic oscillators), several approximative methods have been devised such as Bloch-Redfield master equations which are limited to weak-coupling, or the Non-Interacting Blip Approximation (NIBA), that neglects the system's backaction onto the bath. For a survey, consult *Dynamics of the dissipative two-state system*, A. J. Leggett, S. Chakravarty, A. T. Dorsey, M. P. A. Fisher, A. Garg, W. Zwerger, Rev. Mod. Phys. **59**, 1 (1987). I and collaborators are developing two rigorous methods to tackle this problem: a Feynman-Vernon path integral approach rephrasing the problem as that of (non-)unitary time evolution of a quantum state vector exposed to a random Gaussian perturbation Hamiltonian, and a time-dependent Numerical Renormalization Group (NRG) approach. Changing the state of a two-level system in a controlled manner is an ubiquitous task in atomic physics. Often this is achieved by sweeping the energy levels of the two coupled states adiabatically across the resonance (avoided crossing). For a constant sweep speed and ignoring any coupling with the external environment, this is the well-known Landau-Zener problem which can be solved exactly. This was first done in 1932 independently by Landau, Zener, Stückelberg and Majorana. Exploiting our methods, we now aim at solving Landau-Zener transitions when including the coupling with the bosonic environment.

• A random-noise approach rephrasing the problem as that of (non-)unitary time evolution of a quantum state vector exposed to a random Gaussian perturbation Hamiltonian,
Novel Approach to dissipative spin dynamics and Landau-Zener transitions, P. P. Orth, A. Imambekov, and K. Le Hur, in preparation.
• A time-dependent NRG approach,
Dissipative spin dynamics: A comparative study between time-dependent NRG and theory, D. Roosen, P. P. Orth, K. Le Hur and W. Hofstetter, in progress.

5c) Condensed-matter physics, Atoms and Light

Optical lattices provide an "ideal" way of realizing in experimental practice theoretical models which are fundamental to many-body physics and possess quantum phase transitions[5]. These crystals made of light are used to trap cold atoms at very low temperatures and the ultracold atoms tunnel quantum-mechanically between lattice sites just as single or paired electrons (Cooper pairs) tunnel through the periodic potential wells created by positive ions in crystalline materials. Because dynamics and correlations can now be investigated quantitatively, relevant questions are also emerging, in many cases demanding deeper theoretical understanding. Over

[5]For recent surveys: *Many-Body Physics with Ultracold Gases*, Immanuel Bloch, Jean Dalibard, Wilhelm Zwerger, Rev. Mod. Phys. **80**, 885 (2008); *The cold atom Hubbard toolbox*, D. Jaksch and P. Zoller, Annals of Physics (N.Y.) **315**, 52-79 (2005), Special Issue; *Superconductivity close to the Mott state: From condensed-matter systems to superfluidity in optical lattices*, Karyn Le Hur and T. Maurice Rice, arXiv:0812.1581 (98 pages) and Annals of Physics (N.Y.) **324**, 1452 (2009), Special Issue.

the last few years there has also been tremendous activity in studying the coherent interaction of matter and light[6]. These developments offer a wealth of possibilities, at the interface between quantum optics and condensed-matter. The light field serves not only as a probe of the many-body system, but may also support interesting cavity mediated phenomena and phases. I explore novel phenomena in optical lattices and circuit Quantum Electrodynamics (QED).

• Novel phases with cold atoms and their mixtures
Dissipative Quantum Ising model in a cold atomic spin-boson mixture, P. P. Orth, I. Stanic, and K. Le Hur, Phys. Rev. A **77**, 051601 (2008).
Supersolidity of Cold Atomic Bose-Fermi mixtures in optical lattices, P. P. Orth, D. L. Bergman, and K. Le Hur, arXiv:0905.1125, to be published in Phys. Rev. A, 31 pages (2009).
Near-zero modes in condensate phases of the Dirac theory on the honeycomb lattice, D. L. Bergman and K. Le Hur, Phys. Rev. B **79**, 184520 (2009), 25 pages.

• Novel phases of light in QED cavity systems
Superfluid-Mott Insulator Transition of Light in the Jaynes-Cummings Lattice, Jens Koch and Karyn Le Hur, Phys. Rev. A **80**, 023811 (2009).
On-chip circulators, artificial gauge fields, and novel phases of light, Jens Koch, Karyn Le Hur and Steven Girvin, in progress.

See also, *Quantum Phase Transition of Light*, Andrew D. Greentree, Charles Tahan, Jared H. Cole and Lloyd C. L. Hollenberg, Nature Physics **2**, 856-861 (2006).

• Chapter in a book on quantum phase transitions, 2009
Chapter on *Quantum Phase Transitions in Spin-Boson Systems: Dissipation and Light phenomena*, by Karyn Le Hur in the book on "Developments in quantum phase transitions", editor L. D. Carr (CRC Press, Taylor & Francis Group, to be published soon).

Spin-boson models are essentially useful in quantum optics, nuclear physics, quantum dissipation, and quantum computation. In this chapter, I provide a comprehensive and modern investigation of quantum phase transitions emerging in various spin-boson Hamiltonians.

All contributing authors: I. Bloch, G. Batrouni, L. Carr, S. Chakravarty, I. Cirac, T. Giamarchi, D. Goldhaber-Gordon, A. Greentree, T. Hatsuda, L. Hollenberg, R. Hulet, R. Kanamoto, Y. Kawaguchi, K. Le Hur, A. Millis, K. Novoselov, Y. Oreg, G. Ortiz, M. Oshikawa, A. Polkovnikov, N. Prokof'ev, S. Sachdev, R. Scalletar, U. Schollwoeck, D. Sahar, Q. Si, B. Svitsunov, S. Trebst, M. Troyer, M. Ueda, G. Vidal, Ph. Werner.

5d) Non-equilibrium Quantum Transport in NanoSystems

With the advent of highly tunable strongly correlated systems at the nanoscale, it has not only become possible to systematically realize and investigate well-studied theoretical models but also to pose new theoretical questions of fundamental nature. I have studied low-energy models with a large emergent symmetry and have predicted novel quantum phase transitions. Though non-equilibrium physics in itself has a long history, a lot remains to be unfolded in the context

[6]For recent surveys: *Manipulating quantum entanglement with atoms and photons in a cavity*, J. M. Raimond, M. Brune, and S. Haroche, Rev. Mod. Phys. **73**, 565 (2001); *Wiring up quantum systems*, R. J. Schoelkopf and S. M. Girvin, Nature (London) **451**, 664 (2008).

of strongly correlated quantum systems. In fact, the understanding of strongly correlated quantum systems far from equilibrium is one of the outstanding open questions in condensed-matter physics. Many of the theoretical approaches that have been proven so successful in treating strong correlations are inadequate once the system is driven out of equilibrium. My research objective in this field is to advance the theory of strong correlations away from equilibrium. In particular, I am reformulating non-equilibrium quantum problems onto an effective equilibrium scattering-state picture where standard equilibrium many-body techniques can be applied.

• Transport through quantum dots described by Kondo models with a large symmetry[7]
Probing spin and orbital Kondo effects with a mesoscopic interferometer, R. López, D. Sánchez, M. Lee, M.-S. Choi, P. Simon, and K. Le Hur, Phys. Rev. B **71**, 115312 (2005) [10 pages]
Transport through a quantum dot with SU(4) Kondo entanglement, K. Le Hur, P. Simon and D. Loss, Phys. Rev. B **75**, 035332 (2007)
Maximized Orbital and Spin Kondo effects in a single-electron Transistor, K. Le Hur, P. Simon, and L. Borda, Phys. Rev. B **69**, 045326 (2004).

Effects of Fermi Liquid Interactions on the Shot Noise of an SU(N) Kondo Quantum Dot
P. Vitushinsky, A. A. Clerk and K. Le Hur, Phys. Rev. Lett. **100**, 036603 (2008).
Theory of non-equilibrium transport in the SU(N) Kondo regime, C. Mora, P. Vitushinsky, X. Leyronas, A. A. Clerk, K. Le Hur, arXiv:0906.2791 (to appear in Phys. Rev. B)
See also R. Egger, News and Views, Nature Physics **5**, 175-176 (2009).

• Quantum phase transitions in a quantum dot
Coulomb blockade of a noisy metallic box: A realization of Bose-Fermi Kondo models, Karyn Le Hur, Phys. Rev. Lett. **92**, 196804 (2004).

• Scattering State Equilibrium Theory of Non-Equilibrium Transport (in progress)
P. Dutt, J. Koch, C.-H. Chung, J. Han and K. Le Hur, in progress
See also *Reformulation of steady state nonequilibrium quantum statistical mechanics*, S. Hershfield, Phys. Rev. Lett. **70**, 2134 (1993).

Research Plan:

I am planning to pursue my four main research activities. 5a) Novel quantum phenomena in condensed-matter systems. 5b) Understanding interacting quantum many body systems and engineering and exploiting such quantum systems for quantum information purposes. 5c) Quantum many-body physics with cold atoms and light. 5d) Non-equilibrium quantum many-body physics. In fact, over the last years, novel condensed-matter systems such as a new Iron-based high-Tc superconductor family, topological insulators, novel oxide heterostructures[8], and graphene-based systems have been discovered and deserve further theoretical attention. Concerning quantum computing, I am particularly interested in predicting efficient topological qubits. Topological quantum computation is an appealing proposal for implementing quantum information processing, in which quantum states are encoded in the non-local degrees of freedom of a suitable topologically ordered physical system. Because of the non-local encoding, these quantum states are intrinsically resistant to the debilitating effects of local noise. Cold

[7] For an introduction on Kondo physics in quantum dots, see the review by my colleague Prof. L. Glazman: *Revival of the Kondo effect*, L. Kouwenhoven and L. Glazman, Physics World **14**, 33-38 (2001).
[8] I am collaborating with the experimental group of my colleague Prof. C. Ahn on this issue.

bosonic or fermionic atoms in optical lattices provide an ideal laboratory system for the study of new quantum phenomena due to their high tunability and control. This opens new possibilities of investigating interesting aspects of many body systems. So far, experimenters have mostly studied the Bose-Hubbard model, but there is a lot of physics in boson interactions that is not covered by this 'standard' model, and that is not so well understood theoretically. Then there are fermionic Hubbard models. On the other hand, the Jaynes-Cummings lattice system comprising an array of optical cavities each containing a single atom allows to realize a superfluid-Mott insulator transition for light. Setups of electromagnetic resonators (cavity QED systems) may embody a novel class of quantum simulators. Finally, the theoretical study of nonequilibrium strongly correlated systems is a fascinating, quite recent research area, with the potential for plenty of further discoveries. New conceptual methods need to be developed.

6 Funding and Awards

Yale (since July 2006):
• NSF grant (National Science Foundation)
Condensed Matter and Material Theory (CMMT), 2008
NSF DMR-0803200, 9/1/08-8/31/12
Karyn Le Hur, *Theory of Entanglement in Many-Body Quantum Systems*
http://www.nsf.gov/funding/
• DOE grant (Department of Energy), 2008
DOE award: DE-FG02-08ER46541, 9/1/08-8/31/11
Karyn Le Hur, *Nonequilibrium Transport in NanoSystems*
http://www.energy.gov/
• NSF grant, Yale Center for Quantum Information Physics, 2007
NSF DMR-0653377, 9/1/07-8/31/11
S. Barrett, D. DeMille, M. Devoret, S. Girvin, J. Harris, K. Le Hur and R. Schoelkopf

Canada (2002/2006):
• NSERC, 2002 and 2005 (equivalent of the National Science Fundation (NSF))
http://www.nserc.gc.ca
• FQRNT, 2003 (Main source of funding for institutions in Quebec)
http://www.fcar.qc.ca
• CFI, 2005 (Canadian Foundation for Innovation)
http://www.innovation.ca

Awards:
• CNRS fellowship and visiting scholar at Orsay, Paris, 2010
http://www.cnrs.fr
• CNRS fellowship, invited professor at the École Normale Supérieure of Paris for 1 month (June 2009)
• Prestigious grant from Canadian Foundation for Innovation, 2005
• Invited professor at Spht Saclay for 2 months (Nov-Dec 2004)
• Scholar of the Canadian Institute of Advanced Research since 2004
http://www2.cifar.ca
• Maitre-Assistant position at Geneva University (2000/2002)

• Special Teaching award from University of Cergy-Pontoise, Paris, 1998 (During the PhD, I taught a course on Special Relativity to 1^{st} year students)
• PhD in Theoretical Physics with Distinction, Orsay, Paris, 1998
• DEA of Theoretical Physics with Honors, ENS Paris, 1995

7 Publication List/Only Refereed articles

Book and Survey, 2009
• *Superconductivity close to the Mott state: From condensed-matter systems to Superfluidity in optical lattices*, K. Le Hur and T. Maurice Rice, review article,
Annals of Physics **324**, 1452-1515 (2009), Special Issue July
arXiv:0812.1581, 98 pages
• Book on *New Developments in Quantum Phase Transitions*, editor L. D. Carr
CRC Press, Taylor and Francis Group
Chapter on *Quantum Phase Transitions in Spin-Boson Systems: Dissipation and Light phenomena*, by Karyn Le Hur, 26 pages, to be published soon (accessible at http://www.yale.edu/lehurgroup).

Publications 2009
• *Dimensional Crossover and MagnetoTransport in Ar-Irradiated $SrTiO_3$*, J. H. Ngai, Y. Segal, F. J. Walker, S. Ismail-Beigi, K. Le Hur and C. H. Ahn,
• *Theory of non-equilibrium transport in the SU(N) Kondo regime*, Christophe Mora, Pavel Vitushinsky, Xavier Leyronas, Aashish A. Clerk, Karyn Le Hur, arXiv:0906.2791, 17 pages.
• *Superfluid-Mott Insulator Transition of Light in the Jaynes-Cummings Lattice*, Jens Koch and Karyn Le Hur, Phys. Rev. A **80**, 023811 (2009), 13 pages.
• *Supersolidity of Cold Atomic Bose-Fermi mixtures in optical lattices*, P. P. Orth, D. L. Bergman, and K. Le Hur, arXiv:0905.1125, to be published in Phys. Rev. A, 31 pages (2009).
• *Topological Zero modes in fermionic condensate phases on the honeycomb lattice*,
Doron Bergman and Karyn Le Hur, Phys. Rev. B **79**, 184520 (2009) [25 pages]
• *Non-equilibrium transport at a dissipative quantum phase transition*, Chung-Hou Chung, Karyn Le Hur, Matthias Vojta, Peter Wölfle, Phys. Rev. Lett. **102**, 216803 (2009).
• *Entanglement, decoherence, and dynamics of a two-state system*, Karyn Le Hur
Proceedings of PQE conference 2009, Snowbird, to appear in Journal of Modern Optics.

Publications 2008
• *Charge fractionalization in Quantum Wires*,
Hadar Steinberg, Gilad Barak, Amir Yacoby, Loren N. Pfeiffer, Ken W. West, Bert Halperin, Karyn Le Hur, Nature Physics **4**, 116 (2008).
• *Charge Fractionalization in nonchiral Luttinger systems*,
K. Le Hur, B. I. Halperin, A. Yacoby, Annals of Physics **323**, 3037-3058 (2008).
• *Shot noise in SU(N) Quantum Dot Kondo effects*,
P. Vitushinsky, A. A. Clerk, and K. Le Hur, Phys. Rev. Lett. **100**, 036603 (2008).
• *Discontinuous current-phase relations in small 1D Josephson junction arrays*,
Jens Koch and Karyn Le Hur, Phys. Rev. Lett. **101**, 097007 (2008).
• *Dissipative Quantum Ising model in a cold atomic spin-boson mixture*,
Peter P. Orth, Ivan Stanic, Karyn Le Hur, Phys. Rev. A **77**, 051601 (2008).
• *Double-gap superconducting proximity effect in nanotubes*,

Karyn Le Hur, Smitha Vishveshwara, Cristina Bena, Phys. Rev B **77**, 041406(R) (2008).
• *Entanglement Entropy, decoherence, quantum phase transition of a dissipative two-level system*, Karyn Le Hur, Annals of Physics **323**, 2208-2240 (2008) (34 pages).

Publications 2007
• *Entanglement and Criticality in Quantum Impurity Systems*,
K. Le Hur, Ph. Doucet-Beaupré, W. Hofstetter, Phys. Rev. Lett. **99**, 126801 (2007).
• *Universal and Measurable entanglement entropy in the spin-boson model*,
Angela Kopp and Karyn Le Hur, Phys. Rev. Lett. **98**, 220401 (2007) - General session.
• *Transport through a quantum dot with SU(4) entanglement*,
K. Le Hur, P. Simon, D. Loss, Phys. Rev. B **75**, 035332 (2007).
• *Heavy fermion solution for electrons Hund's coupled to a spin liquid*,
Karyn Le Hur, Phys. Rev B **75**, 014435 (2007).

Publications 2006
• *The electron lifetime in Luttinger liquids*,
Karyn Le Hur, Phys. Rev B **74**, 165104 (2006).
• *Coulomb drag between two spin incoherent Luttinger liquids*,
Greg Fiete, Karyn Le Hur, Leon Balents, Phys. Rev. B **73**, 165104 (2006).
• *A Mesoscopic Resonating Valence Bond system on a triple dot*,
K. Le Hur, Patrik Recher, Émilie Dupont, Daniel Loss, Phys. Rev. Lett. **96**, 106803 (2006).
• *Decoherence of Einstein-Podolsky-Rosen pairs in a noisy Andreev entangler*,
Émilie Dupont and Karyn Le Hur, Phys. Rev. B **73**, 045325 (2006).

Publications 2005
• *Transport in a Spin-Incoherent Luttinger liquid*,
Greg Fiete, Karyn Le Hur and Leon Balents, Phys. Rev. B **72**, 125416 (2005).
• *Dephasing of Mesoscopic Interferences from Electron Fractionalization*,
Karyn Le Hur, Phys. Rev. Lett. **95**, 076801 (2005).
• *Hidden Caldeira-Leggett dissipation in a Bose-Fermi Kondo model*,
Mei-Rong Li, Karyn Le Hur and Walter Hofstetter, Phys. Rev. Lett. **95**, 086406 (2005).
• *Unification of electromagnetic noise and Luttinger liquid via a resonant level*,
Karyn Le Hur and Meirong Li, Phys. Rev. B **72**, 073305 (2005).
• *Probing spin and orbital Kondo effects with a mesoscopic interferometer*,
Rosa Lopez, David Sanchez, Minchul Lee, Mahn-Soo Choi, Pascal Simon, Karyn Le Hur, Phys. Rev. B **71**, 115312 (2005).
• *Quantum Dot in the pseudogap Kondo state*,
J. Hopkinson, K. Le Hur, and É. Dupont, Eur. Phys. J. B **48**, 429-432 (Letter) (2005).

Publications 2004
• *On the double-dot charge qubit and transport via dissipative cotunneling*,
Meirong Li and Karyn Le Hur, Phys. Rev. Lett. **93**, 176802 (2004).
• *Coulomb blockade of a noisy metallic box: A realization of Bose-Fermi Kondo models*,
Karyn Le Hur, Phys. Rev. Lett. **92**, 196804 (2004).
• *From nodal liquid to nodal Mottness in a frustrated Hubbard model*,
J. Hopkinson and K. Le Hur, Phys. Rev. B **69**, 245105 (2004).
• *Maximized Orbital and Spin Kondo effects in a single-electron Transistor*,

K. Le Hur, P. Simon, and L. Borda, Phys. Rev. B **69**, 045326 (2004).

Publications 2003

• *Smearing of charge fluctuations in a grain by spin-flip assisted tunneling*,
Karyn Le Hur and Pascal Simon, Phys. Rev. B **67**, 201308R (2003).

• *Fractional plateaus in the Coulomb blockade of coupled quantum dots*,
Karyn Le Hur, Phys. Rev. B **67**, 125311 (2003).

Publications 2002

• *Capacitance of a quantum dot from the channel-anisotropic two-channel Kondo model*, Karyn Le Hur and Georg Seelig, Phys. Rev. B **65**, 165338 (2002).

• *Electron fractionalization induced dephasing in Luttinger liquids*,
Karyn Le Hur, Phys. Rev. B **65**, 233314 (2002).

Publications 2001

• *Andreev Scattering in ladders with preformed pairs: Similitudes to high-T_c cuprates*,
Karyn Le Hur, Phys. Rev. B **64**, R060502 (2001).

• *Zeeman smearing of the Coulomb-Kondo staircase*,
Karyn Le Hur, Phys. Rev. B **64**, R161302 (2001).

• *Weakly-coupled Hubbard chains at half-filling and Confinement*,
Karyn Le Hur, Phys. Rev. B **63**, 165110 (2001).

Publications 2000

• *Successive opening of the Fermi surface in doped N-leg Hubbard ladders*,
U. Ledermann, K. Le Hur and T.M. Rice, Phys. Rev. B **62**, 16383 (2000).

• *Phases of the two-band model of spinless fermions in one dimension*,
Urs Ledermann and Karyn le Hur, Phys. Rev. B **61**, 2497 (2000).

• *Metal-Kondo insulating transitions and transport in one dimension*,
Karyn Le Hur, Phys. Rev. B **62**, pp. 4408-4425 (2000).

• *Kondo effect in a one dimensional d-wave superconductor*,
Karyn Le Hur, Europhys. Lett. **49** (6), pp. 768-774 (2000).

• *The Kondo effect in crossed Luttinger liquids*,
Karyn Le Hur, Phys. Rev. B **61**, 1853 (2000).

Publications 1999

• *The electronic structure of the heavy fermion metal LiV_2O_4*,
V.I. Anisimov, M.A. Korotin, M. Zölfl, T. Pruschke, K. Le Hur, T.M. Rice,
Phys. Rev. Lett. **83**, 364 (1999).

Publications related to the PhD

• *The underscreened Kondo effect in ladder systems*,
Karyn Le Hur, Phys. Rev. Lett. **83**, 848 (1999).

• *Critical Ising modes in low-dimensional Kondo insulators*,
Karyn Le Hur, Phys. Rev. B **60**, 9116 (1999).

• *The Kondo effect in a Luttinger liquid: nonuniversality of the Wilson ratio*,
Karyn Le Hur, Phys. Rev. B **59**, R11637 (1999).

• *Metal-insulator transition in the one-dimensional Kondo lattice model*,

Karyn Le Hur, Phys. Rev. B **58**, 10261 (1998).
• *Hole doping and disorder effects on the one-dimensional Kondo lattice, for ferromagnetic Kondo couplings*,
Karyn Le Hur, Phys. Rev. B **56**, 14056 (1997).
• *The underscreened Kondo problem: a two S=1 impurity model*,
K. Le Hur and B. Coqblin, Phys. Rev. B **56**, 668 (1997).

8 Contributions to the training of highly-qualified Personnel

Yale (since July 2006):

PhD students:
• **Peter Orth**
I am supervising Peter Orth in the area of cold-atomic systems, Quantum Computation, Novel phases and Quantum Phase Transitions since September 2006.
• **Francis Song** (co-advised with my colleague Prof. Steven Girvin)
Since May 2008, I am co-supervising the PhD student Francis Song with my colleague Prof. Steven Girvin in the area of quantum computing, many-body entanglement, and Density matrix Renormalization Group (DMRG).
• **Ivan Stanic**
Since May 2007, I am supervising Ivan Stanic in the area of graphene and Dirac particles.
• **Prasenjit Dutt**
Since May 2008, I am supervising Prasenjit Dutt in the area of non-equilibrium Quantum Transport in Nanosystems.
• **David Roosen** at Frankfurt (PhD student of Prof. Walter Hofstetter).

Postdoctoral research fellows:
• **Stefan Rachel** (Oct. 2009-)
Stephan Rachel has obtained a DFG postdoctoral fellowship from Germany and has chosen to come to Yale under my supervision. Stephan and I are working in the area of Dirac fermions, topological insulators and cold-atomic realizations.
• **Jens Koch**
I am collaborating with the postdoctoral fellow Jens Koch (group of Prof. Steven Girvin) in the area of Josephson junction arrays and novel correlated many-body phenomena when coupling photons to atoms.
• **Doron Bergman** (2007-2009, now research associate at Caltech)
I have supervised the postdoctoral fellow Doron Bergman (PhD in Santa-Barbara with Prof. Leon Balents) in the area of topological zero modes in superconductors and Dirac models, cold atomic systems and high-T_c superconductors.
• **Adilet Imambekov** (now, assistant professor at Rice University)
I am collaborating with Adilet Imambekov in the area of non-equilibrium spin dynamics applied to cold atomic systems. Adilet was a postdoctoral fellow at Yale (group of my colleague Prof. Leonid Glazman).
• **Pavel Vitushinsky**
I have co-supervised the postdoctoral fellow Pavel Vitushinsky (co-direction with Prof. A. Clerk, McGill) in the area of novel phenomena in nanosystems and non-equilibrium transport.

Visiting Scholar:
I am collaborating with the assistant professor C.-H. Chung (Taiwan); he is taking a half sabbatical leave (Aug 2009-Jan 2010) in my group.

Supervisions before 2006:

PhD students:
• **Émilie Dupont** (2003/2007)
I have supervised Émilie Dupont in the area of Mesoscopic physics, Entanglement, and Quantum Computing. Émilie has obtained a position of ATER at the Université Pierre and Marie Curie, Jussieu (Paris, France).
• **Michel Pioro-Ladrière** (2002/2005)
I have supervised Michel Pioro-Ladrière in co-direction with Andy Sachrajda (NRC Ottawa) in the field of Nanoelectronics and Quantum Computation. Michel has done both theory and experiments. Michel has been a postdoctoral fellow with Tarucha in Japan. In 2006, Michel received the price of the best PhD thesis at Sherbrooke in Science and Engineering.
Michel became my successor at Sherbrooke university.
• **Georg Seelig** (co-direction with Prof. Markus Büttiker, 2000/2002)
I have supervised Georg Seelig on strongly-correlated electron problems at the mesoscopic scale, and we have written a paper together on this topics. Georg was a postdoctoral fellow at Caltech working in bio-physics and he recently obtained a Faculty position at University of Washington.
• **Urs Ledermann** (co-direction with Prof. T.M. Rice in Zürich, 1998/2000)
I co-supervised the PhD Thesis of Urs Ledermann, "Hubbard models and Superconductivity".

Postdoctoral research fellows:
• **Andriy Nevidomskyy** (2005/2006)
I have supervised Andriy Nevidomskyy on mesoscopic physics. Andriy is now a postdoctoral fellow at Rutgers University.
• **Mei-Rong Li** (2002/2005)
I have supervised Mei-Rong Li on mesoscopic physics and more precisely on noisy quantum dots. Mei-Rong obtained an offer for a tenure track position from Hofstra University (New-York) but declined it and she is working in Mathematical Finance.
• **John Hopkinson** (2002/2004)
I have supervised John Hopkinson – PhD student from Rutgers (Piers Coleman) – on the areas high-T_c superconductors, and mesoscopic physics for two years. John then received a prestigious NSERC fellowship and decided to continue his research experience in Toronto with Hae-Young Kee. John is now at Brandon University, Canada.

Other supervisions and collaborations with postdocs:
Also, I collaborate with post-docs at other institutions: **Greg Fiete** (KITP Santa-Barbara and now assistant professor at the University of Texas at Austin), **Angela Kopp** (Rutgers University, now working at D. E. Shaw Research in New-York), **Cristina Bena** (Saclay), **Patrik Recher** (postdoc at Stanford and now assistant professor at Würzburg, Germany).

9 Training of intermediate-qualified students

• **Sean Litsey** (Yale 2009)
I am supervising the student **Sean Litsey** on the intriguing phenomenon of ripples in graphene; Sean will pursue this project as a Senior Project.
• **Raphael Jeanneret** (Master project 2009)
I have supervised the Master student **Raphael Jeanneret** from ENS Lyon for a summer project on graphene systems, Dirac fermions, and Applications.
• **summer students** (2007)
I have supervised the first-year PhD students **Michael Kastoryano** and **Joseph Bae** at Yale.
• **Philippe Doucet-Beaupré** (COOP student 2004/2007)
I have supervised the Bachelor student **Philippe Doucet-Beaupré** on the application of the Wilson Renormalization Group (NRG) approach to the spin-boson model (or Caldeira-Leggett model). He has built a trustable and powerful Numerical Renormalization Group method. We have written a Physical Review Letter together and Philippe is now at ETH Zürich.
• **Louis Gaudreau** (COOP student 2002/2005)
I have supervised the Bachelor student **Louis Gaudreau** during his 3 COOP training courses in the area of Quantum Computing. Louis Gaudreau was a Master student in my group, hired in co-direction with A. Sachrajda at NRC Ottawa. Louis is doing a PhD at NRC Ottawa.

10 Teaching Experiences

Yale 2008/2009	: Undergrad. course, *Quantum Mechanics and Natural Phenomena* (440/441).
Yale Spring 2007/2008	: Graduate Course on Advanced Many-Body theory (632 and 634).
Yale, Fall 2007	: Undergraduate Lab on *Modern Physics Measurement* (205/206)
Sherbrooke	: Undergraduate Course on **Statistical Physics** to second year students.
Sherbrooke	: Advanced Course on **Mesoscopic physics** to Master and PhD students.
Sherbrooke	: Undergraduate Course on **ElectroMagnetism** to first year students.
Genève 2000-2002	: Undergraduate **Electrodynamics** to second year students.
2000	: Organization of Proseminars on **Diagrammatic Techniques** (ETH).
1995-1998	: Undergraduate course to first year students (Cergy-Pontoise), Paris,
	: **Introduction to special relativity**.