

# Mme Karyn LE HUR

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## **1 Brief Resume**

2012: **CNRS Senior Research Director, DR02**, CPHT Ecole Polytechnique, France

2012-: **Professeure Chargée de Cours à l'Ecole Polytechnique, temps partiel**

2012-2016: **Membre du Comité National CNRS, Section 02**

2010: **Qualification Professeure d'Université** Obtenue en France

2006-2011: **Associate professor**, Yale University, USA

2005-2006: **Associate (tenured) professor**, Université de Sherbrooke, Quebec, Canada

2004-present: Membre du Canadian Institute for Advanced Research (CIFAR)

2002-2005: **Assistant professor**, Université de Sherbrooke, Quebec, Canada

2000-2002: **position Maître-Assistante** (6 années), Genève, groupe de M. Büttiker

1998-2000: **Post-Doctoral Fellow** E.T.H Zürich, group of T. M. Rice

Oct. 1998: **PhD**, Theoretical Physics, LPS Orsay, advisor Bernard Coqblin

*Théorie des Systèmes Kondo en basses dimensions*

1995: DEA de Physique Théorique, ENS Paris, directeurs E. Brézin et J. Iliopoulos.

## **2 Scientific Profile**

In my research, I aim to answer fundamental questions in pluridisciplinary areas engaging condensed matter, quantum optics and cold atomic systems, many-body quantum systems, nanoelectronics, quantum information theory and quantum field theory.

99 publications, 1 book chapter, H-index 29, 2012 citations (without self-citations - Web of Science)

Participation in a Popular Book on Quantum Mechanics, *Le Plus Grand des Hasards*, Editeurs Jean-Francois Dars and Anne-Marie Papillaut, 2010, 65 authors

### 3 Books and Surveys

- *Many-Body Quantum Electrodynamics Networks: Non-Equilibrium Condensed Matter Physics with Light*, Karyn Le Hur, Loïc Henriët, Alexandru Petrescu, Kirill Plekhanov, Guillaume Roux, Marco Schiró, arXiv:1505.00167, C. R. Physique **17** (2016) 808-835.
- *Entanglement Entropy, decoherence, quantum phase transition of a dissipative two-level system*, Karyn Le Hur, Annals of Physics **323**, 2208-2240 (2008) (34 pages).
- *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 *Understanding Quantum Phase Transitions*, editor L. D. Carr Taylor and Francis, Boca Raton, 2010  
Chapter on *Quantum Phase Transitions in Spin-Boson Systems: Dissipation and Light phenomena*, by Karyn Le Hur (26 pages, also accessible at arXiv:09094822)
- Survey on *Effective Equilibrium Theory in NonEquilibrium Quantum Transport*, by Prasenjit Dutt, Jens Koch, J. Han and Karyn Le Hur, arXiv:1101.1526, 53 pages Annals of Physics **326** 2963-2999 (2011).
- *Correlated Topological Phases and Exotic Magnetism with Ultracold Fermions* Peter P. Orth, Daniel Cocks, Stephan Rachel, Michael Buchhold, Karyn Le Hur, Walter Hofstetter, arXiv:1212.5607  
Contribution to J. Phys. B special issue on non-Abelian gauge fields, J. Phys. B: At. Mol. Opt. Phys. **46** (2013) 134004.
- *Non-perturbative stochastic method for driven spin-boson model* Peter P. Orth, Adilet Imambekov, Karyn Le Hur Phys. Rev. B **87**, 014305 (2013).  
See also Loïc Henriët, Zoran Ristivojevic, Peter P. Orth, Karyn Le Hur, Phys. Rev. A **90**, 023820 (2014).

### 4 5 Selected Articles

- *Topological Insulators and Mott physics from the Hubbard Interaction*, Stephan Rachel and Karyn Le Hur, Phys. Rev. B **82**, 075106 (2010).
- *Time-reversal symmetry breaking in circuit-QED based photon lattices*, Jens Koch, Andrew Houck, Karyn Le Hur and S. M. Girvin, Phys. Rev. A **82**, 043811 (2010).  
See also Viewpoint: Andrew D. Greentree and Andrew M. Martin Physics **3**, 85 (2010).  
Jens Koch and Karyn Le Hur, Phys. Rev. A **80**, 023811 (2009).  
A. Petrescu, A. Houck, and K. Le Hur, Phys. Rev. A **86**, 053804 (2012).
- *The electronic structure of the heavy fermion metal  $\text{LiV}_2\text{O}_4$* , V.I. Anisimov, M.A. Korotin, M. Zöhlfl, T. Pruschke, K. Le Hur, T.M. Rice, Phys. Rev. Lett. **83**, 364 (1999).
- *Bipartite Fluctuations as a Probe of Many-Body Entanglement* H. Francis Song, Stephan Rachel, Christian Flindt, Israel Klich, Nicolas Laflorencie, Karyn Le Hur, arXiv:1109.1001, 30 pages+25 pages Supplementary Material  
Phys. Rev. B **85**, 035409 (2012), Editors' Suggestion.

- *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 (2008).

## 5 Complete Publication List/Only Published articles (99 articles)

### Publications 2016

- *Many-Body Quantum Electrodynamics Networks: Non-Equilibrium Condensed Matter Physics with Light*, Karyn Le Hur, Loïc Henriët, Alexandru Petrescu, Kirill Plekhanov, Guillaume Roux, Marco Schiró, arXiv:1505.00167, *C. R. Physique* **17** (2016) 808-835.
- *Realizing Topological Mott Insulators from the RKKY Interaction*, Tianhan Liu, Benoît Douçot, Karyn Le Hur *Phys. Rev. B* **93**, 195153 (2016).
- *Phase Diagram and Entanglement of two interacting topological Kitaev chains* Loïc Herviou, Christophe Mora, Karyn Le Hur, *Phys. Rev. B* **93**, 165142 (2016), 24 pages.
- *Entanglement structure of the two-channel Kondo model* Bedoor Alkurtass, Abolfazl Bayat, Ian Affleck, Sougato Bose, Henrik Johannesson, Pasquale Sodano, Erik S. Sorensen, Karyn Le Hur, *Phys. Rev. B* **93**, 081106 (2016).
- *Quantum sweeps, synchronization, and Kibble-Zurek physics in dissipative quantum spin systems*, Loïc Henriët, Karyn Le Hur, *Phys. Rev. B* **93**, 064411 (2016) (24 pages).

### Publications 2015

- *Condensed-matter physics: Quantum dots and the Kondo effect*, Karyn Le Hur, *Nature* **526**, 203204 (2015). News and Views on articles by experiments at Marcoussis (Z. Iftikhar et al. *Nature* 526, 233-236 (2015)) and Stanford (A. J. Keller et al. *Nature* 526, 237-240 (2015)).
- *Electrical Current from Quantum Vacuum Fluctuations in Nano-engines* Loïc Henriët, Andrew N. Jordan, Karyn Le Hur, *Phys. Rev. B* **92**, 125306 (2015).
- *Topological Superconductivity in Two Dimensions with Mixed Chirality* A. M. Black-Schaffer, K. Le Hur, *Phys. Rev. B* **92**, 140503(R) (2015).
- *Chiral Mott Insulators, Meissner Effect, and Laughlin States in Quantum Ladders* Alexandru Petrescu, Karyn Le Hur, *Phys. Rev. B* **91**, 054520 (2015).
- *Chiral Bosonic Phases on the Haldane Honeycomb Lattice*, Ivana Vasic, Alexandru Petrescu, Karyn Le Hur, Walter Hofstetter, *Phys. Rev. B* **91**, 094502 Published 3 March 2015 - Editors Suggestion

### Publications 2014

- *Chiral d-wave superconductivity on the honeycomb lattice close to the Mott state*, Annica M. Black-Schaffer, Wei Wu, Karyn Le Hur, *Phys. Rev. B* **90**, 054521 (2014).
- *Fluctuations and Entanglement spectrum in quantum Hall states*, Alexandru Petrescu, H. Francis Song, Stephan Rachel, Zoran Ristivojevic, Christian Flindt, Nicolas Laflorencie, Israel Klich, Nicolas Regnault, Karyn Le Hur, *J. Stat. Mech.* (2014) P10005.
- *Quantum Dynamics of the Driven and Dissipative Rabi Model*, Loïc Henriët, Zoran Ristivojevic, Peter P. Orth, Karyn Le Hur, *Phys. Rev. A* **90**, 023820

(2014).

- *Tunable Hybrid Quantum Electrodynamics from Non-Linear Electron Transport*, Marco Schiró, Karyn Le Hur, Phys. Rev. B **89**, 195127 (2014).

#### Publications 2013

- *Anisotropic Quantum Spin Hall Effect, Spin-Orbital Textures and Mott Transition*, Tianhan Liu, Benoît Douçot, Karyn Le Hur Phys. Rev. B **88**, 245119 (2013), 24 pages
- *Strongly-Correlated Thermoelectric Transport beyond Linear Response*, Prasenjit Dutt and Karyn Le Hur Phys. Rev. B **88**, 235133 (2013).
- *Bosonic Mott Insulator with Meissner Currents*, Alexandru Petrescu, Karyn Le Hur Phys. Rev. Lett. **111**, 150601 (2013).
- *Admittance of the  $SU(2)$  and  $SU(4)$  Anderson quantum RC circuits*, Michele Filippone, Karyn Le Hur, Christophe Mora, Phys. Rev. B **88**, 045302 (2013).
- *Strongly correlated dynamics in multichannel quantum RC circuits*, Prasenjit Dutt, Thomas Schmidt, Christophe Mora, Karyn Le Hur Phys. Rev. B **87**, 155134 (2013).
- *Correlated Dirac particles and Superconductivity on the Honeycomb Lattice*, Wei Wu, Michael M. Scherer, Carsten Honerkamp, Karyn Le Hur, Phys. Rev. B **87**, 094521 (2013) [12 pages]
- *Correlated Topological Phases and Exotic Magnetism with Ultracold Fermions* Peter P. Orth, Daniel Cocks, Stephan Rachel, Michael Buchhold, Karyn Le Hur, Walter Hofstetter, J. Phys. B: At. Mol. Opt. Phys. **46** (2013) 134004 (topical review)
- *Low Frequency Admittance as a Probe of Majorana Fermions* Christophe Mora, Karyn Le Hur Phys. Rev. B **88**, 241302 (2013).
- *Non-equilibrium Quantum Transport through a dissipative resonant level model* Chung-Hou Chung, Karyn Le Hur, Gleb Finkelstein, Matthias Vojta, Peter Woelfle, Phys. Rev. B **87**, 245310 (2013).
- *Non-perturbative stochastic method for driven spin-boson model* Peter P. Orth, Adilet Imambekov, Karyn Le Hur Phys. Rev. B **87**, 014305 (2013).
- *Scaling of Entanglement Entropy across Lifshitz transitions*, Marlon Rodney, H. Francis Song, Sung-Sik Lee, Karyn Le Hur, Erik Sorensen, Phys. Rev. B **87**, 115132 (2013).

#### Publications 2012

- *Kondo resonance of a microwave photon* Karyn Le Hur, Phys. Rev. B **85** 140506 (2012).
- *Bipartite Fluctuations as a Probe of Many-Body Entanglement* H. Francis Song, Stephan Rachel, Christian Flindt, Israel Klich, Nicolas Laflorencie, Karyn Le Hur, arXiv:1109.1001, 30 pages+25 pages Supplementary Material Phys. Rev. B **85**, 035409 (2012), Editors' Suggestion
- *Quantum Spin Hall Insulators with Interactions and Lattice Anisotropy*, Wei Wu, Stephan Rachel, Wu-Ming Liu and Karyn Le Hur, arXiv:1106.0943 and published Phys. Rev. B **85**, 205102 (2012).
- *Anomalous Hall Effects of Light and Chiral Edge Modes on the Kagome Lattice* Alexandru Petrescu, Andrew Houck, Karyn Le Hur, Phys. Rev. A **86**, 053804 (2012).
- *Time-reversal invariant Hofstadter-Hubbard model with Ultracold Fermions* Daniel Cocks, Peter P. Orth, Stephan Rachel, Michael Buchhold, Karyn Le Hur, Walter Hof-

stetter, Phys. Rev. Lett. **109**, 205303 (2012)

- *Detecting Quantum Critical Points using Bipartite Fluctuations*, Stephan Rachel, Nicolas Laflorencie, H. Francis Song, Karyn Le Hur, Phys. Rev. Lett. **108**, 116401 (2012)
- *Heisenberg Uncertainty Principle as a Probe of Entanglement Entropy: Application to Super-radiant Quantum Phase Transitions* Pierre Nataf, Mehmet Dogan, Karyn Le Hur Phys. Rev. A **86**, 043807 (2012)
- *Noninvasive Probes of Charge Fractionalization in Quantum Spin-Hall Insulators*, Ion Garate and Karyn Le Hur, Phys. Rev. B **85**, 195465 (2012)
- *d-wave superfluid with Gapless Edges in a Cold Atom Trap*, Anne-Louise Gadsbølle, H. Francis Song, Karyn Le Hur, Phys. Rev. A **85**, 051603(R) (2012).

#### Publications 2011

- *Effective Equilibrium Theory in NonEquilibrium Quantum Transport*, by Prasenjit Dutt, Jens Koch, J. Han and Karyn Le Hur, arXiv:1101.1526, 53 pages Annals of Physics **326** 2963-2999 (2011).
- *Giant Charge Relaxation Resistance in the Anderson Model*, Michele Filippone, Karyn Le Hur and Christophe Mora, Phys. Rev. Lett. **107**, 176601 (2011).
- *Entanglement Entropy of the Two-Dimensional Heisenberg Antiferromagnet*, H. Francis Song, Nicolas Laflorencie, Stephan Rachel, Karyn Le Hur, Phys. Rev. B **83**, 224410 (2011).
- *Entanglement from Charge Statistics: Exact Relations for Many-Body Systems*, H. Francis Song, Christian Flindt, Stephan Rachel, Israel Klich, Karyn Le Hur, Phys. Rev. B **83**, 161408(R) (2011).
- *Designing Heterostructures with Higher Temperature Superconductivity*, Karyn Le Hur, Chung-Hou Chung, I. Paul, Phys. Rev. B **84**, 024526 (2011).
- *Effective Thermodynamics of a coupled Two-level system*, N. S. Williams, K. Le Hur and A. Jordan, J. Phys. A: Math. Theor. **44** (2011) 385003.

#### Publications 2010

- *Time-reversal symmetry breaking in circuit-QED based photon lattices*, Jens Koch, Andrew Houck, Karyn Le Hur and S. M. Girvin, Phys. Rev. A **82**, 043811 (2010).  
See also Viewpoint: Andrew D. Greentree and Andrew M. Martin Physics **3**, 85 (2010).
- *Dynamics, Synchronization and Quantum Phase Transitions of Two Dissipative Spins*, Peter P. Orth, David Roosen, Walter Hofstetter and Karyn Le Hur, Phys. Rev. B **82**, 144423 (2010) (Editors' Suggestion).
- *Topological Insulators and Mott physics from the Hubbard Interaction*, Stephan Rachel and Karyn Le Hur, Phys. Rev. B **82**, 075106 (2010).
- *Tunable Kondo-Luttinger systems far from equilibrium*, C.-H. Chung, K.V.P. Latha, K. Le Hur, M. Vojta and P. Wölfle, Phys. Rev. B **82**, 115325 (2010).
- *General Relation between Entanglement and Fluctuations in One Dimension*, Francis Song, Stephan Rachel and Karyn Le Hur, Phys. Rev. B **82**, 012405 (2010).
- *Universal Resistances of the Quantum RC circuit*, Christophe Mora and Karyn Le Hur, Nature Physics, **6** 697 (2010).
- *Universality in dissipative Landau-Zener transitions*, Peter P. Orth, Adilet Imambekov and Karyn Le Hur, Phys. Rev. A **82**, 032118 (2010).
- *Electric field Tuned Dimensional Crossover in Ar-Irradiated SrTiO<sub>3</sub>*, J. H. Ngai, Y. Segal, F. J. Walker, S. Ismail-Beigi, K. Le Hur and C. H. Ahn, Phys. Rev. B **81**, 241307(R) (2010).

### Publications 2009

- *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. Phys. Rev. B **80**, 155322 (2009) (Editors' suggestion).
- *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, Phys. Rev. A **80**, 023624 (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 section.
- *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).  
(This article took some time to be re-written)
- *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  $\text{LiV}_2\text{O}_4$* ,  
V.I. Anisimov, M.A. Korotin, M. Zöhl, 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).

## 6 Research Overview

We have divided our Research in *4 subjects*: Phenomena in Quantum Matter; Theory of Non-Equilibrium Quantum Systems and Applications; Many-Body Physics with Atoms and Light; Quantum Information.

### Phenomena in Quantum Matter

I am interested in exotic phases of matter such as Topological Insulators, Mott physics, Superfluidity, Superconductivity, Luttinger liquids and Heavy-fermion systems applying field-theory methods and Renormalization Group arguments. With T. Maurice Rice (ETH Zuerich), we



have written a review on the Hubbard model close to the Mott state, in relation to the emergence of high- $T_c$  superconductivity, and based on the PhD work by Urs Ledermann (Zuerich 1999). We have done efforts in order to provide a Green's function calculation in the underdoped phase based on a microscopic ladder approach. With Chung-Hou Chung (Taiwan and Yale) and Indranil Paul (CNRS, Grenoble and Paris), we have also made some predictions to increase  $T_c$  in bi-layer systems (with one layer providing the large magnetic super-exchange and one layer providing the charge carriers). I am also interested in novel topological quantum systems (topological insulators). With Stephan Rachel, and also with Wei Wu and Wu-Ming Liu, we have made progress to understand the interplay between Mott physics and the Kane-Mele model on the honeycomb lattice. In collaboration with G. Fiete and L. Balents at KITP Santa-Barbara and separately with B. Halperin and A. Yacoby at Harvard, we have made progress in our understanding of excitations in low-dimensional conductors. Following a work by P. Ghaemi and F. Wilczek, with Doron Bergman, we have also studied 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; we have studied the intriguing heavy-fermion character of  $\text{LiV}_2\text{O}_4$ .

*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.

*Designing Heterostructures with Higher Temperature Superconductivity*

Karyn Le Hur, Chung-Hou Chung, I. Paul *Phys. Rev. B* **84**, 024526 (2011).

*Correlated Dirac particles and Superconductivity on the Honeycomb Lattice,*

Wei Wu, Michael M. Scherer, Carsten Honerkamp, Karyn Le Hur, *Phys. Rev. B* **87**, 094521 (2013) [12 pages].

*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).

- Topological Insulators and Mott physics

*Topological Insulators and Mott Physics from the Hubbard Interaction*, Stephan Rachel and Karyn Le Hur, 21 pages, arXiv:1003.2238 and *Phys. Rev. B* **82**, 075106 (2010).

*Quantum Spin Hall Insulators with Interactions and Lattice Anisotropy*, Wei Wu, Stephan Rachel, Wu-Ming Liu, Karyn Le Hur *Phys. Rev. B* **85**, 205102 (2012).

*Anisotropic Quantum Spin Hall Effect, Spin-Orbital Textures and Mott Transition*, Tianhan Liu, Benoît Douçot, Karyn Le Hur *Phys. Rev. B* **88**, 245119 (2013), 24 pages.

- Charge Fractionalization in low-dimensional electrons systems

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 I. Safi and H. J. Schulz, *Phys. Rev. B* **52**, R17040 (1995); K. V. Pham, M. Gabay and P. Lederer, *Phys. Rev. B* **61**, 16397 (2000).

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).

- 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  
*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  $\text{LiV}_2\text{O}_4$   
*Electronic Structure of the Heavy Fermion Metal  $\text{LiV}_2\text{O}_4$* , V. I. Anisimov, M. A. Korotin, M. Zöfl, T. Pruschke, K. Le Hur and T. M. Rice, *Phys. Rev. Lett.* **83**, 364 (1999).

### **Theory of Non-equilibrium Quantum Systems and Applications**

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. We 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 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. Recently, we have worked on approaches to tackle non-equilibrium quantum systems away from equilibrium:

- *Non-perturbative stochastic method for driven spin-boson model*  
Peter P. Orth, Adilet Imambekov, Karyn Le Hur *Phys. Rev. B* **87**, 014305 (2013).  
Loïc Henriët, Zoran Ristivojevic, Peter P. Orth, Karyn Le Hur, *Phys. Rev. A* **90**, 023820 (2014).  
Loïc Henriët, Karyn Le Hur, *Phys. Rev. B* **93**, 064411 (2016).

- Scattering State Equilibrium Theory of Non-Equilibrium Transport  
**Survey** on *Effective Equilibrium Theory in NonEquilibrium Quantum Transport*, by Prasenjit Dutt, Jens Koch, J. Han and Karyn Le Hur, arXiv:1101.1526, 53 pages

Annals of Physics **326** 2963-2999 (2011).

See also *Reformulation of steady state nonequilibrium quantum statistical mechanics*, S. Hershfield, Phys. Rev. Lett. **70**, 2134 (1993).

Other Developments and Collaborations:

- Universal resistances of the Quantum RC circuit

Christophe Mora and Karyn Le Hur,  
Nature Physics **6**, 697 (2010).

- *Non-equilibrium Quantum Transport through a dissipative resonant level model* Chung-Hou Chung, Karyn Le Hur, Gleb Finkelstein, Matthias Vojta, Peter Woelfle, Phys. Rev. B **87**, 245310 (2013).

- Transport through quantum dots described by Kondo models with a large symmetry  
*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, Phys. Rev. B **80**, 155322 (2009) (Editors' suggestion).  
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).

## **Many-Body physics with 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<sup>1</sup>. These crystals made of light are used to trap cold atoms at very low temperatures and the ultra-cold 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 the last few years there has also been tremendous activity in studying the coherent interaction of matter and light<sup>2</sup>. These developments offer a wealth of possibilities, at the interface be-

<sup>1</sup>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.

<sup>2</sup>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).

tween 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. We explore novel phenomena in optical lattices and circuit Quantum Electrodynamics (QED).

- Novel phases with cold atoms and their mixtures

*Chiral Bosonic Phases on the Haldane Honeycomb Lattice*, Ivana Vasic, Alexandru Petrescu, Karyn Le Hur, Walter Hofstetter Phys. Rev. B **91**, 094502 (2015).

*Chiral Mott Insulators, Meissner Effect, and Laughlin States in Quantum Ladders*, Alexandru Petrescu, Karyn Le Hur Phys. Rev. B **91**, 054520 (2015).

*Bosonic Mott Insulator with Meissner Currents*, Alexandru Petrescu and Karyn Le Hur, Phys. Rev. Lett. **111**, 150601 (2013).

*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, Phys. Rev. A **80**, 023624 (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.

*Time-Reversal-Invariant Hofstadter-Hubbard Model with Ultracold Fermions*

Daniel Cocks, Peter P. Orth, Stephan Rachel, Michael Buchhold, Karyn Le Hur, Walter Hofstetter Phys. Rev. Lett. **109**, 205303 (2012).

- 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).

*Time-reversal symmetry breaking in circuit-QED based photon lattices*, Jens Koch, Andrew Houck, Karyn Le Hur and S. M. Girvin, Phys. Rev. A **82**, 043811 (2010). See also Viewpoint: Andrew D. Greentree and Andrew M. Martin Physics **3**, 85 (2010).

- *Anomalous Hall Effects of Light and Chiral Edge Modes on the Kagome Lattice*

Alexandru Petrescu, Andrew Houck, Karyn Le Hur, Phys. Rev. A **86**, 053804 (2012).

- *Kondo resonance of a microwave photon*

Karyn Le Hur, Phys. Rev. B **85**, 140506(R) (2012).

- *Tunable Hybrid Quantum Electrodynamics from Nonlinear Electron Transport*

Marco Schiró, Karyn Le Hur arXiv:1310.8070.

- Chapter in a book on quantum phase transitions, 2010

Chapter on *Quantum Phase Transitions in Spin-Boson Systems: Dissipation and Light phenomena*, by Karyn Le Hur in the book on “Understanding quantum phase transitions”, editor L. D. Carr ( Taylor & Francis Group, Boca Roca).

## 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 between the two areas. 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 is 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. Recently, we have introduced the concept of “bipartite fluctuations” as a probe of many-body physics, quantum phase transitions and entanglement in quantum systems. Understanding entanglement between a qubit (spin) and its environment also 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.

- Concept of Bipartite Fluctuations in Many-Body Quantum Systems:

**Survey** on *Bipartite Fluctuations as a Probe of Many-Body Physics*,

H. Francis Song, Stephan Rachel, Christian Flindt, Israel Klich, Nicolas Laflorencie and Karyn Le Hur, Phys. Rev. B **85**, 035409 (2012), Editors’ Suggestion.

*Detecting Quantum Critical Points using Bipartite Fluctuations*, Stephan Rachel, Nicolas Laflorencie, H. Francis Song, Karyn Le Hur, Phys. Rev. Lett. **108**, 116401 (2012)

*Fluctuations and Entanglement spectrum in quantum Hall states*, Alexandru Petrescu, H. Francis Song, Stephan Rachel, Zoran Ristivojevic, Christian Flindt, Nicolas Laflorencie, Israel Klich, Nicolas Regnault, Karyn Le Hur J. Stat. Mech. (2014) P10005.

- 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).

## 7 Contributions to the training of highly-qualified Personnel

PhD students:

- **Ariane Soret** (CPHT Ecole Polytechnique and Technion Israel)

Since Fall 2016, I am co-supervising the PhD thesis of Ariane Soret with E. Akkermans on superconductivity, mesoscopic and interaction effects.

- **Loic Henriet** (CPHT Ecole Polytechnique)

I have supervised the PhD student Loic Henriet on Non-Equilibrium Quantum Systems and Light-Matter Interaction. Loic is now a post-doctoral associate at Barcelona in the group of D. Chang.

- **Loic Herviou** (CPHT Ecole Polytechnique and Laboratoire Pierre Aigrin, ENS Paris)

Since 2014, I am co-supervising Loic Herviou together with Christophe Mora (LPA ENS) on Majorana fermions in condensed-matter systems.

- **Kirill Plekhanov** (CPHT Ecole Polytechnique and LPTMS Orsay)

Since 2015, I am co-supervising Kirill Plekhanov with Guillaume Roux (LPTMS Orsay) on Floquet theory and artificial gauge fields, topological phases.

- **Tianhan Liu** (LPTHE Jussieu/CPHT Ecole Polytechnique - graduation September 2015)

Since Summer 2012, I am co-supervising Tianhan Liu with Benoît Douçot (LPTHE Lussieu) on interacting topological phases of matter. Tianhan has obtained a 4-year post-doctoral position in the group of D. Kovrizhin at Cambridge and then Oxford.

- **Tudor Alexandru Petrescu** (Yale/Ecole Polytechnique -graduation September 2015)

I am supervising Alex Petrescu in the area of topological insulators in cold atoms and novel phases of light. Alex has obtained a 3-year postdoctoral position in the group of Hakan Tureci at Princeton.

- **Prasenjit Dutt** (PhD student at Yale, graduation August 2013)

I have been supervising Prasenjit Dutt in the area of non-equilibrium Quantum Transport in Nanosystems. Prasenjit has accepted a position in mathematical finance at UBS Stamford (USA).

- **Peter Orth** (graduation, Yale 2011)

I have supervised Peter Orth in the area of cold-atomic systems, Quantum Computation, Novel phases and Quantum Phase Transitions since September 2006. Peter has successfully graduated in April 2011, and he has been a postdoctoral Fellow at Karlsruhe (Germany), a Junior Group leader in the group of J. Schmalian. He moved to U. Minnesota at Minneapolis and has obtained recently a job offer from Ames Lab, Iowa (assistant professor position).

- **Francis Song** (graduation 2012, Yale)

I have supervised the PhD student Francis Song in the area of quantum computing, many-body entanglement, and Density matrix Renormalization Group (DMRG). Francis is now a post-doctoral fellow at New-York University in Theoretical Neuroscience.

- **Émilie Dupont** (graduation 2006 - Sherbrooke)

I have supervised Émilie Dupont in the area of Mesoscopic physics, Entanglement, and Quantum Computing. Émilie has obtained positions of ATER at the Université Pierre and Marie Curie, Jussieu (Paris, France), at U. Cergy Pontoise and in Caen. Emilie is now a Science Teacher at Cit scolaire Marcel Gambier, Le Havre Area, France.

- **Michel Pioro-Ladrière** (graduation, 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”.

**Note:** I have been collaborating with Michele Filippone, PhD student in the group of Christophe Mora (LPA ENS Paris). M. Filippone has joined the group of P. Brouwer at Freie University Berlin for a post-doc. I am also collaborating with Bedoor Alkurtass (UCL) in the group of Sougato Bose. I have also collaborated with Cécile Repellin (LPA ENS paris and Princeton) in the group of Nicolas Regnault.

- **Wei Wu** (visiting PhD student from Academy of Sciences in China, Beijing)

2011, I have been supervising the PhD student Wei Wu on Hubbard models and Cluster Dynamical Mean Field Theory. Wei has a post-doctoral fellow at Sherbrooke University in the group of André-Marie Tremblay. He is now a post-doctoral fellow with Antoine Georges and Michel Ferrero.

- **Anne-Louise Gadsballe** (Sep 2010-Jan. 2011)

I have supervised the visiting PhD student **Anne-Louise Gadsballe** from Aarhus (Denmark) on D-wave superfluidity of cold atomic fermion systems.

Postdoctoral research fellows:

- **Tal Goren** (2016-2018)

Tal has done in PhD in Israel at Technion in the group of Eric Akkermans, on novel time-dependent protocols to probe electron systems, such as Ramsey protocols. We have collaborated on this subject during her PhD, and Tal is now a post-doctoral fellow in our group.

- **Zoran Ristivojevic** (2012-2014, now CNRS Toulouse)

I have been collaborating with Zoran Ristivojevic and Loic Henriet on quantum impurity systems out of equilibrium (see list of publications). In 2013-2014, Zoran was funded by a post-doctoral fellowship of the Labex Palm, Paris-Saclay. He obtained a permanent CNRS position at Toulouse.

- **Ion Garate** (post-doctoral fellow at Yale and now assistant professor at Sherbrooke)

I have been collaborating with Ion Garate (Yale post-doc, assistant professor at Sherbrooke University) on the theory of quantum RC circuit with interactions and topological insulators.

- **Thomas Schmidt** (since 2011, now assistant professor at university of Luxembourg)

I have been collaborating with the postdoctoral fellow, Thomas Schmidt (group of my colleague Prof. Leonid Glazman at Yale and now Junior Group Leader at Basel) in the area of quantum impurity systems, mesoscopic systems and cold atoms. Thomas has obtained an Assistant Professor position at University of Luxembourg.

- **Stephan Rachel** (Oct. 2009-2012, now associate at T. U. Dresden and Princeton)

Stephan Rachel has obtained a prestigious 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 topological qubits, and cold-atomic realizations. Stephan is now at TU Dresden in the group of Matthias Vojta.

- **Jens Koch** (now, Assistant Professor at Northwestern university)

I have collaborated with the postdoctoral fellow Jens Koch (group of my colleague Prof. Steve Girvin) in the area of Josephson junction arrays and novel correlated many-body phenomena when coupling photons to atoms.

- **Doron Bergman** (2007-2009)

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. Doron has accepted a position in Big-Data Management, at Tachyus, San Francisco.

- **Adilet Imambekov** (assistant professor at Rice University until July 2012)

I have been 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.

- **Andriy Nevidomskyy** (2005/2006, now assistant professor at Rice University)

I have supervised Andriy Nevidomskyy on mesoscopic physics. Andriy is now assistant professor at Rice 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, on frustrated magnetism. John was at Brandon University, Canada as an Associate Professor and he is now an instructor at UBC British Columbia, Vancouver.

#### Visiting Scholars:

Summer 2014: I will host Prof. Henrik Johannesson (U. Goteborg, Sweden) and Prof. Andrew Jordan (U. of Rochester USA). I have been collaborating with the assistant professor C.-H. Chung (Taiwan); he took a sabbatical leave (Aug 2009-Jan 2010) in my group.

#### *Other supervisions and collaborations with postdocs:*

Also, I collaborate with post-docs at other institutions: **Greg Fiete** (KITP Santa-Barbara and now associate professor at the University of Texas at Austin), **Angela Kopp** (Rutgers University, now working at D. E. Shaw Research in New-York), **Cristina Bena** (IPHT Saclay), **Patrik Recher** (postdoc at Stanford and now assistant professor at Würzburg, Germany). I am also collaborating with Laura Messio (IPHT CEA Saclay, MC at UPMC), Marco Schiro (Princeton, CNRS IPHT), I. Vidanovic (Frankfurt, now professor in Serbia), Albolfazl Bayat (UC London), Marie Piraud (Munich).

## 8 Training of intermediate-qualified students

- I am supervising the Master students **Antonio Sclocchi** (Turin, Paris-Saclay), **Mme Fan Yang** (Master Ecole Polytechnique), and **Thilina Arachige** (co-supervision with Julien Laurat, ENS).

- **Kirill Plekhanov, M2 student from Master M2 ICFP**

I have been supervising Kirill Plekhanov, on Dirac Materials and Floquet Topological Insulators. Kirill has applied for a PhD Fellowship from EDPIF to continue at the PhD level, in co-direction with Guillaume Roux (LPTMS Orsay).

- **Loic Herviou, M2 student at Ecole Polytechnique**

I have co-supervised the Master student Loic Herviou on Majorana Fermionq, Superconducting Wires in Cavities, with my colleague Christophe Mora (LPA ENS Paris). Loic is pursuing at the PhD level.

- **Loic Henriet, M2 student at Ecole Polytechnique**

I have supervised the Master Student M2 Loic Henriet, Ecole Polytechnique, on driven and dissipative quantum impurity models, January-April 2013. Loic is pursuing at the PhD level.

- **Alexis Jouan, M2 student**

I have co-supervised the Master student M2 Alexis Jouan, LPA ENS Paris, with Christophe



Mora on Majorana fermions in cavity QuantumElectrodynamics environment, Winter 2013. Alexis is doing PhD thesis with Jérôme Lesueur at ESPCI.

- **Dragos Potirniche**

I have supervised the undergraduate student Dragos Potirniche, Princeton, Summer 2012.

- **Sachin Pathak**

I have supervised the undergraduate student from Bangalore, Sachin Pathak, on QED cavity systems.

- **Mehmet Dogan**

I have supervised the second year Master student **Mehmet Dogan** at Yale on many-body physics with photons and atoms. Mehmet is doing a PhD thesis in the group of S. Ismail-Beighi.

- **Ivan Stanic** (Masters student, Yale)

I have supervised the student Ivan Stanic in the area of graphene (2007-2009).

- **Daliang Li**

I have supervised the first-year student **Daliang Li** at Yale during the summer 2010. Daliang is now a PhD student in the group of Prof. W. Skiba.

- **Jean-Francois Rupprecht** (Master project 2010)

I have supervised the Master student **Jean-Francois Rupprecht** from ENS Paris (Feb-July 2010) on bilayer graphene systems, scattering theory and Berry phase. Jean-Francois has written a Master Thesis on this subject and was a PhD student at LPTMC UPMC with O. Benichou, R. Voituriez. He is now a post-doctoral fellow at ENS Paris.

- **Sean Litsey** (Yale 2009-2010)

I have supervised the Senior student **Sean Litsey** on the intriguing phenomenon of ripples in graphene. Now, Sean is a PhD student at UCLA.

- **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 a PhD student at University of Urbana Champaign USA.

- **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 has done a PhD at NRC Ottawa.

## 9 Teaching Experiences

- X Spring 2015, 2016 : Petites Classes, PHY311, introduction to quantum mechanics.  
X Fall 2014, 2015 : Petites Classes, PHY430, quantum mechanics.  
X Spring 2013-2014 : Petites Classes, PHY432, quantum mechanics and statistical physics.  
Yale Fall 2011 : Graduate course on **Statistical Physics**, 628a  
Yale 2008-09 and 10-11 : Undergrad. course, **Quantum Mechanics & Natural Phenomena** 440-1.  
Yale spring 2007-08 : Graduate Course on **Advanced Many-Body theory** (634 and 632).  
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  
: (course introduced by myself).  
Sherbrooke : Undergraduate Course on **ElectroMagnetism** to first year students, Course  
Genève 2000-2002 : Undergraduate **Electrodynamics** to second year students,  
: assistant Mme Ruth Durrer.  
2000 : Organization of Proseminars on **Diagrammatic Techniques** (ETH).  
1995-1998 (PhD level) : Undergraduate course to 1<sup>st</sup> year students (Cergy-Pontoise), Paris,  
: **Introduction to special relativity**, Course, Small Classes.

## 10 Invitations and Organization of Conferences

Organization of International Conferences and Workshops:

**September 2015:** Participation in the organization of a workshop at ICTP Trieste on “Frustration, Dynamics, Many-Body Localization” with A. Scardicchio, S. Parameswaran, R. Moessner, M. Mueller

**April 2014:** Participation in the organization of an OSA Incubator Meeting in Washington on “Topological Order with Photons” with S. Girvin, M. Hafezi, J. Taylor

**January 2012:** Co-organizer of the Aspen Winter conference on “New Directions in Cold Atoms” with E. Altman, E. Demler, M. Greiner, W. Ketterle and C. Sa DeMelo

**March 2010:** Chair of the APS invited session on “Novel Probes of electron interactions in low-dimensional systems” with C. Ford, L. Glazman, N. Mason, D. Mirlin, S. Cronin

**July 2009:** Organization of a 2-week Summer School in Cargèse, Corsica, France on condensed-matter physics with A. Jagannathan, L. Greene and C. Pépin

<http://icamconferences.org/cargese09/>

**March 2009:** Organization of a symposium with J. Harris at the APS meeting 2009 on *persistent currents in mesoscopic rings*, Pittsburg

**May 2008:** Organization of a 2-week Workshop on, *Quantum Information and Phenomena: From mesoscopic to cold-atomic systems*, with I. Cirac, D. Loss and P. Zoller (ICTP Trieste), <http://cdsagenda5.ictp.trieste.it/>

**March 2006:** Invited talk at APS meeting, Baltimore (speakers: J. Petta, K. Matveev, H. Steinberg, G. Fiete, K. Le Hur and Chairman: L. Balents) and organization of the symposium

**July 2004:** Organization of a Workshop in Cargèse, Corsica, France on condensed-matter physics with A. Kapitulnik, D. Morr and C. Pépin

**March 2004:** Invited talk at APS meeting, Montreal, on SU(4) Kondo confinements and organization of the symposium (Chairman: L. Glazman)

Selected Invitations (International Events) until 2013 (need to be updated):

**September 2013:** Invitation at Harvard, workshop in memory of our friend Adilet Imambekov, organized by D. Abanin, E. Demler, L. Glazman.

**September 2013:** 4 Lectures of 1h30 on Quantum Dynamics of Spin-Boson Systems at the Quebec Mesoscopic School, organized by M. Aprilli, J. Gabelli, B. Reulet.

**September 2013:** Workshop in Memory of my PhD advisor Bernard Coqblin in LPS Orsay

**July 2013:** Invited Presentation at MPIPKS Dresden, Workshop on Spin-Orbit Entanglement and Topological Phases organized by R. Thomale, B. Trauzettel, S. Trebst.

**June-July 2013:** Invitation Cargèse, Workshop on Topological Phases in condensed-matter and Cold Atoms: application to quantum computing, organized by Eddy Ardonne, Didier Poilblanc, Matthias Troyer, Nicolas Regnault.

**May 2013:** Invitation Trieste, Workshop on Ultracold Atoms and Gauge Theories, organized by J. Dalibard, M. Lewenstein, G. Mussardo, C. Sa de Melo, A. Trombettoni

**January 2013:** Workshop at Stockholm on Pushing the Boundaries of Ultracold Atoms

**October 2012:** Invitation KITP Santa-Barbara, Workshop on Non-Equilibrium Quantum Physics

**August 2012:** Invitation for a seminar at Les Houches, school on non-equilibrium quantum systems organized by T. Giamarchi, A. Millis, O. Parcollet, H. Saleur

**June 2012:** Seminar at IHP, Workshop on disordered systems organized by B. Altshuler, B. Douçot, M. Mézard, G. Shlyapnikov

**March 2012:** Invitation to APS meeting in Boston

**March 2012:** 70th Birthday of P. Woelfle in Karlsruhe

**Feb. 2012:** Invitation in Aspen, *Conference on Low-Dimensional Systems*

**October 2011:** Workshop on Charge and heat dynamics in nano-systems October 10-12, 2011, Orsay, France organized by C. Bena and A. Crépieux.

**Sept 2011:** Participation in the Yale-UCL meeting in London on NanoTechnology

**Aug 2011:** Participation in the Aspen Workshop on Topological Quantum Systems

**June 2011:** Invitation at MPIPKS Dresden, Workshop on *New Directions in Quantum Impurity Systems*

**Sept 2010:** Invitation at Nordita, Stockholm, Workshop on *Quantum Matter in Low Dimensions: Opportunities and Challenges*

**Aug 2010:** Invitation at Konstanz, School and Workshop on *Spin-Based Quantum Computing*, organized by G. Burkard and D. Loss

**July-Aug. 2010:** Invitation Aspen, Workshop on *Low-dimensional Systems*, organized by E. Altman, L. Glazman, P. Goldbart, and G. Refael

**July 2010:** Invitation MPIPKS Dresden, Workshop on *Low-dimensional Systems*, organized by J. Meyer, G. Refael and K. Stengel

**June 2010:** Invitation, MPIPKS Dresden, Workshop on *Quantum Information Concepts for Condensed Matter Problems*, organized by I. Affleck, M. Haque and U. Schollwöck

**May 2010:** Invitation at Perimeter Institute, workshop on Emergence and Entanglement, organized by A. Hamma, N. Turok, D. Gottesman, S. Sachdev and X.-G. Wen

**Spring 2010:** CNRS Fellowship and Visiting Scholar at Orsay, Paris

**Oct-Nov. 2009:** Visiting scholar, KITP Santa-Barbara, Workshop on Quantum Information

**June 2009:** Invited Professor at École Normale Supérieure of Paris (1 month)

**Feb. 2009:** Invitation, KITP Santa-Barbara, conference on *New Directions in Low-dimensional Electron Systems*

**Jan. 2009:** Invited presentation at the PQE conference 2009, Snowbird

**July 2008:** Invitation, Boulder summer school, 3 lectures on Condensed Matter Physics

**June 2008:** Invitation to MPIPKS Dresden, Workshop on *Novel Phases of matter and Phase Transitions*, organized by A. Chubukov, M. Vojta and T. Vojta

**March 2008:** International Conference, Moriond, Les Arcs, on *Transport in NanoSystems*  
[http://www.cnano-rhone-alpes.org/IMG/pdf\\_moriond-program.pdf](http://www.cnano-rhone-alpes.org/IMG/pdf_moriond-program.pdf)

**Sept. 2007:** Invited Talk, Workshop at Brookhaven organized by A. Tsvelik, F. Essler, and R. Konik, on *Quantum Field Theory applied to condensed-matter systems*

**Aug. 2007:** Invited Talk at MPIPKS Dresden, Workshop on *Quantum Impurity Systems*, organized by R. Bulla, D. Logan, and A. Schiller

**June 2007:** Invited Talk, ICTP Trieste, Workshop on Nanosystems and Graphene, organized by V. Falko, J. Meyer and A. Millis

**July 2006:** Aspen, Workshop on Mesoscopic Physics organized by M. Devoret, S. Girvin, L. Glazman and C. Marcus

**June 2006:** CEA Saclay (Paris), Claude Itzykson memorial on *Strongly Correlated Electrons* organized by C. Pépin and O. Parcollet

**June 2006:** Gordon conference on Strongly Correlated Electrons. Session on Quantum Phase Transitions by S. Chakravarty (speakers: C. Nayak, M. Fisher, L. Balents, K. Le Hur)

**April 2005:** KITP Santa-Barbara, Workshop on Quantum Criticality, organized by P. Coleman, A. Chubukov, D. Morr, M. Norman. Lecture on “Quantum Criticality at the Nano-Scale”

**Nov 2004:** Invited professor at Saclay for 2 months by the condensed matter group of SPHT

**Sept. 2004:** Gordon Conference on Superconductivity, Oxford, organized by Seamus Davis and Van der Marel. Invited talk on *Exotic Superconductivity*

**July 2004:** Trieste, Workshop on Strongly Correlated Electrons and Mesoscopic Physics, Invited Presentation

**Sept. 2003:** Brookhaven, workshop on “Field Theory Methods applied to Mesoscopic Physics” organized by A. Tsvelik and F. Essler

**April 2003:** Workshop at MPIPKS Dresden; seminar on SU(4) Kondo confinements

**July 2002:** Trieste, Invitation, Workshop on Correlated Electron Systems organized by P. Coleman, A. Tsvelik and A. Chubukov

**March 2000:** European Physics Society meeting in Montreux, Switzerland. Talk on  $\text{LiV}_2\text{O}_4$

**June 1999:** 60<sup>th</sup> birthday of T.M. Rice in Ascona, Switzerland. Seminar on  $\text{LiV}_2\text{O}_4$

**April 1999:** Cambridge, Invitation, Workshop on Correlated Electron Phenomena

## 11 Administrative Task and Other

- Since 2012: Member of the Comité National, CNRS, Section 02 and member of bureau
- Spring 2013: Participation in the selection committee of CNRS Directeurs de Recherche (DR02), Section 03
- Participation ERC Panel PE2 consolidator grant 2015
- January 2013: Participation in AERES committee, visit of LPTMC UPMC UMR 7600
- Member of the CIFAR (Canadian Institute for Advanced Research) program on Quantum Materials
- Member of the Editorial Board of Physical Review B, since 2012
- Referee of Physical Review Journals, Europhysics Journals, Nature and Nature Physics, ...
- Referee for grants from ANR, NSF, DOE, NSERC, DFG...
- Participation in the promotion process to assistant, associate and full professors, of colleagues

in my field of expertise.

- Participation in PhD and HDR Jurys.

## 12 Funding and Awards

### Ecole Polytechnique, since 2012

- DFG German Fellowship, Forschungsgruppe, related to the creation of a new unit on Artificial Gauge Fields and Topological Phases, gathering Munich (I. Bloch, speaker), Hamburg, Frankfurt, Dresden, Barcelona, Cambridge and Ecole Polytechnique. Fellowship for 1 PhD student.

- Grant from LABEX PALM, Paris-Saclay and Ecole Polytechnique Quantum, Post-doctoral Funding, 2016-2018, Mme Tal Goren

- Grant from LABEX PALM, Paris-Saclay Quantum Dynamics in Many-Body Quantum Systems, Post-doctoral Funding, 2013-2014
- Post-doctoral Fellowship from Ecole Polytechnique 2012-2013, Zoran Ristivojevic

### Yale (July 2006-2012):

- NSF grant (National Science Foundation)

Condensed Matter and Material Theory (CMMT), 2008

NSF DMR-0803200, 9/1/08

Karyn Le Hur, *Theory of Entanglement in Many-Body Quantum Systems*

<http://www.nsf.gov/funding/>

- DOE grant (Department of Energy), 2011

DOE award: Renewal DE-FG02-08ER46541

Karyn Le Hur, *Nonequilibrium Dynamics of Many-Body Quantum Systems: Fundamentals and New Frontiers*

<http://www.energy.gov/>

- NSF MRSEC: Material Research Center, 2011 (approved)

PIs: C. Ahn and others

- NSF grant, ITR Center: Yale Center for Quantum Information Physics, 2007

NSF DMR-0653377, 9/1/07-8/31/12

S. Barrett, D. DeMille, M. Devoret, S. Girvin, J. Harris, K. Le Hur and R. Schoelkopf

- Designing Novel Superconductors with Oxides

DARPA, US Army (2010)

DARPA W911NF-10-1-0206

PIs: C. Ahn, S. Ismail-Beigi, K. Le Hur and K. Moller (Stanford)

- 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/>

- YINQE (Yale Institute for NanoScience and Quantum Engineering)  
2007 Seed Award with J. Harris  
the duration was 8/15/07 - 8/14/08

- Startup Funds  
Yale University

**Canada (2002/2006):**

- Regroupement Québécois sur les matériaux de pointe  
FQRNT  
Fonds Québécois de la recherche sur la nature et les technologies  
Regroupement stratégique  
McGill, Montréal, Sherbrooke  
Date Range: 04/2003 to 04/2009

- Kondo Physics in Artificial Structures  
FQRNT  
Young Investigator Award  
Date Range: 04/2004 to 03/2008  
Single PI

- Theory Group Grant  
FQRNT  
Support to Theoretical Group at Sherbrooke  
Date Range: 04/2003 to 04/2007  
PIs: C. Bourbonnais, L.G. Caron, R. Côté, K. Le Hur, D. Sénéchal and A.M. Tremblay

- New Opportunities Funds: Special Award  
Fondation Canadienne pour l'Innovation (FCI)  
MicroFabrication Facility for high temperature superconductors  
Date Range: 09/2004 to 09/2005  
PIs: Serge Charlebois and Karyn Le Hur

- From Mesoscopic Physics to Doped Mott Insulators  
CRSNG or NSERC  
  
Date Range: 04/2002 to 04/2006  
Single PI

- Startup Funds  
Université de Sherbrooke  
Single PI

- Quantum Material Laboratory  
FCI, Date Range: 09/2002 to 09/2005  
PIs: L. Taillefer and Others