GIOVANNI VIGNALE

1. PERSONAL DATA

Year of birth:	1957
Place of birth:	Napoli, Italy
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2. EDUCATION

- Laurea in Fisica, University of Pisa, November 1979.
- Diploma di Licenza in Fisica, Scuola Normale Superiore, Pisa, November 1979.
- Ph. D. in Physics, Northwestern University, August 1984.

3. EMPLOYMENT

1. Postdoctoral Research Associate at the Max-Planck-Institut/FKF, Stuttgart, Germany 1984-1986
2. Postdoctoral Research Associate, Solid State Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, and Department of Physics, University of Tennessee, Knoxville, Tennessee 1986-1987
3. Assistant Professor of Physics, University of Missouri-Columbia 1988-1992
4. Associate Professor of Physics, University of Missouri-Columbia 1993-1996
5. Professor of Physics, University of Missouri-Columbia 1996-2006
6. Curators' Professor of Physics, University of Missouri-Columbia 2006-

4. RESEARCH APPOINTMENTS

1. Ikerbasque Fellow at the European Theoretical Spectroscopy Facilit (ETSF), San Sebastian, Spain, March-September 2009.

2. Visiting professor at the Institute for Solid State Physics (ISSP) of the University of Tokyo, February-May 2010.

5. HONORS

Fellow of the American Physical Society since 1997.
Millsap distinguished professorship at UMC, 2003
Curators' distinguished professorship at UMC, 2006

6. RESEARCH GRANTS

- "*Current density functional theory of electron diamagnetism in periodic structures*", National Science Foundation DMR 91-00988, $105,000, May 1991-June1994.

- "*Construction of an exchange-correlation energy functional for electronic systems in high magnetic fields*", Petroleum Research Fund, administered by the American Chemical Society, Grant No. 23798-G6, $ 18,000; June 1991-June 1993.

- "*Microscopic theory of dielectric response of highly dispersive biological media*" (co-PI Brian DeFacio, UMC), Air Force Office for Scientific Research, Grant No. 91-0203, $101,000, June 1991-June 1993.

- "*Current density functional theory of artificial microstructures at high magnetic field*", National Science Foundation, DMR 94-03908, $ 150,000, June 1994-June 1997.

- "*International Workshop on Electron Density Functional Theory: Recent Progress and New Directions*" (co-PI, John Dobson, Griffith University, Brisbane, Australia) National Science Foundation /Division of International Programs INT-9515457, $ 33,700, May 1996-June 1997.

- "*Theory of time-dependent phenomena in quantum many-body systems*", National Science Foundation DMR-9706788, $ 207,000, June 1997-June 2000.

- "*Theory of Charge and Spin Dynamics in Electron Liquids*", National Science Foundation, DMR-0074959, $ 279,000, June 2000-June 2003.

- "*Mesoscopic Dynamics of Fractional Charge*", INFM-Advanced Research Project (Project manager, Prof. Fabio Beltram, Scuola Normale Superiore, Pisa, Italy; co-PI's Vittorio Pellegrini, Roberto Raimondi, Lucia Sorba.

- "*Many-body effects in electronic dynamics and transport*", National Science Foundation, DMR-0313681, $ 428,000, June 2003-June 2007.

- " *Time-dependent density-functional formulation of transport in nanoscale conductors*", US Department of Energy, $ 300,000, June 2005-May 2008.

- **"*Many-body theory of electronic dynamics and transport*", National Science Foundation, $ 330,000, September 2007-August 2010.**

- ***"Time-dependent current-density functional theory of charge, energy and spin transport in nanoscale conductors"*, US Department of Energy, $ 315,000, June 2008-May 2011.**

- **"*Room-temperature spin-mediated coupling in hybrid magnetic, organic, and oxide structures and devices*", US Army Research Office under MURI**

(Multidisciplinary University Research Initiative) , Team led by M. E. Flatte', University of Iowa); $ 850,000, May 2008-April 2013.

Many-body theory of spin-orbit coupled materials and artificial graphene, NSF-DMR, $469,000/2010-2013, pending.

7. INTERNAL RESEARCH GRANTS AT UNIVERSITY OF MISSOURI

- Weldon Spring Campus Grant 1988 $ 18,335
- Summer Research Fellowship 1988 $ 3,500
- Weldon Spring Campus Grant 1989 $ 13,160
- Weldon Spring Intercampus Grant 1989 $ 16,375
  (co-PI Prof. W. Y. Ching)
- Research Board Grant # RB93-033 (1993-94) $ 36,000
- Research Leave (Academic year 1994-95)
- Research Board Grant # RB96-071 (1996-97) $ 36,000
- Research Leave (Fall Semester 1998)
- Research Board Grant # RB00-029 (2000-01) $ 47,400
- Research Leave (Fall Semester 2002)
- Reasearch Leave (AY2008-2009)

8. Ph.D. ADVISEES

- Mohammed. R. Hedayati, "*Electron correlations in itinerant-electron antiferromagnets*", Ph.D. December 1990.
- Otto Fajen, "*Incommensurate spin-density wave domains and electron spin susceptibility in Cu-Mn alloys*".
- Pawel Skudlarski, "*Electronic correlations in three dimensional electron gas in a uniform magnetic field*",Ph.D. August 1993.

- Sang-Hoon Kim, "*Frequency and wave-vector dependent dielectric function of water-like fluids*", (co-advisor Brian DeFacio) Ph. D August 1993.

- Maurizio Ferconi, "*Density functional theory of two dimensional electronic structures in a magnetic field*", Ph.D. August 1995.

- Irene D'Amico, "*Time dependent density functional theory/Spin Drag"*, Ph.D. August 2000.

- Adi Constantinescu, "*Time dependent spin density functional theory*", 2002-2003

- Matt Mower, *"Spin dynamics in semiconductors"*, Fall 2007 – present

- Tianyu Liu, "*Spin dynamics in ferromagnets*", August 2008 – present

9. POSTDOCTORAL RESEARCH ASSOCIATES

- Michael R. Geller, *"Universal properties of equilibrium currents in quantum Hall fluids*", August 1993- August 1995.

- Sergio Conti, "*Electron spectral function of smooth edges in high magnetic field*", visiting from Scuola Normale Superiore, Pisa, Italy, January-June 1996.

- Carsten Ullrich, "*Time-dependent density functional theory*" January 1997 – August 1999 and September 2000-September 2001.

- Zhixin Qian, *"Spin dynamics from time-dependent density functional theory"*, September 2000 – June 2003.

- Roberto D'Agosta, "*Transport properties of the two-dimensional electron gas at high magnetic field*", September 2001-February 2002 and September 2003-present

- Ruben D. Portugal, "*Spin dynamics and spin density functional theory*", January 2004-December 2004.

- Ewelina Hankiewicz, *"Spin transport and spin dynamics"*, June 2005 –July 2007

- Jianmin Tao, *"Time-dependent density functional theory"*, July 2005 –July 2007

- Saeed Abedinpour, *"Current-spin density functional theory"*, December 2007 –

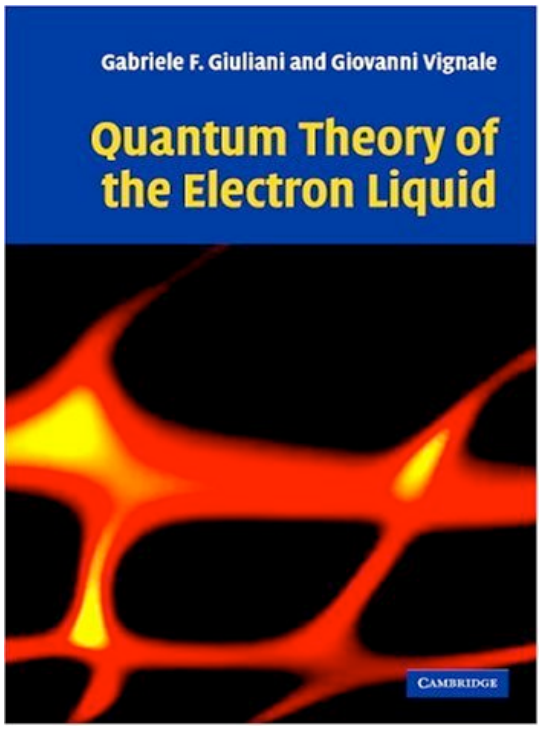
- Xianlong Gao, *"Quantum Continuum Mechanics"*, February 2008 – January 2009

- Oleg Shalaev, "*Spin-Orbit effects in Condensed Matter*", December 2008 –

- Stefano Pittalis, September 2009 –

10. PUBLICATIONS

10.1 BOOK *"Quantum Theory of the Electron Liquid"* , by G. F. Giuliani and G. Vignale (Cambridge University Press, March 2005, ISBN 0-521-82112-6, 780 pages)



This book provides an introduction to the physics of the interacting electron liquid in a broad variety of systems, including metals, semiconductors, artificial nano-structures, atoms, and molecules. One-, two- and three-dimensional systems are treated separately and in parallel. Different phases of the electron liquid, from the Landau Fermi liquid to the Wigner crystal, from the Luttinger liquid to the quantum Hall liquid, are extensively discussed. Both static and time-dependent density functional theory are presented in detail. Although the emphasis is on the development of the basic physical ideas and on a critical discussion of the most useful approximations, the formal derivation of the results is highly detailed and based on the simplest, most direct methods. A self-contained presentation of the necessary techniques, from second quantization to canonicaltransformations to both zero and finite temperature Green's functions is provided. This comprehensive text will be of value to graduate students in physics, electrical engineering and quantum chemistry, as well as practicing researchers in those areas.

10.2 JOURNAL ARTICLES

1. "*Two-component electron-hole liquid: a simple model*", M. Combescot, K.S. Singwi and G. Vignale, Phys. Rev. **B 24**, 7174-7180 (1981).

2. "*Two-photon transitions in two-electron systems: The 1S-2S transition in Helium*", F. Bassani and G. Vignale, Nuovo Cimento **1D**, 519-539 (1982).

3. "*Ground-state energy of a strongly coupled electron liquid*", S. Rahman and G. Vignale, Journal of Physics F: Metal Physics **12**, L41-43 (1982).

4. "*Collective modes in electron-hole liquids*", G. Vignale and K.S. Singwi, Solid State Comm. **44**, 259-261 (1982).

5. "*Ground-state properties, thermodynamics and systematics of the electron-hole liquid in Ge and Si under uniaxial stress*", G. Vignale, K.S. Singwi, R.K Kalia, and P. Vashishta, Journal of Physics C: Solid State Physics **16**, 699-709 (1983).

6. "*Fine structure in the dynamic form factor of an electron liquid*", S. Rahman and G. Vignale, Phys. Rev. **B 30**, 6951-6959 (1984).

7. "*On the possibility of superconductivity in the electron-hole liquid*", G. Vignale and K.S. Singwi, Solid State Comm. **53**, 415-418 (1985).

8. "*Acoustic plasmons in a two component superconducting Coulomb liquid*", G. Vignale and K.S. Singwi, Phys. Rev. **B 31**, 245-250 (1985).

9. "*Possibility of superconductivity in the electron-hole liquid*", G. Vignale and K.S. Singwi, Phys. Rev. **B 31**, 2729-2749 (1985).

10. "*Effective interaction in Coulomb Fermi liquids*", G. Vignale and K.S. Singwi, Phys. Rev. **B 32**, 2156-2166 (1985).

11. "*Spin-flip electron-energy-loss spectroscopy in itinerant electron ferromagnets: collective modes versus Stoner excitations*", G. Vignale and K.S. Singwi, Phys. Rev. **B 32**, 2824-2834 (1985).

12. "*Self-consistent Green's function theory for interacting electrons in a random potential*", G. Vignale and W. Hanke, Z. Phys. **B 60**, 393-400 (1985).

13. "*Many-body theory of electronic excitations in random substitutional alloys I: Formalism*", G. Vignale and W. Hanke, Z. Phys. **B 69**, 193-207 (1987).

14. "*Many-body Theory of electronic excitations in random substitutional alloys II: A model application*", G. Vignale, H. Weiler, W. Hanke and A.A. Maradudin, Z. Phys. **B 69**, 209-225 (1987).

15. "*Many-body theory of electronic excitations in disordered semiconductors*", G. Vignale, W. Hanke and Y. Shinozuka, Proceedings of the 18th International Conference on the Physics of Semiconductors, Stockholm (1986), p. 1145-1148.

16. "*Effect of quantum hopping on the Coulomb gap of localized electrons in disordered systems*", G. Vignale, Y. Shinozuka and W. Hanke, Phys. Rev. **B 34**, 3003-3006 (1986).

17. "*Quantum electron glass*", G. Vignale, Phys. Rev. **B 36**, 8192-8195 (1987).

18. "*Altshuler-Aronov anomalies in the density of states of substitutional alloys*", G. Vignale and W. Hanke, Phys. Rev. **B 36**, 2924-2927 (1987).

19. "*Quantum liquids of charged particles*", K.S. Singwi and G. Vignale, an article for the Dizionario delle Scienze Fisiche, Enciclopedia Italiana Treccani, Vol III, 433-442.

20. "*Density functional theory in strong magnetic fields*", G. Vignale and M. Rasolt, Phys. Rev. Lett**. 59**, 2360-2363 (1987).

21. "*Diamagnetic susceptibility of a dense electron gas*", G. Vignale, M. Rasolt, and D.J.W. Geldart, Phys. Rev. **B 37**, 2502-2507 (1988).

22. "*Acoustic plasmons in a two-dimensional, two-component electron liquid*", G. Vignale, Phys. Rev. **B 38**, 811-814 (1988).

23. "*Current and Spin-Density Functional theory for inhomogeneous electronic systems in strong magnetic fields*", G. Vignale and M. Rasolt, Phys. Rev. **B 38**, 10685-10696 (1988).

24. "*Exact Behavior of the density and spin susceptibilities of a Fermi liquid for large wavevectors: Derivation from diagrammatic many-body theory*", G. Vignale, Phys. Rev. **B 38**, 6445-6451 (1988).

25. "*Superconductivity and Acoustic Plasmons in the two-dimensional electron gas*", G.S. Canright and G. Vignale, Phys. Rev. **B 39**, 2740-2743, 1989.

26. "*Superconducting pairing of holes in the antiferromagnetic state of the two-dimensional Hubbard model*", G. Vignale and K.S. Singwi, Phys. Rev. **B 39**, 2956-2959, 1989.

27. "*Magnetic fields and Density Functional Theory*", G. Vignale, M. Rasolt, and D. J. W. Geldart, Advances in Quantum Chemistry **21**, 235-253 (1990).

28. "*Ground-state energy of the one and two-dimensional Hubbard model calculated by the method of Singwi, Tosi, Land and Sjölander*", M. R. Hedayati and G. Vignale, Phys. Rev. **B 40**, 9044-9051 (1989).

29. "*Properties of doped holes in the antiferromagnetic state of the two-dimensional Hubbard model*", G. Vignale and M. R. Hedayati, Physica **C 162,** 1503-1504 (1989).

30. "*Motion of a single hole in an itinerant-electron antiferromagnet*", G. Vignale and M. R. Hedayati, Physical Review **B 42**, 786-797 (1990).

31. "*Self-induced effective gauge-fields in the copper-oxygen plane of high Tc perovskites: a lattice and a continuum formulation*", M. Rasolt and G. Vignale, Phys. Rev. Lett. **65**, 1498-1501 (1990).

32. "*Crossover in the Heisenberg ferromagnet*", R. S. Fishman and G. Vignale, J. Phys**. C 3**, 4381-4387 (1991).

33. "*Spin disorder in the two-dimensional Hubbard model: A mean field theory*", G. Vignale, Phys. Rev**. B 43**, 6216-6219 (1991).

34. "*Spin density wave domains in copper-manganese alloys: diagnostics for the spin susceptibility of an electron gas*", O. Fajen and G. Vignale, Solid State Comm. **77**, 829-832 (1991).

35. "*Electronic diamagnetism in a three-dimensional lattice*", P. Skudlarski and G. Vignale, Phys. Rev. **B 43**, 5764-5768 (1991).

36. "*The breakdown of the spin wave approximation for the Heisenberg ferromagnet*", R. S. Fishman and G. Vignale, Phys. Rev. **B 44**, 658-674 (1991).

37. "*Orbital paramagnetism of electrons in a two-dimensional lattice*", G. Vignale, Phys. Rev. Lett. **67**, 358-361 (1991).

38. "*Current-density functional theory of electronic systems at high magnetic fields*", G. Vignale, P. Skudlarski and M. Rasolt, Proceedings of the Conference on Physical Phenomena at High Magnetic Fields, Tallahassee, Florida, May 1991, edited by Manousakis et al., pp. 495-502.

39. "*Current-density functional theory of surface properties of electron-hole droplets at high magnetic fields*", G. Vignale, P. Skudlarski and M. Rasolt, Phys. Rev. **B 45**, 8494-8497 (1992).

40. "*Effect of exchange and correlation on the Fermi momenta an electron liquid in magnetic field*", P. Skudlarski and G. Vignale, Phys. Rev. Lett. **69**, 949-952 (1992).

41. "*Phonons of the two-dimensional Wigner crystal in magnetic field from density functional theory*", M. Ferconi and G. Vignale, Europhysics Letters **20**, 457-462 (1992).

42. "*Relation between current and density profiles of interacting systems in a magnetic field*", G. Vignale and P. Skudlarski, Phys. Rev. **B 46**, 10232-10238 (1992).

43. "*Frequency and wave-vector dependent dielectric function of water-like fluid*", S. H. Kim, G. Vignale, and B. DeFacio, Phys. Rev. **A 46**, 7548-7560 (1992).

44. "*Weak coupling theory of the two-dimensional Hubbard model*", G. Vignale, Lectures delivered at the Miniworkshop on classical and quantum many-body theory, ICTP, Trieste, July 22 - August 2, 1991. Published in "*Models and methods of high-Tc*

superconductivity", ed. J. K. Srivastava and S. M. Rao, 2003 (Nova Science Publishers, Inc., Hauppauge, New York).

45. "*Current-density functional theory of the 2-dimensional Wigner crystal in strong magnetic field*", G. Vignale, Phys. Rev. **B 47**, 10105-10111 (1993).

46. "*Exchange correlation energy of a three-dimensional electron gas in a magnetic field*", P. Skudlarski and G. Vignale, Phys. Rev. **B 48**, 8547-8559 (1993).

47. "*Equilibrium density of an electron-hole liquid in strong magnetic field: a possibility of phase separation*", P. Skudlarski and G. Vignale, Phys. Rev. **B 47**, 16647-16650 (1993).

48. "*Theory of the pinning gap in the phonon spectrum of a disordered Wigner crystal*", M. Ferconi and G. Vignale, Phys. Rev**. B 48**, 2831-2834 (1993).

49. "*Zero temperature Hall coefficient of a localized electron insulator: Wigner crystal versus Anderson localization*", G. Vignale, Phys. Rev. **B 48**, 11504-11507 (1993).

50. "*Comment on Persistent current in mesoscopic metal rings*", G. Vignale, Phys. Rev. Lett. **72**, 433 (1994).

51. "*Current density functional theory and orbital magnetism*", G. Vignale in "Density Functional Theory", Proceedings of the NATO-ASI on Density Functional Theory, Il Ciocco, Italy, August 1993, edited by M. Dreizler and E. K. U. Gross, p. 485-511.

52. "*Self-energy and persistent currents in ensembles of mesoscopic rings*", G. Vignale, Physics Letters **A 192**, 117-121 (1994).

53. "*Coulomb interaction and persistent currents in ensembles of mesoscopic metal rings*", G. Vignale, Phys. Rev. **B 50**, 7668-7679 (1994).

54. "*Currents in the compressible and incompressible regions of the two-dimensional electron gas*", M. R. Geller and G. Vignale, Phys. Rev. **B 50**, 11714-11722 (1994).

55. "*Current density functional theory of quantum dots in a magnetic field*", M. Ferconi and G. Vignale, Phys. Rev. **B 50**,14722-14725 (1994).

56. "*Bound on the group velocity of a Bloch electron in a one dimensional periodic potential*", M. R. Geller and G. Vignale, Phys. Rev. **B 51**, 2616-2617 (1995).

57. "*Rigorous upper bound to the persistent current in systems with toroidal geometry*", G. Vignale, Phys. Rev. **B 51**, 2612-2615 (1995).

58. "*Persistent Current in a rotating mesoscopic ring*", G. Vignale and B. Mashhoon, Physics Letters **A 197**, 444-448 (1995).

59. "*Universal equilibrium currents in the quantum Hall fluid*", M. Geller and G. Vignale, Phys. Rev. **B 52**, 14137-14143 (1995).

60. "*Center of mass and relative motion in time dependent density functional theory*", G. Vignale, Phys. Rev. Lett. **74**, 3233-3236 (1995).

61. "*Edge structure of fractional quantum Hall systems from density functional theory*", M. Ferconi, M. R. Geller, and G. Vignale, Phys. Rev. **B 52**, 16357-16360 (1996).

62. "*Equilibrium currents and orbital magnetization in the quantum Hall fluid*", M. R. Geller and G. Vignale, Physica **B 212**, 283-288 (1995).

63. "*Quantum breathing mode of electrons with $1/r^2$ interaction*", M. R. Geller and G. Vignale, Phys. Rev. **B 53**, 6979-6980 (1996).

64. "*Classical continuum theory of the dipole-forbidden collective excitations in quantum strips*", W. L. Schaich, M.R. Geller and G. Vignale, Phys. Rev. **B 53**, 13016-13023 (1996).

65. "*Sum rule for the linear density response of a driven electronic system*", G. Vignale, Physics Letters **A 209**, 206-210 (1995).

66. "*Drag in paired electron-hole layers*", G. Vignale and A. H. MacDonald, Phys. Rev. Lett. **76**, 2786-2789 (1996).

67. "*Current dependent exchange-correlation potential for dynamical linear response theory*", G. Vignale and Walter Kohn, Phys. Rev. Lett. **77**, 2037-2040 (1996).

68. "*Collective modes and electronic spectral function in smooth edges of quantum Hall systems*", Sergio Conti and G. Vignale, Phys. Rev**. B 54**, R14309-14312 (1996).

69. "*Current-density functional theory of linear response to time-dependent electromagnetic fields*", G. Vignale and W. Kohn, "Electronic Density Functional Theory: Recent progress and new directions", edited by J. Dobson, G. Vignale, and M. P. Das (Plenum Press, New York, 1998) p. 199-216.

70. "*Density functional theory of the phase diagram of maximum density droplets in two-dimensional quantum dots in a magnetic field*", M. Ferconi and G. Vignale, Phys. Rev. **B 56**, 12108-12111 (1997).

71. "*Density functional theory of quantum dots in a magnetic field*", M. Ferconi and G. Vignale, in "Atoms and Molecules in Strong External Fields", edited by P. Schmelcher and W. Schweizer (Plenum Press, New York, 1998) p. 313-318.

72. "*Bosonization theory for tunneling spectra in smooth edges of quantum Hall systems*", S. Conti and G. Vignale, Physica **E 1**, 101-104 (1998).

73. "*Time-dependent density functional theory beyond the adiabatic local density approximation*", G. Vignale, C. A. Ullrich and S. Conti, Phys. Rev. Lett. **79**, 4878-4881 (1997).

74. "*Engineering Superfluidity in Electron-Hole Double Layers*", S. Conti, G. Vignale, and A. H. MacDonald, Phys. Rev. **B 57**, R6846-6849 (1998).

75. "*Linewidths of collective excitations of the inhomogeneous electron gas: application to two-dimensional quantum strips*", C. A. Ullrich and G. Vignale, Phys. Rev. **B 58**, 7141-7150 (1998).

76. "*Dynamics of the two-dimensional electron gas in the lowest Landau level: a continuum elasticity approach*", S. Conti and G. Vignale, Journal of Physics Condensed Matter **10**, L779-786 (1998) (cond-mat/9801318).

77. "*Collective intersubband transitions in quantum wells: a comparative density functional study*", C. A. Ullrich and G. Vignale, Phys. Rev. **B 58**, 15756 (1998) (cond-mat/9806252).

78. "*Exact exchange-correlation potential for a time-dependent two-electron system*", I. D'Amico and G. Vignale, Phys. Rev. **B 59**, 7876 (1999) (cond-mat/9809146).

79. "*Elasticity of an electron liquid*", S. Conti and G. Vignale, Phys. Rev. **B 60**, 7966 (1999). (cond-mat/9811214).

80. "*Continuum Elasticity Theory of edge excitations in a two-dimensional electron liquid with finite range interactions*", Irene D'Amico and G. Vignale, Phys. Rev**. B 60,** 2084 (1999) (cond-mat/9901206).

81. "*Effect of disorder on the nondissipative drag between two mesoscopic metal rings*", J. Baker, G. Vignale, and A. Rojo, Phys. Rev. B **60**, 8804 (1999).

82. "*Collective charge-density excitations of non-circular quantum dots in a magnetic field*", C. A. Ullrich and G. Vignale, Phys. Rev. B **61**, 2729 (2000). (cond-mat/9907186)

83. "*Time-dependent Density Functional Theory beyond the adiabatic approximation*", G. Vignale, in Recent Progress in Many-Body Theories (RPMBT-10), Advances in Quantum Many-Body Theory, Vol. 3 Eds. R.F. Bishop, K.A. Gernoth, Niels. R. Walet and Y. Xian (World Scientific, Singapore, 2000). p. 433-442.

84. "*Theory of Spin Coulomb Drag in spin-polarized transport*", Irene D'Amico and G. Vignale, Phys. Rev. **B 62**, 4853 (2000) (cond-mat/9912412).

85. "*Nonuniqueness of the potential of spin-density functional theory*", Klaus Capelle and G. Vignale, Phys. Rev. Lett. **86**, 5546 (2001) (cond-mat/0006116).

86. "*Spin diffusion in doped semiconductors: the role of Coulomb interactions*", I. D'Amico and G. Vignale, Europhysics Letters **55**, 566 (2001)(cond-mat/0007197).

87. *"Unipolar spin diodes and transistors*". M. Flatté and G. Vignale, Applied Physics Letters **78**, 1273 (2001) (cond-mat/0012484).

88. *"Theory of the linewidth of intersubband plasmons in quantum wells"*, C. A. Ullrich and G. Vignale, Phys. Rev. Lett. **87**, 037402 (2001).

89. *"Spin currents and spin dynamics in time-dependent density functional theory"*, Klaus Capelle, G. Vignale, and B. L. Györffy, Phys. Rev. Lett. **87**, 206403 (2001) (cond-mat /0106021).

90. *"Spin dynamics from time-dependent density functional theory*", Zhixin Qian and G. Vignale, Phys. Rev. Lett. **88**, 056404 (2002) (cond-mat/0108193).

91. "*Coulomb interaction effects in spin polarized transport*", Irene D'Amico and G. Vignale, Phys. Rev. B **65**, 085109 (2002). (cond-mat/0108228).

92. *"Nonuniqueness and derivative discontinuities in density functional theories for current-carrying and superconducting systems"*, Klaus Capelle and G. Vignale, Phys. Rev. **B 65**, 113106 (2002) (cond-mat/0110039).

93. "*Spin Coulomb drag in the two-dimensional electron liquid"*, Irene D'Amico and G. Vignale, Phys. Rev. **B 68**, 045307 (2003) (cond-mat/0112294).

94. *"Time-dependent current density functional theory for the linear response of weakly disordered systems"*, C. A. Ullrich and G. Vignale, Phys. Rev. **B 65**, 245102 (2002).

95. "*Dynamical exchange-correlation potentials for the electron liquid*", Zhixin Qian and G. Vignale, Phys. Rev. **B 65**, 235121 (2002).

96. "*Many-body effects in spin transport and spin-density functional theory*", G. Vignale and I. D'Amico, in Condensed Matter Theories **17**, p. 219 (2003), Ed. by M. P. Das and F. Green (Nova Science Publishers, Inc., New York).

97. "*Nonlinear spin polarized transport through a ferromagnetic domain wall*", by G. Vignale and M.E. Flatte', Phys. Rev. Lett. **89**, 098302 (2002).

98. "*Solving the ultra-nonlocality problem in time dependent spin density functional theory*", Z. Qian, A. Constantinescu, G. Vignale, Phys. Rev. Lett. **90**, 066402 (2003) (cond-mat/0209250).

99. "*Nonlinear Quasiparticle Tunneling between Fractional Quantum Hall Edges*", Stefano Roddaro, Vittorio Pellegrini,Fabio Beltram, Giorgio Biasiol, Lucia Sorba, Roberto Raimondi, and Giovanni Vignale, Phys. Rev. Lett. **90**, 046805 (2003).

100. *"Transport properties of a two-dimensional electron liquid at high magnetic field",* R. D'Agosta, R. Raimondi, and G. Vignale, Phys. Rev. B **68**, 035314 (2003).

101. *"Dynamics of dissipative quantum Hall edges",* M. D. Johnson and G. Vignale, Phys. Rev. B **67**, 205332 (2003) (cond-mat/0303090).

102. *"Coulomb drag, magnetoresistance, and spin-current injection in magnetic multilayers",* G. Vignale and I. D'Amico, Solid State Communications **127**, 829 (2003).

103. "*Dynamical exchange-correlation potentials for the electron liquid in the spin channel*", Zhixin Qian and G. Vignale Phys. Rev. B **68**, 195113 (2003).

104. *"The spin mass of an electron liquid",* Zhixin Qian, G. Vignale, and D. C. Marinescu, Phys. Rev. Lett. **93**, 106601 (2004) (cond-mat/0403342).

105. *"Effect of electrical bias on spin transport across a magnetic domain wall"*, M. Deutsch, G. Vignale, and M. E. Flatte', Journal of Applied Physics **96**, 7424-7427 (2004) (cond-mat/0406339).

106. *"Lifetime of a quasiparticle in the electron liquid",* Zhixin Qian and G. Vignale, Phys. Rev. B. **71**, 075112 (2005) (cond-mat/0406119).

107. *"Spin-resolved correlation kinetic energy of the spin-polarized electron gas",* J. F. Dobson, H. M. Lee, and G. Vignale – Phys. Rev. B **70**, 205126 (2004).

108. *"Quasiparticle self-energy and many-body effective mass enhancement in a two-dimensional electron liquid",* R. Asgari, B. Davoudi, M. Polini, G. F. Giuliani, M. P. Tosi, and G. Vignale – Phys. Rev. B **71**, 045323 (2005)

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10.3 BOOKS CHAPTERS

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2. *"Many-body effects in spin polarized transport"*, in "Manipulating Quantum Coherence in Solid State Systems", eds. M. E. Flatte' and Ionel Tifrea, pp. 53 – 96, Springer (2007)

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1. "*Electronic Density Functional Theory: Recent Progress and New Directions*", edited by J. F. Dobson, M. P. Das, and G. Vignale (Plenum Press, New York, 1998).

2. "*The Electron Liquid Paradigm in condensed Matter Physics"*, Proceedings of the International School of Physics "Enrico Fermi", Course 157, edited by G. F. Giuliani and G. Vignale (SIF, Bologna, 2004)

10.5 PATENTS

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11. SEMINARS, COLLOQUIA, INVITED TALKS

- "*Superconductivity in the electron-hole liquid*" Argonne National Laboratory, Argonne, July 1984; Scuola Normale Superiore, Pisa, March 1985; Annual meeting of the Italian Physical Society, Fai della Paganella, April 1985.

- "*Spin-flip electron-energy-loss spectroscopy in itinerant-electron ferromagnets*" International Center for Theoretical Physics, Trieste, July 1985.

- "*Many-body theory of excitations in disordered systems*" Colloquium, Michigan State University, East Lansing, March 1986.

- "*Quantum electron glass*": International Center for Theoretical Physics, Trieste, January 1987; Colloquium, University of Oregon, Eugene, February 1987; Colloquium, University of California, Davis, March 1987; Colloquium, Illinois Institute of Technology, Chicago, March 1987.

- "*Density Functional theory in strong magnetic fields*", University of Würzburg, Würzburg, June 1988, ICTP Trieste, July 1988.

- Panel discussion on "Outstanding Problems in Complex Systems", 3rd University of California Conference on Statistical Mechanics, Davis, March 1988.

- "*Properties of doped holes in the antiferromagnetic state of the two-dimensional Hubbard model*" Colloquium, University of Missouri, Kansas City, April 1989; Colloquium, Northwestern University, Evanston, May 1989.

- "*Ground-state energy of the one and two-dimensional Hubbard model*," "Highlights of Condensed Matter Physics", ICTP Trieste, 1-3 August 1989.

- "*Motion of a single hole in an itinerant electron antiferromagnet*" Indiana University, Bloomington, February 1990; Colloquium, University of Louisville, February 1990.

- "*Spin-disorder in the two-dimensional Hubbard model*", Washington University, September 1990; North Dakota State University, February 1991.

- "*Current-density functional theory in strong magnetic fields*", 31st Sanibel Symposia, St. Augustine, Florida, March 1991.

- "*Weak Coupling Theory of the two-dimensional Hubbard model and its connection to high-Tc superconductivity*" - a set of three lectures presented at the Mini-Workshop on classical and Quantum Many-Body Theory, ICTP, Trieste July 22-August 2 1991.

- "*Density functional theory in strong magnetic fields*", 19th Midwest Solid State Theory Symposium, October 1991.

- "*Density functional theory in strong magnetic fields*", Electronic Structure Seminar, Ohio State University, Columbus, Ohio, January 1992.

- "*Density functional theory of the Wigner crystal in strong magnetic fields, and its collective excitations*", 11th meeting of the Condensed Matter Theory Group of the Italian Physical Society, Fai della Paganella (Trento, Italy) April 1992.

- "*Current-density functional theory and its applications*", Condensed Matter Seminar, Indiana University, Bloomington, Indiana, May 1992.

- "*Current-Density functional theory in magnetic field and its applications*" International Workshop on "States of Matter in high magnetic field", ICTP Trieste, July '92, 3 lectures.

- "*Current-density functional theory of orbital magnetism*": 3 lectures delivered at the NATO ASI on Density Functional Theory, Il Ciocco, Italy, August 1993.

- "*Applications of current density functional theory*", CECAM Workshop on Numerical studies of electronic systems in strong magnetic fields, August 1993.

- "*Calculations of the frequency dependent dielectric function of liquid water*", Workshop on Electromagnetic theory, Brooks Air Force base, San Antonio, Texas 4-7 January 1994.

- "*Current density functional theory of quantum dots in a magnetic field*", Annual meeting of the condensed matter theory group of the Italian Physical Society, Fai della Paganella, Italy, April 1994 (presented by M. Ferconi).

- "*Density and current distribution of two-dimensional confined electron liquid in a magnetic field*", Workshop on Density Functional methods, ITP, Santa Barbara, California, July 1994.

- "*Current density functional theory of quantum dots in a magnetic field*" ECAMI Workshop on quantum microstructures, Ottawa, Canada, August 1994.

- "*Density and current distribution of two-dimensional confined electron liquid in a magnetic field*", CECAM Workshop on Numerical studies of electronic systems at high magnetic field, Lyon, Franc, August 1994.

- "*Density and current distribution of two-dimensional confined electron liquid in a magnetic field*", Seminar, Ecole Polytechnique Federale de Lausanne, Lausanne, Switzerland, August 1994.

- "*Universal properties of equilibrium currents in quantum Hall fluids*" Workshop on Novel physics of low dimensional electron systems, Madras, India, 10th January 1995.

- "*Universal properties of equilibrium currents in quantum Hall fluids*", Condensed Matter Seminar, University of Michigan, Ann Arbor, January 31, 1995.

- "*Time-dependent density functional theory, the generalized Kohn's theorem and Newton's third law*" Condensed Matter Seminar, Indiana University, Bloomington, February 21, 1995; Condensed Matter Seminar, Washington University, St. Louis, Missouri, October 9, 1995.

- "*A universal upper bound on the equilibrium current in rings*", Condensed Matter Seminar, Indiana University, Bloomington, February 28, 1995.

- "*Universal properties of equilibrium currents in quantum Hall fluids*", Condensed Matter Seminar, Purdue University, April 14, 1995; O. M. Stewart Colloquium, UMC, September 25, 1995.

- "*Current density functional theory of linear response to time dependent electromagnetic fields*", Condensed Matter Seminar, Solid State Division, ORNL, Oak Ridge, Tennessee, May 16, 1996.

- "*Drag effects in paired electron-hole liquids*", INFM/FORUM Workshop on "Recent theoretical developments in the two dimensional electron gas", Scuola Normale Superiore, Pisa, June 16-28 1996.

- "*Meaning of the Kohn-Sham eigenvalues and the band gap problem in time-dependent density functional theory*" - an introductory lecture presented at the International Workshop on "Electronic Density Functional Theory", Brisbane, Australia, July 14-19, 1996.

- "*Current density functional theory of linear response to time dependent electromagnetic fields*", International Workshop on "Electronic Density Functional Theory", Brisbane, Australia, July 14-19, 1996.

- "*Current density functional theory of orbital magnetism*" Naval Research Laboratory, Washington, D.C, October 21, 1996.

- "*Collective modes and electronic spectral function in smooth edges of quantum Hall systems*", 24th Midwest Solid State Theory Symposium, University of Illinois at Urbana-Champaign, October 26, 1996.

- "*Coulomb drag between paired electron-hole layers", Symposium on "Coulomb drag*", March meeting of the APS, Kansas City, March '97.

- "*Current-density functional theory of quantum dots in magnetic field*", 172. WE-Heraeus-Seminar on "Atoms and Molecules in strong external fields", Bad Honnef, Germany, 7-11April, 1997.

- "*Superconductivity in electron-hole double layers*", Workshop on Methods of Electronic Structure (ES97), Cornell University, May 31-June 2, 1997.

- "*Time-dependent density functional theory beyond the adiabatic local density approximation*", Symposium on Density Functional Theory and Application, Duke University, June 2-7, 1997.

- "*Single particle and collective excitations in smooth edges of quantum Hall systems*", Workshop on Novel Physics in Low-dimensional Electron Systems, Dresden, Germany July 28- August 8, 1997.

- "*Current-density functional theory versus magnetic field density functional theory*", CECAM Workshop on Atoms in Strong Magnetic Fields, Lyon, France, August 25-August 27, 1997.

- "*Superconductivity and Coulomb Drag in paired electron-hole layers*", FORUM Workshop on Semiconductor Nanostructures, Scuola Normale Superiore, Pisa, Italy, December 20-22, 1997.

- "*Recent developments in time-dependent density functional theory*", Department of Physics/Chemistry, University of Kansas, Lawrence, April 10,1998; Condensed Matter Theory Seminar, Ohio State University, Columbus, Ohio, May 11,1998.

- "*Dynamics of the two dimensional electron gas in the lowest Landau level: the magnetoelasticity approach*"; Condensed Matter seminar, Indiana University, Bloomington, May 22, 1998; FORUM Workshop on Semiconductor Nanostructures, Pisa, Italy, June 11-19, 1998.

- "*Engineering superfluidity in electron-hole double layers*", CECAM Workshop on Physics of Double layer systems, Turin, Italy, June 22-24 1998.

- "*Bosonization of the two dimensional electron gas in the lowest Landau level*", National meeting of the INFM (National Institute for Physics of Matter), Rimini, Italy, June 25-30, 1998.

- "*Dynamics in the lowest Landau level: from hydrodynamics to elasticity theory*", Workshop on Quantum Hall effect and disordered systems, ITP, Santa Barbara, November 13, 1998.

- "*Time-dependent density functional theory beyond the adiabatic approximation*", Condensed Matter Seminar, Georgia Tech, Atlanta GA, January 15, 1999.

- "*Dynamics in the lowest Landau level: from hydrodynamics to elasticity*", Condensed Matter Seminar, Purdue University, Indiana, February 26, 1999.

- " *Time-dependent density functional theory beyond the adiabatic approximation*" Workshop on Time-Dependent Density Functional Theory, ITP, Santa Barbara, CA, April 18, 1999.

- "*Collective dynamics of the two-dimensional electron gas in the lowest Landau level*", a set of 4 lectures held at Scuola Normale Superiore, Pisa, Italy, June 1999.

- "*Time-dependent density functional theory beyond the adiabatic approximation*" Seminar, Department of materials Science, University of Milano, Milano, Italy, June 21, 1999.

- " *Time-dependent density functional theory beyond the adiabatic approximation*" Many Body X, University of Washington, Seattle, 10-15 September 1999.

- *Recent advances in time-dependent density functional theory*", University of Iowa, Iowa City, April 21, 2000.

- "*Spin Diffusion in Doped Semiconductors*", International Conference on Spin Effects in Mesoscopic Systems, Cortona, Italy 6/28-7/2,2000.

- *"Recent advances in time-dependent density functional theory*", Scuola Normale Superiore, Pisa, Italy, June 26, 2000; University of Camerino, Camerino, Italy, July 4, 2000.

- "*Spin Diffusion in Doped Semiconductors",* Colloquium, Clemson University, Clemson, SC, September 28, 2000.

- "*The calculation of excitation energies in time-dependent density functional theory*", 41st Sanibel Symposium, St. Augustine, Florida, 2/24/2001.

- *"Many-body effects in spin-polarized transport"*, Seminar, Solid State Division, ORNL, May 3, 2001.

- *"Many-body effects in spin-polarized transport"*, Colloquium, Physics Department, Universidade de Sao Paulo, Sao Carlos, Brazil, May 25, 2001.

- "*The calculation of excitation energies in time-dependent density functional theory*", Seminar, Chemistry Department, Universidade de Sao Paulo, Sao Carlos, Brazil, June 1, 2001.

- *"Many-body effects in spin-polarized transport"*, Seminar, ICTP, Trieste, Italy, June 12, 2001.

- *"Many-body effects in spin transport and spin-density functional theory"*, Condensed Matter Theories-25 (CMT-25), Canberra, Australia, 3-7 December 2001.

- "*Many-body effects in spin transport and time-dependent spin-density functional theory*", March Meeting of the APS, Indianapolis, IN, March 2002.

- *"Surprises in spin-density functional theory",* Kohn Symposium, NRC, Ottawa, Canada, June 20, 2002.

- "*La nuova elettronica delle nanostrutture*", Corso di Orientamento Universitario, Colle di Val D'Elsa, Italy, July 23, 2001.

- "*Spin transport and spin density functional theory*", Colloquium, Department of Physics, University of Missouri-Rolla, August 29, 2002.

- *"Density functional theory in the age of spintronics",* Colloquium, Department of Physics, Purdue University, January 14, 2003.

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- *"Inter-edge interaction and tunneling in fractional quantum Hall liquids",* Frontiers in Condensed matter theory, Penn State University, April 12,2003.

- *"The Strange world of quantum mechanics",* Peninsula High School, Palos Verdes, CA, February 6, 2004.

- *"Time-dependent spin DFT",* Colloquium, SISSA, Trieste, November 2003.

- *"Chiral Luttinger Liquid: theory and experiment",* Condensed Matter Seminar, Washington University, St. Louis, MO, April 19, 2004.

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- *"Elasticity of the electron liquid"*, TTDFT 04, International School on Tine-dependent density functional theory, Santa Fe, NM June 6, 2004.

- *"Time-dependent current density functional theory",* TTDFT 04, International School on Time-dependent density functional theory, Santa Fe, NM June 7,2004.

- *"Temperature dependence of tunneling between quantum Hall edges",* International Workshop on cooperative and transport phenomena (COPHEN04), Max-Planck Institut für complexer systeme, Dresden, Germany, June 16, 2004.

- *"Many-body effects in spin-polarized transport",* 2nd Asia Pacific Physics Workshop, Hong Kong, China, June 22, 2004.

- *"Unipolar spin diodes and transistors",* Seminar, University of Science and Technology of China, Hefei, June 27, 2004.

- *"Many-body effects in spin-polarized transport",* Colloquium, University of Science and Technology of China, Hefei, June 28, 2004.

- *"Recent advances in time-dependent spin density functional theory",* Seminar, University of Science and Technology of China, Hefei, July 4, 2004.

- *"Time-dependent spin-current-density functional theory*", FOCUS session on optical and dielectric properties in condensed matter at the 20th General Conference of the Condensed Matter Division of the European Physical Society, Prague, Czech Republic, July 19, 2004.

- *"The elasticity of the electron liquid",* Summer School on Time-Dependent Density-Functional Theory: Prospects and Applications, Benasque, September 6, 2004.

- *"Time-dependent current density functional theory"* – Summer School on Time-Dependent Density-Functional Theory: Prospects and Applications, Benasque, September 7, 2004.

- "*Advances in time-dependent spin-current density functional theory"* – Workshop on Time-Dependent Density-Functional Theory: Prospects and Applications, Benasque, September 11, 2004.

- "*Time-dependent current-density functional theory- a new approach to the quantum dynamics of many-electron systems"*, International Conference on Condensed Matter Theory 28, St. Louis, MO, September 27, 2004.

- "*Time-dependent current-density functional theory - a new approach to the quantum dynamics of many-electron systems"*, Seminar, Institute of Physics of the Chinese Academy of Science, October 5, 2004.

- *"The magic world of quantum mechanics"* – Saturday morning science, Columbia, October 23 and 30, 2004.

- *"Time-dependent current density functional theory",* Colloquium, Department of Physics, University of Montreal, Montreal, Quebec Canada, April 4, 2005.

- *"Time-dependent current density functional theory",* Seminar, Department of Physics, Sherbrooke University, Sherbrooke, Quebec, Canada, April 5, 2005.

- *"Many-body effects in Spin Polarized Transport",* Colloquium, Department of Physics, University of Manitoba, Winnipeg, Manitoba, Canada, April 8, 2005.

- *"Many-body effects in Spin Polarized Transport",* Seminar, SNS Pisa, May 26, 2005.

- *"Density functional theory in the age of spintronics",* seminar, UCI June 8, 2005.

- *"Many-body effects in spin polarized transport and dynamics",* 4 one-hour lectures delivered at the NATO ASI on "Manipulation of spin coherence in quantum systems", Cluj, Romania, August 27-September 8, 2005.

- *"The electron gas in the age of spintronics",* Colloquium, Louisville University, Lexington, KY, October 7, 2005.

- *"The electron gas in the age of spintronics",* Colloquium, USC, Los Angeles, CA October 31, 2005.

- *"The electron gas in the age of spintronics",* Seminar, Indiana University, Bloomington, IN, Nov 4, 2005.

- *"The electron gas in the age of spintronics*", Colloquium, University of Milano, March 14, 2006.

- *"Linear response theory and its applications"* – Minicourse in five two-hours lectures presented at the doctorate program of the Department of Physics of the University of Milano, March 2006.

- *"Many-body effects in spintronics",* Workshop on Spintronics, KITP, April 2006.

- *"Many-body effects in spintronics",* Seminar, Department of Physics, UCLA, May 3, 2006.

- *Spin Hall effect, USC May 26, 2006*

- *Spin Hall effect, SCEN06, June 8, 2006*

- *New Collective mode, SCEN06, June 10, 2006*

- *Spin Hall effect, GRC Mount Holyoke June 2, 2006*

- *TDDFT,Montauk, September 6, 2006*

- *Spin Hall Effect, Kansas City, October 7, 2006*
- *Many-body effects in Spintronics, UC Fullerton, October 27, 2006*
- *Spin Hall Effect, Purdue University, February 2007*
- *Current density functional theory as time goes by, April 25, 2007, Theoretical Chemistry Seminar, MIT—Harvard-BU-BC, Boston*
- *Collective modes in the fractional quantum Hall liquid, EPQHS, Penn State, June 13, 2007*
- *Gilbert damping and spin Coulomb drag in a magnetized electron liquid with spin-orbit interaction, SpinTech 5, Maui, June 20, 2007*
- *Dissipative spin dynamics, spin conductivity, and the spin Hall Effect, Seminar, SNS, Pisa, July 9, 2007*
- *The stress tensor in time dependent DFT, Gordon research Conference, Colby College, Waterville, ME, July 18, 2007.*
- *The Calculation of the orbital magnetization in current-spin-density functional theory, CDFT07, Tromso-Trondheim, September 20, 2007*
- *Spin Coulomb Drag: Theory and experiment, ANL, October 2007*
- *Time-dependent current density functional theory: a new approach to quantum many-body dynamics"*, Colloquium, Kansas University, Lawrence, October 2007.
- *Relaxation and Dissipation in TDDFT, Minerva-Genter Symposium, Eilat, Israel, 16-21 December 2007.*
- *Many-body corrections to the Landauer-Büttiker conductance of mesoscopic conductors, UCSD, February 2008.*
- *Quantum stress focusing in descriptive chemistry, DFT FestColloquium, Tulane University, March 2008.*
- *Continuum mechanics of quantum many-body systems, CECAM Workshop on Computational approaches to semiconductor, carbon and magnetic nanostructures, Lyon, France, June 16, 2008.*
- *Ten Years of Spin Hall Effect,* PASPS-V, Foz do Iguacu, Brazil, August 6, 2008.

- *Spin Hall effect at finite frequency and magnetic fields*, 421st Wilhelm and Else Heraeus Seminar, Bad Honnef, Germany, October 20-23, 2008.

- *Many-body corrections to the Landauer-Büttiker conductance of mesoscopic conductors,* Scuola Normale Superiore, Pisa, October 27, 2008.

- *DFT08 – Sao Carlos Brazil, 2-3 December 2008, Continuum Mechanics of Quantum Many-Body Systems: Statics and Dynamics*

- *Ten years of Spin Hall effect,* Seminar UCLA, 2/11/2009.

- *Quantum Continuum Mechanics of Many-Body Systems,* Seminar, ETSF San Sebastian, March 30, 2009.

- *Spin Hall Drag,* Scuola Normale Superiore, Pisa, April 15, 2009.

- *Formal aspects of time dependent density functional theory,* Seminar, ETSF San Sebastian, June 15, 2009.

- *The emergence of the spin-orbit interaction in semiconductors and the side Jump effect, ICTP/IFIN* Advanced Workshop on Charge and Spin Dynamics, Sibiu, Romania, June 29-July 4 2009.

- *Continuum mechanics of quantum many-body systems,* PT Colloquium, Los Alamos National Lab, Los Alamos, NM, October 15, 2009.

- *Continuum mechanics of quantum many-body systems,* KITP Conference, From Basic Concepts to Real Materials, Santa Barbara, CA, November 3, 2009.

- *Coulomb drag and spin Hall Drag: new coupling mechanisms for nanoelectronics; SUNY, Buffalo, November 19, 2009.*

- *Coulomb drag and spin Hall Drag: new coupling mechanisms for nanoelectronics; Colloquium Würzburg, January 25, 2010.*

- *Coulomb drag and spin Hall Drag: new coupling mechanisms for nanoelectronics; ISSP, Tokyo, February 5, 2010.*

- *Coulomb drag and spin Hall Drag: new coupling mechanisms for nanoelectronics, RIKEN April 20,2010*

12. TEACHING

I have taught many different physics courses at both the graduate and the undergraduate level. Most frequent topics have been **Quantum Mechanics II**,

Quantum Mechanics III, **Condensed Matter Physics I & II**, and **Classical Mechanics** at the graduate level; **Introduction to Thermodynamics**, **Classical Mechanics**, and **Thermodynamics** at the advanced undergraduate level, **University Physics** (Physics 175) and **College Physics** (Physics 1210) at the undergraduate entry level. In the Academic Year 1988-89 I developed a graduate course on the **"Microscopic Theory of Superconductivity".** In the Academic Year 1999-2000 I developed a new graduate course on **"Many-Body Theory".** I have also taught the "recitation sessions" that complement **"College Physics 21"** and **"College Physics 22"** -- two algebra-based introductory physics courses for non-physics majors. In 2003 I developed and taught a topical course on **"Quantum information and quantum Computation".** In Winter 2005 I developed and taught (with Shufeng Zhang) a new course for graduates/undergraduates, entitled **"Physics of electronic devices".** For the Spring of 2006 I have been invited to teach a 2-weeks minicourse (5 lectures, 10 hours) on **"Linear response theory for electronic systems and its applications"** at the University of Milano, Italy. In April/May 2010 taught a minicourse (10 hours) on "Density Functional Methods in Condensed Matter Physics" at the University of Tokyo (Hongo Campus).

13. OTHER PROFESSIONAL ACTIVITIES

- Co-director, Advanced Workshop on *Spin and Charge Properties of Low Dimensional Systems*, Sibiu, Romania, June 29-July 4 (2009).
- Review panel, Quantum Transport Theory, DOE, May 2009.
- Divisional Associate Editor, Physical Review Letters - since June 2003.
- Active referee for most major research journals and federal granting agencies.
- Co-director, (with C. A. Ullrich and K. Burke) of the ACS-PRF Summer School on *"Time-Dependent Density-Functional Theory and the Dynamics of Complex Systems"*, Santa Fe, June 5-10, 2004.
- Co-director, (with G. F. Giuliani) of the International School of Physics "Enrico Fermi" on "*The electron liquid paradigm in condensed matter physics*" – Varenna, Italy, July 29 – August 8, 2003.
- Director, International FORUM Workshop on "*Semiconductor Nanostructures*" held at Scuola Normale Superiore, Pisa, Italy, June 11-19, 1998.
- Co-director (with J. Dobson, and M. P. Das), International Workshop on *"Electronic Density Functional Theory: Recent Progress and New Directions*", Brisbane, Australia, July 14-19, 1996.

- Co-director (with M. R. Geller), Workshop on "*Transport in quantum Hall fluids"*, Aspen Center for Physics, Aspen, Colorado, August 5-19, 1996.

- Co-director (with G. F. Giuliani), International Workshop on "*New theoretical developments in the two-dimensional electron gas"*, Scuola Normale Superiore, Pisa, June 16-28, 1996.

- Chair, "Journal Club" - a program featuring presentations of current research papers by students and faculty in the Physics Department at UMC (1994-1998).

- Chair, O.M. Stewart Colloquium, Physics Department, UMC (1996- 2000).

- Chair, Joint Condensed matter/Biological Physics/Electrical Engineering seminar, Physics Department, UMC 2000-present

- Co-director (with C. Dharma-Wardana and F. Perrot), CECAM Workshop on "*Numerical studies of systems at high magnetic field"* Ecole Normale Superieure de Lyon, Lyon, France, August 1994.

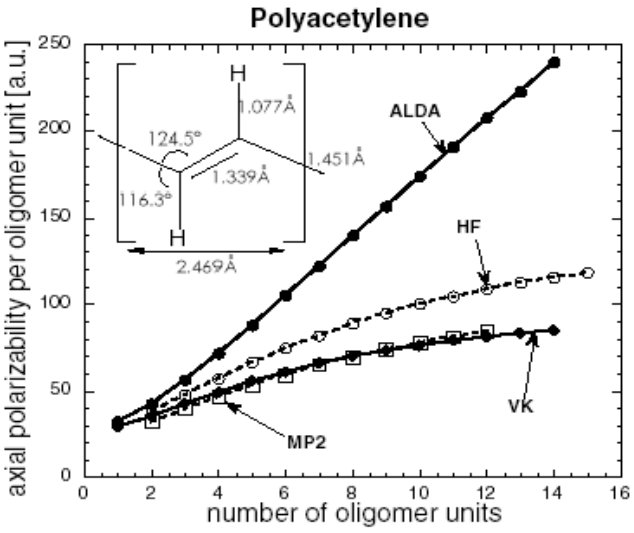
- Co-organizer (with S. Satpathy and P. Pfeifer), 25th Midwest Solid State Theory Symposium, University of Missouri-Columbia, Columbia, Missouri, October 14-15, 1994.

- Co-director (with G. F. Giuliani), Mini-Workshop on "*States of Matter at High Magnetic Fields*", ICTP Trieste, July 21-July 24, 1992.

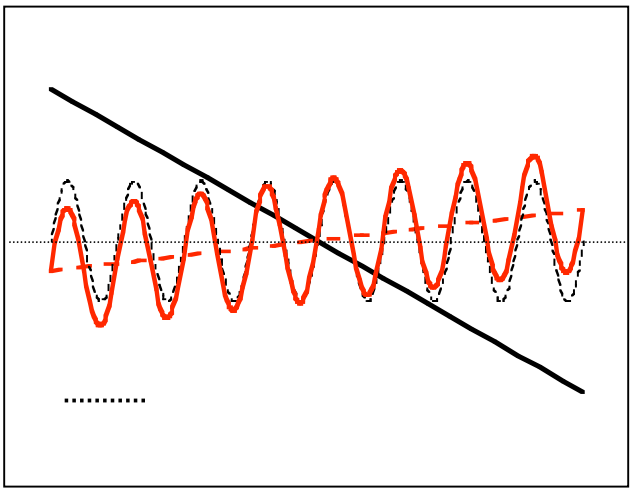
- Co-director (with G. F. Giuliani), Mini-Workshop on "*Classical and Quantum Many-Body Theory*", ICTP Trieste, July 22-August 2, 1991.

Research Highlights

1. Time-dependent current density functional theory



van Faassen *et al.*, PRL 88, 186401 (2002)

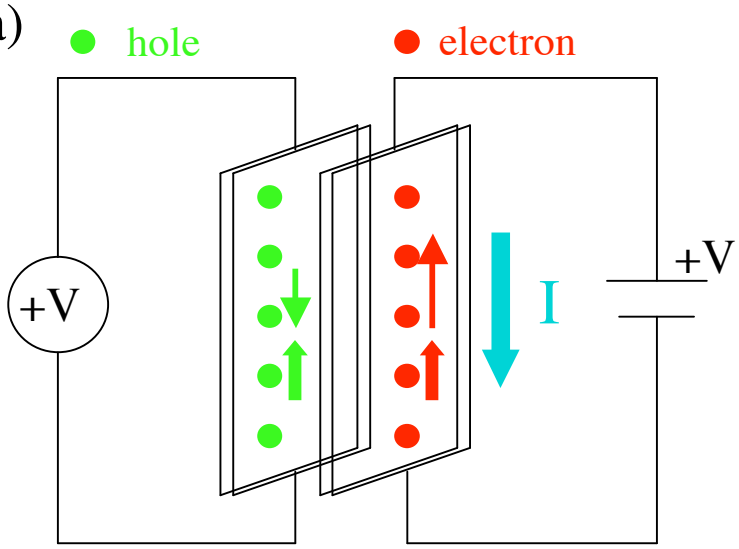


This novel approach to the time-dependent many-body problem introduced by Vignale and Kohn [VK, PRL **77**, 2037 (1996)] and developed by Vignale, Ullrich, and Conti [PRL **79**, 4878 (1997)] describes complex interaction effects in terms of an effective electric field $E_{xc}(r,t)$ that depends on the current density $j(r,t')$ at times $t'<t$. In the linear response regime, simple mathematical expressions (reported below) connect the Fourier amplitude $E_{xc}(r,\omega)$ to the velocity field $v(r,\omega)=j(r,\omega)/n_0(r)$. The top figure on the right shows how well the new theory works in predicting the static electric polarizabilty of a polyacetylene chain. The conventional approach (ALDA) is orders of magnitude off. VK works better than Hartree-Fock (HF) and competes with the best wave function methods (MP2). The bottom figure shows the physical reason for the success of the VK theory. The linearly growing xc potential V_{xc} offsets in part the external potential V_{ext}. Such a linear potential term is absent in the ALDA. We have recently extended the theory to include the electronic spin [Qian et al., PRL **90**, 066402, 2003].

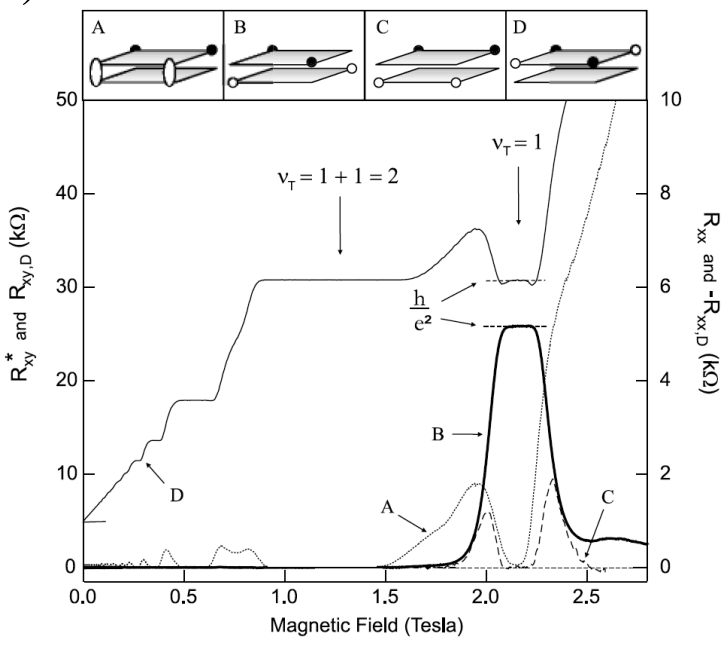
$$\sigma_{xc,ij}(\mathbf{r},\omega) = \underbrace{\eta_{xc}(n_0,\omega)}_{\text{Generalized shear viscosity}}\left[\frac{\partial v_i}{\partial r_j}+\frac{\partial v_j}{\partial r_i}-\frac{2}{3}\nabla\cdot\mathbf{v}\delta_{ij}\right]+\underbrace{\zeta_{xc}(n_0,\omega)}_{\text{Generalized bulk viscosity}}\nabla\cdot\mathbf{v}\delta_{ij}$$

2. Coulomb drag in superfluid electron-hole double layers

(a)



(b)

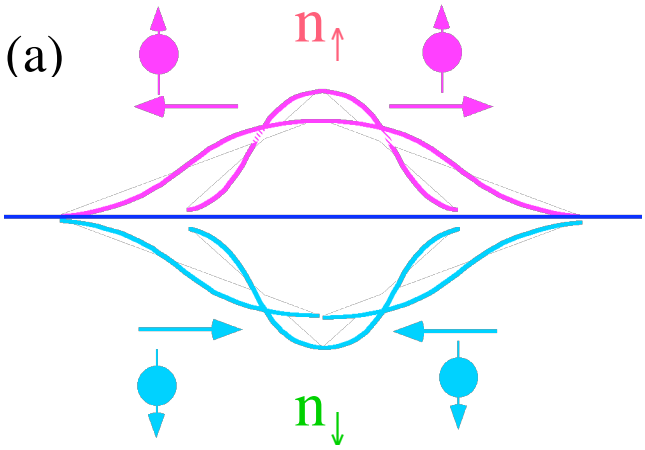


In PRL **76**, 2786 (1996) Vignale and MacDonald identified a new signature of superfluidity in electron-hole double layers.

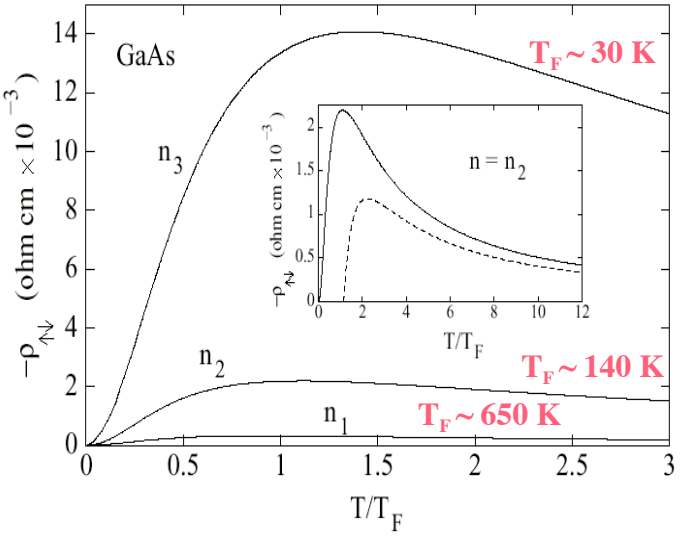
(a) The current **I** driven through the electron layer is accommodated partly as a super-current (thick arrows) and partly as a normal current (thin arrows). In the supercurrent mode electrons and holes are locked together and travel in the same direction, giving rise to electrical currents that flow in opposite directions In the normal current mode the electrical currents in the two layers are parallel. The magnitude of the supercurrent adjusts its value so as to minimize dissipation. When this is accomplished the potential differences along the two layers (+V) become equal. Therefore in the superfluid state the transresistance (= ratio of voltage in one layer to current in the other layer) equals the single layer resistance, while in the normal state it is orders of magnitude smaller.

(b) Experimental evidence for anomalously large drag resistivity in bilayer systems has recently been obtained by Kellogg et al. [PRL **88**, 126804 (2002)] and is shown in this panel. The equality of the Hall voltages in the two layers is very similar in spirit to the effect we predicted in (a), even though the presence of the magnetic field causes differences in detail. Very recently, the existence of counterflowing supercurrents in this system has also been verified [Kellogg et al. , PRL **93**, 036801 (2004)].

3. Spin Coulomb drag and spin diffusion



(b)

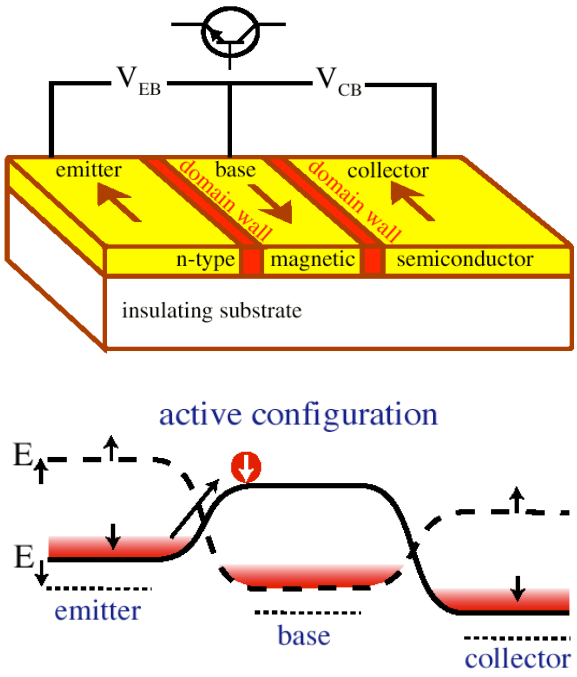


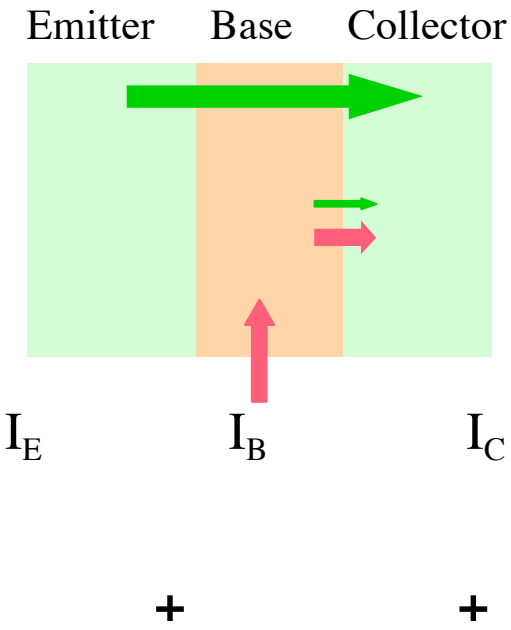
When electrons of opposite spin orientation diffuse in opposite direction as in the spreading of the spin packet shown schematically in Figure (a), a peculiar form of electrical resistance arises. We call this spin Coulomb drag (SCD) resistivity [D'Amico and Vignale, PRB **62**, 4853 (2000)] and denote it by $\rho_{\uparrow\downarrow}$. Ordinary electrical resistance (Drude resistance) arises primarily from collisions between electrons and impurities. The SCD resistivity arises from collisions of spin-up electrons against spin-down electrons travelling in the opposite direction. The behavior of $\rho_{\uparrow\downarrow}$. as a function of temperature is shown in the figure on the bottom right for n-doped GaAs at three different densities (n_1=1.5 × 10^{18} cm^{-3} n_2=1.5 × 10^{17} cm^{-3} n_3=1.5 × 10^{16} cm^{-3}). While vanishing at T=0, $\rho_{\uparrow\downarrow}$ can be as large as the Drude resistivity at temperatures comparable to the Fermi temperature of the electrons (in red in the figure). The existence of the spin drag resistivity yields an absolute *intrinsic upper bound* on the spin diffusion constant. D_s. The latter is given by

$$D_{s,\max} = \frac{1}{e^2 |\rho_{\uparrow\downarrow}| \chi}$$

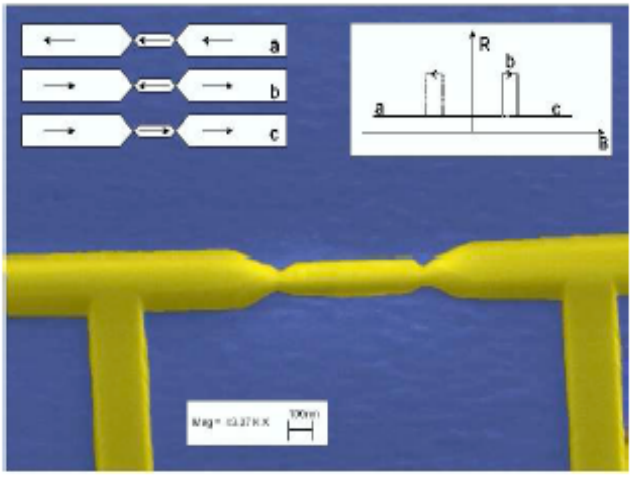
where χ is the spin susceptibility of the electron liquid. Observation of the SCD in a two-dimensional electron gas in GaAs has recently been reported (J. Orenstein, March 2005 Meeting of the APS, Los Angeles, Paper No. W10.1) and found to be in quantitative agreement with our theoretical prediction.

4. Unipolar Spin transistor



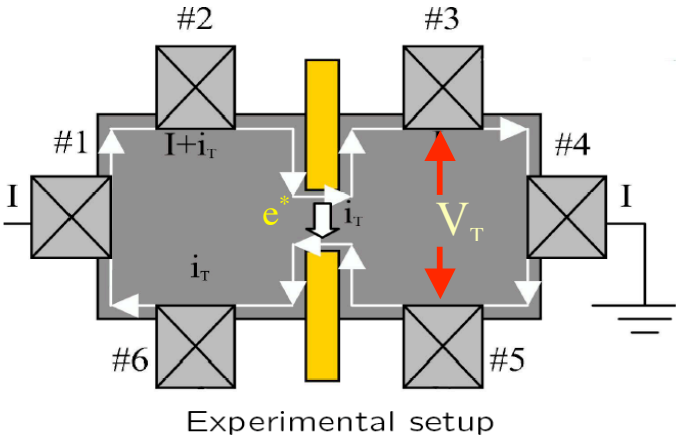


The main idea of this device [Flatte' and Vignale, APL **78**, 1273 (2001)] is to use a spin polarized emitter in lieu of a doped emitter to inject minority spin electrons into the base region (also spin polarized, but in the opposite direction). A small change in the base voltage or in the magnetic field applied to the base region causes a large change in the spin-polarized current from emitter to collector. The device therefore acts as a spin-current amplifier or as a controllable source of spin polarized current. Its possible applications include non volatile memory devices, magnetic sensors, and reprogrammable logic. The figure on the right shows what could become the basic component of this device, namely, the junction between oppositely spin polarized regions, as it has recently been realized by Molenkamp et al. in Würzburg [PRL **91**, 216602 (2003)].

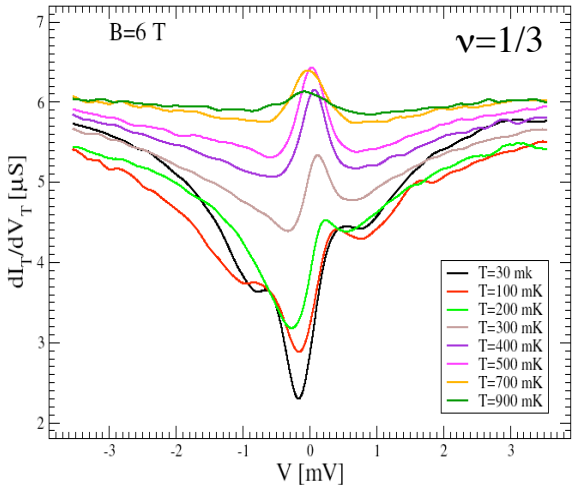


5. Tunneling between the edges of a quantum Hall liquid

(a)

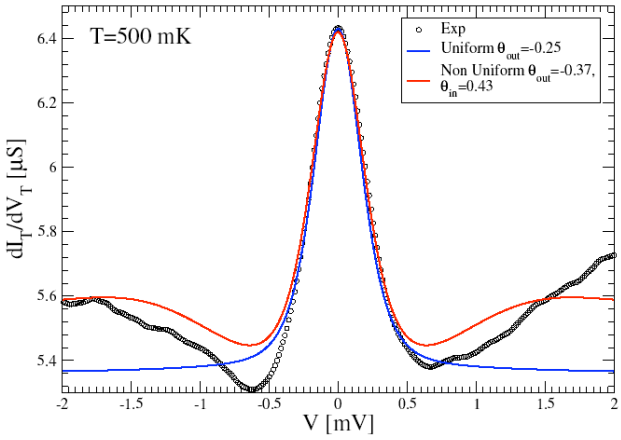


(b)



In the experiment by Roddaro, Pellegrini, and Beltram [PRL **90**, 046805 (2003)] the split gate device shown in Fig. (a) is used to induce tunneling of quasiparticles between opposite edges of a two-dimensional electron liquid at high magnetic field. It is theoretically expected that the quasiparticles have fractional charge e*=*ν*e, where *ν* depends on the magnetic field. The highly correlated nature of the electron liquid, coupled with the fractional charge of the quasiparticles gives rise to a characteristic peak in the tunneling conductance vs bias voltage V_T. This peak has now been observed (Fig. (b)). Fig. (c) shows our theoretical fit to the experimental data [D'Agosta, Raimondi, and Vignale, PRB **68**, 035314 (2003)] at *ν*=1/3 and T=500 mK, which beautifully confirms this aspect of the theory.

(c)



Earlier Research Highlights

- In my Ph.D. thesis, under the direction of Professor Kundan Singwi, I predicted the possibility of superconductivity in an electron-hole liquid [9]. This conclusion was reached on the basis of a multi-component generalization of the Kukkonen-Overhauser effective electron-electron interaction [10]. It was shown that the dominant pairing mechanism was not the exchange of acoustic plasmons [4] (as generally believed) but the exchange of electron-hole pair excitations from the Fermi sea of the heavy component (the holes).

- In 1987, in collaboration with Dr. Mark Rasolt, I formulated the current-density functional theory (CDFT) for inhomogeneous interacting electronic systems in a strong magnetic field [20,23]. The key point in that work was the recognition that the functional theory had to be constructed in terms of the paramagnetic current density $j_p(r)$, a non-gauge invariant quantity, rather than the physical current. The theory is nevertheless gauge-invariant because the exchange-correlation energy is a functional of the vorticity $(\nabla\times(j_p/n))$, which is a gauge-invariant quantity. This functional of the vorticity is amenable to the local density approximation.

- In paper [26], with Prof. Singwi, we published one of the very first theoretical predictions of d-wave superconductivity in the antiferromagnetic Hubbard model, regarded as a model for the superconducting cuprates. In [30], with my student M. R. Hedayati, we presented a study of the spectral properties of doped holes in an antiferromagnetic Hubbard model near half-filling. In [33] I presented numerical evidence that the Hartree-Fock solution for the Hubbard model may be spontaneously spin-disordered.

- Paper [34], with Otto Fajen, analyzes neutron scattering experiments on Cu-Mn alloys and concludes that the published data are inconsistent with the commonly held view that the Mn impurities interact with one another via the RKKY interaction.

- Paper [46], with P. Skudlarski, presents the first numerical calculation of the RPA correlation energy of the 3-dimensional electron gas as a function of density and magnetic field. A possible deviation from conventional Fermi liquid theory in the case of multiple occupied Landau level subbands was pointed out in [40].

- In 1995, with my student Maurizio Ferconi, I presented the first application of the current density functional theory to the calculation of the addition energies of quantum dots in magnetic fields [55]. The results were found to be in good agreement with experiment. Shortly afterwards the method was applied (with M. Geller) to the study of the edge structure of quantum Hall liquids [61]. The possible occurrence of incompressible regions at fractional filling factors was numerically demonstrated.

- In a series of papers with M. Geller [54,59,62] we clarified the general properties of the equilibrium current distribution in quantum Hall liquids.

- In paper [66], in collaboration with Prof. Allan MacDonald, we looked for a signature of superfluid electron-hole pairing in the drag transresistance of a coupled electron-hole double-layer system. Our main prediction was that the transresistance (defined as the ratio of the voltage in one layer to the current flowing in the other) should jump by literally orders of magnitudes at the electron-hole condensation temperature. Observation of this effect would provide a conclusive experimental evidence for the occurrence of electron-hole superconductivity in these systems. In a later publication [74] with Sergio Conti and Allan MacDonald, we tried to determine whether an electron-hole superfluid should be expected in realistic double-layer structures at reasonable temperatures. The main result of this analysis was that anisotropy effects associated with the band structure of the holes (and usually neglected in more optimistic theories) are very large, and, in fact, are very likely to prevent superfluidity under ordinary conditions. We proposed, however, that the application of a uniaxial pressure of a few kilobars perpendicular the plane of the holes might reduce the anisotropy of the hole bands to the point that superfluidity become possible.

- In a series of a papers [60,67,69,73] published between 1995 and 1997 in collaboration with Prof. Walter Kohn, and, later, with Carsten Ullrich and Sergio Conti, a novel formulation of the time dependent density functional was developed. To put this accomplishment in perspective remember that the commonly employed "time-dependent local density approximation" (TDLDA) is really a static approximation in disguise, and can be expected to work only for very low frequency. An early attempt by Gross and Kohn to extend the TDLDA to finite frequencies ran into serious difficulties when it was found to be in contradiction with rigorous theorems and exact symmetries [60]. In an effort to resolve this difficulty I discovered that a consistent TDLDA could only be constructed within the frame of a more general theory in which the current-density, rather than the density, is the basic variable. A most remarkable feature of the "time-dependent current-density functional theory" (TD-CDFT) is that the exchange-correlation potential can be expressed in a form that is completely analogous to the visco-elastic force in a classical visco-elastic medium, but has a purely quantum mechanical origin. This led us to look at the electron liquid as a kind of visco-elastic medium [79] – a point of view which I am confident will eventually prove very fruitful. Several applications of the TD-CDFT formalism have been worked out in [75,77,88] and a systematic formulation for weakly disordered systems has been laid out in [94].

- With Sergio Conti I studied the tunneling of electrons into the edge of a quantum Hall liquid [68,72]. In the limit of "sharp edge", our theory predicted a continuously varying exponent $\alpha=\nu$ (ν is the filling factor in the lowest Landau level) for the $I\sim V^{\alpha}$ relation between tunneling current and voltage. This was in excellent qualitative agreement with the measurements by A. Chang. We went on to formulate an effective elasticity theory [76] for the collective models in the lowest Landau level and showed that the dynamics of the edges could be derived from this theory.