



Robert Laughlin

Anne T. and Robert M. Bass Professor in the School of Humanities and Sciences
Physics

Bio

BIO

Professor Laughlin is a theorist with interests ranging from hard-core engineering to cosmology. He is an expert in semiconductors (Nobel Prize 1998) and has also worked on plasma and nuclear physics issues related to fusion and nuclear-pumped X-ray lasers. His technical work at the moment focuses on “correlated-electron” phenomenology – working backward from experimental properties of materials to infer the presence (or not) of new kinds of quantum self-organization. He recently proposed that all Mott insulators – including the notorious doped ones that exhibit high-temperature superconductivity – are plagued by a new kind of subsidiary order called “orbital antiferromagnetism” that is difficult to detect directly. He is also the author of *A Different Universe*, a lay-accessible book explaining emergent law.

ACADEMIC APPOINTMENTS

- Professor, Physics

ADMINISTRATIVE APPOINTMENTS

- Professor of Applied Physics (Dual Appointment with Physics), Stanford University, (1993-2007)
- Postdoc, AT&T Bell Laboratories, (1979-1981)
- Professor of Physics, Stanford University, (1989- present)

HONORS AND AWARDS

- Onsager Medal, Norwegian University of Science and Technology (2007)
- Doctorate of Letters, University of Maryland (2005)
- Golden Plate, Stanford University (1999)
- Nobel Prize in Physics, Royal Swedish Academy of Sciences (1998)
- Benjamin Franklin Medal for Physics, The Franklin Institute (1998)
- Member, National Academy of Sciences (1994-Present)
- Oliver E. Buckley Prize, American Physical Society (1986)
- E. O. Lawrence Award for Physics, U.S. Department of Energy (1985)

BOARDS, ADVISORY COMMITTEES, PROFESSIONAL ORGANIZATIONS

- Research Scientist, Lawrence Livermore National Laboratory (1981 - 2004)
- President, Korean Advanced Institute for Science and Technology (2004 - 2006)
- President, Asia-Pacific Center for Theoretical Physics (2004 - 2006)
- Board Member, Science Foundation Ireland (2002 - 2003)

PROGRAM AFFILIATIONS

- Science, Technology and Society

PROFESSIONAL EDUCATION

- Ph.D., Massachusetts Institute of Technology , Physics (1979)
- A.B., University of California at Berkeley , Mathematics (1972)

Teaching

COURSES

2020-21

- Introduction to Nuclear Energy: PHYSICS 241 (Win)
- Introduction to the Physics of Energy: PHYSICS 240 (Aut)

2018-19

- Introduction to Nuclear Energy: PHYSICS 241 (Win)
- Introduction to the Physics of Energy: PHYSICS 240 (Aut)

2017-18

- Introduction to Nuclear Energy: PHYSICS 241 (Win)
- Introduction to the Physics of Energy: PHYSICS 240 (Aut)

STANFORD ADVISEES

Doctoral (Program)

Abhimanyu Banerjee, Edgard Bonilla, Caleb Cook, Eric Cooper, Joe Finney, Yudan Guo, Haoyuan Li, Xinghe Li, Eli Mueller, Aidan O'Beirne, Avikar Periwal, Xinyu Ren, Jonathan San Miguel, Ruby Shi, Jun Ho Son, Kaan Yay

Publications

PUBLICATIONS

- **Powering the Future: How We Will (Eventually) Solve the Energy Crisis and Fuel the Civilization of Tomorrow**
Laughlin, R. B.
New York: Basic Books.2011
- **The Crime of Reason**
Laughlin, R. B.
New York: Basic Books.2008
- **Gossamer superconductivity** *PHILOSOPHICAL MAGAZINE*
Laughlin, R. B.
2006; 86 (9): 1165-1171
- **Looking for a Hero**
Laughlin, R. B.
Seoul: Hans Media.2006
- **A Different Universe: Remaking Physics from the Bottom Down**
Laughlin, R. B.
New York: Basic Books.2005
- **Spectroscopy of matter near criticality** *ANNALS OF PHYSICS*

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- Bernevig, B. A., Giuliano, D., Laughlin, R. B.
2004; 311 (1): 182-190
- **The cup of the hand** *SCIENCE*
Laughlin, R. B.
2004; 303 (5663): 1475-1477
 - **Hiawatha's Valence Bonding** *Annals of Improbable Research*
Laughlin, R. B.
2004; 10 (6): 8
 - **Emergent relativity** *International Symposium on Frontiers in Science*
Laughlin, R. B.
WORLD SCIENTIFIC PUBL CO PTE LTD.2003: 18-43
 - **Emergent Relativity and the Physics of Black Hole Horizons** *Analog Models of General Relativity*
Chapline, G., Laughlin, R. B., Santiago, D. I.
edited by Visser, M.
Singapore: World Scientific.2003
 - **Truth, ownership, and scientific tradition** *PHYSICS TODAY*
Laughlin, R. B.
2002; 55 (12): 10-11
 - **Coordinate representation of the one-spinon one-holon wave function and spinon-holon interaction** *PHYSICAL REVIEW B*
Bernevig, B. A., Giuliano, D., Laughlin, R. B.
2002; 65 (19)
 - **The physical basis of computability** *COMPUTING IN SCIENCE & ENGINEERING*
Laughlin, R. B.
2002; 4 (3): 27-30
 - **The quantum criticality conundrum** *ADVANCES IN PHYSICS*
Laughlin, R. B., Lonzarich, G. G., Monthoux, P., Pines, D.
2001; 50 (4): 361-365
 - **Balanced branching in transcription termination** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
Harrington, K. J., Laughlin, R. B., Liang, S.
2001; 98 (9): 5019-5024
 - **Spinon attraction in spin-1/2 antiferromagnetic chains** *PHYSICAL REVIEW LETTERS*
Bernevig, B. A., Giuliano, D., Laughlin, R. B.
2001; 86 (15): 3392-3395
 - **Hidden order in the cuprates** *PHYSICAL REVIEW B*
CHAKRAVARTY, S., Laughlin, R. B., Morr, D. K., Nayak, C.
2001; 63 (9)
 - **Quantum phase transitions and the breakdown of classical general relativity** *PHILOSOPHICAL MAGAZINE B-PHYSICS OF CONDENSED MATTER STATISTICAL MECHANICS ELECTRONIC OPTICAL AND MAGNETIC PROPERTIES*
Chapline, G., Hohlfield, E., Laughlin, R. B., Santiago, D. I.
2001; 81 (3): 235-254
 - **The middle way** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
Laughlin, R. B., Pines, D., Schmalian, J., Stojkovic, B. P., Wolynes, P.
2000; 97 (1): 32-37
 - **The theory of everything** *PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA*
Laughlin, R. B., Pines, D.
2000; 97 (1): 28-31

- **Quantum number fractionalization in antiferromagnets** *Workshop with Learning on Field Theories for Low-Dimensional Condensed Matter Systems*
Laughlin, R. B., Giuliano, D., Caracciolo, R., White, O. L.
SPRINGER-VERLAG BERLIN.2000: 83–115
- **Differential light scattering: Probing the sonoluminescence collapse** *PHYSICAL REVIEW E*
Vacca, G., Morgan, R. D., Laughlin, R. B.
1999; 60 (6): R6303-R6306
- **Nobel Lecture: Fractional quantization** *REVIEWS OF MODERN PHYSICS*
Laughlin, R. B.
1999; 71 (4): 863-874
- **A critique of two metals** *ADVANCES IN PHYSICS*
Laughlin, R. B.
1998; 47 (6): 943-958
- **Magnetic induction of $d(x^2-y^2)+id(xy)$ order in high-T-c superconductors** *PHYSICAL REVIEW LETTERS*
Laughlin, R. B.
1998; 80 (23): 5188-5191
- **Parallels Between Quantum Antiferromagnetism and the Strong Interactions** *Proceedings of the Inaugural Conference of the Asia-Pacific Center for Theoretical Physics*
Laughlin, R. B.
edited by Cho, Y. M., Hong, J. B., Yang, C. N.
Singapore: World Scientific.1998
- **Evidence for quasiparticle decay in photoemission from underdoped cuprates** *PHYSICAL REVIEW LETTERS*
Laughlin, R. B.
1997; 79 (9): 1726-1729
- **Evidence for composite nature of quasiparticles in the 2D t-J model** *NUCLEAR PHYSICS B*
Beran, P., Poilblanc, D., Laughlin, R. B.
1996; 473 (3): 707-720
- **Evidence for electron decay in photoemission from Sr₂CuO₂Cl₂** *Conference on Spectroscopies in Novel Superconductors*
Laughlin, R. B.
PERGAMON-ELSEVIER SCIENCE LTD.1995: 1627–32
- **NUMERICAL EVIDENCE FOR ELECTRON DECAY IN THE 2-DIMENSIONAL T-J MODEL** *International Euroconference on Magnetic Correlations, Metal-Insulator-Transitions, and Superconductivity in Novel Materials*
Laughlin, R. B.
SPRINGER/PLENUM PUBLISHERS.1995: 443–66
- **FRACTIONAL VORTICES AS EVIDENCE OF TIME-REVERSAL SYMMETRY-BREAKING IN HIGH-TEMPERATURE SUPERCONDUCTORS** *PHYSICAL REVIEW LETTERS*
Sigrist, M., Bailey, D. B., Laughlin, R. B.
1995; 74 (16): 3249-3252
- **TUNNELING GAP AS EVIDENCE FOR TIME-REVERSAL SYMMETRY-BREAKING AT SURFACES OF HIGH-TEMPERATURE SUPERCONDUCTORS** *PHYSICA C-SUPERCONDUCTIVITY AND ITS APPLICATIONS*
Laughlin, R. B.
1994; 234 (3-4): 280-284
- **RESPONSE FUNCTION OF THE T-J MODEL CALCULATED USING ANYON TECHNIQUES** *PHYSICAL REVIEW B*
TIKOFISKY, A. M., Laughlin, R. B.
1994; 50 (14): 10165-10189
- **SPIN SUSCEPTIBILITY AND GAP STRUCTURE OF THE FRACTIONAL-STATISTICS GAS** *PHYSICAL REVIEW B*
Levy, J. L., Laughlin, R. B.
1994; 50 (10): 7107-7123

- **TIME-REVERSAL SYMMETRY-BREAKING IN SUPERCONDUCTORS - A PROPOSED EXPERIMENTAL TEST** *PHYSICAL REVIEW B*
Beasley, M. R., Lew, D., Laughlin, R. B.
1994; 49 (17): 12330-12332
- **GAUGE-THEORY OF THE 3-DIMENSIONAL CHIRAL SPIN LIQUID** *NUCLEAR PHYSICS B*
TIKOFISKY, A. M., LIBBY, S. B., Laughlin, R. B.
1994; 413 (3): 579-604
- **D-WAVE SUPERCONDUCTIVITY WITH A GAP** *Conference on Strongly Correlated Electronic Materials: The Los Alamos Symposium 1993*
Laughlin, R. B.
ADDISON-WESLEY PUBL CO.1994: 566-569
- **New Elementary Particles in Quantum Antiferromagnets and Their Potential Relevance to High-Temperature Superconductivity** *Modern Perspectives in Many-Body Physics: Proceedings of the 6th Physics Summer School*
Laughlin, R. B.
edited by Das, M. P., Mahanty, J.
Singapore: World Scientific.1994
- **FRACTIONAL-STATISTICS GAS WITH SPIN AND STABILITY OF THE SUPERFLUID STATE** *PHYSICAL REVIEW B*
Beran, P., Laughlin, R. B.
1993; 48 (14): 10382-10390
- **COMPUTATION OF THE OPTICAL CONDUCTIVITY OF THE T-J MODEL USING ANYON TECHNIQUES** *PHYSICAL REVIEW LETTERS*
TIKOFISKY, A. M., Laughlin, R. B., Zou, Z.
1992; 69 (25): 3670-3673
- **QUANTUM-MECHANICS OF THE FRACTIONAL-STATISTICS GAS - RANDOM-PHASE APPROXIMATION** *PHYSICAL REVIEW B*
Dai, Q., Levy, J. L., Fetter, A. L., Hanna, C. B., Laughlin, R. B.
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- **ABSENCE OF CIRCULAR-DICHROISM IN HIGH-TEMPERATURE SUPERCONDUCTORS** *PHYSICAL REVIEW LETTERS*
LAWRENCE, T. W., Szoke, A., Laughlin, R. B.
1992; 69 (9): 1439-1442
- **MACROSCOPICALLY DOPED CHIRAL-SPIN-LIQUID STATE** *PHYSICAL REVIEW B*
Zou, Z., Levy, J. L., Laughlin, R. B.
1992; 45 (2): 993-1012
- **HOLE PROPAGATOR OF THE CHIRAL SPIN LIQUID** *PHYSICAL REVIEW B*
Laughlin, R. B.
1992; 45 (1): 400-414
- **ANYONS AND SUPERCONDUCTIVITY - RANDOM PHASE APPROXIMATION** *INTERNATIONAL JOURNAL OF MODERN PHYSICS B*
Fetter, A. L., Hanna, C. B., Laughlin, R. B.
1991; 5 (16-17): 2751-2790
- **CURRENT STATUS OF SEMIIONIC PAIRING THEORY OF HIGH-TC SUPERCONDUCTORS** *WORKSHOP ON PHYSICS AND MATHEMATICS OF ANYONS*
Laughlin, R. B.
WORLD SCIENTIFIC PUBL CO PTE LTD.1991: 1507-19
- **NON-ABELIAN MONOPOLES IN THE 3-DIMENSIONAL CHIRAL SPIN LIQUID** *NUCLEAR PHYSICS B*
LIBBY, S. B., Zou, Z., Laughlin, R. B.
1991; 348 (3): 693-713
- **QUANTUM-MECHANICS OF THE FRACTIONAL-STATISTICS GAS - PARTICLE-HOLE INTERACTION** *PHYSICAL REVIEW B*
Hanna, C. B., Laughlin, R. B., Fetter, A. L.
1991; 43 (1): 309-319
- **CHARGED EXCITATIONS OF THE CHIRAL SPIN LIQUID** *PHYSICAL REVIEW B*

Zou, Z., Laughlin, R. B.
1990; 42 (7): 4073-4079

- **Fractional Statistics in the Quantum Hall Effect** *Fractional Statistics and Anyon Superconductivity*
Laughlin, R. B.
edited by Wilzcek, F.
Singapore: World Scientific.1990: 262
- **QUANTUM-MECHANICS OF THE FRACTIONAL-STATISTICS GAS - HARTREE-FOCK APPROXIMATION** *PHYSICAL REVIEW B*
Hanna, C. B., Laughlin, R. B., Fetter, A. L.
1989; 40 (13): 8745-8758
- **THEORY OF THE SPIN LIQUID-STATE OF THE HEISENBERG-ANTIFERROMAGNET** *PHYSICAL REVIEW B*
KALMEYER, V., Laughlin, R. B.
1989; 39 (16): 11879-11899
- **RANDOM-PHASE APPROXIMATION IN THE FRACTIONAL-STATISTICS GAS** *PHYSICAL REVIEW B*
Fetter, A. L., Hanna, C. B., Laughlin, R. B.
1989; 39 (13): 9679-9681
- **SPIN HAMILTONIAN FOR WHICH QUANTUM HALL WAVEFUNCTION IS EXACT** *ANNALS OF PHYSICS*
Laughlin, R. B.
1989; 191 (1): 163-202
- **Fractional Quantization in High-Temperature Superconductivity** *Mechanisms of High-Temperature Superconductivity*
Laughlin, R. B.
edited by Kamimura, H., Oshiyama, A.
Heidelberg: Springer.1989: 76
- **Fractional Statistics in the Quantum Hall Effect** *Two-Dimensional Strongly Correlated Electron Systems*
Laughlin, R. B.
edited by Gan, Z., Sun, Z.
London: Gordon and Breach.1989: 199
- **THE RELATIONSHIP BETWEEN HIGH-TEMPERATURE SUPERCONDUCTIVITY AND THE FRACTIONAL QUANTUM HALL-EFFECT** *SCIENCE*
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1988; 242 (4878): 525-533
- **SUPERCONDUCTING GROUND-STATE OF NONINTERACTING PARTICLES OBEYING FRACTIONAL STATISTICS** *PHYSICAL REVIEW LETTERS*
Laughlin, R. B.
1988; 60 (25): 2677-2680
- **EQUIVALENCE OF THE RESONATING-VALENCE-BOND AND FRACTIONAL QUANTUM HALL STATES** *PHYSICAL REVIEW LETTERS*
KALMEYER, V., Laughlin, R. B.
1987; 59 (18): 2095-2098
- **DIFFERENTIAL CONDUCTANCE IN 3-DIMENSIONAL RESONANT TUNNELING** *PHYSICAL REVIEW B*
KALMEYER, V., Laughlin, R. B.
1987; 35 (18): 9805-9808
- **POSITRONIUM TIME-OF-FLIGHT SPECTROSCOPY OF DISSIMILAR METALS** *PHYSICAL REVIEW B*
Howell, R. H., ROSENBERG, I. J., Fluss, M. J., Goldberg, R. E., Laughlin, R. B.
1987; 35 (10): 5303-5306
- **Dilute Fermi Liquid of Polarons in Copper Oxide Superconductors** *Novel Superconductivity*
Laughlin, R. B., Hanna, C. B.
edited by Wolf, S. A., Kresin, V. Z.
New York: Plenum.1987: 553

- **Electrical Resistivity as Quantum Chaos** *Chaos '87: International Conference on the Physics of Chaos and Systems Far from Equilibrium*
Laughlin, R. B.
edited by Duong-Van, M.
Amsterdam: North-Holland.1987: 213
- **Elemental Theory: The Incompressible Quantum Fluid** *The Quantum Hall Effect*
Laughlin, R. B.
edited by Prange, R. E., Girvin, S. M.
New York: Springer.1987: 233
- **MECHANISM OF CURRENT MODULATION BY OPTIC PHONONS IN HETEROJUNCTION TUNNELING EXPERIMENTS** *PHYSICAL REVIEW B*
Hanna, C. B., Hellman, E. S., Laughlin, R. B.
1986; 34 (8): 5475-5483
- **OSCILLATIONS IN THE CURRENT-VOLTAGE CHARACTERISTICS OF GAAS-ALGAAS TUNNEL-JUNCTIONS** *PHYSICAL REVIEW LETTERS*
Hanna, C. B., Laughlin, R. B.
1986; 56 (23): 2547-2547
- **DESTRUCTION OF THE FRACTIONAL QUANTUM HALL-EFFECT BY DISORDER** *SURFACE SCIENCE*
Laughlin, R. B.
1986; 170 (1-2): 167-172
- **TEMPERATURE-DEPENDENCE OF INTERATOMIC FORCES IN THE THOMAS-FERMI APPROXIMATION** *PHYSICAL REVIEW A*
Laughlin, R. B.
1986; 33 (1): 510-518
- **ONE DIMENSIONAL POLARON EFFECTS AND CURRENT INHOMOGENEITIES IN SEQUENTIAL PHONON EMISSION** *PHYSICA B & C*
Hellman, E. S., Harris, J. S., Hanna, C. B., Laughlin, R. B.
1985; 134 (1-3): 41-46
- **SCALING OF CONDUCTIVITIES IN THE FRACTIONAL QUANTUM HALL-EFFECT** *PHYSICAL REVIEW B*
Laughlin, R. B., Cohen, M. L., KOSTERLITZ, J. M., Levine, H., LIBBY, S. B., Pruisken, A. M.
1985; 32 (2): 1311-1314
- **Quasiparticle Aggregation in the Fractional Quantum Hall Effect** *Proceedings of the 17th International Conference on the Physics of Semiconductors*
Laughlin, R. B.
edited by Chadi, D. J., Harrison, W. A.
New York: Springer.1985: 255
- **The Gauge Argument for Accurate Quantization of the Hall Conductance** *Two-Dimensional Systems, Heterostructures and Superlattices*
Laughlin, R. B.
edited by Bauer, G., Kuchar, F., Heinrich, H.
Heidelberg: Springer.1984: 272
- **Fractional Quantization of the Hall Conductance** *Two-Dimensional Systems, Heterostructures and Superlattices*
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edited by Bauer, G., Kuchar, F., Heinrich, H.
Heidelberg: Springer.1984: 285
- **PRIMITIVE AND COMPOSITE GROUND-STATES IN THE FRACTIONAL QUANTUM HALL-EFFECT** *SURFACE SCIENCE*
Laughlin, R. B.
1984; 142 (1-3): 163-172
- **LEVITATION OF EXTENDED-STATE BANDS IN A STRONG MAGNETIC-FIELD** *PHYSICAL REVIEW LETTERS*
Laughlin, R. B.
1984; 52 (25): 2304-2304
- **EXCITONS IN THE FRACTIONAL QUANTUM HALL-EFFECT** *PHYSICA B & C*
Laughlin, R. B.

1984; 126 (1-3): 254-259

- **QUANTIZED MOTION OF 3 TWO-DIMENSIONAL ELECTRONS IN A STRONG MAGNETIC-FIELD** *PHYSICAL REVIEW B*
Laughlin, R. B.
1983; 27 (6): 3383-3389
- **ANOMALOUS QUANTUM HALL-EFFECT - AN INCOMPRESSIBLE QUANTUM FLUID WITH FRACTIONALLY CHARGED EXCITATIONS** *PHYSICAL REVIEW LETTERS*
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- **HELIUM DIFFRACTION FROM THE GAAS(110) SURFACE AND THE GENERATION OF HELIUM-SURFACE POTENTIALS** *PHYSICAL REVIEW B*
Laughlin, R. B.
1982; 25 (4): 2222-2247
- **UNIVERSAL BEHAVIOR IN THE ELECTRICAL-CONDUCTIVITY OF STRONG-SCATTERING EXPANDED FLUID METALS** *PHYSICAL REVIEW B*
Laughlin, R. B.
1982; 26 (12): 7019-7022
- **EXCHANGE THEORY OF RESISTIVITY SATURATION** *PHYSICAL REVIEW B*
Laughlin, R. B.
1982; 26 (6): 3479-3482
- **QUANTIZED HALL CONDUCTIVITY IN 2 DIMENSIONS** *PHYSICAL REVIEW B*
Laughlin, R. B.
1981; 23 (10): 5632-5633
- **OPTICAL-ABSORPTION EDGE OF SIO₂** *PHYSICAL REVIEW B*
Laughlin, R. B.
1980; 22 (6): 3021-3029