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PLACE OF BIRTH: Berkeley, California

EDUCATION: 1966 B.A. (Physics) Dartmouth College
1971 Ph.D. (Physics) Harvard University

PROFESSIONAL EMPLOYMENT:

1971-73	Visiting Member, Courant Institute of Mathematical Sciences, New York University
1973-77	Assistant Professor of Mathematics, State University of New York at Buffalo
1975-76	On leave at the Department of Theoretical Physics, University of Geneva
1977-83	Associate Professor of Mathematics, State University of New York at Buffalo
1979-80	On leave at the Faculty of Natural Sciences, Institute for Advanced Study, Princeton
1983-present	Professor of Mathematics, State University of New York at Buffalo
Fall 1988	On leave Department of Mathematics, Cornell University
1993-present	Adjunct Professor of Physics, State University of New York at Buffalo
Fall 2002	On leave at School of Mathematics, Institute for Advanced Study, Princeton

RESEARCH GRANTS AND FELLOWSHIPS:

1. NSF Grant PHY 75-06746 (7/1/76 to 12/31/77)
Quantum Field Theory Models as Functions of Their Defining Parameters \$ 7,400
2. NSF Grant PHY 77-21740 (6/1/78 to 11/30/80)
Quantum Field Theory Models as Functions of Their Defining Parameters \$21,300
3. NSF Grant PHY 80-01658 (7/1/80 to 12/31/82)
Selected Topics in Mathematical Quantum Field Theory \$24,000
4. NSF Grant PHY 82-04399 (6/15/82 to 11/30/84)
Selected Topics in Mathematical Quantum Field Theory \$27,251
5. NSF Grant PHY 9001178 (8/1/90-7/31/92)
Renormalization Group Methods \$51,336
6. NSF Grant PHY 9200278 (6/1/92 to 5/31/94)
Renormalization Group Methods \$56,000
7. NSF Grant PHY 9400626 (6/1/94 to 6/30/97)
Constructive Quantum Field Theory \$84,000
8. NSF Grant PHY 9722045 (6/15/97 to 6/30/00)
Constructive Quantum Field Theory \$88,000
9. NSF Grant PHY 0070905 (6/1/00 to 6/30/03)
Constructive Quantum Field Theory \$90,000
10. NSF travel grant to attend International Congress of Mathematical Physics,
Prague, (7/26/09-8/8/09) \$2,712

SELECTED INVITED TALKS:

- September 11, 1975 Talk given at Conference, *Quantum Dynamics: Models and Mathematics*, held at ZIF, University of Bielefeld, Bielefeld, Germany, 9/8/76 to 9/12/76.
- November 13, 1975 to
December 4, 1975 *Series of four two-hour lectures* delivered for the Troisieme Cycle en Suisse Romande at the Ecole Polytechnique Federale, Lausanne, Switzerland.
- May 5, 1980 Talk given at *French-American Seminar on Quantum Field Theory and Statistical Mechanics*, Rutgers University.
- July 2, 1981 Talk given at *Conference on Constructive Quantum Field Theory*, Harvard University.
- August 2, 1983 Talk given at *VII meeting of International Association of Mathematical Physicists*, Boulder, Colorado.
- September 4, 1987 Talk given at *Conference on Mathematical Quantum Field Theory and Related Topics*, Université' de Montréal.
- February 9, 1991 Talk given at *Ontario Mathematics Meeting*, McMaster University.
- August 7, 1991 Talk given at *X Meeting of International Association of Mathematical Physicists*, Leipzig, Germany
- August 5, 1993 Lecture given at *Mathematical Physics Summer School*, Vancouver, Canada
- August 31, 1995 Talk given at conference *Algebraic Quantum Field Theory and Constructive Field Theory*, Göttingen, Germany
- July 8, 1996 Talk given at *AMS Joint Summer Research Conference on Quantization*, Mt. Holyoke
- May 8, 1998 Talk given at *Conference on Mathematical Physics* in honor of Arthur Jaffe, Harvard University
- July 6, 1998 Talk given at *Conference on Rigorous Renormalization*, Ascona, Switzerland
- August 22, 1999 Talk given at *Workshop on Non-linear Dynamics and Renormalization Group*, CRM, University of Montreal.
- July 22, 2000 Talk given at *XIII Meeting of International Association of Mathematical Physicists*, London, UK
- June 15, 2002 Talk given at *Mathematisches Forschungsinstitut Oberwolfach*, Germany.
- July 28, 2003 Talk given at *XIV Meeting of International Association of Mathematical Physicists*, Lisbon.
- April 10, 2009 Talk given at Institute for Advanced Study, Princeton New Jersey
- July 6, 2010 Talk given at conference on Renormalization Group and Statistical Mechanics, UBC, Vancouver, Canada
- September 28, 2011 Talk given at workshop *Rigorous Quantum Field Theory in the LHC Era*, Erwin Schrodinger International Institute for Mathematical Physics, Vienna, Austria.
- May 28, 2013 Talk given at workshop *Analytical Aspects of Mathematical Physics*, ETH, Zurich.
- July 23, 2015 Talk given at workshop *Operator Algebras and Quantum Physics*, Universidade de Sao Paulo, Brazil.
- August 3, 2021 Talk given at International Congress on Mathematical Physics, Geneva, Switzerland.
- August 16, 2022 Talk give at IAMP one world mathematical physics seminar (remote)

- September 13, 2022 Talk given at Qmath 15 conference, UC Davis, Davis, California.
- October 3-14, 2022 Series of 6 two-hour lectures given at Roma Tre Universita, Rome, Italy.
- September 22, 2023. Talk given at 47th local quantum physics workshop, Poznan, Poland. (remote)

BIBLIOGRAPHY:**PAPERS PUBLISHED:**

1. (with R.W. Christy) Color Centers in TlCl, *Physical Review* 141 (1966), 806-814.
2. Estimates, Renormalized Currents, and Field Equations in the Yukawa₂ Field Theory, *Annals of Physics* 72 (1972), 177-242.
3. Spectrum of Local Hamiltonians in the Yukawa₂ Field Theory, *Journal of Mathematical Physics* 13 (1972), 477-481.
4. Perturbation Expansion for the P(∅)₂ Schwinger Functions, in *Lecture Notes in Physics, Vol. 25: Constructive Quantum Field Theory*, G. Velo and A.S. Wightman, eds., Springer-Verlag, Berlin (1973), 317-320.
5. (with J. Glimm) Measures on Schwartz Distributions Space and Applications to P(∅)₂ Field Theories, *Advances in Mathematics* 12 (1974), 58-83.
6. Asymptotic Perturbation Expansion in the P(∅)₂ Quantum Field Theory, *Communications in Mathematical Physics* 35 (1974), 347-356.
7. The P(∅)₂ Green's Functions: Smoothness in the Coupling Constant, *Journal of Functional Analysis* 121 (1976), 340-368.
8. The P(∅)₂ Green's Functions: Asymptotic Perturbation Expansion, *Helvetica Physica Acta* 49 (1976), 199-216.
9. The Structure of (Real Time) P(∅)₂ Green's Function, in *Quantum Dynamics: Models and Mathematics*, L. Streit, ed. Springer-Verlag (1976).
10. (with J.-P. Eckmann) On the Bound State Scattering for Weakly Coupled $(\phi^6 - \phi^4)$ ₂ Communications in *Mathematical Physics* 51 (1976), 41-54.
11. (with J.-P. Eckmann) Spectral Properties and Bound State Scattering for Weakly Coupled $\lambda P(\emptyset)_2$ Models, *Annals of Physics* 103 (1977), 289-314.
12. The Non-relativistic Limit of P(∅)₂ Quantum Field Theories: Two Particle Phenomena, *Communications in Mathematical Physics* 57 (1977), 51-66.
13. Scalar Quantum Field in an External Gauge Field, *Journal of Mathematical Physics* 20 (1979), 1791-96.
14. Scalar Quantum Field in an External Gravitational Field, *Journal of Mathematical Physics* 20 (1979), 2549-2555.
15. Algebras of Local Observables on a Manifold, *Communications in Mathematical Physics* 77 (1980), 219-228.
16. Dirac Quantum Fields on a Manifold, *Transactions of the American Mathematical Society* 269 (1982), 133-147.
17. (with B. Kay) Classical Wave Operators and Asymptotic Quantum Field Operators in Curved Space-time, *Annales de l'Institut Henri Poincaré A*. 37 (1982), 93-114.
18. P(∅)₂ Models with Variable Coefficients, *Annals of Physics* 154 (1984), 283-307.
19. Scattering for the Wave Equation on the Schwarzschild Metric, *General Relativity and Gravitation* 17 (1985), 353-369.
20. (QED)₂ in the Coulomb Gauge, *Annales de l'Institut Henri Poincaré A*, 43 (1985), 167-179.

BIBLIOGRAPHY:**PAPERS PUBLISHED: (con't)**

21. (with B. Kay) Scattering for Scalar Field on Coulomb Potentials and Schwarzschild Metrics, *Classical and Quantum Gravity* 3 (1986), 71-80.
22. (with B. Kay) Classical and Quantum Scattering for Linear Scalar Fields on the Schwarzschild Metric II, *Journal of Mathematical Physics* 27 (1986), 2520-2525.
23. (with B. Kay) Classical and Quantum Scattering for Linear Scalar Fields on the Schwarzschild Metric I, *Annals of Physics* 175 (1987), 366-426.
24. Infrared Asymptotic Freedom for the Pseudoscalar Yukawa Model at the Critical Point, *Communications in Mathematical Physics* 109 (1987), 379-395.
25. Infrared Problems for $(\text{QED})_4$ and $(\text{Yukawa})_4$ on a Lattice, in *Mathematical Quantum Field Theory and Related Topics*, J. Feldman, L. Rosen, Eds., American Mathematical Society, Providence, (1988), 153-159.
26. QED on a lattice: Infrared asymptotic freedom for bounded fields, *Annales de l'Institut Henri Poincaré* 48 (1988), 355-386.
27. A Cluster Expansion for Stochastic Lattice Fields, *Journal of Statistical Physics* 58 (1990), 1181-1207.
28. The Kosterlitz-Thouless Phase in a Hierarchical Model, *Journal of Physics A*, 23 (1990), 1207-1215.
29. (with T. Hurd) A renormalization group analysis of the Kosterlitz-Thouless phase, *Commun. Math. Phys.* 137 (1991), 263-287.
30. (with T. Hurd) A renormalization group analysis of infrared QED, *Journal of Mathematical Physics* 33 (1992), 814-821.
31. (with T. Hurd) A renormalization group analysis of correlation functions for the dipole gas, *Journal of Statistical Physics* 66 (1992), 1277-1318.
32. Quantized electromagnetic field on a manifold, *Reviews in Mathematical Physics* 4 (1992) 223-233.
33. (with T. Hurd) Construction of the two-dimensional sine-Gordon model for $\beta < 8\pi$, *Commun. Math. Phys.* 156 (1993), 547-580.
34. (with D. Brydges, T. Hurd) Weak perturbations of Gaussian measures, *Mathematical Quantum Theory I: Field Theory and Many-body Theory*, J. Feldman, R. Froese, L. Rosen, ed., American Mathematical Society, Providence (1994), 1-28.
35. (with D. Brydges, T. Hurd) Applications of the renormalization group, *Mathematical Quantum Theory I: Field Theory and Many-body Theory*, J. Feldman, R. Froese, ed., American Mathematical Society, Providence (1994), 171-189.
36. (with D. Brydges, T. Hurd) The short distance behavior of $(\phi^4)_3$, *Comm. Math. Phys.* 172 (1995), 143-186.
37. Canonical Quantization of Yang Mills on a circle, *Reviews in Mathematical Physics* 8 (1996), 85-102.
38. A non-Gaussian fixed point for the renormalization group, *Perspectives in Quantization*, L. Coburn, M. Rieffel, Eds., American Mathematical Society, Providence (1998), 39-46.
39. (with D. Brydges, T. Hurd), Estimates on renormalization group transformations, *Canadian Journal of Mathematics* 50 (1998), 756-793.
40. (with D. Brydges, T. Hurd), A non-Gaussian fixed point for ϕ^4 in $4-\epsilon$ dimensions, *Communications in Mathematical Physics* 198 (1998), 111-156.
41. Bosonization of massive fermions, *Communications in Mathematical Physics* 198 (1998), 247-281.

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42. Locality in free string field theory, *Journal of Mathematical Physics* 41 (2000), 40-61.
43. (with T. Hurd), Sine-Gordon revisited, *Annales Henri Poincaré*, 1 (2000), 491-541.
44. The sine- Gordon model at $\beta=4\pi$, in *Nonlinear Dynamics and Renormalization Group*, I. M. Sigal, C. Sulem, eds., American mathematical Society, Providence, (2001).
45. Notes on $(\text{QED})_3$, in *XIII International Congress on Mathematical Physics*, A. Grigoryan, A. Fokas, T. Kibble, B. Zegarlinski, eds., International Press, Boston, (2001).
46. Locality in free string field theory-II, *Annales Henri Poincaré*, 3 (2002), 613-634.
47. Markov quantum fields on a manifold, *Reviews in Mathematical Physics* 16 (2004) 243-255.
48. (with S.G. Rajeev) Multiparticle Schrödinger operators with point interactions in the plane, *Journal of Physics A*, 37 (2004).
49. Local string field theory, *Proceedings of XIV International Congress on Mathematical Physics*, J.-C. Zambrini, ed. World Scientific, (2006).
50. Transition amplitudes and sewing properties for bosons on the Riemann sphere, *J. Math Phys.* 48, 052308, 1-31 (2007).
51. More transition amplitudes on the Riemann sphere, *J. Math. Phys* 49, 062302, (2008), 1-20.
52. Infinite Volume limit for dipole gas, *J. Stat. Phys.* 135, (2009), 393-427.
53. The Dirac sea, *Letters in Mathematical Physics* 98, (2011), 157-166.
54. The renormalization group according to Balaban - I. small fields. *Reviews in Mathematical Physics* 25, 1330010 (2013), 1-64.
55. The renormalization group according to Balaban - II. large fields. *Journal of Mathematical Physics* 54, 092301 (2013), 1-85.
56. The renormalization group according to Balaban - III. convergence. *Annales Henri Poincare* 15 (2014), 2133-2175.
57. Covariant axial gauge, *Letters in Mathematical Physics* 105, (2015), 959-987.
58. Nonperturbative renormalization of scalar QED in $d=3$, *Journal of Mathematical Physics* 56, 102304, (2015), 78 pages.
59. Ultraviolet regularity for QED in $d=3$, *Journal of Mathematical Physics* 59, 012301, (2018), 76 pages.
60. Multiscale block averaging for QED in $d=3$, *Journal of Mathematical Physics* 61, 032302, (2020), 46 pages.
61. Scattering on the Dirac magnetic monopole, *Letters in Mathematical Physics* 111, 40 (2021), 17 pages.
62. A Feynman-Kac formula for magnetic monopoles, *Infinite Dimensional Analysis, Quantum Probability, and Related Topics* 24, 2150015, (2021), 18 pages.
63. Ultraviolet stability for QED in $d=3$, *Annales Henri Poincare* 23, (2022), 2113-2205.
64. Stability for QED in $d=3$: an overview, *Journal of Mathematical Physics* 63, 042305 (2022), 20 pages.
65. Quantum radiation from a classical point source, *Reviews in Mathematical Physics* 34, 2250032, (2022), 18 pages.

66. (with C. Yuan) Structural stability of the RG flow in the Gross-Neveu model, ArXiv 2303.07916, to appear in Annales Henri Poincare, (2024), 79 pages
67. Correlation functions for the Gross-Neveu model, ArXiv 2406.16799, (2024), 29 pages.

BOOKS PUBLISHED:

Quantum Mechanics and Quantum Field Theory: a Mathematical Primer, Cambridge University Press, 2011

PROFESSIONAL SERVICE:

Editorial Board of Journal of Mathematical Physics, 2005-2007

NSF review panel in Mathematical Physics, 2006.

NSF review panel in Mathematical Physics, 2014.

DOCTORAL THESES SUPERVISED:

Edward Furlani (Physics) 1982

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