William A. Schwalm

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Education:

1978 Ph.D., Physics, Montana State University (J. C. Hermanson)
1969 B.Sc., Physics, University of New Hampshire

Employment history:

1978-80	Post Doctoral Research Associate and Teaching Fellow, University of Utah
1980	Instructor of Physics, University of Utah
1980-83	Assistant Professor Physics, University of North Dakota
1983-90	Associate Professor of Physics, University of North Dakota
1990-present	Professor of Physics, University of North Dakota

Major teaching workshops:

1. National Science Foundation Short Course for College Teachers: Insights into Introductory Physics Teaching, Arnold Arons, Two weeks in April, University of Dayton, 1994.
2. Teaching Introductory Differential Equations, Park City Mathematics Institute and Princeton Institute for Advanced Study, Two weeks, Salt Lake City, summer 2002.
3. American Association of Physics Teachers Workshop: Introduction to Standardized Assessment, half day, Salt Lake City, summer 2005.

Awards:

1. University of Utah Department of Physics Award for Outstanding Instructor (1980)
2. University of North Dakota Foundation McDermott Award for Individual Excellence in Teaching (1988)
3. University of North Dakota Summer Research Professorship (1995)
4. University of North Dakota Summer Instructional Development Professorship (1997)
5. University of North Dakota Summer Instructional Development Prof. (shared 2000, 2001)

- Visiting Professor, Kyoto University, Physics and Applied Mathematics, Summer 2003
- Plenary speaker, Workshop on geometric integration theory, Foundations of Computational Mathematics 2002, Minneapolis.
- Local Committee, Midwest Geometry Conference (UND, April 26-28, 2002)
- Co-editor of special issue, *Intl. J. Modern Phys. B*, proceedings for *48th Midwest Solid State Conference*, and the *Midwest Solid State Theory Symposium*, Vol. 15, Nos. 24 & 25, October, 2001.
- Participant, Park City Mathematics Institute (summer 2001)
- Visiting Professor, University of Rome, "La Sapienza," summer 1998
- Member, Scientific Committee of Second International Conference on Disordered Structures, Fractals and Chaos, Sept. 2-5, University of Rome, "La Sapienza," 1996, also Session Chair
- NATO Visiting Scholar, Univ. of Rome, "La Sapienza," Chemical Engineering, summer 1996, 1999

- Visiting Scientist, Montana State University, Physics 1990-91
- Session Chair, Fractals, Am. Phys. Soc. March meeting (San Jose, 1995)
- Session Chair, FRACTAL 97, Denver 1997
- Summer Visiting Scientist, University of Minnesota (Minneapolis), Physics 1983-85
- Regular Reviewer, Physical Review B, Physical Review E and Physical Review Letters

Research:
Condensed matter theory, localization, dynamics of fractal and disordered structures, transport processes, Lie groups and renormalization, discrete exterior calculus with application to physical models.

Membership:
American Association of Physics Teachers, American Physical Society; Mathematical Association of America, Sigma Xi

University faculty administrative experience:
1. Chair of College of Arts and Sciences Curriculum Committee
2. External reviewer, Physics degree programs, Minot State University
3. Chair of Arts & Sciences undergraduate program review committee for Biology
4. Chair of Arts and Sciences Committee on Tenure and Reappointment
5. Member Review Committee for Graduate Programs in Mathematics, UND Grad. School
5. Member University Curriculum Committee
6. Member General Education Requirement Committee
7. Dean's *Ad hoc* committee to update mission statement of College of Arts and Sciences
8. Member taskforce to revise general education requirements
9. Advisor of Society of Physics Students 1980-2004
10. Departmental Undergraduate, Graduate, Teaching Evaluation, Grievance and Library committees
11. At-large member of program evaluation panel for Computer Science undergraduate programs

Teaching:

1. Member of Forum on Physics Education of the American Physical Society.
2. Teaching awards from two different universities (see Awards above).
3. Completed 1-week NSF course on introductory physics teaching (U. Dayton, OH, 1994).
4. PCMI 3-week workshop on teaching differential equations (Salt Lake, UT, 2001).
5. Developed and taught for three semesters a Nuclear Weapons course.
6. Developed public lectures on Einstein's theory of relativity.
7. Developed and taught course in special relativity as Physics for Poets.
8. Developed and taught a course on *Mathematica* computer language.
9. Developed and taught Phys. 402, Computers in Physics, mainly Matlab computer language.
10. Wrote *Physics Introductory Laboratory Manual I,* (Wiley, 2000) 135 pages, ISBN 0-471-41371-2.
11. Wrote *Physics Introductory Laboratory Manual II,* (Wiley, 2001) 120 pages, ISBN 0-471-21550-3.
12. Wrote *Short Course in Mathematica,* 41 pages, for summer course 2002.

13. Taught several IVN Physics courses (Interactive Video Network).
14. Have taught a number of interdisciplinary courses and seminars each time with one other faculty member. These have included faculty from Philosophy, English, History, Chemical Engineering and (several times) Math.
15. Compiled complete volumes of lecture notes (type set using TeX) for graduate physics courses: Analytical Mechanics, first semester each of Electromagnetism and Methods of Theoretical Physics Second volumes of the latter two are in progress.
16. Member American Association of Physics Teachers

Teaching experience:
General Physics (with and without calculus), Physics for Poets, Solid State Physics (U&G), Thermal Physics (U), Nuclear Physics (U), Special Relativity (U), Computational Physics (U&G), Fortran computer language (U), Methods of Theoretical Physics (G), Quantum Mechanics (U&G), Classical Mechanics (U&G), Electromagnetism (U&G), Statistical Physics (G), Digital Electronics Lab (U), Nuclear Weapons (U). Mathematica computer language (U), Matlab computer language, Applied group theory (U).

Graduate students and thesis titles :
1. Kurt Krouss, MS "Tight-binding band structure calculation for ordered models of $Bi_2(Te_{1-x}S_x)_3$," (1988).
2. Kevin G. Rada, MS "Eigenstates of the Schrödinger equation on a well-connected hierarchical glass model with self-similarity dimension d=3," (1989).
3. Lynn D. Reed, MS "Diffraction of waves by ordered fractals," (1989).
4. Bruce F. Sampson, MS "Properties of biased self avoiding walks on the 2D Sierpinski fractal," (1990).
5. Christopher C. Reese, MS "Pencils of plane curves and exact orbits of Green function renormalization maps for hierarchical lattices," (1994).
6. Brian Moritz, MS "Lie groups and the soliton of renormalizable lattice problems," (1997).
7. Brian Moritz, Ph.D. "Vector difference calculus," (2000).
8. Scott Crockett, MS "Topological model of an electron coupled to a classical polarization field," (2001).
9. Cody Nitschke, MS, "Lie Algebra applied to Physics Problems," (2005).

Graduate Thesis Committee:

1. Hai. Ni (Chemical Engineering MS)
2. Ken Pierce (Chemistry Ph. D.)
3. Kathleen Kuhler (Chemistry Ph. D)
4. Ryan Winburn (Chemistry Ph. D.)
5. Leon Nelson (D. Ed.)
6. Gong Liu (Physics Ph.D.)
7. Sean Stone (Physics MS)
8. Jai Sung (Chemistry Ph. D)
9. Tim Dudley (Chemistry Ph.D.)
10. Xiaochu Wang (Physics Ph.D.)
11. Udom Tepparah (Physics Ph.D.)
12. Janardan Pokharel (Physics MS)
12. Hefeng Wang (Chemistry Ph.D.)
13. Sherry Feible-Beyer (Physics MS)

Collaborators since 2000:

1. Mizuho Kawajiri Schwalm (U. N. Dakota, U. Minnesota Crookston) 1969-
2. Scott Crockett (Los Alamos National Laboratory) 2005-

3. Yushmasa Nakamura (Kyoto University, Japan) 2003
4. Massimiliano Giona (University of Rome, "La Sapienza," Italy) 1993-00
5. Alessandra Adrover (University of Rome, "La Sapienza," Italy) 1994-00

Research grants funded:

1. "Infinitely ramified fractal lattices", NSF/EPSCOR, Oct. 1992-June 1995, $41,563.
   PI W. Schwalm, Co-PI M. Schwalm
2. "Diffusion on porous media", NDEPSCoR, Sep. 1994- Aug. 1995, $7,160
   PI D.K. Ludlow, Co-PI W. Schwalm
3. "Fractal isotherms, dynamic scaling in adsorption phenomena on microporous materials", NATO Collaborative Research, June 1995-May 1997, $7,000
   PI W. Schwalm, Co-PIs M. Giona and D. K. Ludlow
4. "Vector Difference Calculus," NATO Collaborative Research Grant 1998-99 $7,000, PI W. Schwalm, co-PI M. Giona.

Instructional grant funded:

5. "NSF Collaborative Research: Adaptation of the University of Minnesota Problem Solving Lab concept to introductory course sequesces," NSF Course Curriculum and Laboratory Improvement (CCLI) 2005-2008 $76,430. W. Schwalm (PI), M. Schwalm and K. Marasinghe.

1. **List of publications in refereed journals:**
2. "Density of States for Directional Photoemission Spectroscopy of W(001)", J. Hermanson, M. Kawajiri and W. Schwalm, Solid State Commun. **21**, 327-329 (1977).
3. "Surface Density of states for Normal Photoemission from Mo(110) and W(111)", M. Kawajiri, J. Hermanson and W. Schwalm, Solid State Commun. **25**, 303-305 (1978).
4. "Surface States on Unrelaxed GaAs(110) in the Bond-orbital Model", W. Schwalm and J. Hermanson, Solid State Commun. **27**, 587-590 (1978).
5. "Hartree-Fock formalism for the calculation of total energies and charge densities of thin films", Frank H. Harris, Hendrik J. Monkhorst and William A. Schwalm, J. Vac. Sci. Technol. **16,** 1318-1322 (1979).
6. "Analytic continuation in exchange perturbation theory", B. Jeziorski, W. A. Schwalm and K. Szaleviwz, J. Chem. Phys. **73**, 6215-6224 (1980).
7. "Site-by-site Madelung energies in semi-infinite NaCl", William A. Schwalm, Am. J. Phys. **50**, 444-447 (1982).
8. "Electrostatics for periodic films of atoms", H. J. Monkhorst and W. A. Schwalm, Phys. Rev. B **23**, 1729-1742(1981).
9. "2D conductance and magnetoconductance in a thin crystal of $Bi_{14}Te_{11}S_{10}$", H. H. Soonpaa and W. A. Schwalm, Sol. St. Commun. **42**, 201-204 (1982).
10. "Generating functions in physics", William A. Schwalm, Am. J. Phys. **51**, 230-235 (1983).
11. "Bridge between particle and fluid kinematics", William A. Schwalm and Mizuho K. Schwalm, Am. J. Phys. **53**, 421-428 (1985).
12. "Single-parameter scaling in thin crystals", H. H. Soonpaa and W. A. Schwalm, Phys. Lett. **98**A, 122-124 (1983).

13. "Generating functions in physics", W. A. Schwalm and M. K. Schwalm, Am. J. Phys. **51**, 230-235 (1983).
14. "Experimental exploration of the scaling theory in 2D", H. H. Soonpaa and W. A. Schwalm, Phys. Lett. **100**A, 156-157 (1984).
15. "Lure of mathematical science", W. A. Schwalm, North Dakota Quarterly, **54**, 212-230 (1986).
16. "Extension theory for lattice Green functions", W. A. Schwalm and M. K. Schwalm, Phys. Rev. B **37** , 9524-9542 (1988).
17. "Electronic properties of fractal glass models", W. A. Schwalm and M. K. Schwalm, Phys. Rev. B **39**, 12872-12882 (1989).
18. "Length scaling of corner-to-corner propagation on fractal lattices," W. A. Schwalm M. K. Schwalm and K. Rada, Phys. Rev. B **44**, 382-385 (1991).
19. "Closed formulae for Green functions on fractal lattices," W. A. Schwalm and M. K. Schwalm, Physica A **185**, 195-201 (1992).
20. "Effects of surface roughness on transport in quasi-one-dimensional and -two-dimensional ballistic channels", M. K. Schwalm and W. A. Schwalm, Phys. Rev. B **45**, 6868-6876 (1992).
21. "Damping effects on the Kubo-Greenwood conductance of lattice models in one, two and three dimensions", W. A. Schwalm and M. K. Schwalm, Phys. Rev. B**45**, 1770-1775 (1992).
22. "Biased interacting self-avoiding walks on the four-simplex lattice", G. F. Tuthill and W. A. Schwalm, Phys. Rev. B **46**, 13722-13734 (1992).
23. "Explicit orbits for renormalization maps for Green functions on fractal lattices", W. A. Schwalm and M. K. Schwalm, Phys. Rev. B **47**, 7847-7858 (1993).
24. "Perfect conductance on fractal lattices", W. A. Schwalm and M. K. Schwalm in Fractals in the Natural and Applied Sciences, M. M. Novak, editor (Elsevier, Amsterdam, 1994).
25. "Conic pencils and renormalization dynamics", W. A. Schwalm, C. C. Reese, M. K. Schwalm and C. J. Wagner, Phys. Lett. A **193** 238-244 (1994).
26. "Explicit Green functions for hierarchical lattices", W. A. Schwalm, C. C. Reese, M. K. Schwalm and C. J. Wagner, Phys. Rev. B **49**, 15650-15663 (1994).
27. "Exact solution of linear transport equations in fractal media I. Renormalization analysis and general theory" , M. Giona, W. A. Schwalm, M. K. Schwalm and A. Adrover, Chem. Engr. Sci. **51,** 4717, (1996).
28. "Exact solution of linear transport equations in fractal media II. Diffusion and Convection" M. Giona, W. A. Schwalm, M. K. Schwalm and A. Adrover, Chem. Engr. Sci. **51**, 4731, (1996).
29. "Exact solution of linear transport equations in fractal media III. Adsorption and Chemical Reaction", M. Giona, A. Adrover, W. A. Schwalm and M. K. Schwalm, Chem. Engr. Sci. **51**, 5065, (1996).
30. "Analysis of linear transport phenomena on fractals" M. Giona, W. A. Schwalm, A. Adrover and M. K. Schwalm, Chem. Engr. J. **64**, 45 (1996).
31. "First-order kinetics in fractal catalysts: renormalization analysis of the effectiveness factor", M. Giona, W. A. Schwalm, A. Adrover and M. K. Schwalm, Chem. Engr. Sci. **51**, 2273 (1996).
32. "Renormalization analysis of diffusion and adsorption on fractal and disordered lattices in the presence of energetic disorder", M. K. Schwalm, M. Giona, W. A. Schwalm, A. Adrover

and M. Giustiniani, Langmuir **13**, 1128 (1997).

33. "Length scaling of conductance distribution for random fractal lattices", M. K. Schwalm and W. A. Schwalm, Phys. Rev. B **54**, 15086 (1996).
34. "Scaling and cross-over for transport on anisotropic structures", A. Adrover, W. A. Schwalm, M. Giona and D. Bachand, Phys. Rev. E **55**, 7304 (1997).
35. "Lie groups and solution of dynamical problems on fractal lattices", W. A. Schwalm, M. K. Schwalm and M. Giona , in *Fractal Frontiers* M.M. Novak T. G. Dewy (World Scientific, Singapore, 1997)
36. "Group theoretic reduction of linear transport on regular fractal structures", W. A. Schwalm, M. K. Schwalm and M. Giona, Phys. Rev. E **55**, 6741 (1997).
37. "Group theoretic reduction of linear transport models on regular fractal structures", W. A. Schwalm, M. K. Schwalm and M. Giona, Fractals and Chaos in Chemical Engineering, ed. M. Giona and G. Biardi (World Scientific, Singapore, 1997) p. 199.
38. "Perspectives and application of Green function renormalization to transport phenomena", M. Giona, W. A. Schwalm, M. K. Schwalm and A. Adrover ibid. p. 68.
39. "Solution of transport schemes on fractal lattices by means of Green function renormalization—Application to integral quantities", M. Giona, W. A. Schwalm, A. Adrover and M. K. Schwalm, Fractals, **5**, 473 (1997).
40. "Finding Lie groups that reduce the order of discrete dynamical systems," B. Moritz, W. Schwalm, and D. Uherka J. Physics A: Math. Gen. (London) **31**, 7379 (1998).
41. "Vector difference calculus for physical lattice models," W. Schwalm, B. Moritz, M. Giona, Phys. Rev. E **59**, 1217-1233 (1999).
42. "Triangle lattice Green functions for Vector fields," B. Moritz, W. Schwalm , J. Phys. A: Math. Gen. (London) **34** 589-602 (2001).
43. "Topological lattice model of an electron coupled to a classical polarization field," W. Schwalm, S. Crockett and B. Moritz, International J. Mod. Phys. B, **24 & 25** 3339 (2001).
44. "Dynamics of Cremona maps from physical models," W. Schwalm, B. Moritz and M. Schwalm, *ibid.* 2379.
45. "Gauge simplification of Hamiltonians with off-diagonal ±1 disorder," M. Schwalm and W. Schwalm, *ibid.* 3287.
46. "Continuous spectra of a family of lattices related to the modified rectangle lattice of Dhar," W. Schwalm and B. Moritz, Phys. Rev. B **71** 1310 (2005)
47. "Generating two-dimensional oscillator matrix elements sorted by angular momentum," W. Schwalm, C. Nitschke and P. Reis, J. Phys. A: Math. Gen. (London) **38**, 9565 (2005).

Conference presentations:

1. "Combined XPS and ISS characterization of Bi-Te-S compounds", Paul A. Linfors, Tom Rush and William A. Schwalm, 4-th International Symposium on Applied Surface Analysis, Dayton, OH, July, (1982).
2. "Detailed electrostatics of the NaCl point lattice by Half-Line decomposition", Am. Phys. Soc. March meeting, Baltimore, MD; Bul. Am. Soc. **30** 319 (1985).
3. "High field conductance in 2D", Bul. Am. Soc. March meeting, Baltimore, MD; Bul. Am. Soc. **30** 550 (1985).
4. "Rings and aromaticity in self-similar graphitic lattices", 33rd Midwest Solid State

Conference, Kansas City, MO, Nov. 8-9, 1985.

5. "Solvable model interface between ordered and chaotic, graphite-related planar lattices", Am. Phys. Soc. March meeting, Las Vegas, NV; Bul. Am. Phys. Soc. **31** 382 (1986).
6. "Algebraic extension theory for lattice Green functions", W. A. Schwalm and M. K. Schwalm, Am. Phys. Soc. March meeting, New Orleans, LA; Bul. **33**, 487 (1988).
7. "Field dependent conduction in thin crystals", H. H. Soonpaa and W. A. Schwalm, Am. Phys. Soc. March meeting, New Orleans, LA; Am. Bul. Am. Phys. Soc. **33**,495 (1988).
8. "Landauer conductance for narrow 2D channels", M. K. Schwalm and W. A. Schwalm, Am. Phys. Soc. March meeting, St. Louis, MO; Bul. Am. Phys. Soc. **34**, 590 (1989).
9. "Schrödinger Eigenstates of infinitely ramified Fractal glass models with fractal dimension $\tilde{d}_f 3$ and spectral dimension $d_s > 2.5$", with K. Rada, Am. Phys. Soc. March meeting, St. Louis, MO; Bul. Am. Phys. Soc. **34**, 629 (1989).
10. "Scattering from ordered fractals", W. A. Schwalm and L. Reed, Am. Phys. Soc. March meeting, St. Louis MO, Bul. Am. Phys. Soc. **34**, 1016 (1989).,
11. "Biased self-avoiding walks on hierarchical lattices", W. Schwalm and B. Sampson, Am. Phys. Soc. March meeting, Anaheim, CA; Bul. Am. Phys. Soc. **35**, 390 (1990).
12. "Effects of rough edges on electron transport", M. Schwalm and W. Schwalm, Am. Phys. Soc. March meeting, Anaheim, CA; Bul. Am. Phys. Soc. **35**, 492 (1990).
13. "Statistical mechanics of biased self-avoiding walks on fractal lattices", W. Schwalm, Gordon Research Conference: Fractals, Plymouth, NH (July 1990).
14. "Closed formulas for Green functions on fractal lattices", W. Schwalm and M. Schwalm, International Conference on Complex Systems: Fractals, Spin-Glasses and Neural Networks, International Center for Theoretical Physics, Trieste, Italy (July 1991).
15. "Constructing exact orbits for chaotic dynamics of certain planar mappings", W. Schwalm and M. Schwalm, Math Assn. of Am., Summer Seminar on Non-Linear Dynamics and Chaos, Duluth, MN (August, 1991).
16. "Constructing exact orbits for the dynamics of the renormalization recursion for Green functions on the (k+1)-simplex", W. Schwalm and M. Schwalm, Am. Phys. Soc. March meeting, Indianapolis, IN; Bul. Am. Phys. Soc. **37**, 70(1992).
17. "Interacting biased SAW's on the 4-simplex lattice", G. F. Tuthill and W. A. Schwalm, Am. Phys. Soc. March meeting, Indianapolis, IN; Bul. Am. Phys. Soc. **37**, 421 (1992).
18. "Perfect conductance on fractal lattices", W. A. Schwalm and M. K. Schwalm, Fractal 93: International working conference on fractals in the natural and applied sciences, London, UK (September, 1993).
19. "Scaling of conductance distribution function for a structure ensemble of fractal lattices with random disorder", M. Schwalm, W. Schwalm and C. J. Wagner, Midwest Solid State Theory Symposium, Detroit, MI, (October, 1993).

20. "Conductance scaling on fractals: Scaling of conductance distribution for structure ensembles", M. Schwalm and W. Schwalm, Am. Phys. Soc. March meeting, Pittsburgh, PA ;Bul. Am. Phys. Soc. **39**, 264 (1994).
21. "Anderson transition in infinitely ramified regular fractals", W. Schwalm and M. Schwalm, Am. Phys. Soc. March meeting, Pittsburgh, PA; Bul. Am. Phys. Soc. **39**, 264 (1994).
22. "Conductance, diffusion/adsorption on regular fractals including infinitely ramified

structures", W. Schwalm, M. Schwalm, M. Giona and A. Adrover, Am. Phys. Soc. March meeting, San Jose; Bul. Am. Phys. Soc. **40**,172 (1995).

23. "Dynamical systems arising from renormalization of wave propagation on regular aperiodic lattices: Cases when recursion involve more than two variables", W. A. Schwalm and M. K. Schwalm, Am. Phys. Soc. March meeting, San Jose, CA; Bul. Am. Phys. Soc. **40**(1) 813 (1995).
24. "Scaling of conductance distribution functions for fractal structure ensembles", M. K. Schwalm and W. A. Schwalm, Am. Phys. Soc. March meeting, San Jose CA; Bul. Am. Phys. Soc. **40**(1) 357 (1995).
25. "Analysis of linear transport phenomena on fractals", M. Giona, M. K. Schwalm, W. A. Schwalm, The second Italian conference on Chemical and Process Engineering, Firenze, May 15-17, (1995).
26. "Renormalization analysis of diffusion and adsorption on fractal and disordered lattices in the presence of energetic disorder", W. A. Schwalm, M. Giona, M. K. Schwalm and A. Adrover, Second International Symposium on Effects of Surfaces Heterogeneity in Adsorption and Catalysis on Solids, Zakopane, Poland; Lavoca, Slovakia Sept. 4-10, 1995.
27. "Decoupling difference equations that appear in real space renormalization", W. A. Schwalm and M. K. Schwalm, Am. Phys. Soc. March meeting, St. Louis, MO; Bul. Am. Phys. Soc. **41**(1) 511 (1996).
28. "Quantum percolation on model percolation clusters", M. K. Schwalm and W. A. Schwalm, Am. Phys. Soc. March meeting, St. Louis, MO; Bul. Am. Phys. Soc. **41**(1) 547 (1996).
29. "Diffusion in anisotropic and heterogeneous fractal structures", A. Adrover, M. Giona, W. A. Schwalm , D. Bachand, Am. Phys. Soc. March meeting, St. Louis, MO, Bul. Am. Phys. Soc. **41**(1) 329 (1996).
30. "Decoupling difference equations that appear in real space renormalization", W. A. Schwalm and M. K. Schwalm, Am. Phys. Soc. March meeting, St. Louis, MO March 18-22, Bul. Am. Phys. Soc. **41**, 511 (1996).
31. "Group Theoretic Reduction of Linear Transport Models on Regular Fractal Structures", W. A. Schwalm, M. K. Schwalm and M. Giona, Conference on Chaos and Fractals in Chemical Engineering (CFIC96, Rome Sept. 2-6, 1996).
32. "Perspectives and application of Green function renormalization to transport phenomena", M. Giona, W. A. Schwalm, M. K. Schwalm and A. Adrover, Conference on Chaos and Fractals in Chemical Engineering (CFIC96, Rome Sept. 2-6, 1996).
33. "Lie groups and solution of problems on fractal lattices," *Fractal 97* (Denver, March, 1997).
34. "Vector difference calculus," W. Schwalm, M. Schwalm and M. Giona, March Meeting of American Physical Society, Los Angeles CA, Bul. Am. Phys. Soc. **43**, 884 (1998).

35. "Lattice analog of differential forms," Centennial Meeting of American Physical Society, Atlanta GA, Bul. Am. Phys. Soc. **44**(1) 277 (1999).
36. "Analysis of full vector Maxwell equations in random structures using vector difference calculus," B. Moritz, W. Schwalm, S. Hewett, *ibid.* (2) 1565.
37. "A vector calculus for physical lattice models," M. Giona, W. Schwalm, B. Moritz and A. Adrover, *IcheaP-4*, 4th Italian Conference on Chemical and Process Engineering, Florence, Italy May 2-5 (1999), extended abstract.

38. "Discrete mathematics of fields and fluid flows," B. Moritz, W. Schwalm, *2nd Biennial North and South Dakota EPSCoR Conference,* Sept. 10, (1999) prog. pg. 27.
39. "Algebraic topology and physics," W. Schwalm, M. Schwalm and B. Moritz, *ibid.*
40. "Cremona maps and discrete dynamics," W. Schwalm, North Central Section, Math. Assn. Am., St.Peter MN, April 2001.
41. "Dynamics of Cremona maps from physical lattice models," B. Moritz, W. Schwalm, M. Schwalm, 48th Midwest Solid State Conference, Solid State Theory Symposium, Grand Forks, Oct. 2001.
42. "Gauge simplification of Hamilitonians with off-diagonal disorder," M. Schwalm and W. Schwalm *ibid.*
43. "Polaron in a simple, topological model of electron-phonon coupling," W. Schwalm, S. Crockett and B. Moritz, *ibid.*
44. "Dynamics of an electron confined to a random dedtritic structure," W. Schwalm and M. Schwalm, March Meeting of American Physical Society, Seattle, Bul Am. Phys. Soc. **46**, 189 (2001).
45. "Toulouse strings and off diagonal disorder in 2D, M. Schwalm and W. Schwalm, *ibid*. 190.
46. "Complete solution of dynamical system associated with the Ashkin-Teller model," B. Moritz and W. Schwalm, *ibid.* 195.
47. "Green functions for modified rectangle lattice of Dhar," C. Reese, W. Schwalm and B. Moritz, *ibid.* 457.
48. "Topological model of small polaron dynamics," W. Schwalm, S. Crockett and B. Moritz, *ibid.* 1056.
49. "Unsolving differential equations," W. Schwalm, North Central Section, Math. Assn. Am., Grand Forks, October 2001.
50. "Continuous spectrum in hierarchical lattice," W. Schwalm, 49th Midwest Solid State Conference, Rapid City, October 2001.
51. "Topological model of coupled electromagnetic and elastic fields," W. Schwalm and M. Schwalm, March Meeting, American Physical Society, Indianapolis IN, March 18-22 : Bul. Am. Phys. Soc. Vol. 47, p.1188.
52. "Homology groups applied to fluid flow and wave interference," M. Schwalm and W. Schwalm, March Meeting, American Physical Society, Indianapolis IN, March 18-22 : Bul. Am. Phys. Soc. Vol. 47, p.860.
53. "Stand-alone laboratory modules for introductory physics, 125th National Meeting of the Americal Association of Physics Teachers, Boise ID, August 3-7, 2002.

54. "Cell-complex model of exterior calculus, W. Schwalm, Conference on Interactions between Representation theories, Knot Theory, Topology and Mathematical Physics, SUNY Potsdam NY, summer 2002, http://www2.potsdam.edu/mahdavk/abst.html
55. "Cell-complex model of vector calculus & physics in discrete space," W. Schwalm, Semi-plenary invited talk, Workshop on geometric integration theory, conference on Foundations of Computational Mathematics, Minneapolis (2002). http://www.damtp.cam.ac.uk/user/na/FoCM/FoCM02
56. "Elliptic functions as trigonometry," W. Schwalm, North Central Section, Math. Assn. Am.,

Moorhead MN, October 25-26, 2002.

57. "Discrete analogs of 2D flow," W. Schwalm and M. Schwalm, March 2003 meeting, Americal Physical Society, Austin TX, Bul. Am. Phys. Soc. Vol. 47, p. 11441, abstract C1.084.
58. "Bessel functions arising in lattice vibration problems," W. Schwalm, Math. Assn. of America, S. Paul MN, April 25-26, 2003.
59. "Local Density of States for nanoscale graphene fragments," W. Schwalm, M. Schwalm, J. Wagner, Physics Univ. N. Dakota, and B. Jaing ME, ND St. Univ, Poster to March Meeting, American Physical Society, Montreal, Canada, Abstract C1.158, Bul. Am. Phys. Soc. **48** 223 (2004).
60. "Using scale invariance," W. Schwalm, Mathematical Association of America meeting, Sioux Falls ND, Oct. 25, 2003.
61. "Harmonic and symmetric polynomials," C. Nitschke and W. Schwalm, Mathematical Association of America, Mathematical Association of America, North Central Section, Winona St. Univ., Winona MN, April 24, 2004.
62. "Evaluation of certain integrals over the unit sphere," W. Schwalm, Mathematical Association of America, Winona St. Univ, Winona MN, April 24, 2004.
63. "Working backward to construct DEs with known symmetries," Mathematical Associaction of America, Fargo, Oct. 24, 2004.
64. "Hierarchical lattice models with evidence of metallic conductance: Implications for localization," B. Moritz and W. Schwalm, Amer. Phys. Soc. March meeting, Los Angeles, 9:00 am March 21, 2005.
65. "Making change and crossing bridges," W. Schwalm, Mathematical Association of America, North Central Section, Sioux Falls SD, April 24, 2005,
66. "Things hidden in Maxwell's equations," W. Schwalm and M. Schwalm, American Association of Physics Teachers, national meeting, summer 2005, Salt Lake City UT,
67. "Differential equations satisfied by elliptic functions," W. Schwalm, Mathematical Association of America, North Central Section meeting, Univ. Minnesota, Morris MN, Oct 28, 2006,
68. "Pedigogical importance of the Cartesian component notation," Gordon Research Conference on research and teaching in electromagnetism, W. Schwalm, presented Gordon Research Conference on electromagnetism research and teaching, Mount Holyoke College, MA 06/11/2006 - 06/16/2006.
69. "Good and bad ways to use symbolic computing," W. Schwalm and M. Schwalm, presented National Meeting of the Am. Assn. Phys. Teachers (AAPT) Syracuse University, Syracuse NY, 07/22/06-07/26/06.
70. "Developing fluid concepts and the fluid/electric circuit analogy," (poster) W. Schwalm, M. Schwalm and D. Smith, AAPT Syracuse University, ibid. 07/22/06-07/26/06.
71. "Reorganizing traditional introductory physics laboratory exercises: MPSL with video capture," M. Schwalm and D. DeMuth (U. Minnesota Crookston) W. Schwalm and G. Johnson (UND), (poster) AAPT Syracuse University, op. cit. 07/22/06-07/26/06.
72. "Singular solutions of nonlinear differential equations," W. Schwalm Mathematical Association of America, April 13-14, 2007, Saint Paul MN.

73. "Light-clock derivation of Lorentz contraction and time dilation formulas," W. Schwalm Mathematical Association of America, Oct. 20, 2007, Bemidiji MN.

University public lecture series:

1. Public lecture series: RELATIVITY, four lectures on Einstein's special theory of relativity, Oct.—Nov. 2005, W. Schwalm and T. Young, Leonard Hall 100.
   a. Oct 11 *Special Theory of Relativity* Strange consequences of relativity of motion, simultaneity, time dilation, length contraction.
   b. Oct 18 *Geometry of Space and Time* Four-dimensional world, universal speed limit, $E=mc^2$, twin paradox, how relativity preserves causality
   c. Nov 1 *General Relativity & Gravity Curvature* of spacetime, aging in a gravitational field, gravitational lensing
   d. Nov 8 *Black Holes* Creation and anatomy of black holes, gravitational waves, cosmology and the large-scale structure of space and time

Summer course in physics content for teachers:

1. Two-week, laboratory based course in physics content for high-school science teachers, summer 2007, with J. Brooks and M. Schwalm.

References:

1. Dr. Massimiliano Giona, Center for Disordered and Fractal Structure in Chemical Engineering, Univ. of Rome "La Sapienza," It, email: max@giona2.ing.uniroma1.it.
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3. Professor Yoshimasa Nakamura, Physics and Applied Mathematics, Kyoto University, Japan