Summary of Curriculum Vitae

(Account of Scientific Activities)

M. W. Evans

PERSONAL INFORMATION

Date of Birth: 26 May, 1950
Place of Birth: Craigcefnparc, South Wales, U.K.
Nationality: Citizen of Great Britain, Permanent Resident of the U.S.A.
Marital Status: Married

EDUCATION & EDUCATION PRIZES

D. Sc. 1977 University College of Wales at Aberystwyth, (D.Sc. stands for Doctor of Science. In the British system, the D.Sc is awarded for contributions to Scientific Knowledge judged to be 'substantial'.)

Ph. D. 1974 University College of Wales at Aberystwyth
1972 French Government Travel Bursary and Scholarship, Nice, Nancy and Paris.

B.Sc. 1971 University College of Wales at Aberystwyth
1971 Dr. Samuel Williams post-graduate studentship for best undergraduate finals results. Graduated summa cum laude, top first of the class of 1971.
1969 Mathews Prize for best first year undergraduate.

Pontardawe Grammar School (1961 - 1968)
1966 School Prize for best "O level" results.

Craigcefnparc Primary School (1954 - 1961)

MEDALS, AWARDS, & HONORS

1993: Sigma Pi Sigma, honorary member
1989: Author Recognition, I.B.M. Data Systems Division. Kingston, NY
1989: Honorary Senior Research Fellow, University of London.
1987: Honorary Research Fellow, University of Lancaster, Great Britain
1980: Royal Society of Chemistry Meldola Medal
1979: Royal Society of Chemistry Harrison Memorial Prize

COMPETITIVE ACADEMIC FELLOWSHIPS

1991: Leverhulme Trust Research Fellowship, London
1990: Swiss NSF Fellow and Guest of the University of Zurich.
1985: Leverhulme Trust Research Fellowship, London
University of Wales Pilcher Senior Fellowship, Swansea.
Not Taken Up:
- I.B.M. Res. Fellowship, U. of Newcastle upon Tyne.
- Alexander von Humboldt Foundation Scholarship.
1983: University Fellowship, University College of North Wales, Bangor, Wales
Not Taken Up:
- University Fellowship, University College of Swansea, Wales
1978: Science and Engineering Research Council Advanced Fellowship, United Kingdom of Great Britain
1976: University College, London U.K. Ramsay Memorial Fellowship.
1975: Junior Research Fellowship of Wolfson College, Oxford University, U.K. of Great Britain.
1974: Science Research Council Post Doctoral Fellowship, U.K. of Great Britian.
Not Taken Up:
- National Research Council of Canada Post Doctoral Fellowship.
- Imperial Chem. Industries European Post Doctoral Fellowship.

POSTDOCTORAL, RESEARCH & ACADEMIC POSITIONS

1996-present	Honorary Praesidium Member and Professor, Alpha Foundation, Institute of Physics, Budapest, Hungary
1995-1996	Visiting Professor of Physics at Indian Statistical Institute, Calcutta, India
1992-1994	Professor of Physics, University of North Carolina, Charlotte, NC 28223, U.S.A.
1991-1992	Senior Visiting Research Associate, Materials Research Laboratory, The Pennsylvania State University, University Park, PA 16802
1990-1991	Senior Visiting Fellow and Guest of the University of Zurich, funded by the Swiss National Science Foundation for computer simulation of novel non-linear optical effects in cooperation with ETH, Zurich.
1990	Visiting Scientist, Cornell University
1988-1989	Academic Visitor & Consultant, I.B.M., Data Systems Division
1988-1990	Senior Research Fellow (Honoris Causa), The University of London
1987-1988	Research Fellow (Honoris Causa), University of Lancaster
1986-1987	I.B.M. Visiting Professor, Data Systems Division, Kingston, New York
1985-1986	University of Wales Pilcher Senior Fellow, U. C. Swansea
1984,1985	Director of Nuffield Foundation Summer Schools.
1983-1985	University of Wales Fellow, University College of North Wales, Bangor, Wales
1983-1985	Tutor in Physics, University College of North Wales, Bangor, Wales
1978-1983	Science and Engineering Council Advanced Fellow, equivalent to a lectureship. This included supervision of post doctoral students. University College of Wales, Aberystwyth, Wales
1976-1978	The British Ramsay Memorial Fellow, University College London,
1974-1976	Science Research Council Fellow and Junior Research Fellow, Wolfson College, Oxford, 1974 to 1976.
1972-1973	Demonstrator in Chemistry., and Tutor, University College of Wales, Aberystwyth, Wales

ADMINISTRATIVE & EDITORIAL POSTS

1993	Appointed to Editorial Board, *Journal of Molecular Liquids*
1992	Series Editor, *Contemporary Chemical Physics*, World Scientific
1991	Appointed Advisory Chemist and Member of the Advisory Board of World Scientific Publishing.
1989	Appointed Consultant Editor, *Journal of Molecular Liquids*.
1980-1984	First Scientific Coordinator and Steering Committee Member of the European Molecular Liquids Group
1979-1982	Royal Society of Chemistry, Thermodynamics and Statistical Mechanics Sub Group.
1979-1982	Committee Member of Science & Engineering Research Council, Collaborative Computational Project 5.
Ongoing	Occasional advisory role, Plaid Cymru Science and Technology.

SHORT SUMMARY OF SOURCES OF FUNDING

- Science and Engineering Research Council, U.K. of Great Britain
- Nuffield Foundation, Regents Park, London, U.K. of Great Britain
- The Leverhulme Trust, London, U.K. of Great Britain
- National Physical Laboratory, London, U.K. of Great Britain
- British Telecom, London, U.K. of Great Britain
- Royal Society of London, U.K. of Great Britain
- European Economic Community Directorate XIII (ESPRIT) and XII (SCIENCE). Brussels
- International Business Machines Incorporated, U.S.A..
- U.S. and Swiss National Science Foundations

OUTSIDE INTERESTS

Poetry, (Published poet in English and Welsh languages), Music, Landscape Photography, Running

VIDEO ANIMATIONS

1989: At I.B.M. Kingston, New York, Clementi Organisation

Animation of Molecular Dynamics by M. W. Evans, I.B.M. (1987), available on a standard video cassette from Dept. 48B/428, Kingston, New York, 12401, U.S.A. Contains three dimensional animation with commentary of molecular dynamics and field effects in various systems. In cooperation with Bill Luken, Michele Re, and Steve Chin.

1990: At Cornell University Theory Center, Visualisation Unit

Animation of molecular dynamics with Chris Pelkie using "Wavefront" software, with narration.

BOOK PUBLICATIONS

(1) M. W. Evans, G. J. Evans, W. T. Coffey and P. Grigolini, *Molecular Dynamics and the Theory of Broad Band Spectroscopy* (John Wiley and Sons: New York, N.Y.) 1982. 866 pp. [publication 108 in complete list], ISBN 0-471-05977-3.

(2a) W.T. Coffey, M. W. Evans, and P. Grigolini *Molecular Diffusion & Spectra* (John Wily and Sons: New York, N.Y) 1984, 378 pp. [publication 161 in complete list], ISBN 0-471-87539-2.

(2b) W. T. Coffey, M. W. Evans, and P. Grigolini, *Molecular Diffusion and Spectra* (Mir: Moscow, USSR, 1987), 379pp (Russian translation of Ref. 2a) [publication 225 in complete list].

(3) M. W. Evans, P. Grigolini, and G. Pastori-Parravicini, eds. *Memory Function Approaches to Stochastic Problems in Condensed Matter* (John Wiley and Sons: New York, N.Y.) 1985, 556pp. [publication 176 in complete list], ISBN 0-471-80482-7.

(4) M. W. Evans, ed., *Dynamical Processes in Condensed Matter*, Vol. 63 of *Advances in Chemical Physics*, I. Prigogine and S. A. Rice, eds. (John Wiley and Sons: New York, 1985). 850 pp. [publication 177 in complete list], ISBN 0-471-80778-8.

(5) M. W. Evans, "Simulation and Symmetry in Molecular Dynamics and Spectroscopy," Vol. 81 of *Advances in Chemical Physics* I. Prigogine and S. A. Rice eds., (John Wiley & Sons, Inc., New York, 1992), pp. 361-702, 450 refs., [publication 352 in complete list], ISBN 0-471-54570-8.

(6) M. W. Evans and S. Kielich, eds. *Modern Nonlinear Optics*, Vol. 85(1) of *Advances in Chemical Physics*, (Wiley Interscience, New York, 1993), ISBN 0-471-17002-X.

(7) M. W. Evans and S. Kielich, eds. *Modern Nonlinear Optics*, Vol. 85(2) of *Advances in Chemical Physics*, I. Prigogine and S. A. Rice, eds., (Wiley Interscience, New York, 1993), ISBN 0-471-16994-3.

(8) M. W. Evans and S. Kielich, eds., *Modern Nonlinear Optics*, Vol. 85(3) of *Advances in Chemical Physics*, I. Prigogine and S. A. Rice, eds., (Wiley Interscience, New York, 1993), ISBN 0-471-16997-8.

- ***The Enigmatic Photon Series***, published in the Fundamental Theories of Physics series by Kluwer Academic Publishers, series editor A. Van Der Merwe

(1) M. W. Evans and J.-P. Vigier, *The Enigmatic Photon, Volume 1: The Field* $\boldsymbol{B}^{(3)}$ (Kluwer Academic Publishers, Dordrecht, 1994), Vol. 64, ISBN 0-7923-3049-8.

(2) M. W. Evans and J.-P. Vigier, *The Enigmatic Photon, Volume 2: Non-Abelian Electrodynamics* (Kluwer Academic Publishers, Dordrecht, 1995), Vol. 68, ISBN 0-7923-3288-1.

(3) M. W. Evans, J.-P. Vigier, S. Roy and S. Jeffers, *The Enigmatic Photon, Volume 3: Theory and Practice of the* $\boldsymbol{B}^{(3)}$ *Field*, (Kluwer Academic Publishers, Dordrecht, 1996), Vol. 77, ISBN 0-7923-4044-2.

(4) M. W. Evans, J.-P. Vigier, S. Roy and G. Hunter (eds.), *The Enigmatic Photon, Volume 4: New Directions* (Kluwer Academic Publishers, Dordrecht, 1997), in press.

(5) M. W. Evans and J.-P. Vigier , *Collected Papers*, in preparation.

- ***Contemporary Chemical Physics series***, published by World Scientific Publishing Company, Series Editor: M. W. Evans, Associate Editors: S. Jeffers, D. Leporini, J. K. Moscicki, L. Pozhar, S. Roy.

(1) M. W. Evans *The Photon's Magnetic Field* in *Contemporary Chemical Physics*, M. W. Evans, ed., (World Scientific, Singapore, 1993) with accompanying animation cassette by M. W. Evans and C. R. Pelkie, Vol. 1, ISBN 981-02-1265-8, 256pp..

(2) A. Lakhtakia, *Beltrami Fields in Chiral Media* (World Scientific, Singapore, 1994), Vol. 2, ISBN 981-02-1403-0, 535 pp.

(3) P. Grigolini, *Quantum Mechanical Irreversibility and Measurement* (World Scientific, Singapore, 1993), Vol. 3, ISBN 981-02-1317-4, 406 pp.

(4) M. W. Evans and A. A. Hasanein *The Photomagneton in Quantum Field Theory* (World Scientific, Singapore, 1994), Vol. 4, ISBN 981-02-1664-5, 358pp.

(5) A. A. Hasanein and M. W. Evans, *Computational Methods in Quantum Chemistry* (World Scientific, Singapore, 1996), Vol. 5, ISBN 981-02-2611-X, 241 pp.

(6) L. A. Pozhar, *Transport Theory of Inhomogeneous Fluids* (World Scientific, Singapore, 1994), Vol. 6, ISBN 981-02-1750-1, 170 pp.
(7) J.-L. Dejardin, "Dynamic Kerr Effect, *The Use and Limits of the Smoluchowski Equation and Nonlinear Inertial Responses* (World Scientific, Singapore, 1995), Vol. 7, ISBN 981-02-1910-5, 229 pp.
(8) V. Gaiduk, "Theory of Diffusion" (or similar), Vol. 8, in prep.
(9) G. W. Robinson, S.-B. Zhu, S. Singh and M. W. Evans, *Water in Biology, Chemistry and Physics, Experimental Overviews and Computational Methodologies*, (World Scientific, Singapore, 1996), Vol. 9, ISBN 981-02-2451-6, 509 pp., 2028 refs.
(10) W. T. Coffey, Yu P. Kalmykov and J. T. Waldron, *The Langevin Equation* (World Scientific, Singapore, 1996), Vol.10, ISBN 981-02-1651-3, 413 pp.
(11) M. Giordano, D. Leporini and M. P. Tois, *Non equilibrium phenomena in supercooled fluids, glasses and amorphous materials* (World Scientific, Singapore, 1996), ISBN 9981-02-2795-7, 392 pp.
(13) J. R. Lalanne, R. Boisgard, D. Chartier, A. Ducasse, J. Hoarau, M. B. Mauhourat, C. Raballand, J.C. Rayez, C. Rulliere, F. Rivoal, and B. Veyret, *Electronic Structure and Chemical Bonding* (World Scientific, Singapore, 1996) Vol. 13, ISBN 981-02-2665-9, 292 pp.

LIST OF PUBLICATIONS, 1990 - PRESENT

see LIST OF PUBLICATIONS, 1971 - 1989", for publication number 1 through 293.)

1990:

(294) M. W. Evans, "On the Experimental Determination of the Enantiomeric Energy Inequivalence" *Journal of Molecular Liquids* **44(2)**, 73-78 (1990).

(295) M. W. Evans and D. M. Heyes, "New Fluctuation Dissipation Theorems" *Journal of Molecular Liquids* **44(2)**, 107-112 (1990).

(296) M. W. Evans and D. M. Heyes, "Asymmetric Correlation Functions in A Sheared Ensemble, Consequences for Langevin Theory" *Journal of Molecular Liquids* **44(2)**, 113-118 (1990).

(297) M. W. Evans and D. M. Heyes, "Group Theory and the Diffusions of Molecules, Dynamics and Structure" *Physica Scripta* **41(3)**, 304-315 (1990).

(298) M. W. Evans, "Group Theoretical Statistical Mechanics of the Evans Effects, Phase Changes Produced by Homogeneous Electric, and Magnetic Fields." *Physica B* **162(3)**, 293-299 (1990). (Regular paper).

(299) M. W. Evans and D. M. Heyes, "Correlation Functions in Non-Newtonian Couette Flow. A Group Theory and Molecular Dynamics Approach" *Journal of the Chemical Society, Faraday Transactions* **86(7)**, 1041-9 (1990).

(300) M. W. Evans, "Chirality of Field Induced Natural and Magnetic Optical Activity." *Physics Letters A* **146(4)**, 185-9 (1990).

(301) M. W. Evans, "Symmetry of Ensemble Averages in Smectic Liquid Crystals." *Molecular Physics* **71(1)**, 193-205 (1990).

(302) M. W. Evans, "Far Infra red Circular Dichroism and Molecular Dynamics." *Journal of Molecular Liquids* **47**, 109-119 (1990).

(303) M. W. Evans and D. M. Heyes, "The Group Theory of Shear Induced Pair Radical Distribution Functions in Atomic Liquids" *Physica Scripta* **42(1)**, 96-9 (1990).

(304) M. W. Evans and D. M. Heyes, "Combined Shear and Elongational Flow by non-Equilibrium Molecular Dynamics" *Molecular Physics* **69(2)**, 241-263 (1990).

(305) M. W. Evans and D. M. Heyes, "Simulation and Symmetry of Simple and Complex Flows" in *Microscopic Simulation of Complex Flows* M. Marechal, ed., NATO ASI Series, Series B, Vol. 236 (Plenum Press: New York, NY, 1990), pp. 85-98.

(306) M. W. Evans, "New Non-Linear Optical Effects: Application of Group Theoretical Statistical Mechanics." *Spectrochimica Acta Part A* **46A(10)**, 1475-85 (1990).

(307) M. W. Evans and D. M. Heyes, "Collective Correlation Functions in Shear Flow, A non-Equilibrium Molecular Dynamics and Group Theory Statistical Mechanics Treatment" *Molecular Simulation* **4**, 399-408 (1990).

(308) M. W. Evans and D. M. Heyes, "Transient Ensemble Averages in non-Newtonian Flow, Symmetry and Simulation" *Physical Review B* **42(7)**, 4363-69 (1990).

(309) M. W. Evans, "On the Isolation of Possible Artifacts due to Cubic Periodic Boundary Conditions." *Computer Physics Communications* **59(3)**, 495-497 (1990).

(310) M. W. Evans, "Applications of Group Theoretical Statistical Mechanics, Interaction of Electromagnetic Fields with Molecular Ensembles." *Physics Review A* **41(9)**, 4601-7 (1990).

(311) M. W. Evans, "New Field Induced Axial and Circular Birefringence Effects." *Physical Review Letters* **64**, 2909-12 (1990).

(312) M. W. Evans, "Non-Linear Optical Rotatory Dispersion: Application of Group Theoretical Statistical Mechanics." *Journal of Modern Optics* **37**, 1655-60 (1990).

(313) M. W. Evans, "New Non-Linear Circular Birefringence Effects of the Electromagnetic Field." *Physics Letters A* **147(7)**, 364-8 (1990).

(314) M. W. Evans, "Multi-Electrode Dielectric Spectroscopy." *Chemical Physics* **143(2)**, 163-70 (1990).

(315) M. W. Evans, "Shear Induced Asymmetric Cross-Correlation Functions in Liquid Water : A Computer Simulation." *Physics Letters A* **149(5-6)**, 328-30 (1990).

(316) M. W. Evans, "Axial Birefringence due to Intense Electromagnetic Fields: Electric and Magnetic Rectification." *Optics Letters* **15(15)**, 836-8 (1990).

(317) M. W. Evans, "Axial Birefringence due to Electromagnetic Fields: Spin Chiral Effects." *Physics Letters A* **146(9)**, 475-478 (1990).

(318) M. W. Evans and G. Wagnière, "Frequency-Dependent Electric Polarization due to Optical Rectification: Computer Simulation and Semiclassical Theory" *Physical Review A: General Physics* **42(11)**, 6732-6736, (1990).

(319) M. W. Evans, "Axial and Circular Birefringence due to Static Electric and Magnetic Field Combinations." *Journal of Chemical Physics* **93(9)**, 2328-31 (1990).

(320) M. W. Evans, "Pump Laser Induced Atomic and Molecular Angular Momentum; Some Spectral Effects." *Journal of Molecular Spectroscopy* **143(2)**, 327-35 (1990).

1991:

(321) M. W. Evans, "The Violation of Parity and Reversality in Molecular Ensembles: Field Induced Circular and Axial Birefringence." *Physica B* **168**, 9-31 (1991).

(322) M. W. Evans, "Relativistic Theory of Polarisation and Magnetization due to an Electromagnetic Field. Part 1: The Velocity Dependence of Optical Rotatory Dispersion." *Journal of Modern Optics* **38(2)**, 299-304, (1991).

(323) M. W. Evans, "The Role of Net Angular Momentum in Pump Probe Spectroscopy: Absorption, Refringence, Scattering, and Nuclear Resonance." *Journal of Molecular Spectroscopy* **146**, 351-368 (1991).

(324) M. W. Evans, "The Effect of Orthogonal Electric Fields on the Molecular Dynamics of Liquid Water: Testing Principle Three of Group Theoretical Statistical Mechanics." *Journal of Molecular Liquids* **48**, 1-7 (1991).

(325) M. W. Evans, "Shear Induced Dipole Relaxation, Far Infra red Absorption and Depolarised Light Scattering." *Journal of Molecular Liquids* **47**, 203-209 (1991).

(326) M. W. Evans and D. M. Heyes, "Simulation and Symmetry of Shear and Elongational Flow" *Comp. Phys. Comm.* Thematic Issue, invited review, **62**, 249-266 (1991).

(327) M. W. Evans and D. M. Heyes, "Group Theory Statistical Mechanics and Simulation Studies of Electrorheology" *Journal of Physical Chemistry* **95**, 5287-5292 (1991).

(328) M. W. Evans, "Correlation Between Rotation and Translation in Chiral Ensembles: Comparison of Molecule Fixed and Laboratory Frame Time Correlation Functions." *Journal of Molecular Liquids* **48**, 9-16 (1991).

(329) M. W. Evans, "The Electric Field Equivalent of the Faraday Effect: A Computer Simulation." invited paper in *Journal of Molecular Liquids* Klages honour issue, **49**, 29-36 (1991).

(330) M. W. Evans, "The Breakdown of Microscopic Reversibility in a Chiral Ensemble in a Time Varying Enantiomorphous Influence: a Computer Simulation." *Journal of Molecular Liquids* **50**, 13-20 (1991).

(331) M. W. Evans, "The Spin Polarisability of the Electron." *Journal of Molecular Liquids* **48**, 77-84 (1991).

(332) M. W. Evans, "Nuclear Electromagnetic Resonance Spectroscopy." *Molecular Physics* **72**, 1193-1201 (1991).

(333) M. W. Evans, "Pump Laser Induced Net Angular Momentum: Spin Polarisability, Induced Electric Polarisation, and the Inverse Faraday Effect." *Journal of Molecular Liquids* **48**, 61-76 (1991).

(334) M. W. Evans, "Comments on Reply by Eu on Co-Rotating Frames." *Journal of Molecular Liquids* **47**, 231-234 (1991).

(335) M. W. Evans, "Transient and Steady State Properties of the Inverse Faraday Effect - Simulation and Theory." *Modern Physics Letter* **5**, 1533-1542 (1991).

(336) M. W. Evans, "Optical Phase Conjugation in Nuclear Magnetic Resonance : Laser NMR Spectroscopy." *Journal of Physical Chemistry* **95**, 2256-2260 (1991).

(337) M. W. Evans, "Circular Birefringence and Dichroism due to Shear Stress: Optical Measurement of Non-Newtonian Viscosity", *Chemical Physics* **154**, 193-196 (1991).

(338) M. W. Evans and G. Wagnière, "Frequency Dependent Electric Polarisation due to Optical Rectification: Effect on Infra Red Bandshapes" *Journal of Molecular Liquids* Klages Honour Issue, invited paper, **49**, 17-27 (1991).

(339a) M. W. Evans, "Spectral Splitting due to a Circularly Polarised Pump Laser: Laser Zeeman Spectroscopy." *Modern Physics Letters B* **5**, 1065-1073 (1991).

(339b) ibid, Cornell Theory Center Technical Report, CTC91TR79.

(340) M. W. Evans, "Laser Zeeman and N.M.R. Spectroscopy: Effective Torque and Laser Larmor Precession." *International Journal of Modern Physics B* **5**, 1263-1272 (1991).

(341) M. W. Evans, "Chirality and the Weak Current Interactions in Molecular Spectroscopy : A Symmetry Analysis." *Theochemistry* **82**, 113-118 (1991).

(342) M. W. Evans, "Circular and Uni-Axial Dichroism and Birefringence: The Emergence of NonLinear Optical NMR and ESR." vited review article in *International Journal of Modern Physics B* **5**, 1963-2001, (1991).

(343) M. W. Evans, "Theory & Simulation of Optically Induced Line Shifts in NMR." *Chemical Physics* **157**, 1-24, (1991).

(344) M. W. Evans, "Semi-Classical Theory of Laser-Induced Circular Birefringence, Resonance, and Optical Activity in Scattered Radiation." *Chemical Physics* **150(2)** 197-206, (1991).

(345) M. W. Evans, G. Wagnière, and S. Woźniak, "Molecular Dynamics Computer Simulation of Non-Linear Optical Effects: Electric Polarisation due to Optical Rectification in a Circularly Polarised Laser" *Physica B* **173**, 357-385, (1991).

(346) M. W. Evans, "Optical NMR and ESR." *Journal of Molecular Spectroscopy* **150**, 120-136 (1991).

(347) M. W. Evans, "Molecular Dynamics Computer Simulation of Magnetisation by an Electromagnetic Field." *Physics Letters A* **157**, 383-390, (1991).

(348) M. W. Evans, S. Woźniak, and G. Wagnière, "Generalized Langevin Kielich Functions for the Optical Kerr Effect in Liquid Water: Theory and Simulation" *Physica B* **175**, 412-34, (1991).

(349) M. W. Evans, "Computer Simulation of the Optical Kerr Effect in Liquid Water." *Physics Letters A* **158**, 216-226 (1991).

(350) M. W. Evans, "Field Applied (FMD) Computer Simulation of the Frequency Doubled Optical Stark Effect" *Zeitschrift für Physik B Condensed Matter* **85**, 135-143 (1991).

(351) M. W. Evans, "Optical NMR", *Optics and Photonics News* **2**, No. 12, 42 (1991).

1992:

(352) M. W. Evans, "Simulation and Symmetry in Molecular Dynamics and Spectroscopy," Vol. 81 of *Advances in Chemical Physics* I. Prigogine and S. A. Rice eds., (John Wiley & Sons, Inc., New York, 1992), pp. 361-702.

(353) S. Wozniak, M. W. Evans, and G. Wagniere, "Optically-Induced Static Magnetization near Optical Resonances in Molecular Systems. I. Inverse Faraday Effect (IFE)" *Mol. Phys*. **75**, 81-98, (1992).

(354) M. W. Evans, S. Woźniak, and G. Wagnière, "Field applied molecular dynamics (FMD) simulation of the inverse Faraday effect" *Physica B* **176**, 33-53, (1992).

(355) S. Wozniak, M. W. Evans, and G. Wagniere, "Optically-Induced Static Magnetization Near Optical Resonances in Molecular Systems. II. Inverse Magneto-chiral Birefringence (IMCHB)" *Mol. Phys*. **75**, 99-125, (1992).

(356) M. W. Evans, "Orientational Anisotropy Induced by the Interaction of a Laser with a Permanent Electric Dipole: An FMD Simulation." *Journal of Molecular Liquids* **51**, 245-259, (1992).

(357) M. W. Evans, "Optical NMR and ESR - Dipole Dipole and Fermi Contact Interactions." *Physica B* **176**, 254-262 (1992).

(358) M. W. Evans, "Computer Simulation of Circular Dichroism and Optical Rotatory Dispersion." *Journal of Molecular Liquids* **51**, 231-244 (1992)

(359) M. W. Evans and Chris Pelkie, "Optical NMR Theory, Simulation and Animation." *J. Opt. Soc. Am., B-Opt Physics* **9(7)**, 1020-1029, (1992).

(360) ibid., in *Scientific Excellence in Supercomputing, The IBM 1990 Contest Prize Papers*, Volume 1, Keith R. Billingsley , Hilton U. Brown III & Ed Derohanes eds. (Athens, Georgia: The Baldwin Press, The University of Georgia) 107-134, (1992).

(361a) M. W. Evans, S. Wozniak and G. Wagniere, "Field Applied Molecular Dynamics (FMD) Computer Simulation of Circular Dichroism and Optical Rotatory Dispersion: The Discovery by FMD of Bi-Axial Rosenfeld Birefringence." *Physica B* **179**, 133-156, (1992).

(361b) ibid. Cornell Theory Center Technical Report, CTC91TR78

(362) M. W. Evans, S. Wozniak, and G. Wagniere, "The Far Infra Red Molecular Dynamics of Circular Dichroism and Optical Rotatory Dispersion." Cornell Theory Center Technical Report, CTC91TR77

(363) M. W. Evans, "Electrodynamics of a Rotating Body, Relativistic Theory of Circular and Axial Birefringence" *Int. J. Modern Phys*. B **18**, 3043-3056 (1992).

(364) M. W. Evans, "The Coupling of Three Angular Momenta in the Optical NMR and ESR of Atoms, Quantum Theory." *Physica B* **179**, 342-348, (1992).
(365) M. W. Evans, "Laser Enhanced Optical NMR Spectroscopy, The Role of Atomic Hyperpolarisability." *Physica B* **179**, 157-170, (1992).
(366) M. W. Evans, "The Light Magnet, Coupling of Electronic and Nuclear Angular Momenta in Optical NMR and ESR in Atoms: Quantum Theory." *Journal of Molecular Spectroscopy* **154**, 1-11 (1992).
(367) M. W. Evans, "Quantum Theory of Optical NMR and ESR in Atoms." *Physica B* **179**, 237-248, (1992).
(368) M. W. Evans and S. Wozniak, "Frequency Doubled Biaxial Anisotropy due to the Rosenfeld Tensor: An FMD computer Simulation." *Physica B* **179**, 6-18 (1992).
(369) M. W. Evans, "Quantum Optics in NMR Spectroscopy." *Modern Physics Letters* **6**, No. 20, 1237-1244 (1992).
(370) M. W. Evans, "Field Applied Molecular Dynamics (FMD) Simulation of Optical Frequency Doubling in a Chiral Molecular Ensemble." *Physica B* **182**, 118-136 (1992).
(371) M. W. Evans, S. Wozniak and G. Wagniere, "The Far Infra-red Molecular Dynamics of Circular Dichroism and Optical Rotatory Dispersion." *Phys. Lett. A* **171**, 355-359 (1992).
(372) M. W. Evans, "The Elementary Static Magnetic Field of the Photon." *Physica B* **182**, 227-236 (1992); also in Ref. 378, pp. 112—126; also in Ref. 374, pp. 57—88.
(373) M. W. Evans, "On the Experimental Measurement of the Photon's Fundamental Static Magnetic Field Operator B : The Optical Zeeman Effect in Atoms." *Physica B* **182**, 237-243 (1992); also in Ref. 374, pp. 89—109.
(374) M. W. Evans, *The Photon's Magnetic Field* (World Scientific, Singapore, 1992).
(375) M. W. Evans, "Optical NMR and ESR Spectroscopy - Equivalent Magnetic Flux Density of the Circularly Polarised Laser." in Ref. 374, pp. 1—36.
(376) M. W. Evans, "The Magnetostatic Field of a Laser: Development and Classical Interpretation." in Ref. 374, pp. 37—56.
(377) M. W. Evans, "The Photon's Magnetostatic Flux Quantum $\mathbf{B}_{II}$: On the Absence of Faraday Induction", in Ref. 374, pp. 171—182.

1993:

(378) M. W. Evans and S. Kielich, eds., *Modern Nonlinear Optics* Vol. 85(1), of *Advances in Chemical Physics* I. Prigogine and S. A. Rice, eds., (Wiley Interscience, New York, 1993).
(379) M. W. Evans and S. Kielich, eds., *Modern Nonlinear Optics*, Vol. 85(2), of *Advances in Chemical Physics*, I. Prigogine and S. A. Rice, eds., (Wiley Interscience, New York, 1993).
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PLENARY LECTURES

- Gordon Conference.
- Dielectric Society.
- European Molecular Liquids Group.
- Royal Society of Chemistry Discussions and Symposia.
- Royal Society of Chemistry Statistical Mechanics & Thermodynamics Sub Group
- Science & Engineering Research Council, Collaborative Computational Project
- Setore Proprieta Collective Meetings.
- French Centre National du Recherche Scientifique Meetings.
- Italian Consilio Nazionale dei Ricerche Meetings.
- E.U.C.M.O.S. Meetings.
- Lectures at the above and most of the U.K. Universities, including:
  - the Meldola Lecture at Oxford,
  - plenaries at; (1) Cambridge, (2) London, (3) Bristol, (4) Lancaster, (5) Glasgow, (6) Trinity College, Dublin, (7) Leicester, (8) Southampton, (9) Hull, (10) Keele, (11) St. Andrew's, (12) Newcastle upon Tyne, (13) Swansea, (14) Bangor, (15) King's College, London, and (17) in Industrial Centres.

SUMMARY OF SCIENTIFIC CONTRIBUTIONS : M. W. Evans and Co-Workers.

(1) About four hundred and thirty publications to date (May, 1993), including monographs, reviews, papers and letters in the international scientific journals.

(2) Planning of the Delta Project of the European Molecular Liquids Group. This work applied spectroscopy, simulation and analytical theory to the study of molecular diffusion processes in a variety of new materials, including liquid crystals, molecular liquids, glasses, rotator phases and compressed gases.

(3) Development of the far infra red region as an incisive investigative technique for diffusion processes in condensed matter, summarised in detail in "Molecular Dynamics", Evans et al.

(4) Development of the analytical theory and computer simulation of diffusion processes to describe data from the far infra red and lower frequency regions on a variety of new materials.

(5) Exploration and definition of the limits of conventional diffusion theory with the theory of memory functions and computer simulation.

(6) The development of the principles of group theoretical statistical mechanics and their application to non Newtonian rheology. Discovery of novel flow induced dissymmetric time cross correlation functions by computer simulation and the application of symmetry principles for the prediction of new rheological phenomena in fluid materials.

(7) Discovery using the D symmetries of g.t.s.m. of novel non-linear optical phenomena, including i) spin-chiral dichroism; ii) novel laser induced polarisation and magnetisation effects; iii) novel laser induced forward backward birefringence and dichroism; iv) the optical Zeeman effect; v) optical or "laser" NMR/ESR. Supercomputer simulation and animation of these effects at the Cornell Theory Center. Theory and experimental development of optical NMR spectroscopy.

(8) Development of optically induced magnetic effects due to the conjugate product and longitudinal equivalent magnetic field of the photon.

(9) Investigations of the role of chirality in quantum mechanics and spectroscopy, using D symmetry analysis.

(10) Development of computer simulation methods for the investigation of nonlinear optical effects, culminating in "field applied molecular dynamics" (FMD).

(11) Theory and development of the optical equivalent of the Bohm-Aharonov effect.

(12) Theory of finite photon mass, with Jean-Pierre Vigier, Univ. Pierre et Marie Curie.

NOTE: For (2) and (3) above, received recognition in the form of two awards of the U.K. Royal Society of Chemistry. International recognition in the form of visiting professorships, plenary lectures, and publication contracts.

DETAILED DESCRIPTION OF SCIENTIFIC CONTRIBUTIONS

1971-1978 Ph.D. and D.Sc. (Early Post-doctoral)

This early period produced about 43 publications, including two Theses and several review articles.

Several lines of research developed from my Ph. D. work under Prof. Mansel Davies, which was primarily concerned with far infra red interferometric investigations of molecular dynamics in liquids, liquid crystals, condensed gases, and rotator phases. I produced the first far infra red spectrum of a liquid crystal in 1972 / 1973, and applied to its interpretation the theory of the itinerant oscillator. This produced several insights to Brownian dynamics in a potential well as applied to the far infra red and lower frequency regions. Other activities of this time included the measurement of the quadrupole moment of compressed gases using collision induced absorption; the discovery using this technique of the hexadecapole moment of oxygen, and its measurement; the discovery and measurement of quantised rotation in the liquid state; introduction of the Mori formalism to the far infra red; the measurement of some of the higher multipole moments of dipolar molecules; characterisation of water dynamics free of H bonding; generalisation of the itinerant oscillator theory in terms of Mori formalism; early development of computer simulation at Oxford, and its application to the far infra red.

I was awarded the Ph. D. degree of the University of Wales in 1974 and its D. Sc. degree in 1977.

1978-1983: S.E.R.C. Advanced Fellowship

About 130 papers and books were produced in this period by a group which I established and led under the terms of the Fellowship.

Experimental Results.

(1) A large body of data was collected by a combination of far infra red interferometry and submillimetre laser spectroscopy and a systematic classification scheme established for power absorption profiles of molecular liquids, supercooled liquids and glasses, associated liquids, proteins and enzymes, chiral liquids and disordered solids. Among the significant results obtained was the first far infra red spectrum of bacteriorhodopsin in an attempt at detecting the Frohlich giant oscillation frequencies. The work on molecular liquids led to the unification, experimentally and theoretically, of the absorption and dispersion spectra from static to THz frequencies, a range of fourteen frequency decades.

(2) Laser induced fluorescence in vapours was investigated with a spectrometer which we built using an Apollo Instruments laser system. Fluorescence was studied at very high resolution with a view to looking at time resolved studies of intermolecular collisions. A Nuffield Foundation grant was awarded to extend the system for infra red / radio frequency double resonance and inverse Lamb dip spectroscopy.

(3) A range of data was collected in rotator phases, with a view to establishing the rototranslational nature of the fundamental molecular dynamics. These far infra red data were interpreted with computer simulation algorithms developed inside the group for the same systems. The results showed that rotation and translation are strongly coupled, a new and fundamental characteristic of "rotator" phases in general.

(4) Submillimetre and dielectric spectroscopy of liquid crystals isolated some novel features in several conditions, including the supercooled and aligned nematogenic.

Theoretical Results

(1) The theoretical work of this period enveloped the theory of the itinerant oscillator, tested in detail with far infra red and lower frequency data; computer simulation; the interface with hydrodynamics; the theory of power reflection; and ab initio studies of the intermolecular pair potential. All this was forged into the "Delta" pilot project of the European Molecular Liquids Group. Computer simulation was extended rapidly from simple diatomics to medium sized molecules, using a variety of new algorithms. The interrelation between the fundamental molecular modes of diffusion was established in a series of papers dealing with the statistical correlation between rotation and translation using the molecule fixed frame of reference.

(2) The theory of the itinerant oscillator was developed to include different model potentials, including the first attempt at using a non linear (cosine) potential. The itinerant oscillator was classified as a sub theory of Mori form, and by linking empirically the molecular mean square torque with the volume of rotation, a classification scheme was developed in terms of empirical coefficients.

(3) Reduced model theory was developed in cooperation with Grigolini and his Pisa group, thus providing a formal and rigorous means of numerically approximating the fundamental equations of motion by projecting into Hilbert sub spaces, forming different types of continued fractions akin to the original Mori formalism of 1965. The framework of reduced model theory was applied in several subject areas in a monograph edited with Grigolini and Pastori, vol. 62 of the "Advances in Chemical Physics" series.

(4) R.M.T. was used to generalise non-linear itinerant oscillator theory with what came to be known as the "Pisa Algorithm".

(5) The "Decoupling Effect", due to competition between an aligning field and thermal motion in a molecular ensemble, was confirmed by computer simulation, using an electric field, proving the inherently non linear nature of the effective potential between diffusing molecules.

(6) Non Markovian and non Gaussian effects were studied in detail with computer simulation, and the phenomenon of fall transient acceleration discovered by simulation and interpreted and explained with reduced model theory. This showed for the first time the existence of an effect capable of providing unambiguous evidence for the non linear nature of diffusion processes, in or out of equilibrium.

(7) Computer simulation was developed rapidly in cooperation with the U.K. Science and Engineering Research Council's Collaborative Computational Project, and a library of algorithms established at the S.E.R.C. Daresbury Laboratory during the European Molecular Liquids Group Delta project, which I planned and coordinated. Simulation was used to solve numerically the fundamental equations of motion and to interpret Zero-THz data on a wide range of systems. Among many successful developments were the reproduction from model pair potentials of the far infra red power absorption spectrum of dipolar liquids; the discovery of fall transient acceleration and decoupling effects in molecular liquids; the characterisation of statistical cross correlation in the molecule fixed frame; the explanation of chiral properties using these cross

correlations; the development of techniques to look at the dynamical effect of applied external fields of arbitrary intensity.

(8) Detailed simulations of spectral data from many sources were carried out for a range of molecular symmetries, exemplified by: dichloromethane, chloroform, bromoform, t butyl chloride, methyl iodide, acetonitrile, acetone, ethyl chloride, and chiral molecules in the liquid, rotator, supercooled, enantiomeric and racemic conditions over a range of temperature. For each case a range of correlation times was computed and compared with experimental data from sources that included far infra red and dielectric spectroscopy, infra red and Raman bandshape analysis; N.M.R. relaxation; light and neutron scattering; and other available sources. This provided, for the first time, a comprehensive appreciation of self consistency among the available experimental sources, a central theme of Project Delta of the European Molecular Liquids Group, (E.M.L.G.).

(9) Some ab initio computations were made to try to develop pair potentials to replace the atom atom form, a method which was later taken up with the IBM Clementi Organisation at Kingston, New York, with Lie, Clementi, and co workers. Among the many novel outcomes of this approach was the discovery that the molecular dynamics of an enantiomer and racemic mixture are differentiated only in terms of time cross correlation functions, providing a fundamentally new explanation which was revealed by computer simulation.

1983-1987:

In these years a further 130 or so articles and books were produced. The scientific emphasis shifted towards computer simulation, and more latterly, towards group theoretical statistical mechanics and non-equilibrium molecular dynamics computer simulation. The following is a brief highlight of some of the developments.

Insights into the fundamental nature of classical molecular diffusion processes using a combination of field effect computer simulation, a technique which I developed in 1982/1983, and analytical theory. In 1984 / 1985 it was demonstrated that an externally applied electric field has the effect of making possible the dynamical cross correlation between molecular rotation and translation direct in the laboratory frame (X, Y, Z). This was a fundamentally new result which affects the theory of molecular diffusion at the basic level. This result turned out to be the first in a series of new insights which has recently culminated in the emergence of "group theoretical statistical mechanics" (g.t.s.m.).

This work extends the limits of diffusion theory, for example itinerant oscillator formalisms, which were the subject of earlier development. Many computer simulations have been used to show conclusively that a set of non vanishing cross correlation functions (c.c.f.'s) exists in frame (X, Y, Z) which conventional theory assumes to have no members. The set exists in all molecular symmetries, including that of the spherical top, which I first demonstrated in 1986 / 1987. The members of this set are selected by Axiom 1, which is a variation on the Neumann (or Curie) Principle, proposed originally in an entirely different context over a hundred years ago. It is a key statement of equilibrium statistical mechanics. Powerful evidence for the role of time c.c.f.'s governed by axiom (3) has emerged as recently as 1988: characteristic

macroscopic phenomena such as convective and structural turbulence in couette flow were traced to the appearance of new c.c.f.'s at the basic, atomic, level. These were induced by shear in couette flow, an external force field which allows the appearance of c.c.f.'s of the same symmetry, but, according to axiom (3), at the fundamental, microscopic level. These c.c.f.'s provided, for the first time, a microscopic explanation for the well known Weissenberg effect, the macroscopically measurable pressure generated in a plane perpendicular to the shearing plane.

Axiom (2) was based on the results of many computer simulations, using the method I developed in about 1981, in cooperation with G. J. Evans, M. Ferrario and the Brussels School. It means essentially that members of the set of non vanishing time c.c.f.'s may appear in frame (x, y, z) but not in frame (X, Y, Z), and that both frames are needed for a complete picture to emerge. The axiom applies to all isotropic condensed matter, and was developed in cooperation with D. H. Whiffen. It has been applied successfully to the results of my computer simulations in an independent test carried out by Whiffen, proving the validity and consistency of both approaches (1988). A combination of simulation with axioms (1) and (2) has made progress far beyond the earlier modelling approach, exemplified by itinerant oscillators and truncated Mori continued fractions.

Axiom (3) is a statement of how externally applied force fields of any kind set up extra ensemble averages in condensed molecular matter. It is based on numerous computer simulations which I carried out in the eighties. These have shown decisively that in the presence of external fields, for example an electric field, or a strain rate tensor, the number of independent c.c.f.'s of all orders is increased at the field-on steady state. This is independent of the applied field strength, but depends on the field symmetry according to axiom (3).

Among the experimental developments of this time was the discovery of the inverse of the Costa-Ribeiro effect by my colleague in the SERC Advanced Fellowship group, Dr. G. J. Evans, which we developed jointly thereafter. This made a significant impression on scientific contemporaries, judging from correspondence received.

1988 to Present

Microrheology

Using non-equilibrium molecular dynamics simulation, the existence of asymmetric time correlation functions was demonstrated at a fundamental level. These appear in response to shear stress and imply the existence of asymmetric correlation functions which are Fourier transforms of observable frequency dependent spectra. For example, shear stress in a dipolar molecular liquid produces asymmetric correlation between orthogonal components of the molecular dipole. This implies shear induced polarisation and frequency dependent complex permittivity which can be used to measure experimentally the response to shear. Other types of shear induced asymmetric correlation functions imply the existence of other types of spectra, for example depolarised light scattering, far infra red power absorption and N.M.R. relaxation. Essentially speaking, we are finding effects that traditional rheology misses. An example is the appearance of heat flux, and consequently thermal conductivity, in response to combined

shear and elongational flow. The heat flux disappears when either type of flow is removed. This was anticipated by group theoretical statistical mechanics and confirmed by non-equilibrium computer simulation. There is now a pressing need to look at these many new effects experimentally. This work was received with significant interest by contemporaries, especially in regard to asymmetric correlation functions that appear to breach the Onsager Casimir Principle.

Group theoretical statistical mechanics has been used to anticipate the existence of a variety of new effects caused by a combination of shear and elongational flow. These phenomena cannot be described on the molecular level with the customary methods used in finite element analysis, and show considerable promise for the computer simulation of materials under shear and elongational stress. This work shows the existence of a hitherto unestablished cross-viscosity between elongation and shear.

The existence under shear of dissymmetric time c.c.f.'s (Evans and Heyes, Mol. Phys., 65, 1441 (1988)) implies shear induced polarisation and light scattering.

Chirality and Non-Linear Optics.

in *Chemical Physics Letters* 152, 33 (1988) I discussed the molecular dynamical origin of chirality and introduced the new phenomenon of "spin-chiral dichroism", or forward backward birefringence due to the non-linear conjugate product of an intense electromagnetic field. Within three years an invitation for a review of this and related effects was received from the International J. Modern Phys., indicating peer interest in a rapidly expanding area. The original work was based on the irreducible D symmetries of the three dimensional rotation-reflection point group used in group theoretical statistical mechanics. D symmetry (g.t.s.m.) considerably sharpens our appreciation of the basics of chirality, and may even provide a way of appreciating the role of the weak force in parity non-conservation, quantum mechanics and spectroscopy.

Chirality has been defined in the context of non-linear optics in letters and papers of 1990, for example in the context of the inverse Faraday effect, which is circular birefringence due to an intense laser. Using the field applied computer simulation methods which I first introduced in 1982/1983 for an applied static electric field, the molecular dynamical nature of several non-linear optical effects has been investigated using statistical analysis (correlation functions) and computer animation. These include the inverse Faraday effect, inverse magnetochiral birefringence, and a novel dynamic polarisation effect recently proposed (Phys. Rev. A, 1990) with Prof. Georges Wagniere, University of Zurich.

The Zeeman Effect, Optical ESR and NMR and Related Magnetizing Effects of Light.

My proposal and systematic theoretical and experimental development of various new magnetizing effects of circularly polarized light near to and far from optical resonance (papers circa 1989 to present), are based on the replacement of static magnetic flux density, used for example to split spectral lines in the conventional Zeeman effect by the conjugate product of an intense laser. One of the many useful practical outcomes of this work is "optical NMR /

ESR", in which a laser beam is used in an ESR or NMR spectrometer (or 2 D Fourier transform spectrometer) to produce site specific spectral effects. I have described the theoretical groundwork of this effect in a series of papers dated 1990/1991, and the effect has been verified experimentally in Science, 255, 1683 (1992).

Optical NMR depends fundamentally on a non-linear optical process, magnetisation by the conjugate product of a circularly polarised laser, and appears ultimately to be of widespread interest, because it combines laser physics and the physics and chemistry of magnetic resonance, two large contemporary fields. I have recently been awarded a Leverhulme Trust Fellowship for the development of ONMR, roughly speaking the equivalent of a Guggenheim Fellowship.

Of basic importance is that the laser induces a shift, analogous to the chemical shift, the latter being the basis of analytical NMR. Therefore the technique is ultimately as useful as conventional NMR in all its current variations.

Similarly, optical ESR, in which the conventional magnetic field is augmented by a pulsed, circularly polarised, and tuned laser field, is useful for analytical application and fundamental science.

Other optical effects due to the conjugate product, which work on the same fundamental idea of augmenting a magnet with a circularly polarised laser include:

1) The optical Faraday effect and optical magnetic circular dichroism.
2) The optical Cotton Mouton and Majorana effects.
3) Various optically induced birefringence effects.
4) Developments with SQUID technology of the inverse Faraday effect, which is magnetization due to light.
5) Other more exotic effects such as inverse magnetochiral birefringence (with Wagniere).
6) Fundamental effects such as optically induced fringe shifts with electron beams.
7) Several other topics.

The Photon's Mass and the Evans-Vigier Field, B(3).

I have recently (1992/1995) made some contributions to the question of whether the photon has mass and a longitudinal magnetic field. It appears possible theoretically at this point in time to assert that the photon has a longitudinal magnetic field in vacuo. It has been shown in various publications in 1992 to 1995 that this idea does not contradict fundamental theory, as is widely assumed, and does not contradict fundamental energy laws and fundamental relativistic quantum field theory. I have published recent collections of papers on the idea. The novel longitudinal magnetic field is directly proportional to the conjugate product, i.e. to the antisymmetric part of light intensity, and if verified experimentally, will be a novel fundamental property of the photon. Its existence is related to questions concerning the mass of the photon, a topic of thought in natural philosophy since the time of Cavendish. I have recently published two volumes on the subject with Prof. Jean-Pierre Vigier, Editor of Physics Letters A, and several letters and papers. The major theoretical properties and implications of

the so-called Evans-Vigier field, B(3), have been developed in letters and papers in the journal "Foundations of Physics", (See 1995 list), and several reviews have appeared of books dealing with B(3). Experiments to detect it are planned at the time of writing, and a conference partly devoted to it is planned for August 1995 in Toronto. It is now understood that B(3) changes the group symmetry of electromagnetism to the non-Abelian O(3). It propagates FAPP at the speed of light in vacuo with its source, the well-known conjugate product; and can be detected via the Dirac equation through its action on matter, e.g. an electron or proton. It implies that the photon has three physical degrees of poalrization, not two, and cannot be massless within the structure of Wigner's theory. The existence of B(3) implies the existence of photon mass. It produces, theoretically, an optical Aharonov Bohm effect, but no free space Faraday induction due to the structure and symmetry of the Evans-Vigier field equations. The existence of B(3) is shown experimentally in several magneto-optical effects.

For practical spectroscopy and optics, this new fundamental field has many useful possibilities, some of which have been discussed already in terms of the conjugate product, to which the field is directly proportional. These are all fundamental spectroscopies with widespread applicative possibilities. The latest development (Jan. 1995) is radio-frequency enhanced NMR, in which the so-called Evans-Vigier field, B(3), is demonstrated to have the ability in theory of greatly enhancing NMR resolution (Physica B, submitted for publication). This work has become the basis of two patent claims.

Field Applied Computer Simulation in Nonlinear Optics.

This technique has been developed and reported in articles from about 1990 to present at Cornell and Zurich, and was recognised by an award in the 1992 IBM Supercomputer Competition. The code applies the technique of molecular dynamics to nonlinear optical effects in general, and is applicable in all materials and under all conditions, irrespective of how intense or short the laser pulse. It is therefore applicable to materials analysis of all kinds, as well as to fundamental questions in nonlinear optics.

So far (May 1993) the technique has been used to produce several novel phenomena, previously unknown in nonlinear optics, in particular novel birefringence effects due to light, reported from the University of Zurich with Wagnière and Woźniak.

Quantum Simulation of Nonlinear Optical Effects.

This is the subject of current work, which aims to extend the classical work just described to quantum mechanically based code.

BRIEF SUMMARY

These five hundred or so articles and books in natural philosophy are concerned with developments in various kinds of spectroscopy and optics, with an element of computer

simulation and theory used as an aid to analysis of data, originally analysis in the far infra red range. The trend is towards fundamental analysis of the various phenomena studied experimentally and computationally, and recently, theoretically, culminating in the inference of the Evans-Vigier field and field equations. An attempt has been made to summarise some points of interest, but such an attempt made by the author himself, is somewhat subjective. An objective idea of the influence of this work may be based, perhaps, on voluminous correspondence received (several thousand requests for reprints for example), citation indices and so on, and on various awards, and interest generated among peers, culminating in the forthcoming Toronto conference. The overall aim, as always in natural philosophy, has been the development of hypothesis for comparison with data. When data are not yet available, computer simulation has been found to be a valuable guide. Overall, the work has been in fundamental optics, but with many possibilities for practical development, the latest being RF-NMR (radio frequency enhanced NMR (and also ESR) spectroscopy).