

M P SILVERMAN: CURRICULUM VITAE (Short)

- 1) Name & Position
Mark P Silverman
George A Jarvis Professor of Physics
- 2) Address
Department of Physics, Trinity College
Hartford, Connecticut 06106 USA
Tel: 1-(860)-297-2298
email mark.silverman@trincoll.edu
website mpsilverman.com
author site amazon.com/-e/B001HMOC5O
- 3) Doctoral Degree
Ph.D. (Chemical Physics/Atomic Physics), Harvard University, Cambridge MA
- 4) Professional Appointments (selection)
George A Jarvis Professor of Physics, Trinity College, Hartford CT, USA
Frédéric Joliot Chair of Physics and National Science Foundation Senior Scientist, Ecole Supérieure de Physique et Chimie, Paris, France
Chief Researcher, Hitachi Advanced Research Laboratory, Kokubunji, Tokyo, Japan
Erskine Professor of Physics, University of Canterbury, Christchurch, New Zealand
Guest Professor, National Science Foundation High Resolution Electron Microscope Facility and Department of Physics, Arizona State University, Tempe, Arizona
Guest Professor, James Franck Institute of the University of Göttingen, Göttingen, Germany
Guest Professor and National Science Foundation Scientist at the Laboratoire Kastler/Brossel, Ecole Normale Supérieure, Paris, France.
Guest Professor, Helsinki University of Technology, Espoo, Finland
Guest Professor, Institute of Theoretical Physics, University of Helsinki, Helsinki, Finland
- 5) Professional Societies
American Physical Society
Sigma Xi: The Scientific Research Society
Optical Society of America
- 6) Selection of Professional Activities (past & present)

Consultant for National Science Foundation Science and Mathematics Programs, National Science Foundation International Cooperative Science Programs, National Research Council Office of Scientific and Engineering Personnel. Consultant for the International Science Foundation (Soros Foundation) and for the Foundation for Research, Science & Technology. Member of the SPIE Program Committee of the International Conference on Polarization Measurement and Analysis (SPIE: Society of Photo-Optical Instrumentation Engineers). Member of the editorial boards of Graduate Texts in Contemporary Physics (Springer), Frontiers of Physics (Springer), and Advanced Texts in Physics (Springer); editorial consultant for optics, quantum physics, and history of science to Princeton University Press and the Johns Hopkins University Press; member of the editorial board of *The Physics Teacher*; referee or editorial consultant for journals of the American Physical Society (APS), Optical Society of America (OSA), American Association of Physics Teachers (AAPT), and the Institute of Physics (IOP) (Angle-European physical society). Voluntary advisor on science curricula to local public schools.

7) Research Experience

My research is principally concerned with fundamental problems, both experimental and theoretical, in quantum physics, nuclear physics, optics, gravitation & astrophysics. Some examples past and present:

Experimental studies: accelerator-based atomic spectroscopy; pulsed laser studies of highly excited atoms; light amplification by enhanced reflection; polarimetry of chiral materials; studies of optical phase modulation; electron microscopy and interferometry with atomic-sized field-emission sources; lensless imaging and diffractive optics; light scattering from turbid media; nuclear alpha-, beta-, gamma, and electron-capture decay processes; radiative and conductive energy loss in materials; investigation of stochastic phenomena (e.g. explosive fragmentation of glass; solar energy diffusion in soil; fluctuations in stock market time series, residential electric energy usage, and others); development of new method to measure indoor radon concentration; deformation and static equilibrium of structures in solid mechanics.

Theoretical studies: *Quantum Physics*: interactions of atoms with radiofrequency and microwave fields; laser-induced quantum interference in fluorescence; model quantum systems in strong static electric and magnetic fields; spinor dynamics; interactions of charged particles with electromagnetic potentials; quantum interference and entanglement of correlated particles. *Nuclear Physics*: nuclear decay lineshapes; methods to search for anomalous nuclear decay processes. *Thermodynamics and Statistical Physics*: Ranque-Hilsch effect; colligative properties of solutions, heat transfer by radiation and conduction, tests of stochastic processes for randomness, temperature variation and local climate change. *Gravitation and Astrophysics*: intermediate-range deviation from Newtonian gravity; effect of gravity on quantum mechanical systems; nature of dark matter; properties of relativistic degenerate stars. *Electromagnetism & Optics*: optical properties of inhomogeneous media, amplifying media, and gyrotropic media; diffraction and point-projective imaging of both light and electrons. *Aerodynamics*: physics of descent in an atmosphere in isentropic equilibrium. *Mechanics of Deformable Media*: deformation curve (elastica) of a tapered cantilever; theory of the reaction forces on a ladder in static equilibrium.

8) Teaching Experience

I have taught at several universities and colleges in the US (Harvard, UC-Berkeley, Wesleyan (CT), Trinity (CT)) and abroad. Subjects included core undergraduate and graduate physics courses as well as special topics courses devoted to contemporary atomic and molecular physics, laser physics, special and general relativity, coherent optics, and issues of general societal concern such as energy resources and global climate change. Besides technical courses, I have designed liberal arts courses, such as *Science as a Human Endeavour*, *The Philosophical Role of Controversy in Science*, *Cosmic Evolution and the Search for Life in the Universe*, and *Power for the People: The Insatiable Quest for Energy and Its Consequences*, which emphasise societal aspects of science and the nature of scientific enquiry. For much of my teaching career I have been exploring non-traditional, interactive approaches to science education that motivate students to learn through independent projects that stimulate their curiosity. [See, for example, M. P. Silverman, "Motivating Students to Learn Science: A Physicist's Perspective", *Creative Education* **6** (2015) 1982-1992, or my book, *Waves and Grains: Reflections on Light and Learning* (Princeton 1998).]

9) Publications & Presentations

A. Books

- 1) *A Certain Uncertainty: Nature's Random Ways* Cambridge University Press (2014)
ISBN 9781107032811 (Hardcover); ISBN 9781139990103

The technical narratives in the book illuminate the use of probabilistic and statistical reasoning through examination of a wide range of investigations I have made in statistical physics. Examples include controversies over the decay of radioactive nuclei, the suitability of polarised photons in the secure transmission of information, flight of aircraft and motion of projectiles in gravity, modelling of electric energy consumption, measurement of solar heat flow and implications of local climate change, the extraction of information from crowdsourcing, and other topics.

- 2) ***Quantum Superposition: Counterintuitive Consequences of Coherence, Entanglement and Interference***, Springer-Verlag, Frontiers of Physics Collection (2008); ISBN 978-3-540-71883-3 (Hardcover)

Based on my experimental and theoretical investigations of different quantum systems, the book examines the role of quantum superposition in matters as diverse as the wavelike nature of particle propagation, indistinguishability of identical particles, nonlocal interactions of correlated particles, topological effects of magnetic fields, and chiral asymmetry in nature. Included is a comprehensive discussion of my studies of fermion condensation and its potential relevance to the terminal states of relativistic degenerate stars. The book proposes how macroscopic quantum coherence may be able to extricate physics from its most challenging quandary, the collapse of massive stars to a singularity in space in which the laws of physics are thought to break down.

- 3) ***A Universe of Atoms, An Atom in the Universe***, Springer-Verlag (2002); ISBN 0-387-95437-6 (Hardcover); Japanese Edition, Springer-Verlag Tokyo (2004), ISBN 4-431-71132-5 (Softcover).

Semi-technical narrative covering various topics drawn from my investigations of nuclei, atoms, light, heat, and gravity. The book examines the question of whether radioactive nuclei decay randomly and whether galactic dark matter is a quantum condensate arising from spontaneous symmetry breaking of a field of low-mass bosons, a theoretical possibility that leads to a relation between dark matter and dark energy.

- 4) ***Probing The Atom: Interactions of Coupled States, Fast Beams, and Loose Electrons***, Princeton University Press (2000); ISBN 0-691-00962-7 (Hardcover)

Technical narrative based on my investigations of the detailed structure and interactions of the hydrogen atom and tests of quantum electrodynamics by means of accelerator-based spectroscopy in the radiofrequency, microwave, and optical domains. The book gives a systematic and comprehensive presentation of my theoretical studies of the interaction (classical and quantum; single-photon and multi-photon) of radiation (visible and radio/microwave) with atoms.

- 5) ***Waves and Grains: Reflections on Light and Learning***, Princeton University Press (1998); ISBN 0-691-02741-2 (Hardcover), 0-691-00113-8 (Softcover)

Technical narrative based on my experimental and theoretical work in physical optics, including light reflection, refraction, interference, diffraction, polarisation, and scattering— and associated non-technical essays giving historical perspective to this research. Also included are essays describing some of my experiments in teaching designed to motivate students to learn physics.

- 6) ***More Than One Mystery: Explorations in Quantum Interference***, Springer-Verlag (1995); ISBN 0-387-94340-4 (Hardcover), 0-387-94376-5 (Softcover)

Technical narrative based on my investigations of quantum interference and diffraction phenomena including single-slit electron interference, Aharonov-Bohm effect, laser-induced quantum beats, resonance effects in radiofrequency and microwave fields, multiparticle correlations resulting from the spin-statistics connection, and other examples.

- 7) ***And Yet It Moves: Strange Systems and Subtle Questions in Physics***, Cambridge University Press (1993); ISBN 0-521-39173-3 (Hardcover), 0-521-44631-7 (Softcover); Japanese Edition *Soredemo Butsuri-wa Mawaru*, Springer (1998), ISBN 4-431-70761-1 (Softcover)

And Yet It Moves: Strange Systems and Subtle Questions in Physics 2nd Edition, Cambridge University Press (2015) ISBN 9781316344897 (eBook); ISBN 9780521446310 (Softcover), 9780521391733 (Hardcover)

Collection of largely non-technical essays based on selected investigations I have made in quantum mechanics, atomic physics, thermodynamics, and other areas of physics. The narratives describe different physical systems whose behaviour provokes surprise and challenges the imagination. There are strange processes for which no visualisable mechanism can be given; processes that seem to violate fundamental physical laws, but which is reality do not; processes that are superficially well understood, yet turn out to be subtly devious. The essays address questions or controversies from whose resolution emerge lessons of general significance regarding the nature of motion.

- 8) ***The Radioactivity Controversies: Fundamental Issues of Randomness, Decay, and Diffusion*** (in preparation for publication by Springer).

B. Papers: More than 200 published papers and 150 invited lectures and presentations at academic institutions and professional meetings.

Sample of published papers:

Crowdsourced Sampling of a Composite Random Variable: Analysis, Simulation, and Experimental Test, *Open Journal of Statistics* **9** (2019) 494-529.

Progressive Randomization of a Deck of Playing Cards: Experimental Tests and Statistical Analysis of the Riffle Shuffle, *Open Journal of Statistics* **9** (2019) 268-298.

Reaction Forces on a Fixed Ladder in Static Equilibrium: Analysis and Definitive Experimental Test of the Ladder Problem, *World Journal of Mechanics* **8** (2018) 311-342.

Bending of a Tapered Rod: Modern Application and Experimental Test of Elastica Theory, *World Journal of Mechanics* **8** (2018) 272-300 [Co-author J Farrah].

Brownian Motion of Decaying Particles: Transition Probability, Computer Simulation, and First-Passage Times, *Journal of Modern Physics* **8** (2017) 1809-1849 [Co-author A Mudvari].

Analysis of Residence Time in the Measurement of Radon Activity by Passive Diffusion in an Open Volume: A Micro-Statistical Approach, *World Journal of Nuclear Science and Technology* **7** (2017) 252-273.

Scientific Controversies: Authentic and Contrived, *Science & Education* **26** (2017) 397-405 [Invited paper].

Method to Measure Radon Concentration in an Open Volume with Geiger-Mueller Counters: Analysis from First Principles, *World Journal of Nuclear Science and Technology* **6** (2016) 232-260.

Search for Anomalies in the Decay of Radioactive Mn-54, *Europhysics Letters* **114** (2016) 62001 (1-6).

Motivating Students to Learn Science: A Physicist's Perspective, *Journal of Creative Education* **6** (2015) 1982-1992.

Effects of a Periodic Decay Rate on the Statistics of Radioactive Decay: New Methods to Search for Violations of the Law of Radioactive Change, *Journal of Modern Physics* **6** (2015) 1533-1553.

Search for Non-Standard Radioactive Decay Based on Distribution of Activities, *Europhysics Letters* **110** (2015) 52001 (1-5).

Cheating or Coincidence? Statistical Method Employing the Principle of Maximum Entropy for Judging Whether a Student Has Committed Plagiarism, *Open Journal of Statistics* **5** (2015) 143-157.

Statistical Analysis of Subsurface Diffusion of Solar Energy with Implications for Urban Heat Stress, *Journal of Modern Physics* **5** (2014) 751-762.

Theory of Nuclear Half-life Determination by Statistical Sampling, *Europhysics Letters* **105** (2014) 22001 (p1-p5).

Numerical Procedures for Calculating the Probabilities of Recurrent Runs, *Open Journal of Statistics* **4** (2014) 122-131.

Fragmentation of Explosively Metastable Glass, *Physica Scripta* **85** (2012) 065403 (1-9). [Co-authors W Strange, J Bower, L Ikejimba]

Quantum Stabilization of General-Relativistic Variable-Density Stars, *Journal of Modern Physics* **3** (2012) 561-569. [Co-authors D Cox and R Mallett]

Search for Patterns in Sequences of Single-Photon Polarization Measurements, *Journal of the Optical Society of America B* **28** (2011) 1423-1429. [Co-authors D Branning, A Katcher]

Two-dimensional Descent through a Compressible Atmosphere: Sequential Deceleration of an Unpowered Load, *Europhysics Letters* **89** (2010) 48002 p1-6.

Search for Correlated Fluctuations in the β^+ Decay of Na-22, *Europhysics Letters* **87** (2009) 32001 p1-6. [Co-author W Strange]

Sample of recent lectures:

Radioactivity and the Sun: A VERY Strange Controversy

Search for Anomalies in the Decay of Radioactive Nuclei

Warning from the Weather Under Ground: Solar Energy Flow and Climate Implications

A Series of Fortunate Events: Serendipitous Encounters with the Laws of Physics