

## **Jerry Paul Gollub**

*John and Barbara Bush\* Professor in the Natural Sciences*

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(\*John Bush was founder of Millipore Corporation and a Haverford graduate.)

### **Major Positions**

*Professor of Physics at Haverford College, 1979-present; John and Barbara Bush Professor in the Natural Sciences, 1996-; William Kenan Professor, 1987-1992; Provost (chief academic officer), 1988-90. Coordinator of the Natural Science Division, 1987-88; Chair of Physics, 1975-77, 1982-88, and 1998-2002; Assistant and Associate Professor of Physics, 1970-79.*

*Adjunct Professor of Physics at The University of Pennsylvania, 1981-present; Member of the Graduate Group in Physics, and (formerly) in Mechanical Engineering and Applied Mechanics.*

### **Honors**

American Physical Society Fluid Dynamics Prize, 2003

Elected member of the U.S. National Academy of Sciences, 1993

Fellow of the American Academy of Arts and Sciences, 1992

LVMH Science for Art Award, 1994.

Morris Loeb Lecturer in Physics, Harvard University, 1990.

Fellow of the John Simon Guggenheim Foundation, 1984-85.

First Amer. Phys. Soc. Award for Research in an Undergraduate Institution, 1985.

Fellow of the American Physical Society.

Fellow of the American Association for the Advancement of Science

Sigma Xi Society National Lecturer, 1983-85.

### **Education**

Ph.D. in Physics, Harvard University, 1971; A.M. in Physics, 1967.

A.B. (Summa cum Laude), Oberlin College, 1966.

### **Visiting Positions**

Visiting Researcher, University of California at Santa Barbara, 2005

Belkin Visiting Professor, The Weizmann Institute of Science, 1998

Visiting Professor, Paris VII and Ecole Normale Supérieure, 1985 and 1991.

Visiting Researcher, University of California at San Diego, 1991; Cornell U. 1978.

### **National Leadership Positions**

*Chair, Division of Fluid Dynamics of the American Physical Society, 2005.*

Nominated in 2000 to stand for election as Vice-President of APS.

*Member of the governing Council of the National Academy of Sciences, 2005-08.*  
Chair, NAS Nominating Committee 2003.

*Co-Chair: National Research Council (NRC) Committee on Programs for Advanced High School Science and Mathematics Education, 1999-2002.*

### **Additional Professional Activities**

Invited columnist, *Physics Today*, 2002-present.

Editorial Board, *Physics of Fluids*, 2005-present.

Divisional Associate Editor, *Physical Review Letters*, 2003-05.

Member of the Executive Board of the American Physical Society, 2001-02.

Steering Group, AAAS Section on Physics, 1997-2000.

Advisory Board, National Science Resources Center (curriculum developers), 1995-2000.

Co-chair: 1997 Conference of Physics Department Chairs,:

Chair of a Site Review for the National Science Foundation, 1996.

Board of Editors, *Nonlinearity*, 1993-97; *Journal of Nonlinear Science*, 1990-1993,  
*Physical Review A*, 1986-89, *American Journal of Physics*, 1985-88.

Materials Research Advisory Committee of NSF, 1986-87.

National Research Council Physics Survey Committee, 1983-84.

Invited lecturer: about 200 lectures during the past 20 years.

Co-organizer of four international conferences.

### **Research Accomplishments**

Gollub's research group was one of the first to demonstrate the phenomenon of chaos in simple physical systems, especially fluids, and to study pattern formation in nonlinear systems. His group has played a leading role in understanding the flow of granular materials. This work was recognized by two national prizes and by election to the National Academy of Sciences and the American Academy of Arts and Sciences. It has important connections to both physics and engineering.

*Superconductivity*: Discovered diamagnetism due to fluctuations above the superconducting phase transition. (1968-70)

*Hydrodynamic instabilities*: Made the first extensive measurements of the critical exponents for a hydrodynamic instability; developed automated laser light scattering methods to achieve a qualitative advance in the study of hydrodynamic instabilities and the transition to turbulence in fluids; showed (with H. Swinney) Landau's model of the onset of turbulence to be incorrect, and that only a few instabilities precede the onset. (1975-76)

*Routes to chaos and spatiotemporal chaos*: Discovered various "routes to chaos" that can be interpreted in terms of elementary models in nonlinear dynamics. (1976-79) Since that time *spatiotemporal chaos* in hydrodynamics has been a central focus. (1985-present).

*Nonlinear dynamics*: Studied the response of hydrodynamic systems to periodic and nonperiodic driving forces, and showed that even periodic forcing can induce a nonperiodic response; showed that a simple electrical system of coupled relaxation oscillators has chaotic regimes, and made the first laboratory

measurements of phase space divergence for a laboratory dynamical system. (1978-80)

*Instrumentation*: Devised Doppler mapping and digital imaging systems that allowed slowly changing fluid velocity fields to be scanned in both space and time; used these systems to study pattern evolution in convecting fluids. (1980-86)

*Novel patterns in liquid crystal convection*: Discovered commensurate and incommensurate states in convecting nematic liquid crystal layers. (1983-86)

*Crystal growth*: Initiated precision experiments on dendritic crystal growth, leading to the first experimental tests of continuum theories based on microscopic solvability. (1985-89)

*Interfacial pattern formation*: Studied nonlinear pattern formation at interfaces in various systems. *Porous media*: showed that penetrating interfaces are self-affine fractals. *Unstable film flows*: determined the nature of the secondary instabilities giving rise to spatiotemporal chaos. Other systems: *electrodeposition*; *pattern formation in flowing streams*. (1985-present)

*Turbulent convection*: Studied turbulent thermal convection and the structure of time-dependent thermal boundary layers to explain the anomalous behavior of the heat transport; made novel observations of the geometrical structure of thermal turbulence. (1988-94)

*Nonlinear waves*: Showed that competition between different modes or patterns leads to chaos in hydrodynamic surface waves; studied the effect of boundary symmetry on bifurcations; studied the development of spatiotemporal chaos. Investigated transport of material by nonlinear interfacial waves; showed that fractal concentration patterns are produced, and tested mathematical models of transport. Discovered novel superlattice patterns. (1984-2000)

*Dynamics of friction*: Motivated by recent efforts to understand earthquakes, studied an idealized laboratory model of frictional sliding: first measurements that were fully resolved in both space and time. (1991-94).

*Chaotic and turbulent mixing*: Studied chaotic transport processes in convecting fluids; showed how instabilities to periodic oscillations enhance transport and mixing. (1986-88). Discovered a novel non-equilibrium stationary state in chaotic mixing. Showed that the building blocks of a nonlinear dynamical description of mixing (flow maps and their fixed points) can be measured experimentally. Extended this work to non-Newtonian fluids and to chemically reacting systems. (1995-present)

*Granular Materials*: Made the first time-resolved measurements of frictional forces within granular materials undergoing stick-slip motion (1997-present); demonstrated clustering phenomena (1997) and front propagation (1998) experimentally. Studied the hydrodynamic properties of fluidized material, and the dynamics of granular shear flows. (1999-present)

*Clustering in Fluids*: Studied the clustering of particles that move with respect to a fluid, as a result of interactions mediated by the fluid. (2000-present)

*Origins of Irreversibility*: We showed that slow fluid flows containing particles are not reversible if sheared more than a critical amount (2005).

## **Books**

*Learning and Understanding: Improving Advanced Study of mathematics and Science of U.S. High Schools*, with M.W. Bertenthal, J.B. Labov, and P.C. Curtis, Editors.

*Chaotic Dynamics: An Introduction*, with G.L. Baker (Cambridge University Press, 1990 and 1996), an undergraduate textbook.

*Hydrodynamic Instabilities and the Transition to Turbulence*, with H.L. Swinney (Springer, 1985), an edited volume.

## **Grants and Fellowships**

NSF research grants, Division of Materials Research, 1985-present.

Participant in University of Pennsylvania's NSF MRSEC Grant.

NSF research grants, Fluid Dynamics Program, 1977-87 and 1992-96.

NATO Collaborative Research Grant, 1992-1996.

Subcontract, Princeton URI Program on turbulence, 1986-91.

Principal author of major grants (over \$1,000,000 each) for science education,

Howard Hughes Medical Institute and the Pew Memorial Trusts, 1988

NATO grant for an Advanced Research Workshop, 1983-84.

Japan Society for the Promotion of Science, Research Fellowship, 1983.

Research Corporation grant for light scattering, 1975-79.

Danforth and Woodrow Wilson Graduate Fellowships, 1966-70.

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