

## David Pines

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| <b>Born</b>                    | June 8, 1924<br><a href="#">Kansas City, Missouri</a>     |
| <b>Died</b>                    | May 3, 2018 (aged 93)<br><a href="#">Urbana, Illinois</a> |
| <b>Citizenship</b>             | <a href="#">American</a>                                  |
| <b>Alma mater</b>              | <a href="#">Princeton University</a>                      |
| <b>Scientific career</b>       |   |
| <b><u>Doctoral advisor</u></b> | <a href="#">David Bohm</a>                                |

**David Pines** (June 8, 1924 – May 3, 2018) was the founding director of the [Institute for Complex Adaptive Matter](#) (ICAM) and the [International Institute for Complex Adaptive Matter](#) (I2CAM) (respectively, US-wide and international institutions dedicated to research in and the understanding of emergent phenomena), distinguished [professor](#) of [physics](#), [University of California, Davis](#), research professor of physics and [professor emeritus](#) of physics and [electrical](#) and [computer engineering](#) in the Center for Advanced Study, [University of Illinois at Urbana-Champaign](#) (UIUC), and a staff member in the office of the Materials, Physics, and Applications Division at the [Los Alamos National Laboratory](#).

His seminal contributions to the theory of many-body systems and to [theoretical astrophysics](#) have been recognized by two [Guggenheim Fellowships](#), the [Feenberg Medal](#), the [Edward A. Frieman Prize for Excellence in Graduate Student Research](#), [Dirac](#) and [Drucker](#) prizes, and by his election to the [National Academy of Sciences](#), [American Philosophical Society](#), [American Academy of Arts and Sciences](#), [Russian Academy of Sciences](#), and [Hungarian Academy of Sciences](#) and visiting professorships at the [California Institute of Technology](#), [College de France](#), [Trinity College, Cambridge](#), [University of Leiden](#), and the [Université de Paris](#).

He was the founding director of the Center for Advanced Study, UIUC (1968–70), was vice-president of the [Aspen Center for Physics](#) from 1968 to 1972, founder and co-chair of the US-[USSR](#) Cooperative Program in Physics, 1968–89; and a co-founder, vice-president, chair of the board of trustees, and co-chair of the science board of the [Santa Fe Institute](#), from 1982 to 1996.

He has been the organizer or co-organizer of fifteen workshops and two summer schools of theoretical physics, is currently an honorary trustee and honorary member of the Aspen Center for Physics, and a member of the board of overseers at [Sabanci University](#) in [Istanbul](#). Pines passed away on May 3, 2018.<sup>[1]</sup>

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## Research interests

His latest research concerned the search for the organizing principles responsible for emergent behavior in materials where unexpectedly new classes of behavior emerge in response to the strong and competing

interactions among their elementary constituents. Some recent research results on correlated electron materials are the development of a consistent phenomenological description of protected magnetic behavior in the pseudogap state of underdoped cuprate superconductors and the discovery of the protected emergence of itinerancy in the Kondo lattice in heavy electron materials and its description using a two-fluid model. He continues his interest in the superfluidity of neutron stars revealed by pulsar glitches and in elementary excitations in the helium liquids.<sup>[\[citation needed\]](#)</sup>

## Recent scientific articles

- Protected Behavior in the Pseudogap State of Underdoped Cuprate Superconductors (with V. Barzykin), Phys. Rev. Lett., in the press and condmat 0601396, 2006
- Complex Adaptive Matter: Emergent Phenomena in Materials (with D.L. Cox), MRS Bulletin 30, 425-429, 2005
- Scaling and the Magnetic Origin of Emergent Behavior in Correlated Electron Superconductors (with N. Curro and Z. Fisk), MRS Bulletin 30, pp442–446, 2005
- The Pseudogap: Friend or Foe of High Temperature Superconductivity (with M. Norman and C. Kallin), Adv. Phys. 54, 715, 2005
- Scaling in the Emergent Behavior of Heavy Electron Materials, (with N. Curro, B-L. Young, and J. Schmalian) Phys. Rev.B. 70, 235117 (2004)
- Two Fluid Description of the Kondo Lattice (with S. Nakatsuji and Z. Fisk), Phys Rev. Lett. 92,016401, 2004
- Low Frequency Spin Dynamics in the CeMn5 Materials (with N. Curro et al.), Phys, Rev. Lett.90, 227202, 2003
- A Spin Fluctuation Model for d-wave Superconductors (with A. Chubukov and j. Schmalian), in "The Physics of Conventional and Unconventional Superconductors", ed. K.H. Benneman and J. B. Ketterson, Springer Pub, 2003 (condmat/0201140)
- The Quantum Criticality Conundrum (with R.B. Laughlin, G. Lonzarich, and P. Monthoux), Advances in Physics 50, 361-365, 2001
- The Middle Way (with R. B.Laughlin, B.Stojkovic, J. Schmalian, P.Wolynes), PNAS 97,32-37, 2000
- The Theory of Everything (with R. B. Laughlin), PNAS 97, 27-32 (2000)

## Career history

- [A.B. University of California, Berkeley](#) 1944
- [M.A. Princeton University](#) 1948
- [Ph.D.](#) Princeton University 1950
- Instructor, [University of Pennsylvania](#) 1950–52
- Research assistant professor, UIUC 1952–55
- Assistant professor, Princeton University 1955–58
- Member, [Institute for Advanced Study](#) 1958–59
- Professor of physics & electrical engineering, UIUC 1959–1995
- Professeur Associe, Faculte des Sciences, Université de Paris 1962–63
- Founding director, Center for Advanced Study, UIUC 1967–70
- Visiting professor, NORDITA 1970
- Visiting scientist, Academy of Sciences, USSR 1970 and 1978
- Visiting scientist, Academy of Sciences, [China](#) 1973
- Exchange professor, Université de Paris 1978
- Professor, Center for Advanced Study, UIUC 1978–1990
- Visiting scientist, Hungarian Academy of Sciences 1979
- Gordon Godfrey Professor, [University of New South Wales](#) 1985
- B. T. Matthias Visiting Scholar (Los Alamos National Laboratory) 1986
- Professor, College de France 1989
- Center for Advanced Study professor of physics and electrical computer engineering, UIUC 1990–1995
- External professor, [Santa Fe Institute](#) 1989–2002
- Robert Maxwell Professor, Santa Fe Institute 1991

- S. Ulam Visiting Scholar, Los Alamos National Laboratory 1996–97
- Visiting professor, [Royal Institute of Technology, Stockholm](#), 1998
- Visiting fellow-commoner, Trinity College, University of Cambridge 2000

## Honors

- Member, National Academy of Sciences
- Member, American Philosophical Society
- Fellow, American Academy of Arts and Sciences
- Foreign member, Russian Academy of Sciences
- Honorary member, Hungarian Academy of Sciences
- Fellow, American Association for Advancement of Science
- Fellow, American Physical Society

## Awards

- National Science Foundation Senior Postdoctoral Fellow in Copenhagen and Paris 1957–58
- John Simon Guggenheim Memorial Fellow 1962–63 and 1970–71
- Lorentz Professor, University of Leiden 1971
- [Fritz London](#) Memorial Lecturer (Duke Univ.) 1972
- Giulio Racah Memorial Lecturer (Hebrew Univ.) 1974
- Marchon Lecturer (Univ. of Newcastle upon Tyne) 1976
- Sherman Fairchild Distinguished Scholar (Caltech) 1977
- Eugene Feenberg Memorial Lecturer (Washington U) 1982
- Eastman Kodak - Univ. of Rochester Distinguished Lecturer 1983
- [Friemann Prize](#) in Condensed Matter Physics 1983
- [Dirac Medal](#) for the Advancement of Theoretical Physics 1985
- Emil Warburg Lecturer (Univ. of Bayreuth) 1985
- [Eugene Feenberg Medal](#) 1985
- Daniel C. Drucker Eminent Faculty Award 1994
- [John Bardeen Prize](#) for Superconductivity Theory 2009

## Significant publications on quantum liquids

- A Collective Description of Electron Interactions: III. Coulomb Interactions in a Degenerate Electron Gas (with D. Bohm). Phys. Rev. 92, 609-625 (1953)
- A Collective Description of Electron Interactions: IV. Electron Interaction in Metals. Phys. Rev. 92, 626-636 (1953)
- Electron Interaction in Metals. Solid State Physics, eds. F. Seitz and D. Turnbull, Academic, N.Y., 1, 3-51 (1955)
- The Correlation Energy of a Free Electron Gas (with P. Nozières). Phys. Rev. 111, 442-454 (1958)
- Collective Energy Losses in Solids. Rev. Mod. Phys. 28, 184-199 (1956)
- The Motion of Slow Electrons in Polar Crystals (with T. D. Lee and F. Low). Phys. Rev. 90, 297-302 (1953)
- Electron-Phonon Interaction in Metals (with J. Bardeen). Phys. Rev. 99, 1140–1150 (1955)
- Nuclear Superconductivity, Proc. of the Rehovoth Conf. on Nuclear Structure, Interscience Press, 26-27 (1957)
- Possible Analogy Between the Excitation Spectra of Nuclei and Those of the Superconducting Metallic State (with A. Bohr and B. Mottelson). Phys. Rev. 110, 936-938 (1958)
- Ground-State Energy and Excitation Spectrum of a System of Interacting Bosons (with N. Hugenholtz). Phys. Rev. 116, 489-506 (1959)
- Effective Interaction of He<sup>3</sup> Atoms in Dilute Solutions of He<sup>3</sup> in He<sup>4</sup> at Low Temperatures (with J. Bardeen and G. Baym). Phys. Rev. 156, 207-221 (1967)
- Zero Sound in Liquid <sup>4</sup>He and <sup>3</sup>He, Quantum Fluids, Proc. of the Sussex University Symp., 16–20 August 1965, ed. D. F. Brewer, North-Holland Pub. Co., Amsterdam, pp. 257–277 (1966)

- Polarization Potentials and Elementary Excitations in He II at Low Temperatures (with C. H. Aldrich III). *J. Low Temp. Phys.* 25, 677-690 (1976)
- Polarization Potentials and Elementary Excitations in Liquid  $^3\text{He}$  (with C. H. Aldrich III). *J. Low Temp. Phys.* 32, 689-715 (1978)
- Roton Liquid Theory (with K. Bedell and I. Fomin). *J. Low Temp. Phys.* 48, 417-433 (1982)
- Pseudopotential Theory of Interacting Roton Pairs in Superfluid  $^4\text{He}$  (with K. Bedell and A. Zawadowski). *Phys. Rev. B* 29, 102-122 (1984)
- Superfluidity in Neutron Stars (with G. Baym and C. Pethick). *Nature* 224, 673-674 (1969)
- Inside Neutron Stars, Proc. of 12th Int. Conf. on Low Temperature Physics, ed. Eizo Kanda, Academic Press of Japan, pp. 7–21 (1971)
- Superfluidity in Neutron Stars (with M. A. Alpar). *Nature* 316, 27-32 (1985)
- Quasiparticle Interactions in Neutron Matter for Applications in Neutron Stars (with J. Wambach and T. L. Ainsworth). *Nucl. Phys. A* 555, 128-150 (1993)
- Phenomenological Model of Nuclear Relaxation in the Normal State of  $\text{YBa}_2\text{Cu}_3\text{O}_7$  (with A. Millis and H. Monien). *Phys. Rev. B* 42, 167-177 (1990)
- Toward a Theory of High Temperature Superconductivity in the Antiferro-magnetically Correlated Cuprate Oxides (with P. Monthoux and A. Balatsky). *Phys. Rev. Lett.* 67, 3448-3451 (1991)
- Spin-fluctuation-induced Superconductivity in the Copper Oxides: A Strong Coupling Calculation (with P. Monthoux). *Phys. Rev. Lett.* 69, 961-964 (1992)
- Nearly Antiferromagnetic Fermi Liquids are High Temperature Superconductors: Are the Superconducting Cuprates Nearly Antiferromagnetic Liquids? *J. Chem. Phys. Solids* 54, 1447–1455 (1993)
- Complex Adaptive Matter: Emergent Phenomena in Materials (with D.L. Cox), *MRS Bulletin* 30, 425-429, 2005
- Scaling in the Emergent Behavior of Heavy Electron Materials (with N. Curro, B-L. Young, and J. Schmalian, *Phys. Rev. B* 70,235117 (2004)
- Protected Behavior in the Pseudogap State of Underdoped Cuprate Superconductors (with V. Barzykin), *Phys. Rev. Lett.*, in the press and condmat 0601396, 2006

## Books

- The Many-Body Problem. (W. A. Benjamin: N.Y) 456 pp. (1961) (Russian translation, State Publishing House, Moscow, 1963)
- Elementary Excitations in Solids. (W. A. Benjamin: N. Y.) 312 pp. (1963) (Russian translation, State Publishing House, Moscow, 1965). Japanese translation (Syokabo Press, Tokyo, 1974)
- The Theory of Quantum Liquids, Vol. I Normal Fermi Liquids. W. A. Benjamin: NY, 1, 355 pp. (1966). (Russian Translation, Publishing House MIR, Moscow, 1968)
- Pines, David; [Anderson, Philip W.](#); [Arrow, Kenneth J.](#), eds. (1988). *The economy as an evolving complex system: the proceedings of the Evolutionary Paths of the Global Economy Workshop, held September, 1987 in Santa Fe, New Mexico. Redwood City, California: Addison-Wesley Pub. Co. ISBN 9780201156850. Book details.*
- The Theory of Quantum Liquids Vol. II: Superfluid Bose Liquids (with P. Nozières), Addison-Wesley, 180pp (1990)

## Editorial contributions

- Founding editor, *Frontiers in Physics*, 1961–present
- Editor, *Reviews of Modern Physics* 1973–96
- Editor/co-editor of five books

## Educational and public service

- Co-founder of the Center for Advanced Study, UIUC, 1967; the Aspen Center for Physics, 1967–69; the US-USSR Cooperative Program in Physics, 1968; the Santa Fe Institute, 1982–84; and the Institute for Complex Adaptive Matter, 1998–1999
- Organizer or co-organizer of fifteen workshops and two summer schools of theoretical physics
- Aspen Center for Physics: vice-president, 1968–72;

- Board of trustees 1968–80; honorary trustee, 1980–; member, 1980–
- Santa Fe Institute: co-founder, 1984; vice-president, 1984–86; board of trustees, 1984–2002; chair, board of trustees, 1986–87; founding co-chair, science board, 1987–96; member, science board, 1987–1999; 2001–; external faculty 1995–
- Institute for Complex Adaptive Matter: founding director and member of board of trustees (now board of governors) and science steering committee, 1999–present
- National Academy of Sciences; chair, Panel on Condensed Matter Physics, 1994–98
- National Academy of Sciences/National Research Council:
- Physics Survey Committee, 1965–66;
- Board on International Scientific Exchange, founder and chair, 1973–1977
- US/USSR Workshops in Condensed Matter Theory, founder and co-chair, 1968; 1970; 1974; 1978; 1988
- US/USSR Commission on Cooperation in Physics, founder and co-chair, 1975–80
- American Academy of Arts and Sciences: chair, physics section and class membership committee, 1996–99
- Los Alamos National Laboratory:
- T Division Advisory Committee: member 1975–82; chair, 1977–1982
- Institute for Defense Analyses, mentor, Defense Sciences Study Group, 1985–2000

## External links

- [Institute for Complex Adaptive Matter](#)- a Multicampus and Multidisciplinary Research Program of the University of California