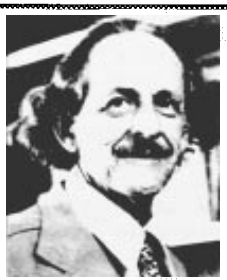
Essays of an Information Scientist: Creativity, Delayed Recognition, and other Essays, Vol:12, p.117, 1989 Current Contents, #17, p.3-9, April 24, 1989



Current Comments®
EUGENE GARFIELD
INSTITUTE FOR SCIENTIFIC INFORMATION®
3501 MARKET ST. PHILADELPHIA, PA 19104

The 1989 NAS Award for Excellence in Scientific Reviewing Goes to Sidney Coleman for His Reviews in Theoretical Physics

Number 17 April 24, 1989

Sidney Coleman, Harvard University, wins the 11th National Academy of Sciences scientific reviewing award for his reviews in field theory and particle physics. In an interview, Coleman discusses various aspects of reviews and reviewing. Included are a few of his own guidelines in preparing reviews, his thoughts on the value of review articles, and a discussion of some of his most-cited works and the ISI® research fronts in which they appear.

Some years ago the Harvard University physicist Sidney Coleman was lecturing at the International School of Subnuclear Physics, a summer school for graduate and postdoctoral students held each year in the town of Erice, Sicily. Coleman was speaking on gauge field theory and functional integration. Although now part of the first-year curriculum for every graduate student in theoretical physics, the topic was at that time considered somewhat exotic and even a bit suspect. A few months earlier, Coleman had seen the documentary film *Marjoe*, an exposé about the occasionally shady practices of traveling evangelists in rural America. The film featured scenes of revival meetings in which members of the congregation, at the fervent exhortation of the preacher, would raise both arms, wave their hands and call out, "I believe!"

"I was about to talk about functional integration," recalls Coleman with a laugh, "and I said, 'Now, I'm not going to be able to give you rigorous mathematical treatments. I'm going to explain the whole thing, beginning to end, in about 25 minutes. This is not going to be like the rest of the lecture. This is going to require faith. This is going to be like those evangelical meetings we have in America.' And I described the people in the movie waving their hands to signify belief. Then I went through the whole thing and explained it and did some demonstrations, and after about 25 minutes I said, 'Now, do you understand functional integration?' And the whole class raised their hands and said, 'We believe!' I thought, this is terrific—this is real power. Maybe I should have gone into the rock music business."[1]

That idle bit of career assessment notwithstanding, Coleman undoubtedly made the right vocational decision in choosing physics—and countless physicists have benefited because of it. Coleman's skills as a lecturer and expositor were recently acknowledged with the announcement that he is the 1989 recipient of the National Academy of Sciences (NAS) Award for Excellence in Scientific Reviewing. The academy cited Coleman's "lucid, insightful, and influential reviews on partially conserved currents, gauge theories, instantons, and magnetic monopoles—subjects fundamental to theoretical physics."[2]

ISI® and Annual Reviews, Inc., Palo Alto, California, established the award in 1977 (although the first prize was not actually awarded until 1979) to recognize and encourage high quality in the writing of scientific reviews. The award honors James Murray Luck, founder of Annual Reviews. Although ISI and Annual Reviews jointly sponsor the award and provide funding for the $5,000 honorarium, the actual selection of winners is performed independently by a committee at the NAS.

Coleman is the fourth reviewer in the physical sciences to be honored. In 1980 the award recognized Conyers Herring, Stan-

ford University, for reviews in solid-state physics.[3] The 1983 winner, Michael Ellis Fisher, Cornell University, received the award for his reviews on the theory of equilibrium critical phenomena.[4] The 1986 winner, Virginia L. Trimble, University of California, Irvine, was selected for her reviews in astronomy and astrophysics.[5] In addition to the physical sciences, the NAS award honors authors in the life sciences and the social and behavioral sciences, on a rotating basis.

Sidney Coleman

Biographical Information

Coleman was born in Chicago, Illinois, in 1937 and received a BS from the Illinois Institute of Technology in 1957. In 1962 he received his PhD from the California Institute of Technology (Caltech). His association with Harvard began in 1961, with his appointment as Corning Lecturer on and Research Fellow in Physics, and has continued ever since. He has also held visiting professorships at the University of Rome, Italy (1968), Princeton University (1973), Stanford University (1979), and the University of California, Berkeley (1989).

Coleman says he decided to be a physicist fairly early in life, having had a strong interest in science as a child. "Einstein was a mythological figure of great force in the period of my childhood, the forties," he recalls. "And I think the atom bomb probably had a significant effect—not so much that I was impressed. I was scared stiff by it."[1] In 1945, the year the first A-bombs were detonated, the Chicago *Tribune* ran an extended popular-science supplement on the atom and atomic energy. "I read that and it fascinated me," says Coleman, "and what fascinated me in particular was all the things I didn't understand. By the time I was in high school I was pretty sure I wanted to be a physicist, and it might even have been earlier than that."[1]

Coleman's first published paper, written while he was a graduate student at Caltech, appeared in *Physical Review Letters* in 1961: "Electrodynamic properties of baryons in the unitary symmetry scheme." The coauthor was Sheldon L. Glashow, then a postdoctoral student at Caltech but later Coleman's colleague at Harvard.[6] Glashow, of course, was a cowinner of the 1979 Nobel Prize in physics. Since 1961 Coleman has published nearly 100 publications, which together have attracted over 8,800 citations.

In 1966 Coleman and Glashow were contacted by Antonino Zichichi, CERN, Geneva, Switzerland, and invited to lecture at the Erice summer school, which Zichichi had organized in the early 1960s. The two joined the other scientists whom Zichichi had recruited, preparing and presenting lecture series on advanced topics in physics.

For the next 15 years or so, Coleman was a regular attendee at the school; in the preface to *Aspects of Symmetry*, a collection of his Erice lectures published in 1985, he wrote that he was "charmed by the beauty of Erice, fascinated by the thick layers of Sicilian culture and history, and terrified by the iron rule with which [Zichichi] kept students and faculty in line. In a word, I was won over...."[7] By all accounts, the school community was equally won over by Coleman's skills as a lecturer. The 1979 book *The Whys of Subnuclear Physics* (edited by Zichichi), a collection of the lectures from the Erice school's 15th year (1977), contains just one photograph, of Coleman, with a caption describing the "Best Lecturer" prize he was awarded on the occasion of the school's 15th anniversary.[8]

Table 1: Sidney Coleman's most-cited publications in the *SCI®*, 1945-1988. A=number of citations. B=bibliographic data. The *SCI/SSCI®* research fronts to which the paper is core are included in parentheses.

A	B
1,115	**Coleman S & Weinberg E.** Radiative corrections as the origin of spontaneous symmetry breaking. *Phys. Rev. D—Part. Fields* 7:1888-910, 1973. (81-0313, 83-4624, 84-4667, 85-1628, 86-4285, 87-1402)
665	**Coleman S.** Quantum sine-Gordon equation as the massive Thirring model. *Phys. Rev. D—Part. Fields* 11:2088-97, 1975. (79-0988, 81-0739, 82-1647, 83-2122, 84-4669, 85-4255, 86-4286, 87-4271, 88-4161)
389	**Coleman S, Wess J & Zumino B.** Structure of phenomenological Lagrangians. I. *Phys. Rev.* 177:2239-46, 1969. (84-0265, 85-3642, 86-3652, 87-3660, 88-4160)
341	**Coleman S.** Fate of the false vacuum: semiclassical theory. *Phys. Rev. D—Part. Fields* 15:2929-36, 1977. (80-0522, 81-0313, 82-0029, 83-0319, 84-3961, 85-0716, 86-2322, 87-0091, 88-3556)
339	**Coleman S & Glashow S L.** Electrodynamic properties of baryons in the unitary symmetry scheme. *Phys. Rev. Lett.* 6:423-4, 1961.
335	**Callan C G, Coleman S & Jackiw R.** A new improved energy-momentum tensor. *Ann. Phys. NY* 59:42-73, 1970.
304	**Coleman S & Glashow S L.** Departures from the eightfold way: theory of strong interaction symmetry breakdown. *Phys. Rev. B* 134:671-81, 1964.
247	**Coleman S.** There are no Goldstone bosons in two dimensions. *Commun. Math. Phys.* 31:259-64, 1973.
205	**Coleman S, Jackiw R & Politzer H D.** Spontaneous symmetry breaking in the O(N) model for large N. *Phys. Rev. D—Part. Fields* 10:2491-9, 1974. (84-4668, 85-4256)
179	**Coleman S.** More about the massive Schwinger model. *Ann. Phys. NY* 101:239-67, 1976. (79-0870, 80-1036, 83-2122)
161	**Callan C G, Coleman S, Wess J & Zumino B.** Structure of phenomenological Lagrangians. II. *Phys. Rev.* 177:2247-50, 1969. (84-0265, 85-3642, 86-3652, 87-3660)
150	**Coleman S, Jackiw R & Susskind L.** Charge shielding and quark confinement in the massive Schwinger model. *Ann. Phys. NY* 93:267-75, 1975. (79-0870, 80-1036, 85-4255)
147	**Coleman S.** The uses of instantons. (Zichichi A, ed.) *The whys of subnuclear physics.* New York: Plenum Press, 1979. p. 805-916.
136	**Coleman S & Jackiw R.** Why dilatation generators do not generate dilatations. *Ann. Phys. NY* 67:552-98, 1971.
131	**Callan C G & Coleman S.** Fate of the false vacuum. 2. First quantum corrections. *Phys. Rev. D—Part. Fields* 16:1762-8, 1977. (81-0313, 82-0029, 83-0319, 84-3961, 85-0716, 86-2322, 87-0091, 88-3556)

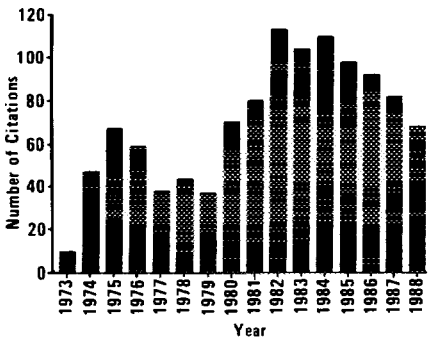
Coleman's Harvard colleagues, Glashow and Howard Georgi, had this to say in a nominating letter to the NAS: "Most outstanding theorists prefer doing physics to writing about it.... Even among those few great theorists who make the effort, there are still fewer who have the combination of skills required to write something really useful.... Sidney Coleman is one particle theorist who can both do brilliant particle theory and write about it brilliantly."[9]

On Reviewing

"I've found that if you have things clear in your own mind," says Coleman, "it normally comes out clear for the students. You have to be relentless in trying to understand the material. And you have to resist the temptation to copy the way things are done in the literature, because then you end up with an anthology. You have to think it out afresh, and not just copy someone else. And in the course of doing that, you learn what is important and what is not, and you see connections that, although not necessarily subtle or deep, may not be visible in the literature to a student."[1]

For Coleman, preparing a lecture is one thing. Writing it up, however, and achieving clarity without the immediacy and interaction provided by a lecture audience are considerably more difficult. He has developed a few principles. "It helps to use simple declarative sentences," he says, "and one should not resist jokes. I've also found that long writing makes for short reading—that is, if it takes three paragraphs to explain it, take three paragraphs. A student would rather read three paragraphs than spend three *hours* trying to puzzle out the meaning of one orphic sentence. Readers can

Figure 1: Chronological distribution of number of papers citing S. Coleman's most-cited publication on spontaneous symmetry breakdown in the field of theoretical particle physics, *Phys. Rev. D—Part. Fields* 7:1888-910, 1973.



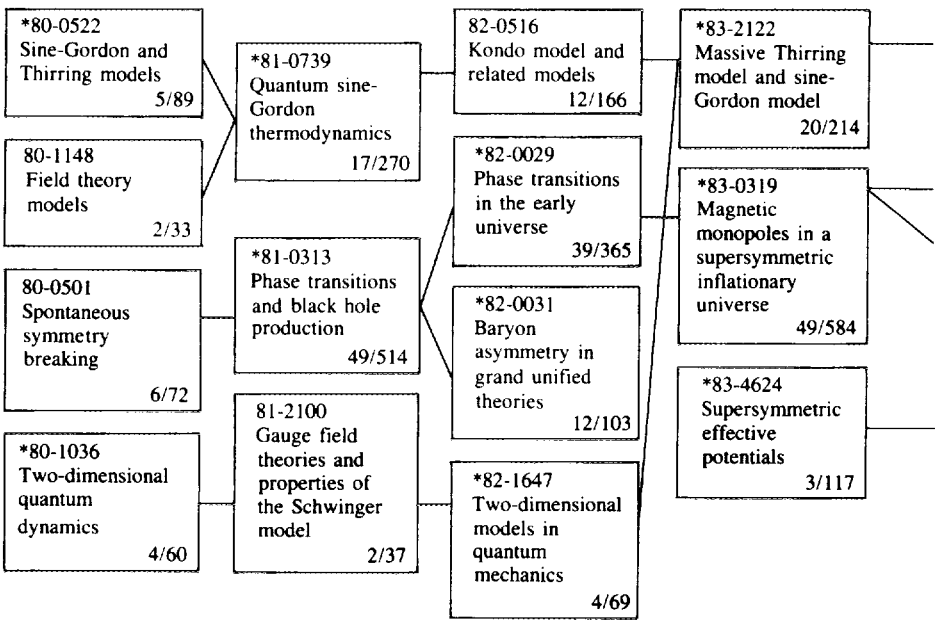
always skip sections, but they can't call up missing material. Actually, there's nothing in good scientific writing that can't be found in Strunk and White [*The Elements of Style*]."[1]

Most-Cited Papers

Table 1 lists Coleman's most-cited papers. Topping the list is a 1973 paper from *Physical Review D—Particles and Fields*: "Radiative corrections as the origin of spontaneous symmetry breaking," coauthored with Harvard colleague Erick Weinberg.[10] This paper has been cited in over 1,100 publications. As Glashow and Georgi point out, although the paper is not a review *per se*, it is unusually well-written and has had a wide and enduring influence (as have many other of Coleman's works of original research). Such papers, they note, could even be said to play the role of review articles. This paper has been particularly useful in teaching theorists some of the finer points of modern quantum field theory.[9]

"The technology the paper introduces is widely used in a narrow field," says Coleman. "We get a general formula for doing a kind of calculation that is highly useful to people investigating a particular kind of theory. That may be one reason it's been highly cited. Another is that the paper de-

Figure 2: Historiograph showing developments in field theory and particle physics. Numbers of core/citing papers are indicated at the bottom of each box. Asterisks (*) indicate research fronts in which S. Coleman is a core author. Connecting lines reflect minimum threshold of continuity of core papers.



votes a lot of time to explaining the general formalism in which our method is placed. Instead of beginning with a flurry of references and just copying paragraphs from the literature, we took the trouble of explaining about the various properties—we had a coherent, unified treatment. The fact that this was a clear explanation may be one of those things that's made this a much referred-to paper."[1] Figure 1 shows a chronological distribution of citations to this paper. The figure shows a distinct surge in citations to the paper around 1982-1984. Coleman speculates that this may be connected to a wave of interest at that time in cosmological applications of elementary particle physics.[1]

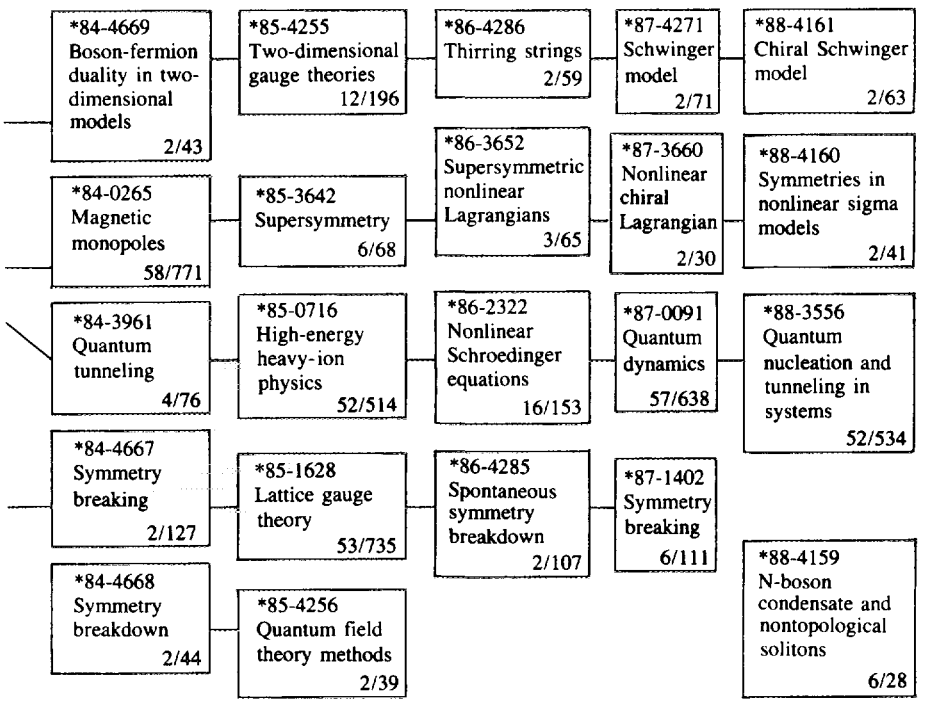
The paper clearly qualifies as a *Citation Classic®*. It was discussed in our 1986 study of primary authors of highly cited works in the 1984 *Science Citation Index®*.[11] It is also one of the core papers for several ISI research fronts, including the 1987 front "Symmetry breaking," #87-1402. This front is included in the historiograph in Figure 2 showing developments in field theory and particle physics.

Coleman's second most-cited work, "Quantum sine-Gordon equation as the massive Thirring model," a 1975 paper also published in *Physical Review D—Particles and Fields*, has been cited in over 660 publications.[12] This work appeared in our study of 1975 physical-sciences articles highly cited in 1975.[13] It was also one of approximately 35 physics papers that were identified as being among the 100 most-cited articles in the *CompuMath Citation Index®*, 1976-1980.[14]

Also among Coleman's most-cited papers is one of the Erice lectures collected in *The Whys of Subnuclear Physics*, "The uses of instantons."[15] The instanton is a solution to the nonlinear field equation that arises in Yang-Mills field theory. Coleman discusses the application of instantons to phenomena in quantum chromodynamics. This work has been cited over 140 times.

On the Value of Reviews

"A review article should be a textbook," says Coleman. "When you're finished reading the review, you should know the sub-



ject—you should be prepared to go into the literature and start doing calculations or running experiments." There are, he notes, many channels of scientific communication, such as seminars, the published literature, informal meetings at scientific conferences, and so on. "However," he says, "writing that is specifically pedagogical—textbooks or reviews—serves a function that none of these things serve. For one thing, it is accessible to someone who is unsophisticated and perhaps *not* at one of the greater centers of learning. Being at Harvard, I'm fortunate in that if I need to learn more about, say, phase transitions, I can go three doors down the hall and find an expert. Otherwise, it would be hopeless to just open up the appropriate section of *Physical Review* and start searching for articles on that topic. Or someone may be addressing a topic a bit more obscure than phase transitions. When you are in that position, you need a review."[1]

In our discussion of last year's recipient of the NAS award, Eric R. Kandel, Columbia University College of Physicians & Surgeons, New York, we noted that many writers of reviews, even the most expert and esteemed practitioners, often express dismay at the time-consuming nature of the reviewer's job.[16] Coleman has also had to contend with this problem. In recent years, he has preferred to concentrate on original work. Still, he acknowledges that the work of reviewing is unquestionably worthwhile and valuable.

"Reviews," he concludes, "really keep the enterprise going."

* * * * *

My thanks to C.J. Fiscus and Christopher King for their help in the preparation of this essay.

REFERENCES

1. **Coleman S.** Personal communication. 28 February 1989.
2. **Raven P H.** Personal communication. 6 February 1989.
3. **Garfield E.** The 1980 NAS James Murray Luck Award for Excellence in Scientific Reviewing: Conyers Herring receives second award for his work in solid-state physics. *Essays of an information scientist.* Philadelphia: ISI Press, 1981. Vol. 4. p. 512-4.
4. ----------. The 1983 NAS Award for Excellence in Scientific Reviewing goes to Michael Ellis Fisher for his reviews of the theory of equilibrium critical phenomena. *Ibid.*, 1984. Vol. 6. p. 139-43.
5. ----------. The 1986 NAS Award for Excellence in Scientific Reviewing goes to Virginia L. Trimble for her reviews in astronomy and astrophysics. *Ibid.*, 1988. Vol. 9. p. 146-54.
6. **Coleman S & Glashow S L.** Electrodynamic properties of baryons in the unitary symmetry scheme. *Phys. Rev. Lett.* 6:423-4, 1961.
7. **Coleman S.** Preface. *Aspects of symmetry.* Cambridge, UK: Cambridge University Press, 1985. p. xiii.
8. **Zichichi A,** ed. *The whys of subnuclear physics.* New York: Plenum Press, 1979. p. vi.
9. **Georgi H & Glashow S.** Letter to Bryce Crawford, Jr. 25 April 1985.
10. **Coleman S & Weinberg E.** Radiative corrections as the origin of spontaneous symmetry breaking. *Phys Rev. D—Part. Fields* 7:1888-910, 1973.
11. **Garfield E.** The 250 most-cited primary authors in the 1984 *SCI.* Part 2. Most-cited works, 1955-1985. *Essays of an information scientist: towards scientography.* Philadelphia: ISI Press, 1988. Vol. 9. p. 355-65. (Reprinted from: *Current Contents* (46):3-13, 17 November 1986.)
12. **Coleman S.** Quantum sine-Gordon equation as the massive Thirring model. *Phys. Rev. D—Part. Fields* 11:2088-97, 1975.
13. **Garfield E.** 1975 physical sciences articles highly cited in 1975. *Op. cit.*, 1977. Vol. 2. p. 457-60.
14. ----------. The multidisciplinary impact of math and computer science is reflected in the 100 most-cited articles in *CompuMath Citation Index*, 1976-1980. *Ibid.*, 1985. Vol. 7. p. 232-9.
15. **Coleman S.** The uses of instantons. (Zichichi A, ed.) *The whys of subnuclear physics.* New York: Plenum Press, 1979. p. 805-916.
16. **Garfield E.** Of sea snails and science reviews: neurobiologist Eric R. Kandel receives the 1988 NAS Award for Excellence in Scientific Reviewing. *Current Contents* (40):3-10, 3 October 1988.