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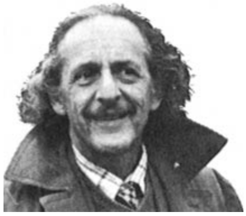

The 1980 Articles Most Cited in 1980 and 1981. 2. Physical Sciences

Number 20 May 16, 1983

In a recent essay, I presented the 1980 life sciences papers most cited in 1980-1981.[1] This essay covers the physical sciences, exclusive of chemistry, which will be examined in a future essay. These studies typify the special type of science journalism we have developed. It's our way of telling you about some of the "hot spots" of scientific research. Indeed, these active areas of research almost always develop into major specialties.

Table 1 lists the 105 articles included in this study. The number of citations each received in 1980 and 1981 is also shown. To emphasize the unique and immediate impact of these papers, let me remind you that most of the millions of papers and books cited each year in *Science Citation Index*® (*SCI*®) receive about two citations during any given two-year period. Even after a five-year period, the average paper is cited less than three times. Consider that the average paper listed in Table 1 received 36 citations—eight in 1980 and 28 in 1981. The most-cited paper received 102 citations, and the least-cited, 25 citations.

The papers in Table 1 are divided into six broad subject categories, and are arranged alphabetically therein by first author. We hope this arrangement will discourage invidious comparisons between individual papers ranked by citation frequency. And although each of these papers has had significant impact, I must also caution that they do not necessarily represent the "best" papers of 1980. Many other papers not listed here will eventually prove to have equal, or even greater, impact in later years. We really do not know enough about the phenomenon of delayed recognition, in both the historical and the short-term sense. But it is significant in itself that we must treat chemistry differently than physics in order to conduct these studies. And that difference will also be observed in many other fields.

Eighty-eight of the 105 articles in this study have already been included as "core" documents in the Research Front Specialty Index of our *Index to Scientific Reviews*™ (*ISR*™). Research front data on the more than 13,000 review articles indexed in *ISR* from January to June 1982 were made available last year.[2] Table 2 lists the names of the 1982 *ISR* research fronts that each include at least two papers in this study as *core* documents. A research front is a group of papers that cite one or more core papers or books collected in a co-citation cluster.

I have explained ISI®'s clustering techniques before.[3] The classification value of clustering is amply demonstrated by considering, for example, that the 11 core papers in research front 82-0312, "Grand unified theories, proton decay, neutrino masses, flavor dynamics, and Higgs boson in the SO(10) model," listed in Table 2, are divided into three broader, less descriptive categories established by "subjective indexing."

Research front searching is available through numerous online services—*ISI/BIOMED*®,[4] *ISI/CompuMath*®,[5] *ISI/GeoSciTech*™,[6] and soon, *ISI/BioChem*™. We added this capability to *ISR* to test the concept of printing a comprehensive, multidisciplinary list of

Table 1: The 1980 physical sciences articles most cited in 1980-1981. The authors' addresses follow each citation. Code numbers indicate the *ISR*™ research front specialties for which these are *core* papers. Asterisked code numbers indicate the *ISI/GeoSciTech*™ research front specialties for which these are *core* papers. A = number of citations received, 1980. B = number of citations received, 1981. C = total number of citations received, 1980-1981.

A	B	C	Bibliographic Data
			Chemical Physics
6	23	29	Alvesalo T A, Haavasoja T, Manninen M T & Soinne A T. **Pressure dependence of the specific-heat jump at the superfluid transition and the effective mass of ^{3}He.** *Phys. Rev. Lett.* 44:1076-9, 1980. Helsinki Univ. Technol., Low Temp. Lab., Helsinki, Finland. 82-0485
7	22	29	Balle T J, Campbell E J, Keenan M R & Flygare W H. **A new method for observing the rotational spectra of weak molecular complexes: KrHCl.** *J. Chem. Phys.* 72:922-32, 1980. Univ. Illinois, Noyes Chem. Lab., Urbana, IL.
4	24	28	Bartlett R J & Purvis G D. **Molecular applications of coupled cluster and many-body perturbation methods.** *Phys. Scr.* 21:255-65, 1980. Battelle Columbus Labs., Columbus, OH. 82-0397
7	46	53	Bechgaard K, Jacobsen C S, Mortensen K, Pedersen H J & Thorup N. **The properties of five highly conducting salts: $(TMTSF)_2X$, X = PF_6^-, AsF_6^-, SbF_6^-, BF_4^- and NO_3^-, derived from tetramethyltetraselenafulvalene (TMTSF).** *Solid State Commun.* 33:1119-25, 1980. Univ. Copenhagen, H.C. Orsted Inst., Copenhagen; Techn. Univ. Denmark, Phys. Lab. III & Chem. Dept., Lyngby, Denmark. 82-0534
14	38	52	Billmann J, Kovacs G & Otto A. **Enhanced Raman effect from cyanide adsorbed on a silver electrode.** *Surface Sci.* 92:153-73, 1980. Univ. Dusseldorf, Phys. Inst. III, Dusseldorf, FRG. 82-0421
9	19	28	Bodenhausen G, Vold R L & Vold R R. **Multiple quantum spin-echo spectroscopy.** *J. Magn. Resonance* 37:93-106, 1980. Univ. Calif., Dept. Chem., La Jolla, CA. 82-0586
4	32	36	Boesl U, Neusser H J & Schlag E W. **Visible and UV multiphoton ionization and fragmentation of polyatomic molecules.** *J. Chem. Phys.* 72:4327-33, 1980. Munich Techn. Univ., Inst. Phys. & Theor. Chem., Garching, FRG. 82-0917
7	54	61	Furtak T E & Reyes J. **A critical analysis of theoretical models for the Giant Raman effect from adsorbed molecules.** *Surface Sci.* 93:351-82, 1980. Iowa State Univ., Ames Lab. & USDOE, Ames, IA. 82-0421
1	25	26	Gersten J & Nitzan A. **Electromagnetic theory of enhanced Raman scattering by molecules adsorbed on rough surfaces.** *J. Chem. Phys.* 73:3023-37, 1980. CUNY, Dept. Phys., New York, NY; Bell Labs., Murray Hill, NJ. 82-0421
8	29	37	Holonyak N, Kolbas R M, Dupuis R D & Dapkus P D. **Quantum-well heterostructure lasers.** *IEEE J. Quantum Electron.* 16:170-85, 1980. Univ. Illinois, Dept. Elec. Eng., Urbana, IL; Rockwell Internatl. Corp., Electron. Res. Ctr., Anaheim, CA. 82-1869
2	25	27	Johansson B & Martensson N. **Core-level binding-energy shifts for the metallic elements.** *Phys. Rev. B—Condensed Matter* 21:4427-57, 1980. FOA, Sect. Stockholm; Uppsala Univ., Inst. Phys., Uppsala, Sweden.
8	29	37	Lane N F. **The theory of electron-molecule collisions.** *Rev. Mod. Phys.* 52:29-119, 1980. Rice Univ., Dept. Phys., Houston, TX and Univ. Colorado & Natl. Bureau Stand., Joint Inst. Lab. Astrophys., Boulder, CO. 82-1272
1	30	31	Lo H W & Compaan A. **Raman measurement of lattice temperature during pulsed laser heating of silicon.** *Phys. Rev. Lett.* 44:1604-7, 1980. Kansas State Univ., Dept. Phys., Manhattan, KS. 82-0612
5	31	36	Lubman D M, Naaman R & Zare R N. **Multiphoton ionization of azulene and naphthalene.** *J. Chem. Phys.* 72:3034-40, 1980. Stanford Univ., Dept. Chem., Stanford, CA. 82-0917
1	38	39	McCall S L, Platzman P M & Wolff P A. **Surface enhanced Raman scattering.** *Phys. Lett. A* 77:381-3, 1980. Bell Labs., Murray Hill, NJ; Mass. Inst. Technol., Res. Lab. Electron., Cambridge, MA. 82-0421
2	23	25	Nagai H, Noguchi Y, Takahei K, Toyoshima Y & Iwane G. **InP/GaInAsP buried heterostructure lasers of 1.5 μm region.** *Jpn. J. Appl. Phys.* 19:L218-20, 1980. Nippon Teleg. Teleph. Publ. Corp., Musashino Elec. Commun. Lab., Tokyo, Japan.
3	26	29	Reimer J A, Vaughan R W & Knights J C. **Proton magnetic resonance spectra of plasma-deposited amorphous Si:H films.** *Phys. Rev. Lett.* 44:193-6, 1980. Calif. Inst. Technol., Div. Chem. & Chem. Eng., Pasadena, CA; Xerox Palo Alto Res. Ctr., Palo Alto, CA. 82-0508
6	36	42	Rowe J E, Shank C V, Zwemer D A & Murray C A. **Ultrahigh-vacuum studies of enhanced Raman scattering from pyridine on Ag surfaces.** *Phys. Rev. Lett.* 44:1770-3, 1980. Bell Labs., Murray Hill & Bell Labs., Holmdel, NJ. 82-0421
6	26	32	Thompson G H B & Henshall G D. **Nonradiative carrier loss and temperature sensitivity of threshold in 1.27 μm (GaIn)(AsP)/InP d.h. lasers.** *Electron. Lett.* 16:42-4, 1980. Standard Telecommun. Labs., Harlow, UK. 82-1128
			Quantum Field Theory
8	18	26	Amit D J, Goldschmidt Y Y & Grinstein G. **Renormalization group analysis of the phase transition in the 2D Coulomb gas, sine-Gordon theory and XY-model.** *J. Phys.—A—Math. Gen.* 13:585-620, 1980. Hebrew Univ., Racah Inst. Phys., Jerusalem, Israel; Saclay Nucl. Res. Ctr., Serv. Theor. Phys., Gif-sur-Yvette, France; NORDITA, Copenhagen, Denmark. 82-0498

Quantum Field Theory (continued)

A	B	C	Bibliographic Data
13	20	33	Barbieri R, Nanopoulos D V, Morchio G & Strocchi F. **Neutrino masses in grand unified theories.** *Phys. Lett. B* 90:91-7, 1980. CERN, Geneva, Switzerland; Univ. Pisa, Inst. Phys.; INFN, Pisa Sect.; Scuola Normale Super., Pisa, Italy. 82-0312
9	21	30	Bassetto A, Ciafaloni M & Marchesini G. **Inelastic distributions and color structure in perturbative QCD.** *Nucl. Phys. B* 163:477-518, 1980. Libera Univ., Dept. Phys., Trento; INFN, Pisa & Milan Sects.; Scuola Normale Super., Pisa; Univ. Parma, Inst. Phys., Parma, Italy. 82-0182
12	28	40	Callan C G, Dashen R F & Gross D J. **Are instantons found?** *Phys. Rev. Lett.* 44:435-8, 1980. Princeton Univ.; Inst. Adv. Study, Princeton, NJ. 82-0314
3	22	25	Coleman S & Witten E. **Chiral-symmetry breakdown in large-*N* chromodynamics.** *Phys. Rev. Lett.* 45:100-2, 1980. Stanford Univ., SLAC, Stanford, CA; Harvard Univ., Dept. Phys., Cambridge, MA. 82-0680
10	92	102	Creutz M. **Monte-Carlo study of quantized SU(2) gauge theory.** *Phys. Rev. D—Part. Fields* 21:2308-15, 1980. Brookhaven Natl. Lab., Dept. Phys., Upton, NY. 82-0314
2	27	29	Currie J F, Krumhansl J A, Bishop A R & Trullinger S E. **Statistical mechanics of one-dimensional solitary-wave-bearing scalar fields: exact results and ideal-gas phenomenology.** *Phys. Rev. B—Condensed Matter* 22:477-96, 1980. Cornell Univ., Lab. Atom. Solid State Phys., Ithaca, NY; Queen Mary Coll., Dept. Phys., London, UK; Univ. S. Calif., Dept. Phys., Los Angeles, CA. 82-0952
9	46	55	Eichten E & Lane K. **Dynamical breaking of weak interaction symmetries.** *Phys. Lett. B* 90:125-30, 1980. Harvard Univ., Lyman Lab. Phys., Cambridge, MA. 82-0314
1	34	35	Ellis J, Gaillard M K & Zumino B. **A grand unified theory obtained from broken supergravity.** *Phys. Lett. B* 94:343-8, 1980. CERN, Geneva, Switzerland; LAPP, Annecy-le-Vieux, France. 82-1001
5	42	47	Gross D J & Witten E. **Possible third-order phase transition in the large-*N* lattice gauge theory.** *Phys. Rev. D—Part. Fields* 21:446-53, 1980. Princeton Univ., J. Henry Labs., Princeton, NJ; Harvard Univ., Lyman Lab. Phys., Cambridge, MA. 82-0316
3	36	39	Hasenfratz A & Hasenfratz P. **The connection between the Λ parameters of lattice and continuum QCD.** *Phys. Lett. B* 93:165-9, 1980. Eotvos Lorand Univ., Budapest, Hungary; CERN, Geneva, Switzerland. 82-0314
1	36	37	Itzykson C, Peskin M E & Zuber J B. **Roughening of Wilson's surface.** *Phys. Lett. B* 95:259-64, 1980. Saclay Nucl. Res. Ctr., Gif-sur-Yvette, France. 82-0319
1	40	41	Le Guillou J C & Zinn-Justin J. **Critical exponents from field theory.** *Phys. Rev. B—Condensed Matter* 21:3976-98, 1980. Univ. Paris VI, Lab. Theor. Phys. High Energy, Paris; Saclay Nucl. Res. Ctr., Serv. Theor. Phys., Gif-sur-Yvette, France. 82-2071
12	27	39	Mohapatra R N & Senjanovic G. **Neutrino mass and spontaneous parity nonconservation.** *Phys. Rev. Lett.* 44:912-5, 1980. CUNY, Dept. Phys., New York, NY; Univ. Maryland, Dept. Phys. & Astron., College Park, MD. 82-0312
8	20	28	Polyakov A M. **Gauge fields as rings of glue.** *Nucl. Phys. B* 164:171-88, 1980. L.D. Landau Inst. Theor. Phys., Moscow, USSR. 82-0316
2	26	28	Rebbi C. **Phase structure of non-Abelian lattice gauge theories.** *Phys. Rev. D—Part. Fields* 21:3350-9, 1980. Brookhaven Natl. Lab., Dept. Phys., Upton, NY. 82-0314
12	13	25	Ukawa A, Windey P & Guth A H. **Dual variables for lattice gauge theories and the phase structure of *Z(N)* systems.** *Phys. Rev. D—Part. Fields* 21:1013-36, 1980. Princeton Univ., J. Henry Labs., Princeton, NJ; Cornell Univ., Lab. Nucl. Stud., Ithaca, NY.
7	29	36	Weinberg S. **Effective gauge theories.** *Phys. Lett. B* 91:51-5, 1980. Harvard Univ., Lyman Lab. Phys and Harvard-Smithsonian Ctr. Astrophys., Cambridge, MA. 82-0312
17	47	64	Witten E. **Neutrino masses in the minimal O(10) theory.** *Phys. Lett. B* 91:81-4, 1980. Harvard Univ., Lyman Lab. Phys., Cambridge, MA. 82-0312

Astrophysics & Geophysics

A	B	C	Bibliographic Data
8	21	29	Alvarez L W, Alvarez W, Asaro F & Michel H V. **Extraterrestrial cause for Cretaceous-Tertiary extinction.** *Science* 208:1095-108, 1980. Univ. Calif., Lawrence Berkeley Lab. & Dept. Geol. Geophys., Berkeley, CA. *81-0167
5	20	25	Bath G T, Pringle J E & Whelan J A J. **Spectrophotometry of dwarf-novae in the wavelength range 1250-7500 Å.** *Mon. Notic. Roy. Astron. Soc.* 190:185-94, 1980. Oxford Univ., Dept. Astrophys., Oxford; Univ. Cambridge, Inst. Astron., Cambridge, UK.
1	30	31	Bohlin R C, Holm A V, Savage B D, Snijders M A J & Sparks W M. **Photometric calibration of the international ultraviolet explorer (IUE): low dispersion.** *Astron. Astrophys.* 85:1-13, 1980. NASA, GSFC, Greenbelt; Comput. Sci. Corp., Silver Spring, MD; Univ. Wisconsin, Dept. Astron., Madison, WI; Univ. Coll. London, Dept. Phys. & Astron., London, UK. 82-0887
2	24	26	Conti P S & Garmany C D. **Mass loss from O-type stars.** *Astrophys. J.* 238:190-5, 1980. Univ. Colorado & Natl. Bureau Stand., Joint Inst. Lab. Astrophys., Boulder, CO. 82-0180
8	20	28	Crampton D, Cowley A P & Hutchings J B. **The probable binary nature of SS-433.** *Astrophys. J.* 235:L131-5, 1980. Herzberg Inst. Astrophys., Dominion Astrophys. Observ., Victoria, Canada. 82-0257
4	24	28	Dressler A. **Galaxy morphology in rich clusters: implications for the formation and evolution of galaxies.** *Astrophys. J.* 236:351-65, 1980. Calif. Inst. Technol. and Carnegie Inst. Washington, Hale Observ., Pasadena, CA. 82-1454

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A	B	C	
21	4	25	Pillius W, Ip W H & McIlwain C E. **Trapped radiation belts of Saturn: first look.** *Science* 207:425-31, 1980. Univ. Calif., La Jolla, CA; Max Planck Inst. Aeron., Katlenburg-Lindau, FRG.
25	13	38	Gehrels T, Baker L R, Beshore E, Blenman C, Burke J J, Castillo N D, DaCosta B, Degewij J, Doose L R, Fountain J W, Gotobed J, KenKnight C E, Kingston R, McLaughlin G, McMillan R, Murphy R, Smith P H, Stoll C P, Strickland R N, Tomasko M G, Wijesinghe M P, Coffeen D L & Esposito L. **Imaging photopolarimeter on Pioneer Saturn.** *Science* 207:434-9, 1980. Univ. Arizona, Tucson, AZ; Goddard Inst. Space Stud., New York, NY; Univ. Colorado, Lab. Atmos. Space Phys., Boulder, CO. *81-0032
6	20	26	Geldzahler B J, Pauls T & Salter C J. **Continuum observations of the supernova remnants W 50 and C 74.9 + 1.2 at 2695 MHz.** *Astron. Astrophys.* 84:237-44, 1980. Max Planck Inst. Radioastron., Bonn, FRG; Univ. Pennsylvania, Dept. Astron., Philadelphia, PA. 82-0257
10	38	48	Guth A H & Tye S-H H. **Phase transitions and magnetic monopole production in the very early universe.** *Phys. Rev. Lett.* 44:631-5, 1980. Stanford Univ., SLAC, Stanford, CA; Cornell Univ., Lab. Nucl. Stud., Ithaca, NY. 82-0313
6	21	27	Ridgway S T, Joyce R R, White N M & Wing R F. **Effective temperatures of late-type stars: the field giants from K0 to M6.** *Astrophys. J.* 235:126-37, 1980. Kitt Peak Natl. Observ., Tucson; Lowell Observ., Flagstaff, AZ; Ohio State Univ., Dept. Astron., Columbus, OH. 82-0703
6	29	35	Sclater J G, Jaupart C & Galson D. **The heat flow through oceanic and continental crust and the heat loss of the earth.** *Rev. Geophys. Space Phys.* 18:269-311, 1980. Mass. Inst. Technol., Dept. Earth Planet. Sci., Cambridge, MA. 82-0578
23	4	27	Simpson J A, Bastian T S, Chenette D L, Lentz G A, McKibben R B, Pyle K R & Tuzzolino A J. **Saturnian trapped radiation and its absorption by satellites and rings: the first results from Pioneer 11.** *Science* 207:411-5, 1980. Univ. Chicago, Enrico Fermi Inst., Chicago, IL. *81-0032
21	12	33	Smith E J, Davis L, Jones D E, Coleman P J, Colburn D S, Dyal P & Sonett C P. **Saturn's magnetic field and magnetosphere.** *Science* 207:407-10, 1980. Calif. Inst. Technol., Jet Propulsion Lab., Pasadena, CA; Brigham Young Univ., Provo, UT; Univ. Calif., Los Angeles; NASA, Ames Res. Ctr., Moffett Field, CA; Univ. Arizona, Tucson, AZ. *81-0032
5	21	26	Spiess F N, Macdonald K C, Atwater T, Ballard R, Carranza A, Cordoba D, Cox C, Diaz Garcia V M, Francheteau J, Guerrero J, Hawkins J, Haymon R, Hessler R, Juteau T, Kastner M, Larson R, Luyendyk B, Macdougall J D, Miller S, Normark W, Orcutt J & Rangin C. **East Pacific Rise: hot springs and geophysical experiments.** *Science* 207:1421-33, 1980. Univ. Calif., Scripps Inst. Oceanogr., La Jolla, CA; Mass. Inst. Technol., Dept. Earth Planet. Sci., Cambridge; Woods Hole Oceanogr. Inst., Woods Hole, MA; Natl. Univ. Mexico, Ctr. Ocean Sci. & Inst. Geol., Mexico City, Mexico; Natl. Ctr. Exploit. Oceans, Ctr. Oceanolog., Brest; Univ. Louis Pasteur, Lab. Min. Petrogr., Strasbourg, France; Lamont-Doherty Geol. Observ., Palisades, NY; Univ. Calif., Geol. Dept., Santa Barbara; US Geol. Survey, Off-Marine Geol., Menlo Park, CA; Univ. Paris VI, Inst. Geol., Paris, France. 82-0860
27	8	35	Van Allen J A, Thomsen M F, Randall B A, Rairden R L & Grosskreutz C L. **Saturn's magnetosphere, rings, and inner satellites.** *Science* 207:415-21, 1980. Univ. Iowa, Dept. Phys. Astron., Iowa City, IA. *81-0032
4	23	27	Walter F M, Cash W, Charles P A & Bowyer C S. **X-rays from RS Canum Venaticorum systems: a *HEAO-1* survey and the development of a coronal model.** *Astrophys. J.* 236:212-8, 1980. Univ. Calif., Space Sci. Lab., Berkeley, CA. 82-0606
6	22	28	Zinn R. **The globular cluster system of the galaxy. 1. The metal abundances and reddenings of 79 globular clusters from integrated light measurements.** *Astrophys. J. Suppl. Ser.* 42:19-40, 1980. Calif. Inst. Technol. and Carnegie Inst. Washington, Hale Observ., Pasadena, CA. 82-0703

Materials Science

A	B	C	
7	48	55	Altshuler B L, Aronov A G & Lee P A. **Interaction effects in disordered Fermi systems in two dimensions.** *Phys. Rev. Lett.* 44:1288-91, 1980. Leningrad Nucl. Phys. Inst., Leningrad, USSR; Bell Labs., Murray Hill, NJ. 82-0306
8	30	38	Bishop D J, Tsui D C & Dynes R C. **Nonmetallic conduction in electron inversion layers at low temperatures.** *Phys. Rev. Lett.* 44:1153-6, 1980. Bell Labs., Murray Hill, NJ. 82-0306
5	26	31	Blinowski J, Hau N H, Rigaux C, Vieren J P, Le Toullec R, Furdin G, Herold A & Melin J. **Band structure model and dynamical dielectric function in lowest stages of graphite acceptor compounds.** *J. Phys.—Paris* 41:47-58, 1980. Ecole Normale Super., Group Phys. Solids; Univ. Paris VI, Lab. Phys. Solids, Paris; Lab. Chem. Miner. Appl., Nancy, France. 82-0726
10	26	36	Chadi D J, Bauer R S, Williams R H, Hansson G V, Bachrach R Z, Mikkelsen J C, Houzay F, Guichar G M, Pinchaux R & Petroff Y. **Atomic and electronic structure of the 7x7 reconstructed Si(111) surface.** *Phys. Rev. Lett.* 44:799-802, 1980. Xerox Palo Alto Res. Ctr., Palo Alto, CA; Univ. Paris-Sud, Lab. Util. Rayon. Electromag., Orsay, France. 82-1148
5	20	25	Eastman D E. **Geometrical and electronic structure of Si (001) and Si (111) surfaces: a status report.** *J. Vac. Sci. Technol.* 17:492-500, 1980. IBM Thomas J. Watson Res. Ctr., Yorktown Heights, NY. 82-1148
2	34	36	Fisher M E & Selke W. **Infinitely many commensurate phases in a simple Ising model.** *Phys. Rev. Lett.* 44:1502-5, 1980. Cornell Univ., Baker Lab., Ithaca, NY; Univ. Saarlandes, Inst. Theor. Phys., Saarbrucken, FRG. 82-0657

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A	B	C	
18	18	36	Greiner J H, Kircher C J, Klepner S P, Lahiri S K, Warnecke A J, Basavaiah S, Yen E T, Baker J M, Brosious P R, Huang H-C W, Murakami M & Ames I. **Fabrication process for Josephson integrated circuits.** *IBM J. Res. Develop.* 24:195-205, 1980. IBM Thomas J. Watson Res. Ctr., Yorktown Heights, NY; IBM Gen. Prod. Div. Lab., San Jose, CA.
8	38	46	Hikami S, Larkin A I & Nagaoka Y. **Spin-orbit interaction and magnetoresistance in the two dimensional random system.** *Progr. Theor. Phys. Kyoto* 63:707-10, 1980. Kyoto Univ., Res. Inst. Fund. Phys., Kyoto, Japan. 82-0306
5	22	27	Hjalmarson H P, Vogl P, Wolford D J & Dow J D. **Theory of substitutional deep traps in covalent semiconductors.** *Phys. Rev. Lett.* 44:810-3, 1980. Univ. Illinois, Dept. Phys. & Mat. Res. Lab., Coord. Sci. Lab. & Dept. Elec. Eng., Urbana, IL; Univ. Graz, Inst. Theor. Phys., Graz, Austria; IBM Thomas J. Watson Res. Ctr., Yorktown Heights, NY; Solar Energy Res. Inst., Golden, CO. 82-0689
7	21	28	Kawaguchi Y & Kawaji S. **Negative magnetoresistance in silicon (100) MOS inversion layers.** *J. Phys. Soc. Jpn.* 48:699-700, 1980. Gakushuin Women's Jr. Coll.; Gakushuin Univ., Dept. Phys., Tokyo, Japan. 82-0306
3	23	26	Knights J C. **Growth morphology and defects in plasma-deposited a-Si:H films.** *J. Non-Cryst. Solids* 35/36:159-70, 1980. Xerox Palo Alto Res. Ctr., Palo Alto, CA. 82-0508
4	22	26	Mikeska H J. **Non-linear dynamics of classical one-dimensional antiferromagnets.** *J. Phys.—C—Solid State Phys.* 13:2913-23, 1980. Univ. Hannover, Inst. Theor. Phys., Hannover, FRG. 82-0952
6	31	37	Reynolds P J, Stanley H E & Klein W. **Large-cell Monte Carlo renormalization group for percolation.** *Phys. Rev. B—Condensed Matter* 21:1223-45, 1980. Boston Univ., Dept. Phys. & Ctr. Polym. Stud., Boston, MA. 82-1279
5	20	25	Riedinger L L, Andersen O, Frauendorf S, Garrett J D, Gaardhoje J J, Hagemann G B, Herskind B, Makovetzky Y V, Waddington J C, Guttormsen M & Tjom P O. **Frequency and alignment classification of multiple band crossings.** *Phys. Rev. Lett.* 44:568-72, 1980. Univ. Copenhagen, Niels Bohr Inst., Copenhagen, Denmark; McMaster Univ., Hamilton, Canada; Univ. Bergen, Inst. Phys., Bergen; Univ. Oslo, Inst. Phys., Oslo, Norway. 82-0506
12	25	37	Silvera I F & Walraven J T M. **Stabilization of atomic hydrogen at low temperature.** *Phys. Rev. Lett.* 44:164-8, 1980. Univ. Amsterdam, Natuurkundig. Lab., Amsterdam, the Netherlands.
6	34	40	Spicer W E, Lindau I, Skeath P, Su C Y & Chye P. **Unified mechanism for Schottky-barrier formation and III-V oxide interface states.** *Phys. Rev. Lett.* 44:420-3, 1980. Stanford Univ., Electron. Labs., Stanford, CA. 82-0539
8	17	25	van der Veen J F, Himpsel F J & Eastman D E. **Structure-dependent 4f—core-level binding energies for surface atoms on Ir(111), Ir(100)-(5x1), and metastable Ir(100)-(1x1).** *Phys. Rev. Lett.* 44:189-92, 1980. IBM Thomas J. Watson Res. Ctr., Yorktown Heights, NY.
10	26	36	White C W, Wilson S R, Appleton B R & Young F W. **Supersaturated substitutional alloys formed by ion implantation and pulsed laser annealing of group-III and group-V dopants in silicon.** *J. Appl. Phys.* 51:738-49, 1980. Oak Ridge Natl. Lab., Solid State Div., Oak Ridge, TN. 82-2407

Theoretical Elementary Particle Physics

A	B	C	
4	23	27	Abbott L F & Barnett R M. **The effect of $1/Q^2$ and α_s corrections on tests of QCD.** *Ann. Phys. NY* 125:276-308, 1980. Stanford Univ., SLAC, Stanford, CA. 82-0181
16	34	50	Bander M, Silverman D & Soni A. **Mechanism for the difference in lifetimes of charged and neutral *D*-mesons.** *Phys. Rev. Lett.* 44:7-9, 1980. Univ. Calif., Dept. Phys., Irvine, CA. 82-0478
10	19	29	Barger V, Keung W Y & Phillips R J N. **On ψ and τ production via gluons.** *Phys. Lett. B* 91:253-8, 1980. Univ. Wisconsin, Dept. Phys., Madison, WI; Rutherford Lab., Chilton, UK. 82-0698
26	67	93	Buras A J. **Asymptotic freedom in deep inelastic processes in the leading order and beyond.** *Rev. Mod. Phys.* 52:199-276, 1980. Fermi Natl. Accel. Lab., Batavia, IL. 82-0181
5	20	25	Casalbuoni R & Gatto R. **Subcomponent models of quarks and leptons.** *Phys. Lett. B* 93:47-52, 1980. INFN, Florence Sect., Florence, Italy; Univ. Geneva, Dept. Theor. Phys., Geneva, Switzerland. 82-0312
2	39	41	Creutz M. **Asymptotic-freedom scales.** *Phys. Rev. Lett.* 45:313-6, 1980. Brookhaven Natl. Lab., Dept. Phys., Upton, NY. 82-0314
6	23	29	Delorme J, Ericson M, Figureau A & Giraud N. **Critical opalescence of the nuclear pion field: possible evidence in the M1 (15.11 MeV) form factor of ^{12}C.** *Phys. Lett. B* 89:327-32, 1980. Univ. Claude-Bernard (Lyon I), Inst. Nucl. Phys., Lyon, France. 82-0408
4	22	26	Desplanques B, Donoghue J F & Holstein B R. **Unified treatment of the parity violating nuclear force.** *Ann. Phys. NY* 124:449-95, 1980. CNRS, Inst. Nucl. Phys., Orsay, France; Mass. Inst. Technol., Lab. Nucl. Sci. and Dept. Phys., Cambridge, MA; Natl. Sci. Fdn., Div. Phys., Washington, DC.
3	23	26	Dimopoulos S. **Technicoloured signatures.** *Nucl. Phys. B* 168:69-92, 1980. Stanford Univ., Dept. Phys., Stanford, CA. 82-0314
11	45	56	Dokshitzer Yu L, Dyakonov D I & Troyan S I. **Hard processes in quantum chromodynamics.** *Phys. Rep.—Rev. Sect. Phys. Lett. C* 58:270-395, 1980. Leningrad Nucl. Phys. Inst., Leningrad, USSR. 82-0181
7	23	30	Donoghue J F & Johnson K. **The pion and an improved static bag model.** *Phys. Rev. D—Part. Fields* 21:1975-85, 1980. Mass. Inst. Technol., Lab. Nucl. Sci. & Dept. Phys., Cambridge, MA. 82-0317
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A	B	C	
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9	20	29	De Rujula A, Lusignoli M, Maiani L, Petcov S T & Petronzio R. **A fresh look at neutrino oscillations.** *Nucl. Phys. B* 168:54-68, 1980. CERN, Geneva, Switzerland. 82-0312
4	23	27	Eastman D E, Donelon J J, Hien N C & Himpsel F J. **An ellipsoidal mirror display analyzer system for electron energy and angular measurements.** *Nucl. Instrum. Method. Phys. Res.* 172:327-36, 1980. IBM Thomas J. Watson Res. Ctr., Yorktown Heights, NY.
28	50	78	Eichten E, Gottfried K, Kinoshita T, Lane K D & Yan T M. **Charmonium: comparison with experiment.** *Phys. Rev. D—Part. Fields* 21:203-33, 1980. Cornell Univ., Lab. Nucl. Stud., Ithaca, NY. 82-0183
3	24	27	Finocchiaro G, Giannini G, Lee-Franzini J, Schamberger R D, Sivertz M, Spencer L J, Tuts P M, Bohringer T, Costantini F, Dobbins J, Franzini P, Han K, Herb S W, Kaplan D M, Lederman L M, Mageras G, Peterson D, Rice E, Yoh J K & Levman G. **Observation of the Υ''' at the Cornell Electron Storage Ring.** *Phys. Rev. Lett.* 45:222-5, 1980. SUNY, Stony Brook; Columbia Univ., New York, NY; Louisiana State Univ., Baton Rouge, LA. 82-0183
3	24	27	Goodman C D, Goulding C A, Greenfield M B, Rapaport J, Bainum D E, Foster C C, Love W G & Petrovich F. **Gamow-Teller matrix elements from $0°(p,n)$ cross sections.** *Phys. Rev. Lett.* 44:1755-9, 1980. Oak Ridge Natl. Lab., Oak Ridge, TN; Florida A&M Univ.; Florida State Univ., Tallahassee, FL; Ohio Univ., Athens, OH; Emporia State Univ., Emporia, KS; Indiana Univ., Bloomington, IN; Univ. Georgia, Athens, GA. 82-0165
1	31	32	Lubimov V A, Novikov E G, Nozik V Z, Tretyakov E F & Kosik V S. **An estimate of the ν_e mass from the β-spectrum of tritium in the valine molecule.** *Phys. Lett. B* 94:266-8, 1980. Inst. Theor. Exp. Phys., Moscow, USSR. 82-0312
4	65	69	Reines F, Sobel H W & Pasierb E. **Evidence for neutrino instability.** *Phys. Rev. Lett.* 45:1307-11, 1980. Univ. Calif., Dept. Phys., Irvine, CA. 82-0312

Table 2: 1982 *ISR*™ research fronts which contain two or more 1980 most-cited physical sciences papers as core documents. A = research front number. B = research front name. C = number of 1980 most-cited physical sciences papers included in the core of each research front. D = total number of core documents in each research front.

A	B	C	D
82-0181	Perturbative quantum chromodynamics, hadron jets, structure functions, and quarks	5	70
82-0183	Quarkonia, interquark forces, flavor independence, and charmed particles	5	26
82-0257	Radio observations, kinematical analysis, and the structure of the galactic radio source SS433	2	4
82-0306	Effects of Anderson localization in disordered systems on magnetoresistance, conductance, and Zeeman splitting	4	17
82-0312	Grand unified theories, proton decay, neutrino masses, flavor dynamics, and Higgs boson in the SO(10) model	11	63
82-0314	Lattice gauge theory, quark confinement, and strong and weak coupling	7	43
82-0316	Quantum chromodynamics as a dynamics of loops, the loop space solution of 2-dimensional quantum chromodynamics, and the large N limit for euclidean field theories	2	11
82-0421	Surface-enhanced Raman scattering	5	27
82-0478	Properties of non-leptonic and charmed meson decays	2	14
82-0508	Properties of amorphous hydrogenated silicon, with emphasis on preparation by sputtering	2	24
82-0653	Nuclear structure: Gamow-Teller states, spin excitations, axial polarizabilities, and scattering at intermediate energies	2	4
82-0703	Chemical composition and structure of globular clusters, extragalactic objects, and gaseous nebula	2	56
82-0917	Multiphoton ionization studies	2	11
82-0952	Solitons in one-dimensional magnets, sine-Gordon systems, and equilibrium dynamics	2	8
82-1148	Electronic structure of silicon crystals	2	5

research fronts. We have just completed processing *ISR* for August-December 1982. This has provided some interesting insights on the number of *SCI* research fronts not covered by review articles. I want to stress that it is the entire *SCI* which is used to identify research fronts, not just the articles selected for *ISR*.

The numbers of the relevant 1982 research fronts from Table 2 follow the authors' addresses in Table 1. Of the 17 papers not included as core documents in *ISR* research fronts, five are core documents in *ISI/GeoSciTech* research fronts. These research front numbers are distinguished by asterisks in Table 1. Five are core papers in 1981 research fronts. Four of these are included in research front specialty 81-0032, "Trapped radiation, formation of rings, and energetic particle fluxes in the magnetosphere of Saturn." The fifth paper is contained in research front specialty 81-0167, "Paleomagnetism of Cretaceous and Tertiary rocks from the Mediterranean Sea region and cause of Cretaceous-Tertiary extinction." Three additional papers are *citing* documents in the *ISI/GeoSciTech* research fronts, and one other paper appears as a citing document in an *ISI/CompuMath* research front.

We fully expect that by the time the 1983 editions of *ISR* and *ISI/GeoSciTech* are compiled, the remaining eight papers in this study will also have become core documents in ISI research fronts. The names of research fronts, incidentally, are derived from the words and phrases most frequently used in the titles of the articles that cite core documents. Indeed, research front names can be used as an alternative method of classifying the papers in this study.

Sixteen of the papers in Table 1 are single-author works. Twenty-two list two authors, 27 have three, 14 have four, and eight have five. Four papers have seven authors, and two list eight. One paper each lists nine, ten, 11, 12, 19, 20, 22, 23, 62, 66, 73, and 86 authors. The latter four papers are from the field of experimental elementary particle physics, where much of the research requires the use of gigantic particle accelerators. These experiments require enormous collaborative effort. The *average* number of authors per paper in this group is 26. I should point out that this number is not remarkable—in our study of the most-cited 1979 physical sciences papers, the experimental particle physics papers averaged 39 authors each![7] It seems to me, however, that perhaps this type of multiple-author study cries out for the kind of reforms I have spoken of in the past,[8] in which most contributors are given credit in an acknowledgment section, rather than as authors in the byline.

Ninety-six authors have more than one paper in Table 1. Of these, 93 have two papers listed. Only three authors—D.G. Cassel, D.E. Eastman, and E. Witten—have three papers in Table 1.

Table 3 lists the 33 journals that published the most-cited articles in this study. Four journals account for over half of the papers. They are: *Physical Review Letters*, 28 papers; *Physics Letters B*, 16; *Physical Review D—Particles and Fields*, 7; and *Science*, 7. *Physical Review Letters* has topped the journal list each year since 1976.[7,9-11]

The authors in this study are affiliated with 118 institutions in 18 different countries. Table 4 lists these institutions in descending order of the number of papers produced. Sixty-two institutions are located in the US—a significant increase over our last two studies. There were 44 US institutions in our study of the 1978 physical sciences papers,[11] and 48 in our survey of the 1979 most-cited articles.[7] However, the number of *papers* from US institutions has actually *decreased* slightly. In our study of the 1979 physical sciences papers, the number of papers from US institutions was 88. Of these, 15 were coauthored with scientists from other countries. In this study, 73 papers were produced by authors with US institutional affiliations. Fourteen of these papers were collaborative efforts with authors from other countries. Thus, the number of institutions increased without

Table 3: The 33 journals represented on the list of 1980 physical sciences papers most cited in 1980-1981. The numbers in parentheses are the impact factors for the journals (1980 impact factor equals the number of citations received by 1978-1979 articles in a journal divided by the number of articles published by the journal during the same period). Data were taken from the 1980 *Journal Citation Reports®*. The figures at the right indicate the number of papers from each journal which appears on the list.

Phys. Rev. Lett. (5.4)	28
Phys. Lett. B (3.6)	16
Phys. Rev. D—Part. Fields (2.6)	7
Science (5.7)	7
Astrophys. J. (4.0)	6
J. Chem. Phys. (3.2)	4
Nucl. Phys. B (4.3)	4
Phys. Rev. B—Condensed Matter (2.6)	4
Ann. Phys. NY (2.9)	2
Astron. Astrophys. (2.5)	2
Rev. Mod. Phys. (9.3)	2
Surface Sci. (3.0)	2
Electron. Lett. (1.2)	1
IBM J. Res. Develop. (1.1)	1
IEEE J. Quantum Electron. (3.1)	1
J. Appl. Phys. (1.6)	1
J. Magn. Resonance (2.1)	1
J. Non-Cryst. Solids (2.7)	1
J. Phys.—Paris (1.2)	1
J. Phys. Soc. Jpn. (1.5)	1
J. Phys.—A—Math. Gen. (1.6)	1
J. Phys.—C—Solid State Phys. (2.9)	1
J. Vac. Sci. Technol. (2.1)	1
Jpn. J. Appl. Phys. (0.8)	1
Mon. Notic. Roy. Astron. Soc. (2.5)	1
Nucl. Instrum. Method. Phys. Res. (1.2)	1
Phys. Lett. A (1.1)	1
Phys. Rep.—Rev. Sect. Phys. Lett. C (7.1)	1
Phys. Rev. C—Nucl. Phys. (1.8)	1
Phys. Scr. (1.4)	1
Progr. Theor. Phys. Kyoto (1.5)	1
Rev. Geophys. Space Phys. (1.9)	1
Solid State Commun. (1.9)	1

a corresponding increase in the number of papers. These results imply that current research in the physical sciences is being produced at a greater number of institutions than ever before.

Of the remaining institutions in Table 4, ten are located in the Federal Republic of Germany (FRG), while France has nine, and the United Kingdom (UK) has seven. Italy and Japan are each represented by five institutions, and Denmark and Switzerland by three each. It should be noted that CERN, located in Geneva, Switzerland, is actually a consortium of 12 European nations. Canada, Israel, Norway, and Sweden each have two institutions in the table. Austria, Finland, Hungary, Mexico, the Netherlands, and the USSR are each represented by one institution. All of the papers in Table 1 were published in English.

Of the institutions represented in Table 4, the University of California produced nine papers—more than any other institution. Cornell University and Harvard University followed with seven each. Stanford University produced six papers. Interestingly, CERN appeared only four times—a total identical with that of the 1979 study,[7] but down substantially from the 1978 total of 19.[11]

Table 5 lists the national affiliations of the authors included in Table 1, in order of the total number of papers on which authors from each nation appeared. As I mentioned earlier, US authors were represented on 73 of the 105 papers in this study. Of these, 59 papers listed authors from the US alone. The remaining 14 papers were coauthored with scientists from Austria, France, the FRG, Israel, Mexico, the UK, and the USSR.

The six subject categories represented in Table 1 are: chemical physics, quantum field theory, astrophysics and geophysics, materials science, theoretical elementary particle physics, and experimental elementary particle physics. It should be kept in mind, however, that these distinctions are made as a matter of convenience, and do not necessarily reflect the way that physicists or others might classify the papers. The line between chemical physics and physical chemistry, for instance, is often quite thin.

Nineteen papers in Table 1 are from the field of chemical physics. Nine of the papers in this group deal explicitly with some aspect of spectroscopy or with lasers. Five more are concerned primarily with the Raman effect, or the change in the wavelength of light after it has been scattered by particles of a given material.[12] The remaining five papers deal with various subjects of interest to chemical physicists.

Nineteen papers in this study deal with quantum field theory. Briefly, quantum field theory states that systems composed of matter or energy may exist only

Table 4: The institutional affiliations of the authors on the list. Institutions are listed in descending order of the number of papers produced.

Univ. California, CA*		9
Berkeley[1]	3	
La Jolla	3	
Irvine	2	
Los Angeles	2	
Livermore	1	
Santa Barbara	1	
Cornell Univ., Ithaca, NY		7
Harvard Univ., Cambridge, MA[2]		7
Stanford Univ., CA[3]		6
Bell Labs., NJ*		5
Murray Hill	5	
Holmdel	1	
IBM*		5
Thomas J. Watson Res. Ctr., Yorktown Heights, NY	5	
Gen. Prod. Div. Lab., San Jose, CA	1	
Massachusetts Inst. Technol., Cambridge, MA		5
Univ. Paris, France		5
VI - Pierre et Marie Curie, Paris	4	
XI - Paris-Sud, Orsay	1	
Acad. Sci. USSR		4
Leningrad Nucl. Phys. Inst.	2	
Inst. Theor. Exp. Phys., Moscow	1	
L.D. Landau Inst. Theor. Phys., Moscow	1	
California Inst. Technol., Pasadena, CA		4
CERN, Geneva, Switzerland		4
Rutherford Lab., Chilton, UK		4
Univ. Wisconsin, Madison, WI		4
Brookhaven Natl. Lab., Upton, NY		3
CUNY, New York, NY		3
Fermi Natl. Accelerator Lab., Batavia, IL		3
Natl. Inst. Nucl. Phys. (INFN), Italy*		3
Pisa	2	
Florence	1	
Milan	1	
Oak Ridge Natl. Lab., TN		3
Princeton Univ., NJ		3
Saclay Nucl. Res. Ctr. (CENS), Gif-sur-Yvette, France		3
Univ. Colorado, Boulder, CO		3
Univ. Illinois, Urbana, IL		3
Univ. London, UK		3
Imperial Coll. Sci. Technol.	1	
Queen Mary Coll.	1	
Univ. Coll. London	1	
Xerox, Palo Alto Res. Ctr., CA		3
Carnegie Inst. Washington, Pasadena, CA		2
CNRS, Inst. Nucl. Phys., Orsay, France		2
Columbia Univ., New York, NY		2
Florida A&M Univ., Tallahassee, FL		2
German Electron Synchrotron (DESY), Hamburg, FRG		2
Indiana Univ., Bloomington, IN		2
Inst. Advanced Study, Princeton, NJ		2
Ithaca Coll., NY		2
Le Moyne Coll., Syracuse, NY		2
Max Planck Soc., FRG		2
Inst. Aeron., Katlenburg-Lindau	1	
Inst. Radioastron., Bonn	1	
NASA		2
Ames Res. Ctr., Moffett Field, CA	1	
Goddard Space Flight Ctr. (GSFC), Greenbelt, MD	1	
Natl. Bureau Standards, Boulder, CO		2
Ohio Univ., Athens, OH		2
Oxford Univ., UK		2
Rutgers Univ., New Brunswick, NJ		2
Scuola Normale Superiore, Pisa, Italy		2
SUNY, Stony Brook, NY		2
Syracuse Univ., NY		2
Univ. Arizona, Tucson, AZ		2
Univ. Copenhagen, Denmark		2
Univ. Hamburg, FRG		2
Univ. Rochester, NY		2
Univ. Tokyo, Japan		2
Vanderbilt Univ., Nashville, TN		2
Weizmann Inst. Sci., Rehovot, Israel		2
Argonne Natl. Lab., IL		1
Battelle Columbus Labs., Columbus, OH		1
Boston Univ., MA		1
Brigham Young Univ., Provo, UT		1
Computer Sciences Corp., Silver Spring, MD		1
Ecole Normale Superieure, Paris, France		1
Emporia State Univ., KS		1
Eotvos Lorand Univ., Budapest, Hungary		1
Florida State Univ., Tallahassee, FL		1
Gakushuin Univ., Tokyo, Japan		1
Gakushuin Women's Jr. Coll., Tokyo, Japan		1
Goddard Inst. Space Studies, New York, NY		1
Hebrew Univ., Jerusalem, Israel		1
Helsinki Univ. Technol., Finland		1
Herzberg Inst. Astrophys., Victoria, Canada		1
Iowa State Univ., Ames, IA		1
Kansas State Univ., Manhattan, KS		1
Kitt Peak Natl. Observ., Tucson, AZ		1
Kyoto Univ., Japan		1
Lab. Annecy-le-Vieux Phys. Part. (LAPP), France		1
Lab. Chem. Mineral Appl., Nancy, France		1
Lamont-Doherty Geol. Observ., Palisades, NY		1
Libera Univ., Trento, Italy		1
Louisiana State Univ., Baton Rouge, LA		1
Lowell Observ., Flagstaff, AZ		1
McMaster Univ., Hamilton, Canada		1
Munich Techn. Univ., Garching, FRG		1
Natl. Ctr. Exploit. Oceans, Brest, France		1
Natl. Sci. Fdn., Washington, DC		1
Natl. Univ. Mexico, Mexico City, Mexico		1
Nippon Telegraph & Telephone Public Corp., Tokyo, Japan		1
Nordisk Inst. Theor. Atomic Phys. (NORDITA), Copenhagen, Denmark		1
Ohio State Univ., Columbus, OH		1
Rhine-Westphalia Techn. Univ. (RWTH), Aachen, FRG		1
Rice Univ., Houston, TX		1
Rockwell Internatl. Corp., Electron. Res. Ctr., Anaheim, CA		1
Solar Energy Res. Inst., Golden, CO		1
Standard Telecommun. Labs., Harlow, UK		1
Swedish Natl. Defense Res. Inst. (FOA), Stockholm, Sweden		1
Techn. Univ. Denmark, Lyngby, Denmark		1
Univ. Amsterdam, the Netherlands		1
Univ. Bergen, Norway		1
Univ. Bern, Switzerland		1
Univ. Bonn, FRG		1
Univ. Cambridge, UK		1
Univ. Chicago, IL		1
Univ. Claude-Bernard, Lyon, France		1
Univ. Dusseldorf, FRG		1
Univ. Geneva, Switzerland		1
Univ. Georgia, Athens, GA		1
Univ. Graz, Austria		1
Univ. Hannover, FRG		1
Univ. Heidelberg, FRG		1
Univ. Iowa, Iowa City, IA		1
Univ. Lancaster, UK		1
Univ. Louis Pasteur, Strasbourg, France		1
Univ. Manchester, UK		1
Univ. Maryland, College Park, MD		1
Univ. Oslo, Norway		1
Univ. Parma, Italy		1
Univ. Pennsylvania, Philadelphia, PA		1

Univ. Pisa, Italy	1
Univ. S. California, Los Angeles, CA	1
Univ. Saarlandes, Saarbrucken, FRG	1
Uppsala Univ., Sweden	1
US Geol. Survey, Menlo Park, CA	1
Virginia Polytech. Inst. and State Univ., Blacksburg, VA	1
Woods Hole Oceanographic Inst., MA	1
Yale Univ., New Haven, CT	1

*Some of the papers list more than one location for an institution.
[1]Includes Los Alamos Natl. Lab., NM
[2]Includes Harvard-Smithsonian Ctr. for Astrophysics
[3]Includes Stanford Linear Accelerator Ctr. (SLAC)

Table 5: National affiliations of the authors of the 1980 physical sciences papers most cited in 1980-1981, in order of the total number of papers on which each nation's authors appeared, shown in column A. B = number of papers coauthored with scientists from other countries. C = nationality of coauthors.

Country	A	B	C
US	73	14	Austria, France, FRG, Israel, Mexico, UK & USSR
France	10	5	Denmark, Israel, Mexico, Switzerland & US
FRG	8	5	Israel, Japan, UK & US
UK	7	6	FRG, Israel, Japan & US
Switzerland	6	4	France, Italy & Hungary
Japan	5	1	FRG & UK
USSR	4	1	US
Denmark	3	2	Canada, France, Israel & Norway
Israel	3	3	Denmark, France, FRG, UK & US
Italy	3	2	Switzerland
Canada	2	1	Denmark & Norway
Austria	1	1	US
Finland	1	0	
Hungary	1	1	Switzerland
Mexico	1	1	France & US
the Netherlands	1	0	
Norway	1	1	Canada & Denmark
Sweden	1	0	

in certain discrete, well-defined energy states. Transitions from one state to another are achieved only by the gain or loss of particular bundles, or quanta, of energy. Ten of the papers in this category are devoted to various aspects of gauge theory, including the most-cited article in this study, by Michael Creutz, Brookhaven National Laboratory, Upton, New York. Interactions between particles of matter are described in terms of gauge theories. Creutz's paper discusses a possible link between three of the laws governing the behavior of subatomic particles: the "strong" nuclear force, which holds atomic nuclei together; the "weak" nuclear force, which is responsible for radioactive decay; and electromagnetism.

Three papers in the quantum field theory group deal specifically with quantum chromodynamics, which forms a subspecialty within the larger framework of gauge theory. It is in terms of quantum chromodynamics that the strong force is described. Three more papers discuss various aspects of grand unified theories (GUTs). GUTs are attempts to show that the four fundamental forces recognized by physicists—gravity, electromagnetism, and the strong and weak nuclear forces—are but different manifestations of a single force.[13] The rest of the papers in this group are concerned with various theoretical aspects of low-temperature thermodynamics; ferromagnetism; and phase transitions, during which matter is transformed from one state to another.

Eighteen papers in this study are from the fields of astrophysics and geophysics. Five discuss the results of *Pioneer II*'s September 1979 flyby of the planet Saturn. Five more discuss various stellar observations and discoveries. Two papers report improved techniques for observing objects in the sky. Two more discuss sources of heat and heat flow within the Earth's crust. The rest deal with various subjects.

Eighteen papers come under the heading of materials science, which includes disciplines concerned with the behavior of materials when they are under various kinds of stress and strain. This field includes the disciplines of low-temperature and condensed-matter physics. The latter embraces the specialty of solid-state physics. Thirteen of the papers in this category deal with practical and theoretical aspects of semiconductors. The remaining five papers are concerned with such matters as new processes for fabricating integrated circuits, studies of hydrogen at low temperatures, ferromagnetism, and percolation models.

Articles in theoretical elementary particle physics account for 16 papers. This group includes the second most-cited article on the list, a review of current theories concerning the behavior of interacting subatomic particles. The paper was written by Andrzej J. Buras, Fermi National Accelerator Laboratory, Batavia, Illinois, and was cited in 93 publications. The majority of the remaining papers in this group discuss various aspects of existing theoretical models concerning subatomic particles.

Experimental elementary particle physics contributed 15 papers to the list. The third most-cited paper in the study is a comparison of experimental data with various theoretical models concerning the behavior of elementary particles. The paper was written by E. Eichten and colleagues, Cornell University, and has received 78 citations. A paper by F. Reines and colleagues, University of California, Irvine, is the fourth most-cited paper on the list. It reports evidence of the instability of the neutrino, an elementary particle associated with the weak nuclear force. The remaining 13 papers report various experimental results.

We have now published lists of the most-cited articles in the life and physical sciences for each year since 1970. Our next study will deal with the 1980 chemical sciences papers most cited between 1980 and 1982. Later this year we will report on the 1981 articles most cited in 1981 and 1982. Since the *SCI* for 1982 is now completed, we will report on the new hot spots of science a little earlier than in previous years.

* * * * *

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12. **Pitt V H**, ed. *The Penguin dictionary of physics.* Middlesex, UK: Penguin Books, 1977. 428 p.
13. **Sutton C.** Waiting for the end. *New Sci.* 85:1016-9, 1980.

Correction

In the essay, "The 1980 Articles Most Cited in 1980 and 1981. 1. Life Sciences," *Current Contents* (10):5-15, 7 March 1983, one author's affiliation was incorrect. The entry should read:

> Cheung W Y. **Calmodulin plays a pivotal role in cellular regulation.**
> *Science* 207:19-27, 1980. St. Jude Children's Res. Hosp., Memphis, TN. 81-1181

We regret the error.