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Current Comments®

The 1981 Articles Most Cited in 1981 and 1982. 2. Physical Sciences

Number 46 November 14, 1983

This is the latest in a series of essays in which we examine papers that become highly cited shortly after publication. Presumably, papers which have an immediate impact upon the research community, as indicated by rapid citation, point to "where the action is" in science. In this essay, we list those 1981 papers in the physical sciences which were among the most cited in 1981 and 1982. Recently, we published the comparable list for the life sciences.[1]

Table 1 presents the 101 papers in this study. They are listed alphabetically by first author, rather than by number of citations. The purpose of this arrangement is to inhibit invidious comparisons among papers on the basis of citation frequency. Of course, these papers are not necessarily the "best" research. Many seminal papers not listed here will eventually be highly cited. However, the evidence is clear from earlier studies that most of the papers we do detect by this "early warning system" prove to be classics. And they persist as core papers in the research fronts they help to identify in the first place.

Most of the 4,000,000 papers and books cited in *Science Citation Index®* (*SCI®*) each year receive one or two citations over a two-year period. However, the papers in Table 1 received an average of 41 citations: eight in 1981, and 33 in 1982. The most-cited paper received 92 citations, while the least cited received 30.

As with the 1981 life sciences papers,[1] we have chosen not to group these papers under traditional disciplinary subject headings. Such headings are at times arbitrary, and always subjective. Instead, we used the same automatic classification scheme which helps us identify thousands of research fronts each year by processing *SCI*. Briefly, a research front is a group of current papers which cite a smaller group of objectively determined core papers identified by a single-link, co-citation clustering routine. I have described co-citation clustering previously.[2]

Last year, we introduced research fronts as a new way of searching our *Index to Scientific Reviews™* (*ISR™*).[3] Eighty-three of the papers in Table 1 have already been incorporated into the core literature of *ISR* research fronts. Table 2 lists the names and numbers of those research fronts which are represented by at least two papers in this study. The numbers of the relevant research fronts in Table 2 follow the author addresses in Table 1.

Four of the papers identified as core papers in *ISR* research fronts are also core papers for research fronts in *ISI/GeoSciTech™*, our online data base covering the earth sciences. Of these, three appear in research front #81-0986, "Observation of plasma waves near Saturn." The other paper appears in research front #81-0803, "Electrostatic shocks and auroral particle acceleration."

An additional four papers in Table 1 cite into one or more of the cores of various research fronts, including one pa-

Table 1: The 1981 physical sciences articles most cited in 1981-1982. The authors' addresses follow each citation. Code numbers indicate the *ISR*™ research front specialties for which these are *core* papers. Code numbers with a ● indicate the *ISI/GeoSciTech*™ research front specialties for which these are *core* papers. Code numbers with one asterisk indicate *ISI/CompuMath*® research front specialties for which these are *citing* papers. Code numbers with two asterisks indicate *ISI/GeoSciTech* research front specialties for which these are *citing* papers. A = number of citations received, 1981. B = number of citations received, 1982. C = total number of citations received, 1981-1982.

A	B	C	Bibliographic Data
7	30	37	Abruna H D, Denisevich P, Umana M, Meyer T J & Murray R W. **Rectifying interfaces using two-layer films of electrochemically polymerized vinylpyridine and vinylbipyridine complexes of ruthenium and iron on electrodes.** *J. Amer. Chem. Soc.* 103:1-5, 1981. Univ. North Carolina, Kenan Labs. Chem., Chapel Hill, NC. 83-0169
5	34	39	Alexander S, Bernasconi J, Schneider W R & Orbach R. **Excitation dynamics in random one-dimensional systems.** *Rev. Mod. Phys.* 53:175-98, 1981. Hebrew Univ., Racah Inst. Phys., Jerusalem, Israel; Brown Boveri Res. Ctr., Baden, Switzerland; Univ. California, Dept. Phys., Los Angeles, CA.
8	32	40	Andrieux A, Jerome D & Bechgaard K. **Spin-density wave ground state in the one-dimensional conductor $(TMTSF)_2PF_6$: microscopic evidence from ^{77}Se and ^{1}H NMR experiments.** *J. Phys. Lett.* 42:L87-90, 1981. Univ. Paris-Sud, Lab. Phys. Solids, Orsay, France; Univ. Copenhagen, H.C. Orsted Inst., Copenhagen, Denmark. 83-0558
11	66	77	Barber M, Bordoli R S, Sedgwick R D & Tyler A N. **Fast atom bombardment of solids (F.A.B.): a new ion source for mass spectrometry.** *J. Chem. Soc. Chem. Commun.* 7:325-7, 1981. Univ. Manchester Inst. Sci. Technol., Dept. Chem., Manchester, UK. 83-0768
0	32	32	Barber M, Bordoli R S, Sedgwick R D & Tyler A N. **Fast atom bombardment of solids as an ion source in mass spectrometry.** *Nature* 293:270-5, 1981. Univ. Manchester Inst. Sci. Technol., Dept. Chem., Manchester, UK. 83-0768
17	21	38	Bebek C, Haggerty J, Izen J M, Longuemare C, Loomis W A, Pipkin F M, Rohlf J, Tanenbaum W, Wilson R, Sadoff A J, Bridges D L, Chadwick K, Ganci P, Kagan H, Kass R, Lobkowicz F, Melissinos A, Olsen S L, Poling R, Rosenfeld C, Rucinski G, Thorndike E H, Warren G, Bechis D, Mueller J J, Potter D, Sannes F, Skubic P, Stone R, Brody A, Chen A, Goldberg M, Horwitz N, Kandaswamy J, Kooy H, Lariccia P, Moneti G C, Alam M S, Csorna S E, Panvini R S, Poucher J S, Andrews D, Berkelman K, Cabenda R, Cassel D G, DeWire J W, Ehrlich R, Ferguson T, Gentile T, Gilchriese M G D, Gittleman B, Hartill D L, Herrup D, Herzlinger M, Kreinick D L, Mistry N B, Nordberg E, Perchonok R, Plunkett R, Shinsky K A, Siemann R H, Silverman A, Stein P C, Stone S, Talman R, Thonemann H G & Weber D. **Evidence for new-flavor production at the Υ(4S).** *Phys. Rev. Lett.* 46:84-7, 1981. Harvard Univ., Cambridge, MA; Ithaca Coll.; Cornell Univ., Ithaca; Le Moyne Coll. and Syracuse Univ., Syracuse; Univ. Rochester, Rochester, NY; Rutgers Univ., New Brunswick, NJ; Vanderbilt Univ., Nashville, TN. 83-0563
6	51	57	Bechgaard K, Carneiro K, Olsen M, Rasmussen F B & Jacobsen C S. **Zero-pressure organic superconductor: di-(tetramethyltetraselenafulvalenium)-perchlorate $[(TMTSF)_2ClO_4]$.** *Phys. Rev. Lett.* 46:852-5, 1981. Univ. Copenhagen, H.C. Orsted Inst., Copenhagen; Tech. Univ. Denmark, Phys. Lab. III, Lyngby, Denmark. 83-0558
2	49	51	Bechgaard K, Carneiro K, Rasmussen F B, Olsen M, Rindorf G, Jacobsen C S, Pedersen H J & Scott J C. **Superconductivity in an organic solid. Synthesis, structure, and conductivity of bis (tetramethyltetraselenafulvalenium) perchlorate, $(TMTSF)_2ClO_4$.** *J. Amer. Chem. Soc.* 103:2440-2, 1981. Univ. Copenhagen, H.C. Orsted Inst., Copenhagen; Tech. Univ. Denmark, Chem. Lab. B & Phys. Lab. III, Lyngby, Denmark; Cornell Univ., Lab. Atom. Solid State Phys., Ithaca, NY. 83-0558
12	40	52	Bhanot G & Rebbi C. **SU(2) string tension, glueball mass and interquark potential by Monte Carlo computations.** *Nucl. Phys. B* 180:469-82, 1981. Brookhaven Natl. Lab., Upton, NY; CERN, Geneva, Switzerland. 83-0030
11	20	31	Blote H W J, Nightingale M P & Derrida B. **Letter to editor. (Critical exponents of two-dimensional Potts and bond percolation models.)** *J. Phys. A—Math. Gen.* 14:L45-9, 1981. Delft Univ. Technol., Lab. Phys. Delft, the Netherlands; Saclay Nucl. Res. Ctr. (CENS), Serv. Theor. Phys., Gif-sur-Yvette, France. 83-0376
6	27	33	Bohm M C & Gleiter R. **A CNDO/INDO molecular orbital formalism for the elements H to Br. theory.** *Theor. Chim. Acta* 59:127-51, 1981. Univ. Heidelberg, Inst. Org. Chem., Heidelberg, FRG. 83-1117
12	45	57	Bohr A & Mottelson B R. **On the role of the Δ resonance in the effective spin-dependent moments of nuclei.** *Phys. Lett. B* 100:10-2, 1981. Niels Bohr Inst.; NORDITA, Copenhagen, Denmark. 83-0504
13	31	44	Borgarello E, Kiwi J, Pelizzetti E, Visca M & Gratzel M. **Photochemical cleavage of water by photocatalysis.** *Nature* 289:158-60, 1981. Swiss Fed. Inst. Technol., Inst. Chem. Phys., Lausanne, Switzerland; Univ. Torino, Inst. Anal. Chem., Torino; SIBIT, Ctr. Res., Spinetta Marengo, Italy. 83-0754
16	23	39	Broadfoot A L, Sandel B R, Shemansky D E, Holberg J B, Smith G R, Strobel D F, McConnell J C, Kumar S, Hunten D M, Atreya S K, Donahue T M, Moos H W, Bertaux J L, Blamont J E, Pomphrey R B & Linick S. **Extreme ultraviolet observations from Voyager 1 encounter with Saturn.** *Science* 212:206-11, 1981. Univ. S. California, Earth Space Sci. Inst., Los Angeles, CA; Naval Res. Lab., Washington, DC; York Univ., Ontario, Canada; Univ. Arizona, Tucson, AZ; Univ. Michigan, Ann Arbor, MI; Johns Hopkins Univ., Baltimore, MD; CNRS, Serv. Aeronom., Verrieres le Buisson, France; Calif. Inst. Technol., Jet Propulsion Lab., Pasadena, CA. 83-1234; ● 81-0986
10	23	33	Caldeira A O & Leggett A J. **Influence of dissipation on quantum tunneling in macroscopic systems.** *Phys. Rev. Lett.* 46:211-4, 1981. Univ. Sussex, Sch. Math. Phys. Sci., Sussex, UK.
17	18	35	Chadwick K, Ganci P, Kagan H, Kass R, Lobkowicz F, Melissinos A C, Olsen S L, Poling R, Rosenfeld C, Rucinski G, Thorndike E H, Mueller J J, Potter D, Sannes F, Skubic P, Stone R, Brody A, Chen A, Goldberg M, Horwitz N, Kandaswamy J, Kooy H, Lariccia P, Moneti G C, Alam M S,

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			Csorna S E, Panvini R S, Poucher J S, Andrews D, Berkelman K, Cabenda R, Cassel D G, DeWire J W, Ehrlich R, Ferguson T, Gentile T, Gilchriese M G D, Gittelman B, Hartill D L, Herrup D, Herzlinger M, Kreinick D L, Mistry N B, Nordberg E, Perchonok R, Plunkett R, Shinsky K A, Siemann R H, Silverman A, Stein P C, Stone S, Talman R, Thonemann H G, Weber D, Bebek C, Haggerty J, Izen J M, Longuemare C, Loomis W A, Mackay W W, Pipkin F M, Rohlf J, Tanenbaum W, Wilson R, Sadoff A J & Bridges D L. **Decay of *b*-flavored hadrons to single-muon and dimuon final states.** *Phys. Rev. Lett.* 46:88-91, 1981. Univ. Rochester, Rochester; Syracuse Univ.; Le Moyne Coll., Syracuse; Cornell Univ.; Ithaca Coll., Ithaca, NY; Rutgers Univ., New Brunswick, NJ; Vanderbilt Univ., Nashville, TN; Harvard Univ., Cambridge, MA. 83-0563
9	23	32	Chanowitz M. **Have we seen our first glueball?** *Phys. Rev. Lett.* 46:981-4, 1981. Univ. California, Lawrence Berkeley Lab., Berkeley, CA. 83-1521
11	21	32	Coppersmith S N, Fisher D S, Halperin B I, Lee P A & Brinkman W F. **Dislocations and the commensurate-incommensurate transition in two dimensions.** *Phys. Rev. Lett.* 46:549-52, 1981. Bell Labs., Murray Hill, NJ; Harvard Univ., Dept. Phys., Cambridge, MA. 83-0726
0	72	72	Dimopoulos S & Georgi H. **Softly broken supersymmetry and SU(5).** *Nucl. Phys. B* 193:150-62, 1981. Stanford Univ., Inst. Theor. Phys., Stanford; Univ. California, Inst. Theor. Phys., Santa Barbara, CA; Univ. Michigan, Ann Arbor, MI; Harvard Univ., Lyman Lab. Phys., Cambridge, MA. 83-0885
0	34	34	Dimopoulos S & Raby S. **Supercolor.** *Nucl. Phys. B* 192:353-68, 1981. Stanford Univ., Inst. Theor. Phys. & SLAC, Stanford; Univ. California, Inst. Theor. Phys., Santa Barbara, CA; Univ. Michigan, Dept. Phys., Ann Arbor, MI. 83-0885
3	50	53	Dine M, Fischler W & Srednicki M. **A simple solution to the strong *CP* problem with a harmless axion.** *Phys. Lett. B* 104:199-202, 1981. Inst. Adv. Study; Princeton Univ., J. Henry Labs., Princeton, NJ; Univ. Pennsylvania, Dept. Phys., Philadelphia, PA. 83-0898
0	31	31	Dine M, Fischler W & Srednicki M. **Supersymmetric technicolor.** *Nucl. Phys. B* 189:575-93, 1981. Inst. Adv. Study; Princeton Univ., J. Henry Labs., Princeton, NJ; Univ. Pennsylvania, Dept. Phys., Philadelphia, PA. 83-0885
13	27	40	Dolgov A D & Zeldovich Ya B. **Cosmology and elementary particles.** *Rev. Mod. Phys.* 153:1-41, 1981. Acad. Sci. USSR, Inst. Theor. Exp. Phys. & Inst. Appl. Math., Moscow, USSR.
11	20	31	Donoghue J F, Johnson K & Li B A. **Low mass glueballs in the meson spectrum.** *Phys. Lett. B* 99:416-20, 1981. Univ. Massachusetts, Dept. Phys. Astron., Amherst; Mass. Inst. Technol., Ctr. Theor. Phys., Cambridge, MA; Stanford Univ., SLAC, Stanford, CA; Chinese Acad. Sci., Inst. High Energy Phys., Peking, People's Rep. China. 83-1521
7	34	41	Downes D, Genzel R, Becklin E E & Wynn-Williams C G. **Outflow of matter in the KL Nebula: the role of IRc2.** *Astrophys. J* 244:869-83, 1981. Inst. Radio Astron. Millimetr., Grenoble, France; Harvard-Smithsonian Ctr. Astrophys., Cambridge, MA; Univ. Hawaii, Inst. Astron. & Infrared Telescope Facility, Honolulu, HI. 83-0875
3	38	41	Dresselhaus M S & Dresselhaus G. **Intercalation compounds of graphite.** *Advan. Phys.* 30:139-326, 1981. Mass. Inst. Technol., Dept. Elec. Eng. Comput. Sci., Ctr. Mat. Sci. Eng. & Francis Bitter Natl. Magnet Lab., Cambridge, MA. **81-1408; **81-0799; **81-0553; **81-2469; **81-3141
9	24	33	Drummond T J, Morkoc H & Cho A Y. **Dependence of electron mobility on spatial separation of electrons and donors in $Al_xGa_{1-x}As/GaAs$ heterostructures.** *J. Appl. Phys.* 52:1380-6, 1981. Univ. Illinois, Dept. Elec. Eng. & Coord. Sci. Lab., Urbana, IL. 83-1860
6	25	31	Dutta N K & Nelson R J. **Temperature dependence of threshold of InGaAsP/InP double-heterostructure lasers and Auger recombination.** *Appl. Phys. Lett.* 38:407-9, 1981. Bell Labs., Murray Hill, NJ. 83-0180
2	29	31	Dziewonski A M & Anderson D L. **Preliminary reference Earth model.** *Phys. Earth Planet. Interiors* 25:297-356, 1981. Harvard Univ., Dept. Geol. Sci., Cambridge, MA; Calif. Inst. Technol., Seismol. Lab., Pasadena, CA. 83-1921
3	27	30	Engels J, Karsch F, Satz H & Montvay I. **High temperature SU(2) gluon matter on the lattice.** *Phys. Lett. B* 101:89-94, 1981. Univ. Bielefeld, Dept. Theor. Phys., Bielefeld; Univ. Hamburg, Inst. Theor. Phys., Hamburg, FRG. 83-0030
7	36	43	Fork R L, Greene B I & Shank C V. **Generation of optical pulses shorter than 0.1 psec by colliding pulse mode locking.** *Appl. Phys. Lett.* 38:671-2, 1981. Bell Labs., Holmdel, NJ.
10	26	36	Frishman Y, Schwimmer A, Banks T & Yankielowicz S. **The axial anomaly and the bound-state spectrum in confining theories.** *Nucl. Phys. B* 177:157-71, 1981. Weizmann Inst. Sci., Dept. Phys., Rehovot; Tel Aviv Univ., Dept. Phys. Astron., Tel Aviv, Israel. 83-0035
1	29	30	Gabay M & Toulouse G. **Coexistence of spin-glass and ferromagnetic orderings.** *Phys. Rev. Lett.* 47:201-4, 1981. Univ. Paris-Sud, Lab. Phys. Solids, Orsay; Ecole Normale Super., Lab. Phys., Paris, France. 83-0863
9	31	40	Genzel R, Reid M J, Moran J M & Downes D. **Proper motions and distances of H_2O maser sources. I. The outflow in Orion-KL.** *Astrophys. J.* 244:884-902, 1981. Harvard-Smithsonian Ctr. Astrophys., Cambridge, MA; Inst. Radio Astron. Millimetr., Grenoble, France; Max Planck Inst. Radioastron., Bonn, FRG. 83-0875
0	36	36	Gibbs H M, Hopf F A, Kaplan D L & Shoemaker R L. **Observation of chaos in optical bistability.** *Phys. Rev. Lett.* 46:474-7, 1981. Univ. Arizona, Opt. Sci. Ctr., Tucson, AZ. 83-2213
14	18	32	Gorney D J, Clarke A, Croley D, Fennell J, Luhmann J & Mizera P. **The distribution of ion beams and conics below 8000 km.** *J. Geophys. Res.* 86:83-9, 1981. Aerospace Corp., Space Sci. Lab., Los Angeles, CA. 83-1086; ● 81-0803
6	32	38	Greenberg O W & Sucher J. **A quantum structuredynamic model of quarks, leptons, weak vector bosons and Higgs mesons.** *Phys. Lett. B* 99:339-43, 1981. Univ. Maryland, Ctr. Theor. Phys., College Park, MD. 83-0035
16	46	62	Gross D J, Pisarski R D & Yaffe L G. **QCD and instantons at finite temperature.** *Rev. Mod. Phys.* 53:43-80, 1981. Princeton Univ., Dept. Phys., Princeton, NJ; Yale Univ., J.W. Gibbs Labs., New Haven, CT. 83-0030

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7	24	31	Gruner G, Zawadowski A & Chaikin P M. **Nonlinear conductivity and noise due to charge-density-wave depinning in $NbSe_3$.** *Phys. Rev. Lett.* 46:511-5, 1981. Univ. California, Dept. Phys., Los Angeles, CA. 83-0775
12	80	92	Guth A H. **Inflationary universe: a possible solution to the horizon and flatness problems.** *Phys. Rev. D—Part. Fields* 23:347-56, 1981. Stanford Univ., SLAC, Stanford, CA. 83-0029
6	28	34	Guth A H & Weinberg E J. **Cosmological consequences of a first-order phase transition in the SU_5 grand unified model.** *Phys. Rev. D—Part. Fields* 23:876-85, 1981. Mass. Inst. Technol., Ctr. Theor. Phys., Cambridge, MA; Stanford Univ., SLAC, Stanford, CA; Columbia Univ., Dept. Phys., New York, NY. 83-0029
5	25	30	Halliday I G & Schwimmer A. **The phase structure of SU(*N*)/Z(*N*) lattice gauge theories.** *Phys. Lett. B* 101:327-31, 1981. Imperial Coll. Sci. Technol., Blackett Lab., London, UK. 83-0030
1	29	30	Hamber H & Parisi G. **Numerical estimates of hadronic masses in a pure SU(3) gauge theory.** *Phys. Rev. Lett.* 47:1792-5, 1981. Brookhaven Natl. Lab., Dept. Phys., Upton, NY; Natl. Inst. Nucl. Phys., Frascati, and Inst. Phys., Facult. Eng., Rome, Italy. 83-0032
10	42	52	Hanel R, Conrath B, Flasar F M, Kunde V, Maguire W, Pearl J, Pirraglia J, Samuelson R, Herath L, Allison M, Cruikshank D, Gautier D, Gierasch P, Horn L, Koppany R, Ponnamperuma C. **Infrared observations of the Saturnian system from Voyager 1.** *Science* 212:192-200, 1981. Goddard Space Flight Ctr., Greenbelt, MD; Rice Univ., Houston, TX; Univ. Hawaii, Honolulu, HI; Paris Observ., Meudon, France; Cornell Univ., Ithaca, NY; Calif. Inst. Technol., Jet Propulsion Lab., Pasadena, CA; Univ. Maryland, College Park, MD. 83-1234
15	32	47	Harari H & Seiberg N. **A dynamical theory for the rishon model.** *Phys. Lett. B* 98:269-73, 1981. Weizmann Inst. Sci., Dept. Nucl. Phys., Rehovot, Israel. 83-0035
20	17	37	Hasenfratz A, Hasenfratz E & Hasenfratz P. **Generalized roughening transition and its effect on the string tension.** *Nucl. Phys. B* 180:353-67, 1981. Eotvos Lorand Univ.; Eotvos Lorand Geophys. Inst., Budapest, Hungary; CERN, Geneva, Switzerland. 82-0319
3	27	30	Hauser H, Pascher I, Pearson R H & Sundell S. **Preferred conformation and molecular packing of phosphatidylethanolamine and phosphatidylcholine.** *Biochim. Biophys. Acta* 650:21-51, 1981. Swiss Fed. Inst. Technol., Lab. Biochem., Zurich, Switzerland; Univ. Goteborg, Facult. Med., Goteborg, Sweden; Med. Fdn. Buffalo and Roswell Park Mem. Inst., Biophys. Dept., Buffalo, NY. 83-1524
10	26	36	Herrmann W A, Plank J, Riedel D, Ziegler M L, Weidenhammer K, Guggolz E & Balbach B. **Transition-metal methylene complexes. 14. Reactions of an electron-rich dimetallacyclopropane with protic acids: synthesis and X-ray crystal structures of novel rhodium-methyl and -methylidyne complexes.** *J. Amer. Chem. Soc.* 103:63-75, 1981. Univ. Regensburg, Inst. Chem., Regensburg; Univ. Heidelberg, Inst. Inorg. Chem., Heidelberg, FRG. 83-1103
7	31	38	Horel J D & Wallace J M. **Planetary-scale atmospheric phenomena associated with the Southern Oscillation.** *Mon. Weather Rev.* 109:813-29, 1981. Univ. Washington, Dept. Atmosph. Sci., Seattle, WA. 83-1054
4	30	34	Jacobsen C S, Tanner D B & Bechgaard K. **Dimensionality crossover in the organic superconductor tetramethyltetraselenafulvalene hexafluorophosphate [$(TMTSF)_2PF_6$].** *Phys. Rev. Lett.* 46:1142-5, 1981. Tech. Univ. Denmark, Phys. Lab., Lyngby; Univ. Copenhagen, H.C. Orsted Inst., Dept. Gen. Org. Chem., Copenhagen, Denmark; Ohio State Univ., Dept. Phys., Columbus, OH. 83-0558
5	31	36	Kalyanasundaram K, Borgarello E & Gratzel M. **Visible light induced water cleavage in CdS dispersions loaded with Pt and RuO_2, hole scavenging by RuO_2.** *Helv. Chim. Acta* 64:362-6, 1981. Swiss Fed. Inst. Technol., Inst. Chem. Phys., Lausanne, Switzerland. 83-0755
17	55	72	Kim J E, Langacker P, Levine M & Williams H H. **A theoretical and experimental review of the weak neutral current: a determination of its structure and limits on deviations from the minimal $SU(2)_L \times U(1)$ electroweak theory.** *Rev. Mod. Phys.* 53:211-52, 1981. Univ. Pennsylvania, Dept. Phys., Philadelphia, PA.
6	29	35	Kinzel W & Yeomans J M. **Directed percolation: a finite-size renormalisation group approach.** *J. Phys. A—Math. Gen.* 14:L163-8, 1981. Julich Nucl. Res. Ctr., Julich, FRG; Cornell Univ., Baker Lab., Ithaca, NY. 83-1254
17	35	52	Kuti J, Polonyi J & Szlachanyi K. **Monte Carlo study of SU(2) gauge theory at finite temperature.** *Phys. Lett. B* 98:199-204, 1981. Central Res. Inst. Phys., Budapest, Hungary. 83-0030
7	80	87	Langacker P. **Grand unified theories and proton decay.** *Phys. Rep.—Rev. Sect. Phys. Lett.* 72:185-385, 1981. Stanford Univ., SLAC, Stanford, CA and Univ. Pennsylvania, Dept. Phys., Philadelphia, PA.
9	37	46	LaRue G S, Phillips J D & Fairbank W M. **Observation of fractional charge of (1/3)*e* on matter.** *Phys. Rev. Lett.* 46:967-70, 1981. Stanford Univ., Stanford, CA. 83-1824
2	36	38	Lawrence J M, Riseborough P S & Parks R D. **Valence fluctuation phenomena.** *Rep. Progr. Phys.* 44:1-84, 1981. Univ. California, Phys. Dept., Irvine, CA; Polytech. Inst. New York, Phys. Dept., Brooklyn, NY. 83-0412
4	27	31	Love W G & Franey M A. **Effective nucleon-nucleon interaction for scattering at intermediate energies.** *Phys. Rev. C—Nucl. Phys.* 24:1073-94, 1981. Univ. Georgia, Dept. Phys. Astron., Athens, GA and Los Alamos Natl. Lab., Los Alamos, NM; Univ. Minnesota, Dept. Phys., Minneapolis, MN.
19	14	33	Luscher M, Munster G & Weisz P. **How thick are chromo-electric flux tubes?** *Nucl. Phys. B* 180:1-12, 1981. German Electron-Accelerator (DESY); Univ. Hamburg, Inst. Theor. Phys., Hamburg, FRG. 82-0319
15	22	37	Marciano W J & Sirlin A. **Precise SU(5) predictions for $\sin^2\theta_W{}^{exp}$, m_W and m_Z.** *Phys. Rev. Lett.* 46:163-6, 1981. Northwestern Univ., Dept. Phys. Astron., Evanston, IL; New York Univ., Dept. Phys., New York, NY. 83-0576
5	26	31	Martin A. **A simultaneous fit of bb, cc, ss (bcs pairs) and cs-spectra.** *Phys. Lett. B* 100:511-4, 1981. CERN, Geneva, Switzerland. 83-0586
7	26	33	Masamune S, Choy W, Kerdesky F A J & Imperiali B. **Stereoselective aldol condensation. Use of chiral boron enolates.** *J. Amer. Chem. Soc.* 103:1566-8, 1981. Mass. Inst. Technol., Dept. Chem., Cambridge, MA. 83-1995

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6	31	37	Mazets E P, Golenetskii S V, Aptekar' R L, Gur'yan Yu A & Il'inskii V N. **Cyclotron and annihilation lines in γ-ray bursts.** *Nature* 290:378-82, 1981. Acad. Sci. USSR, A.F. Ioffe Phys. Tech. Inst., Leningrad, USSR. 83-1483
14	39	53	McLerran L D & Svetitsky B. **A Monte Carlo study of SU(2) Yang-Mills theory at finite temperature.** *Phys. Lett. B* 98:195-8, 1981. Stanford Univ., SLAC, Stanford, CA. 83-0030
10	30	40	Mohapatra R N & Senjanovic G. **Neutrino masses and mixings in gauge models with spontaneous parity violation.** *Phys. Rev. D—Part. Fields* 23:165-80, 1981. CUNY, City Coll., New York, NY; Fermi Natl. Accelerator Lab., Batavia, IL and Univ. Maryland, Dept. Phys., College Park, MD. 83-0883
10	26	36	Morrow M, Jochemsen R, Berlinsky A J & Hardy W N. **Zero-field hyperfine resonance of atomic hydrogen for $0.18 \leqslant T \leqslant 1$ K: the binding energy of H on liquid ^{4}He.** *Phys. Rev. Lett.* 46:195-8, 1981. Univ. Brit. Columbia, Dept. Phys., Vancouver, Canada. 83-2860
5	42	47	Mortensen K, Tomkiewicz Y, Schultz T D & Engler E M. **Antiferromagnetic ordering in the organic conductor *bis*-tetramethyltetraselenafulvalene-hexafluorophosphate [$(TMTSF)_2$-PF_6].** *Phys. Rev. Lett.* 46:1234-7, 1981. IBM, T.J. Watson Res. Ctr., Yorktown Heights, NY. 83-0558
9	25	34	Mulder C A M, van Duyneveldt A J & Mydosh J A. **Susceptibility of the *Cu* Mn spin-glass: frequency and field dependences.** *Phys. Rev. B—Condensed Matter* 23:1384-96, 1981. Rijks Univ., Kamerlingh Onnes Lab., Leiden, the Netherlands. 83-0863
15	28	43	Nadasen A, Schwandt P, Singh P P, Jacobs W W, Bacher A D, Debevec P T, Kaitchuck M D & Meek J T. **Elastic scattering of 80-180 MeV protons and the proton-nucleus optical potential.** *Phys. Rev. C—Nucl. Phys.* 23:1023-43, 1981. Indiana Univ., Cyclotron Facility, Bloomington, IN.
19	21	40	Ness N F, Acuna M H, Lepping R P, Connerney J E P, Behannon K W, Burlaga L F & Neubauer F M. **Magnetic field studies by Voyager 1: preliminary results at Saturn.** *Science* 212:211-7, 1981. NASA, Goddard Space Flight Ctr., Lab. Extraterrestrial Phys., Greenbelt, MD; Tech. Univ., Braunschweig, FRG. 83-1234; ●81-0986
1	31	32	Olive K A, Schramm D N, Steigman G, Turner M S & Yang J. **Big-bang nucleosynthesis as a probe of cosmology and particle physics.** *Astrophys. J.* 246:557-68, 1981. Univ. Chicago, Astron. Astrophys. Ctr., Chicago, IL; Franklin Inst., Bartol Res. Fdn., Newark, DE. 83-0034
7	28	35	Perdew J P & Zunger A. **Self-interaction correction to density-functional approximations for many-electron systems.** *Phys. Rev. B—Condensed Matter* 23:5048-79, 1981. Tulane Univ., Dept. Phys., New Orleans, LA; Solar Energy Res. Inst., Golden and Univ. Colorado, Dept. Phys., Boulder, CO.
4	33	37	Polyakov A M. **Quantum geometry of bosonic strings.** *Phys. Lett. B* 103:207-10, 1981. Acad. Sci. USSR, L.D. Landau Inst. Theor. Phys., Moscow, USSR. 83-3045
2	29	31	Prange R E. **Quantized Hall resistance and the measurement of the fine-structure constant.** *Phys. Rev. B—Condensed Matter* 23:4802-5, 1981. Univ. Maryland, Dept. Phys. Astron. & Ctr. Theor. Phys., College Park, MD. 83-0541
3	29	32	Rizzo T G & Senjanovic G. **Can there be low intermediate mass scales in grand unified theories?** *Phys. Rev. Lett.* 46:1315-7, 1981. Brookhaven Natl. Lab., Dept. Phys., Upton, NY. 83-0883
0	32	32	Rizzo T G & Senjanovic G. **Grand unification and parity restoration at low energies. Phenomenology.** *Phys. Rev. D—Part. Fields* 24:704-18, 1981. Brookhaven Natl. Lab., Dept. Phys., Upton, NY. 83-0883
12	24	36	Rossiter B E, Katsuki T & Sharpless K B. **Asymmetric epoxidation provides shortest routes to four chiral epoxy alcohols which are key intermediates in synthesis of methymycin, erythromycin, leukotriene C-1, and disparlure.** *J. Amer. Chem. Soc.* 103:464-5, 1981. Stanford Univ., Dept. Chem., Stanford, CA. 83-2637
11	19	30	Rothman L S. **AFGL atmospheric absorption line parameters compilation: 1980 version.** *Appl. Opt.* 20:791-5, 1981. USAF, Opt. Phys. Div., Hanscom AFB, MA.
0	39	39	Sakai N. **Naturalness in supersymmetric GUTS.** *Z. Phys. C—Par. Field.* 11:153-7, 1981. Tohoku Univ., Dept. Phys., Sendai, Japan. 83-0885
9	29	38	Savage B D & de Boer K S. **Ultraviolet absorption by interstellar gas at large distances from the galactic plane.** *Astrophys. J.* 243:460-84, 1981. Univ. Wisconsin, Washburn Observ., Madison, WI. 83-2298
14	17	31	Scalapino D J & Sugar R L. **Method for performing Monte Carlo calculations for systems with fermions.** *Phys. Rev. Lett.* 46:519-21, 1981. Univ. California, Inst. Theor. Phys., Santa Barbara, CA.
16	25	41	Schramm D N & Steigman G. **Relic neutrinos and the density of the universe.** *Astrophys. J.* 243:1-7, 1981. Univ. Chicago, Enrico Fermi Inst. and Depts. Astron. & Phys., Chicago, IL; Franklin Inst., Bartol Res. Fdn., Newark, DE. 83-1132
10	28	38	Siegbahn P E M, Almlof J, Heiberg A & Roos B O. **The complete active space SCF (CASSCF) method in a Newton-Raphson formulation with application to the HNO molecule.** *J. Chem. Phys.* 74:2384-96, 1981. Univ. Stockholm, Inst. Theor. Phys., Stockholm; Lund Univ., Chem. Ctr., Phys. Chem. 2, Lund, Sweden; Univ. Oslo, Dept. Chem., Oslo, Norway. 83-1761
23	57	80	Smith B A, Soderblom L, Beebe R, Boyce J, Briggs G, Bunker A, Collins S A, Hansen C J, Johnson T V, Mitchell J L, Terrile R J, Carr M, Cook A F, Cuzzi J, Pollack J B, Danielson G E, Ingersoll A, Davies M E, Hunt G E, Masursky H, Shoemaker E, Morrison D, Owen T, Sagan C, Veverka J, Strom R & Suomi V E. **Encounter with Saturn: Voyager 1 imaging science results.** *Science* 212:163-91, 1981. Univ. Arizona, Dept. Planet. Sci. & Lunar Planet. Lab., Tucson; US Geol. Survey, Flagstaff, AZ; New Mexico State Univ., Dept. Astron., Las Cruces, NM; NASA Headquarters, Washington, DC; Harvard-Smithsonian Ctr. Astrophys., Cambridge, MA; US Geol. Survey, Menlo Park, CA; NASA/Ames Res. Ctr., Moffett Field; Calif. Inst. Technol., Div. Geol. Planet. Sci. and Jet Propulsion Lab., Pasadena; Rand Corp., Santa Monica, CA; Univ. Coll. London, London, UK; Univ. Hawaii, Inst. Astron., Honolulu, HI; SUNY, Dept. Earth Space Sci., Stony Brook; Cornell Univ., Ithaca, NY; Univ. Wisconsin, Madison, WI. 83-1234

A	B	C	Bibliographic Data
4	26	30	Surman D J & Vickerman J C. **Fast atom bombardment quadrupole mass spectrometry.** *J. Chem. Soc. Chem. Commun.* 7:324-5, 1981. Univ. Manchester Inst. Sci. Technol., Dept. Chem., Manchester, UK. 83-0768
12	21	33	Swanenburg B N, Bennett K, Bignami G F, Buccheri R, Caraveo P, Hermsen W, Kanbach G, Lichti G G, Masnou J L, Mayer-Hasselwander H A, Paul J A, Sacco B, Scarsi L & Wills R D. **Second *COS B* catalog of high-energy gamma-ray sources.** *Astrophys. J.* 243:L69-73, 1981. Huygens Lab., Cosm.-Ray Working Group, Leiden; Eur. Space Agency, ESTEC, Noordwijk, the Netherlands; CNR, Inst. Cosm. Phys. Data, Milano; Univ. Palermo, Inst. Phys., Palermo, Italy; Max Planck Inst. Phys. Astrophys., Munich, Inst. Extraterrestrial Phys., Garching by Munich, FRG; Saclay Nucl. Res. Ctr. (CENS), Serv. Electron Phys., Gif-sur-Yvette, France. **81-2789; **81-0565
1	33	34	Thorup N, Rindorf G, Soling H & Bechgaard K. **The structure of Di(2,3,6,7-tetramethyl-1,4,5,8-tetraselenafulvalenium) hexafluorophosphate, $(TMTSF)_2PF_6$, the first superconducting organic solid.** *Acta Crystallogr. B—Struct. Sci.* 37:1236-40, 1981. Tech. Univ. Denmark, Chem. Dept., Lyngby; Univ. Copenhagen, H.C. Orsted Inst., Dept. Gen. Organ. Chem., Copenhagen, Denmark. 83-0558
11	31	42	Tyler G L, Eshleman V R, Anderson J D, Levy G S, Lindal G F, Wood G E & Croft T A. **Radio science investigations of the Saturn system with Voyager 1: preliminary results.** *Science* 212:201-6, 1981. Stanford Univ., Ctr. Radar Astron., Stanford; Calif. Inst. Technol., Jet Propulsion Lab., Pasadena; SRI Intl., Radio Phys. Lab., Menlo Park, CA. 83-1234
21′	41	62	Vaiana G S, Cassinelli J P, Fabbiano G, Giacconi R, Golub L, Gorenstein P, Haisch B M, Harnden F R, Johnson H M, Linsky J L, Maxson C W, Mewe R, Rosner R, Seward F, Topka K & Zwaan C. **Results from an extensive *Einstein* stellar survey.** *Astrophys. J.* 245:163-82, 1981. Harvard-Smithsonian Ctr. Astrophys., Cambridge, MA; Astron. Observ. Palermo, Palermo, Italy; Univ. Wisconsin, Washburn Observ., Madison, WI; Lockheed Palo Alto Res. Lab., Palo Alto, CA; Univ. Colorado & Natl. Bureau Stand., Joint Inst. Lab. Astrophys. (JILA), Boulder, CO; Astron. Inst., Utrecht, the Netherlands. 82-1691
9	29	38	Van den Dries L, Van Haesendonck C, Bruynseraede Y & Deutscher G. **Two-dimensional localization in thin copper films.** *Phys. Rev. Lett.* 46:565-8, 1981. Univ. Leuven, Vaste Stof-Phys. Magnet. Lab., Leuven, Belgium; Tel Aviv Univ., Dept. Phys. Astron., Tel Aviv, Israel. 83-0157
4	43	47	van Nieuwenhuizen P. **Supergravity.** *Phys. Rep—Rev. Sect. Phys. Lett.* 68:189-398, 1981. SUNY, Inst. Theor. Phys., Stony Brook, NY *80-1432; *80-1434; *80-1433; *80-0281; *80-0106
8	32	40	Vliegenthart J F G, van Halbeek H & Dorland L. **The applicability of 500-MHz high-resolution ^{1}H-NMR spectroscopy for the structure determination of carbohydrates derived from glycoproteins.** *Pure Appl. Chem.* 53:45-77, 1981. State Univ. Utrecht, Dept. Bio-Organ. Chem., Utrecht, the Netherlands.
14	17	31	Warwick J W, Pearce J B, Evans D R, Carr T D, Schauble J J, Alexander J K, Kaiser M L, Desch M D, Pedersen M, Lecacheux A, Daigne G, Boischot A & Barrow C H. **Planetary radio astronomy observations from Voyager 1 near Saturn.** *Science* 212:239-43, 1981. Radiophys. Inc., Boulder, CO; Univ. Florida, Dept. Astron., Gainesville, FL; Goddard Space Flight Ctr., Lab. Extraterrestrial Phys., Greenbelt, MD; Observ. Paris, Sect. Astrophys. Meudon, Meudon, France. 83-1234; ●81-0986
0	34	34	Williams D H, Bradley C, Bojesen G, Santikarn S & Taylor L C E. **Fast atom bombardment mass spectrometry: a powerful technique for the study of polar molecules.** *J. Amer. Chem. Soc.* 103:5700-4, 1981. Univ. Chem. Lab., Cambridge; Kratos Ltd., Manchester, UK. 83-0768
7	27	34	Wilson R C, Gulkis S, Janssen M, Hudson H S & Chapman G A. **Observations of solar irradiance variability.** *Science* 211:700-2, 1981. Calif. Inst. Technol., Jet Propulsion Lab., Pasadena; Univ. California, Ctr. Astrophys. Space Sci., San Diego; Calif. State Univ., San Fernando Observ., Northridge, CA.
3	43	46	Wise M B, Georgi H & Glashow S L. **SU(5) and the invisible axion.** *Phys. Rev. Lett.* 47:402-4, 1981. Harvard Univ., Lyman Lab. Phys.; MIT, Ctr. Theor. Phys., Cambridge, MA. 83-0898
13	23	36	Witten E. **Cosmological consequences of a light Higgs boson.** *Nucl Phys. B* 177:477-88, 1981. Harvard Univ., Lyman Lab. Phys., Cambridge, MA. 83-0029
0	30	30	Witten E. **Mass hierarchies in supersymmetric theories.** *Phys. Lett. B* 105:267-71, 1981. Intl. Ctr. Theor. Phys., Trieste, Italy. 83-0885
0	87	87	Witten E. **Dynamical breaking of supersymmetry.** *Nucl. Phys. B* 185:513-54, 1981. Princeton Univ., J. Henry Labs., Princeton, NJ. 83-0885
13	40	53	Zamorani G, Henry J P, Maccacaro T, Tananbaum H, Soltan A, Avni Y, Liebert J, Stocke J, Strittmatter P A, Weymann R J, Smith M G & Condon J J. **X-ray studies of quasars with the *Einstein* observatory. II.** *Astrophys. J.* 245:357-74, 1981. Harvard-Smithsonian Ctr. Astrophys., Cambridge, MA; Copernicus Astron. Ctr., Warsaw, Poland; Weizmann Inst. Sci., Rehovot, Israel; Univ. Arizona, Steward Observ., Tucson, AZ; Royal Observ., Edinburgh, UK; Natl. Radio Astron. Observ., Charlottesville, and Virginia Polytech. Inst. State Univ., Dept. Phys., Blacksburg, VA. **81-0469; **81-3355; **81-1463; **81-1826; **81-2955

per found in a search of *ISI/CompuMath*®, our online data base covering the mathematical and computer sciences. That leaves just 14 papers in this study which are neither core nor citing papers in any ISI® research front. Most of these will undoubtedly become core papers unless they are a "flash in the pan." In any case, they alone can help you identify the literature for the unique research fronts they identify. Just use *SCI* in the straightforward manner you always did.

Twelve papers are single author works. Thirty papers list two authors, 20 have three, 16 have four, and eight have

Table 2: The 1982 and 1983 *ISR*™ research fronts which contain at least two of the 1981 most-cited physical sciences papers as core documents. A=research front number. B=research front name. C=number of 1981 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
82-0319	Roughening transitions and crossover phenomena in lattice gauge theories	2	3
83-0029	Phase transitions in the early universe and the inflationary universe scenario	3	39
83-0030	Dynamic aspects of lattice gauge theories	6	35
83-0035	Composite and electroweak gauge models	3	37
83-0558	Organic superconductors; properties of tetramethyl-tetraselenafulvalene-2X and other superconductors	6	21
83-0563	Upsilon physics and B-meson decay	2	6
83-0768	Fast atom bombardment and secondary ion mass spectrometry of involatile biomolecules	4	16
83-0863	Phase diagram and phase transitions for Ising spin glasses	2	24
83-0875	Mass outflow from the Orion molecular-cloud and other star formation regions	2	17
83-0883	Weak neutral bosons in gauge models and grand unified theories	3	10
83-0885	Supersymmetric grand unified theories	6	16
83-0898	Theoretical and experimental aspects of axions	2	15
83-1234	Voyager 1 and Voyager 2 observations of Saturn and Titan and analysis of rings of Saturn, magnetosphere and atmosphere	6	9
83-1521	Decay patterns and other aspects of pseudoscalar glueballs	2	6

five authors. One has six authors, three have seven authors, and two have eight. One paper each lists 12, 13, and 14 authors, while three papers have 16 authors. One paper each lists 27 and 66 authors. The paper with the most authors has 67. This is not unusual for physics. In our study of the most-cited physical sciences papers of 1980,[4] one paper had 86 authors.

Most such papers involve experiments with huge particle accelerators. While it is true that an enormous collaborative effort is involved in these experiments, it is hard to believe that so many individuals merit full authorship. In the past, I have called for reforms in this area.[5] Most contributors should receive credit in an acknowledgment. Current practices only pollute the bibliographic archives.

Ninety-two authors have more than one paper listed in Table 1. C.S. Jacobsen, G. Senjanović, and E. Witten each have three papers. K. Bechgaard has five papers in Table 1.

The papers in this study were published in 30 journals, listed in Table 3. Just six journals published more than 60 percent of the papers. They are: *Physical Review Letters* (19 papers), *Physics Letters B* (12), *Nuclear Physics B* (9), *Astrophysical Journal* (8), *Journal of the American Chemical Society* (7), and *Science* (7). These journals consistently publish a high proportion of papers in these studies. In fact, *Physical Review Letters* has topped our list each year since we began this series by examining the most-cited physical science papers of 1976![6] This also reflects the need for rapid communication in a field where preprints are common.

The authors in this study are affiliated with 118 institutions in 18 countries. Table 4 lists these institutions in descending order by the number of times they appear in Table 1. Sixty-three are located in the US, about the same as in our study of the 1980 papers. This represents a significant increase over the US totals for 1978[7] and 1979[8] which were 44 and 48, respectively. However, the actual number of *papers* in these studies produced by US institutions has been declining in recent years. For example, authors from US institutions produced 88 papers in our study of 1979 articles. For 1980 this dropped to 73 and for 1981 it is 67 papers. By the way, it is an important commentary on the international role of American and other scientific journals to see that three papers from the USSR are included in this study.

Table 3: The 30 journals represented on the list of the 101 1981 physical sciences papers most cited in 1981-1982. The numbers in parentheses are the impact factors for the journals. (1981 impact factor equals the number of citations received by 1979-1980 articles in a journal divided by the number of articles published by the journal during the same period.) Data were taken from the 1981 *JCR*™. The figures at the right indicate the number of papers from each journal which appears on the list.

Journal	Number of Papers
Phys. Rev. Lett. (6.06)	19
Phys. Lett. B (3.82)	12
Nucl. Phys. B (4.25)	9
Astrophys. J. (4.04)	8
J. Amer. Chem. Soc. (4.26)	7
Science (6.24)	7
Phys. Rev. D—Part. Fields (2.94)	4
Rev. Mod. Phys. (16.23)	4
Nature (7.19)	3
Phys. Rev. B—Condensed Matter (2.94)	3
Appl. Phys. Lett. (3.15)	2
J. Chem. Soc. Chem. Commun. (2.17)	2
J. Phys. A—Math. Gen. (1.86)	2
Phys. Rep.—Rev. Sect. Phys. Lett. (6.68)	2
Phys. Rev. C—Nucl. Phys. (2.23)	2
Acta Crystallogr. B—Struct. Sci. (.96)	1
Advan. Phys. (8.71)	1
Appl. Opt. (1.57)	1
Biochim. Biophys. Acta (2.64)	1
Helv. Chim. Acta (1.84)	1
J. Appl. Phys. (1.67)	1
J. Chem. Phys. (3.03)	1
J. Geophys. Res. (2.76)	1
J. Phys. Lett. (2.04)	1
Mon. Weather Rev. (1.42)	1
Phys. Earth Planet. Interiors (1.06)	1
Pure Appl. Chem. (1.88)	1
Rep. Progr. Phys. (4.82)	1
Theor. Chim. Acta (2.08)	1
Z. Phys. C—Par. Field. (2.13)	1

Of the remaining institutions in Table 4, eight each are located in the Federal Republic of Germany (FRG) and Italy. Six each are located in France and the UK. Five of the institutions are located in the Netherlands, while Denmark, Israel, Sweden, and Switzerland each have three. It should be noted, however, that the CERN facility, although located in Switzerland, is actually operated by a consortium of 12 European nations. Canada and Hungary each have two institutions in this study, and Belgium, Japan, Norway, the People's Republic of China, Poland, and the USSR each have one. Incidentally, the People's Republic of China was also represented by one institution in our look at the most-cited physics papers of 1979.[8] Perhaps the appearance of an institution from there in the present study is a harbinger of things to come.

Harvard University was listed 12 times on Table 1, more than any other institution. Stanford University was represented 11 times. The University of California was represented nine times, while CERN was represented only three. In our 1978 study, CERN was represented 19 times.

Table 5 lists the national affiliations of authors in this study. As I mentioned earlier, 67 of the 101 papers in this study had authors from the US. Seventeen of these were coauthored with scientists from Canada, Denmark, France, FRG, Israel, Italy, the Netherlands, People's Republic of China, Poland, Sweden, Switzerland, and the UK. Without exception, the papers were written in English.

The list of research fronts in Table 2 provides a good indication of some of the hot subjects of current interest to physical scientists. In fact, four research fronts are represented by six core papers listed here.

Six papers are core to research front #83-0030, "Dynamic aspects of lattice gauge theories." Interactions between subatomic particles are described in terms of gauge theories. Five of the highly cited papers in this research front apply so-called "Monte Carlo methods," a statistical technique, to the study of "strong force" interactions. The strong force, one of the four fundamental forces of nature, is what holds the nucleus of an atom together.

The list includes six papers in research front #83-0558, "Organic superconductors." Superconductors are substances which, when cooled to extremely low temperatures, lose virtually all resistance to the flow of electricity. All six of

Table 4: The institutional affiliations of the authors on the list. *Institutions are listed in descending order of the number of times they appear in Table 1.*

Harvard Univ., Cambridge, MA[1]		12
Stanford Univ., CA[2]		11
Univ. California, CA		9
Santa Barbara	3	
Berkeley[3]	2	
Los Angeles	2	
Irvine	1	
San Diego	1	
California Inst. Technol., Pasadena, CA		7
Massachusetts Inst. Technol., Cambridge, MA		7
Cornell Univ., Ithaca, NY		6
Univ. Copenhagen, Denmark		6
H.C. Orsted Inst.	5	
Niels Bohr Inst.	1	
NASA		5
Goddard Space Flight Ctr., Greenbelt, MD	3	
Ames Res. Ctr., Moffett Field, CA	1	
NASA Headquarters, Washington, DC	1	
Tech. Univ. Denmark, Lyngby, Denmark		5
Univ. Arizona, Tucson, AZ		5
Univ. Maryland, College Park, MD		5
Acad. Sci. USSR		4
A.F. Ioffe Phys. Tech. Inst., Leningrad	1	
Inst. Appl. Math., Moscow	1	
Inst. Theor. Exp. Phys., Moscow	1	
L.D. Landau Inst. Theor. Phys., Moscow	1	
Brookhaven Natl. Lab., Upton, NY		4
Princeton Univ., NJ		4
Univ. Chicago, IL		4
Univ. Hawaii, Honolulu, HI		4
Univ. Pennsylvania, Philadelphia, PA		4
Bell Laboratories, NJ		3
Murray Hill	2	
Holmdel	1	
CERN, Geneva, Switzerland		3
Max Planck Soc., FRG		3
Inst. Extraterrestrial Phys., Garching by Munich	1	
Inst. Phys. Astrophys., Munich	1	
Inst. Radioastron., Bonn	1	
Swiss Fed. Inst. Technol., Switzerland		3
Lausanne	2	
Zurich	1	
Univ. Colorado, CO		3
Boulder	2	
Joint Inst. Lab. Astrophys., Boulder[4]	1	
Univ. Manchester Inst. Sci. Tech., UK		3
Univ. Michigan, Ann Arbor, MI		3
Univ. Wisconsin, Madison, WI		3
Weizmann Inst. Sci., Rehovot, Israel		3
Eotvos Lorand Univ., Budapest, Hungary		2
Franklin Inst., Bartol Res. Fdn., Newark, DE		2
Inst. Advan. Study, Princeton, NJ		2
Inst. Radio Astron. Millimetr., Grenoble, France		2
Ithaca Coll., NY		2
Le Moyne Coll., Syracuse, NY		2
Paris Observatory, Meudon, France		2
Rutgers Univ., New Brunswick, NJ		2
Saclay Nucl. Res. Ctr. (CENS), Gif-sur-Yvette, France		2
State Univ. Utrecht, the Netherlands		2
SUNY, Stony Brook, NY		2
Syracuse Univ., NY		2
Tel Aviv Univ., Israel		2
Univ. Hamburg, FRG		2
Univ. Heidelberg, FRG		2
Univ. Illinois, Urbana, IL		2
Univ. London, UK		2
Imperial Coll. Sci. Technol.	1	
Univ. Coll. London	1	
Univ. Paris-Sud (XI), Orsay, France		2
Univ. Rochester, NY		2
US Geol. Survey		2
Flagstaff, AZ	1	
Menlo Park, CA	1	
Vanderbilt Univ., Nashville, TN		2
Aerospace Corp., Los Angeles, CA		1
Brown Boveri Res. Ctr., Baden, Switzerland		1
Calif. State Univ., Northridge, CA		1
Chinese Acad. Sci., Peking, People's Republic of China		1
CNR, Inst. Cosm. Phys. Data, Milano, Italy		1
CNRS, Serv. Aeronom., Verrieres le Buisson, France		1
Columbia Univ., New York, NY		1
CUNY, New York, NY		1
Delft Univ. Technol., the Netherlands		1
Ecole Normale Superieure, Paris, France		1
Eur. Space Agency, Noordwijk, the Netherlands		1
Fermi Natl. Accelerator Lab., Batavia, IL		1
German Electron-Accelerator (DESY), Hamburg, FRG		1
Hebrew Univ., Jerusalem, Israel		1
Hungarian Acad. Sci., Central Res. Inst. Phys., Budapest, Hungary		1
Huygens Lab., Leiden, the Netherlands		1
IBM, Thomas J. Watson Res. Ctr., Yorktown Heights, NY		1
Indiana Univ., Bloomington, IN		1
Intl. Ctr. Theor. Phys., Trieste, Italy		1
Inst. & Observ. Astron., Palermo, Italy		1
Johns Hopkins Univ., Baltimore, MD		1
Julich Nucl. Res. Ctr., FRG		1
Kratos Ltd., Manchester, UK		1
Leiden State Univ., the Netherlands		1
Lockheed Missiles & Space Co., Palo Alto, CA		1
Lund Univ., Sweden		1
Med. Fdn. Buffalo Inc., NY		1
Natl. Inst. Nucl. Phys., Frascati, Italy		1
Natl. Radio Astron. Observ., Charlottesville, VA		1
New Mexico State Univ., Las Cruces, NM		1
New York State Dept. Hlth., Roswell Park Mem. Inst., Buffalo, NY		1
New York Univ., New York, NY		1
NORDITA, Copenhagen, Denmark		1
Northwestern Univ., Evanston, IL		1
Ohio State Univ., Columbus, OH		1
Polish Acad. Sci., Copernicus Astron. Ctr., Warsaw, Poland		1
Polytech. Inst. New York, Brooklyn, NY		1
Radiophys. Inc., Boulder, CO		1
Rand Corp., Santa Monica, CA		1
Rice Univ., Houston, TX		1
Science and Engineering Council, Royal Observ., Edinburgh, UK		1
SIBIT, Spinetta Marengo, Italy		1
Solar Energy Res. Inst., Golden, CO		1
SRI Intl., Menlo Park, CA		1
Tech. Univ., Braunschweig, FRG		1
Tohoku Univ., Sendai, Japan		1
Tulane Univ., New Orleans, LA		1
Univ. Bielefeld, FRG		1
Univ. Brit. Columbia, Vancouver, Canada		1
Univ. Cambridge, UK		1
Univ. Florida, Gainesville, FL		1
Univ. Georgia, Athens, GA		1
Univ. Goteborg, Sweden		1
Univ. Leuven, Belgium		1
Univ. Massachusetts, Amherst, MA		1
Univ. Minnesota, Minneapolis, MN		1
Univ. North Carolina, Chapel Hill, NC		1
Univ. Oslo, Norway		1
Univ. Palermo, Italy		1
Univ. Regensburg, FRG		1
Univ. Rome, Italy		1
Univ. S. California, Los Angeles, CA		1
Univ. Stockholm, Sweden		1

Univ. Sussex, UK	1
Univ. Torino, Italy	1
Univ. Washington, Seattle, WA	1
USAF, Hansom AFB, MA	1
USN, Naval Res. Lab., Washington, DC	1
Virginia Polytech. Inst. State Univ., Blacksburg, VA	1
Yale Univ., New Haven, CT	1
York Univ., Ontario, Canada	1

1. Includes Harvard-Smithsonian Ctr. for Astrophysics
2. Includes Stanford Linear Accelerator Ctr. (SLAC)
3. Includes Los Alamos Natl. Lab., NM
4. Operated jointly with the Natl. Bureau of Standards, Washington, DC

Table 5: National affiliations of the authors of the 1981 physical sciences papers most cited in 1981-1982, in order of the total number of papers on which each nation's authors appeared (column A). B=number of papers coauthored with scientists from other countries. C=nationality of coauthors.

Country	A	B	C
US	67	17	Canada, Denmark, France, FRG, Israel, Italy, the Netherlands, People's Republic of China, Poland, Sweden, Switzerland & UK
France	9	8	Canada, Denmark, FRG, Italy, the Netherlands & US
FRG	8	4	France, Italy, the Netherlands & US
UK	8	2	Israel, Poland & US
Switzerland	7	5	Hungary, Israel, Italy, Sweden & US
Denmark	6	3	France & US
Israel	5	3	Belgium, Poland, Switzerland, UK & US
Italy	5	4	France, FRG, the Netherlands, Switzerland & US
the Netherlands	5	3	France, FRG, Italy & US
USSR	3	0	
Canada	2	1	France & US
Hungary	2	1	Switzerland
Sweden	2	2	Norway, Switzerland & US
Belgium	1	1	Israel
Japan	1	0	
Norway	1	1	Sweden
People's Republic of China	1	1	US
Poland	1	1	Israel, UK & US

the papers describe organic compounds which can be transformed into superconductors. K. Bechgaard, University of Copenhagen, Denmark, appears on five of the papers in this group: twice as a first author, and three times as a secondary author.

Six papers in Table 1 are core documents for research front #83-0885, "Supersymmetric grand unified theories." "Supersymmetry" is the label given to one of several theoretical approaches for attaining the long sought after "unified field theory," which would explain the four fundamental forces of nature in terms of a single theoretical framework. This research front includes the second most-cited paper, a single author work by E. Witten, Princeton University, New Jersey. Witten's paper was cited 87 times during the two-year period. A check of the 1983 *SCI* shows that it continues to be heavily cited.

Research front #83-1234, "Voyager 1 and Voyager 2 observations of Saturn and Titan and analysis of rings of Saturn, magnetosphere and atmosphere," contains six papers in this study as core documents. Papers reporting observations of the Voyager space probes have appeared in these studies before. This research front contains the third most-cited paper in this study, that by B.A. Smith, University of Arizona, Tucson, and colleagues. The paper reports on a number of observations of the planet Saturn, its rings, and moons. It was cited 80 times during 1981-1982.

The most-cited paper in this study, a single author work by A.H. Guth, Stanford Linear Accelerator Center, California, received 92 citations during the two-year period. It is one of the core papers in research front #83-0029, "Phase transitions in the early universe and the inflationary universe scenario." Guth's paper advances a proposition regarding the temperature of the universe early in its history, and discusses its implications for the so-called "big bang" theory of creation. It has already been cited 43 times in the first six months of 1983.

Tied for the second most-cited paper in this study is a lengthy review by P. Langacker, University of Pennsylvania and Stanford Linear Accelerator Center, of various unified field theories. It was published in *Physics Reports—Review Section of Physics Letters*, which is published by the North-Holland Publishing Co. The paper received 87 citations in 1981-1982.

The fourth most-cited paper in Table 1 describes a new method developed by M. Barber and colleagues, University of Manchester Institute of Science and Technology, England. The method improves the results of mass spectronomy performed on nongaseous substances. It received 77 citations during the two-year period.

This concludes our study of the most-cited physical sciences papers of 1981. This series will continue next year when we identify the most-cited papers of 1982. Remember that we treated chemistry separately in a study of the 1980 papers.[9] We will continue to do so for 1981, although several chemistry papers were cited frequently enough to meet the threshold for this study.

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