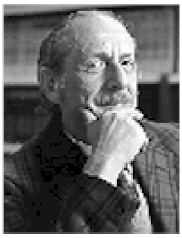
Essays of an Information Scientist: Ghostwriting and Other Essays, Vol:8, p.105, 1985. Current Contents, #12, p.3-16, March 25, 1985



Current Comments®

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

The 1981 Most-Cited Chemistry Papers. Part 1. Pure and Synthetic Chemistry. Or, Should I Say, Most-Cited Papers Published in 1981 in the *Journal of the American Chemical Society*?

Number 12 March 25, 1985

Of the hundreds of thousands of articles published each year, at least 250,000 could be interpreted to be related to chemistry. Of these, the number in "pure" chemistry—as for example, those published in the journals of the world's chemical societies—is probably over 125,000. About one-third of these would be biochemistry; another third would be synthetic and organic chemistry; and yet another third in general, physical, or inorganic chemistry. These are rough estimates.

No matter how you look at the literature, however, there are plenty of chemistry papers published annually. So with this flood of information, how do the experts decide each year what has been the most exciting group of papers published? There is no formal procedure for this. At ISI® we use our citation indexes as a substitute for a mass peer review "voting" system. We simply make an approximation—we count the number of times each paper is cited in the two or three years after its publication. This number provides one indication of its "impact" on the scientific community. Our purpose in doing so is not to obtain a precise result. After all, even the most sophisticated group of experts could not do so. Scientists rarely agree on the relative importance of discoveries especially in their early history. They may eventually reach a consensus, but then they rarely express their views in public. Mostly journalists have the temerity to do so.

You may be wondering why I've included this somewhat different preamble to the list of 1981 chemistry papers most cited from 1981 to 1983. I felt that this was necessary because our annual listings have become so ritualized. Many readers may forget that we do realize that the lists are interesting but imperfect indicators of the past, present, and future most-active areas of science. Chemistry is a peculiar area because, unlike molecular biology or biomedicine, or even high-energy physics, most new chemical discoveries seem to be absorbed at a significantly slower rate. Of course, we must remember that there are many more researchers working in the life sciences, therefore new discoveries in these fields are apt to be absorbed more quickly. Perhaps this is why it seems to take more time for new methods of synthesis or new chemical theories to percolate through the "barriers" to change. The absorption rate may be even slower in other fields such as plant science, earth science, or the social sciences.

We first noticed this phenomenon years ago when we began our annual "hit parade" of essays on most-cited papers. We arbitrarily divided these essays into life and physical sciences. However, we found that physics dominated the latter group. It is rare indeed to see a paper from a journal of organic or physical chemistry in our physical sciences studies. And even papers from the illustrious *Journal of the American Chemi-*

cal Society (*JACS*) were relatively scarce. So a few years ago we decided to wait for an additional year of citation data to accumulate—enough to exceed a useful citation threshold for chemistry papers. For pure and synthetic chemistry papers published in 1981 and cited from 1981 to 1983, this threshold turns out to be 25 citations. (The average number of citations for the top 103 papers is 34—the most-cited paper received 56.) In Table 1, we have listed the papers in that august group. Full bibliographic information is provided. The papers are listed in alphabetic order by first author. The numbers of citations found in the *Science Citation Index®* (*SCI®*) for 1981-1983 and 1984 are also provided.

In additional tables and in later text, we have provided the usual litany of comments about the numbers of authors, institutions, and geographical distributions for these 103 papers. But first you should be aware of how we identified these chemistry articles. Since we felt that chemistry papers, particularly those from pure and synthetic chemistry, were being excluded from the physical sciences studies, we decided to identify the most-cited papers from these specialties by using the source journal list of *Current Abstracts of Chemistry and Index Chemicus®* (*CAC&IC®*). *CAC&IC*, which recently went online as *Index Chemicus Online*,[1] indexes 112 chemistry journals. Selection of articles emphasizes the fields of organic, pharmaceutical, and medicinal chemistry. (Where relevant, we have added the *CAC&IC* abstract numbers for 28 papers in Table 1.)

As it so happens, papers from *JACS* dominate this list—74 *JACS* papers—as compared with just seven in the 1981 physical sciences study.[2] "Only" 35 articles from *JACS* appeared in our 1980 chemistry study.[3] So, as it turns out, we are in effect discussing the most-cited 1981 *JACS* papers. We also identified three other articles from *CAC&IC* that had already been mentioned in the 1981 physical sciences study. These were published in *Nature*[4,5] and *Helvetica Chimica Acta*.[6]

When you use journals to classify papers, the result will never be perfect because *a priori* journal boundaries just won't work. In this study, for example, an important paper on the chemical structure of antibiotics turns up because it was published in *JACS*. Had this paper been published in the *Journal of Antibiotics* it would have been excluded as life sciences. In order to avoid this problem in the future, we will use our new system of classifying by research fronts. For the present, we had to accept the shortcomings of this discipline-based categorization. However, we do provide some separate data on research fronts.

Some readers wonder why we cover such pure chemistry journals as *JACS* in *Current Contents®/Life Sciences* (*CC®/LS*). I hope some of the following examples will help explain this. For instance, deoxypolynucleotide synthesis is a hot topic covered by *SCI* research front #83-0684. Almost any biochemistry journal would have been thrilled to publish the Beaucage-Caruthers paper (see Table 1). It describes a new class of key intermediates for deoxypolynucleotide synthesis, but it appeared in *Tetrahedron Letters*, an organic chemistry journal. But most of the other papers in this research front were published in non-organic journals. And, as our *SCI* research front analysis in Table 2 shows, fast-atom bombardment is currently quite prevalent in the literature. Fast-atom bombardment is used in mass spectrometry to measure the mass of molecular ions of highly polar (nonvolatile) organic, inorganic, and biologically important materials. For example, in the biological area, it can provide nearly the complete amino acid sequences of peptides.[7]

The boundaries between chemistry and the life sciences are constantly changing. But our co-citation analyses

Table 1: The 1981 pure and synthetic chemistry articles most cited in the *SCI*®, 1981-1983, listed in alphabetic order by first author. The authors' affiliations follow each citation. Code numbers indicate the 1982 *SCI* and the 1983 *SCI/SSCI*® research front specialties for which these are core papers. Code numbers with an asterisk indicate the 1982-1983 *CCI* research front specialties for which these are core papers. (*CCI* research front code numbers are shown only for those papers not appearing in 1982-1983 *SCI* research fronts of which *CCI* is a subset.) A number sign (#) indicates the 1981-1982 *CAC* abstract number. A = number of citations in 1981. B = number of citations in 1982. C = number of citations in 1983. D = total number of citations 1981-1983. The number of 1984 citations follow in parentheses. E = bibliographic information.

A	B	C	D	E
3	11	13	27 (17)	**Adman E T & Jensen L H.** Structural features of azurin at 2.7 Å resolution. *Isr. J. Chem.* 21:8-12, 1981. Univ. Washington, Depts. Biol. Struct. & Biochem., Seattle, WA. *83-0105
1	12	18	31 (10)	**Albers-Schonberg G, Arison B H, Chabala J C, Douglas A W, Eskola P, Fisher M H, Lusi A, Mrozik H, Smith J L & Tolman R L.** Avermectins. Structure determination. *J. Amer. Chem. Soc.* 103:4216-21, 1981. Merck, Sharp & Dohme Res. Labs., Rahway, NJ. 83-0435, #317079
2	12	11	25 (12)	**Albery W J, Eddowes M J, Hill H A O & Hillman A R.** Mechanism of the reduction and oxidation reaction of cytochrome *c* at a modified gold electrode. *J. Amer. Chem. Soc.* 103:3904-10, 1981. Univ. Oxford, Inorg. Chem. Lab.; Univ. London, Imperial Coll. Sci. Technol., UK. *83-0189
1	12	13	26 (5)	**Balch A L, Hunt C T, Lee C-L, Olmstead M M & Farr J P.** Organo halide addition to $Pd_2(Ph_2PCH_2PPh_2)_3$. Preparation of novel methylene- and phenylene-bridged complexes by two-center, three-fragment oxidative addition. *J. Amer. Chem. Soc.* 103:3764-72, 1981. Univ. California, Dept. Chem., Davis, CA. *83-0636
0	21	11	32 (6)	**Barber M, Bordoli R S, Sedgwick R D & Tetler L W.** Fast atom bombardment mass spectrometry of two isomeric tripeptides. *Org. Mass Spectrom.* 16:256-60, 1981. Victoria Univ. Manchester, Inst. Sci. Technol., UK. 82-0768
0	22	15	37 (12)	**Barber M, Bordoli R S, Sedgwick R D, Tyler A N & Whalley E T.** Fast atom bombardment mass spectrometry of bradykinin and related oligopeptides. *Biomed. Mass Spectrom.* 8:337-42, 1981. Victoria Univ. Manchester, Inst. Sci. Technol. & Fac. Med., UK. 82-0768, 83-0072
4	16	18	38 (12)	**Bax A, Freeman R & Frenkiel T A.** An NMR technique for tracing out the carbon skeleton of an organic molecule. *J. Amer. Chem. Soc.* 103:2102-4, 1981. Univ. Oxford, Phys. Chem. Lab., UK. 82-0665, 83-1380
0	10	31	41 (43)	**Beaucage S L & Caruthers M H.** Deoxynucleoside phosphoramidites—a new class of key intermediates for deoxypolynucleotide synthesis. *Tetrahedron Lett.* 22:1859-62, 1981. Univ. Colorado, Dept. Chem., Boulder, CO. 83-0684, #328398
0	12	22	34 (14)	**Beckwith A L J.** Regio-selectivity and stereo-selectivity in radical reactions. *Tetrahedron* 37:3073-100, 1981. Univ. Adelaide, Dept. Org. Chem., Australia, 83-1823
5	12	13	30 (10)	**Beno M A, Williams J M, Tachikawa M & Muetterties E L.** A closed three-center carbon-hydrogen-metal interaction. A neutron diffraction study of $HFe_4(\eta^2\text{-}CH)(CO)_{12}$. *J. Amer. Chem. Soc.* 103:1485-92, 1981. Argonne Natl. Lab., Chem. Div., IL; Brookhaven Natl. Lab., Chem. Dept., Upton, NY; Univ. California, Dept. Chem., Berkeley, CA. *83-0906
0	16	20	36 (12)	**Bentley T W, Bowen C T, Morten D H & Schleyer P V R.** The S_N2-S_N1 spectrum. 3. Solvolyses of secondary and tertiary alkyl sulfonates in fluorinated alcohols. Further evidence for the S_N2 (intermediate) mechanism. *J. Amer. Chem. Soc.* 103:5466-75, 1981. Univ. Wales, Univ. Coll. Swansea, UK; Friedrich-Alexander Univ., Inst. Org. Chem., Erlangen, FRG. 82-0942, 83-0101
0	21	22	43 (30)	**Borgarello E, Kiwi J, Pelizzetti E, Visca M & Gratzel M.** Sustained water cleavage by visible light. *J. Amer. Chem. Soc.* 103:6324-9, 1981. Ecole Polytech. Fed. Lausanne, Inst. Chem. Phys., Switzerland. 82-1149, 83-3184
0	8	17	25 (20)	**Bradley P G, Kress N, Hornberger B A, Dallinger R F & Woodruff W H.** Vibrational spectroscopy of the electronically excited state. 5. Time-resolved resonance Raman study of tris(bipyridine)ruthenium(II) and related complexes. Definitive evidence for the "localized" MLCT state. *J. Amer. Chem. Soc.* 103:7441-6, 1981. Univ. Texas, Dept. Chem., Austin, TX. 83-1717
10	21	19	50 (20)	**Brady R C & Pettit R.** On the mechanism of the Fischer-Tropsch reaction. The chain propagation step. *J. Amer. Chem. Soc.* 103:1287-9, 1981. Univ. Texas, Dept. Chem., Austin, TX. 82-0591, 83-1064

A	B	C	D	E
4	15	9	28 (10)	**Brugger P-A, Cuendet P & Gratzel M.** Ultrafine and specific catalysts affording efficient hydrogen evolution from water under visible light illumination. *J. Amer. Chem. Soc.* 103:2923-7, 1981. Ecole Polytech. Fed. Lausanne, Inst. Chem. Phys., Switzerland.
8	24	11	43 (16)	**Brugger P-A, Infelta P P, Braun A M & Gratzel M.** Photoredox reactions in functional micellar assemblies. Use of amphiphilic redox relays to achieve light energy conversion and charge separation. *J. Amer. Chem. Soc.* 103:320-6, 1981. Ecole Polytech. Fed. Lausanne, Inst. Chem. Phys., Switzerland. 82-0754
4	13	8	25 (11)	**Burk P L, Osborn J A, Youinou M-T, Agnus Y, Louis R & Weiss R.** Binuclear copper complexes: an open and shut case. A strong antiferromagnetically coupled μ-monohydroxo bridged complex. *J. Amer. Chem. Soc.* 103:1273-4, 1981. Univ. Louis Pasteur, Inst. Le Bel, Strasbourg, France. *83-0124
2	11	20	33 (17)	**Caramella P, Rondan N G, Paddon-Row M N & Houk K N.** Origin of π-facial stereoselectivity in additions to π-bonds: generality of the anti-periplanar effect. *J. Amer. Chem. Soc.* 103:2438-40, 1981. Louisiana State Univ., Dept. Chem., Baton Rouge, LA; Univ. Pittsburgh, Dept. Chem., PA. *83-0204
5	18	19	42 (10)	**Carty A J, MacLaughlin S A & Taylor N J.** Open and closed ruthenium and osmium clusters with μ_3-acetylide and phosphido bridges. *J. Organomet. Chem.* 204:C27-32, 1981. Univ. Waterloo, Chem. Dept., Ontario, Canada. *83-0512
7	23	16	46 (14)	**Chan S-F, Chou M, Creutz C, Matsubara T & Sutin N.** Mechanism of the formation of dihydrogen from the photoinduced reactions of poly(pyridine) ruthenium(II) and poly(pyridine)rhodium(III) complexes. *J. Amer. Chem. Soc.* 103:369-79, 1981. Brookhaven Natl. Lab., Chem. Dept., Upton, NY. 82-0754
2	11	29	42 (19)	**Chandrasekhar J, Andrade J G & Schleyer P V R.** Efficient and accurate calculation of anion proton affinities. *J. Amer. Chem. Soc.* 103:5609-12, 1981. Friedrich-Alexander Univ., Inst. Org. Chem., Erlangen, FRG. *83-1525
0	14	27	41 (22)	**Cookson D J & Smith B E.** Improved methods for assignment of multiplicity in ^{13}C NMR spectroscopy with application to the analysis of mixtures. *Org. Magn. Resonance* 16:111-6, 1981. Broken Hill Proprietary Co. Ltd., Melbourne Res. Lab., Clayton, Australia. 83-1380
1	17	10	28 (18)	**Denisevich P, Willman K W & Murray R W.** Unidirectional current flow and charge state trapping at redox polymer interfaces on bilayer electrodes: principles, experimental demonstration, and theory. *J. Amer. Chem. Soc.* 103:4727-37, 1981. Univ. N. Carolina, Kenan Lab. Chem., Chapel Hill, NC. 82-0169
0	10	16	26 (7)	**Dombek B D.** A novel catalytic system for homogeneous hydrogenation of carbon monoxide: ruthenium complexes in the presence of iodide promoters. *J. Amer. Chem. Soc.* 103:6508-10, 1981. Union Carbide Corp., S. Charleston, WV. *83-0972, #320387
4	25	16	45 (25)	**Duonghong D, Borgarello E & Gratzel M.** Dynamics of light-induced water cleavage in colloidal systems. *J. Amer. Chem. Soc.* 103:4685-90, 1981. Ecole Polytech. Fed. Lausanne, Inst. Chem. Phys., Switzerland. 82-1149, 83-0489
0	17	15	32 (11)	**Eisenstein O & Hoffmann R.** Transition-metal complexed olefins: how their reactivity toward a nucleophile relates to their electronic structure. *J. Amer. Chem. Soc.* 103:4308-20, 1981. Cornell Univ., Dept. Chem., Ithaca, NY. 83-0465
5	16	16	37 (15)	**Evans D A, Bartroli J & Shih T L.** Enantioselective aldol condensations. 2. Erythro-selective chiral aldol condensations via boron enolates. *J. Amer. Chem. Soc.* 103:2127-9, 1981. Caltech, Labs, Chem., Pasadena, CA. *83-2153, #333404
4	17	12	33 (7)	**Evans D A & McGee L R.** Enantioselective aldol condensations. 3. Erythro-selective condensations via zirconium enolates. *J. Amer. Chem. Soc.* 103:2876-8, 1981. Caltech, Labs. Chem., Pasadena, CA. 82-1995, #332671
4	15	17	36 (11)	**Evans D A, Nelson J V, Vogel E & Taber T R.** Stereoselective aldol condensations via boron enolates. *J. Amer. Chem. Soc.* 103:3099-111, 1981. Caltech, Labs. Chem., Pasadena, CA. *83-2153
3	15	7	25 (10)	**Fagan P J, Manriquez J M, Vollmer S H, Day C S, Day V W & Marks T J.** Insertion of carbon monoxide into metal-nitrogen bonds. Synthesis, chemistry, structures, and structural dynamics of bis(pentamethylcyclopentadienyl) organoactinide dialkylamides and η^2-carbamoyls. *J. Amer. Chem. Soc.* 103:2206-20, 1981. Northwestern Univ., Dept. Chem., Evanston, IL; Univ. Nebraska, Dept. Chem.; Crystalytics Co., Dept. Chem., Lincoln, NE. *83-0537, #331740
6	21	23	50 (10)	**Fahey D R.** Rational mechanism for homogeneous hydrogenation of carbon monoxide to alcohols, polyols, and esters. *J. Amer. Chem. Soc.* 103:136-41, 1981. Phillips Petrol. Co., Res. Dev., Bartlesville, OK. 82-1189, 83-1064

A	B	C	D	E
2	16	13	31 (8)	**Frechet J M J.** Synthesis and applications of organic polymers as supports and protecting groups. *Tetrahedron* 37:663-83, 1981. Univ. Ottawa, Dept. Chem., Canada. 83-0393
3	9	16	28 (7)	**Gray S K, Miller W H, Yamaguchi Y & Schaefer H F.** Tunneling in the unimolecular decomposition of formaldehyde: a more quantitative study. *J. Amer. Chem. Soc.* 103:1900-4, 1981. Univ. California, Lawrence Berkeley Lab., Berkeley, CA; Univ. Texas, Dept. Chem. & Inst. Theor. Chem., Austin, TX. *83-0586
7	9	10	26 (12)	**Griller D, Howard J A, Marriott P R & Scaiano J C.** Absolute rate constants for the reactions of *tert*-butoxyl, *tert*-butylperoxyl, and benzophenone triplet with amines: the importance of a stereoelectronic effect. *J. Amer. Chem. Soc.* 103:619-23, 1981. Natl. Res. Council Canada, Div. Chem., Ottawa, Canada. 83-0584
3	11	13	27 (8)	**Griller D & Lossing F P.** On the thermochemistry of α-aminoalkyl radicals. *J. Amer. Chem. Soc.* 103:1586-7, 1981. Natl. Res. Council Canada, Div. Chem., Ottawa, Canada.
6	20	30	56 (27)	**Groves J T, Haushalter R C, Nakamura M, Nemo T E & Evans B J.** High-valent iron-porphyrin complexes related to peroxidase and cytochrome P-450. *J. Amer. Chem. Soc.* 103:2884-6, 1981. Univ. Michigan, Dept. Chem., Ann Arbor, MI. 82-1509, 83-3652
2	10	15	27 (5)	**Gutsche C D, Dhawan B, No K H & Muthukrishnan R.** Calixarenes. 4. The synthesis, characterization, and properties of the calixarenes from *p-tert*-butylphenol. *J. Amer. Chem. Soc.* 103:3782-92, 1981. Washington Univ., Dept. Chem., St. Louis, MO. 83-4120, #317904
4	9	18	31 (12)	**Haasnoot C A G, de Leeuw F A A M, de Leeuw H P M & Altona C.** The relationship between proton-proton NMR coupling constants and substituent electronegativities. II. Conformational analysis of the sugar ring in nucleosides and nucleotides in solution using a generalized Karplus equation. *Org. Magn. Resonance* 15:43-52, 1981. State Univ., Gorlaeus Lab., Leiden, the Netherlands. 83-0104
3	12	10	25 (6)	**Hall L D & Sanders J K M.** Analysis of the proton nuclear magnetic resonance spectrum of 11β-hydroxyprogesterone by one- and two-dimensional methods. Some implications for steroid and terpenoid chemistry. *J. Org. Chem.* 46:1132-8, 1981. Univ. British Columbia, Dept. Chem., Vancouver, Canada. 83-2068
4	14	9	27 (2)	**Hanson L K, Chang C K, Davis M S & Fajer J.** Electron pathways in catalase and peroxidase enzymic catalysis. Metal and macrocycle oxidations of iron porphyrins and chlorins. *J. Amer. Chem. Soc.* 103:663-70, 1981. Brookhaven Natl. Lab., Dept. Energy Environ., Upton, NY; Michigan State Univ., Dept. Chem., East Lansing, MI. *83-0086
1	9	18	28 (19)	**Heathcock C H.** Acyclic stereocontrol through the aldol condensation. *Science* 214:395-400, 1981. Univ. California, Dept. Chem., Berkeley, CA. 83-0571
3	10	15	28 (21)	**Hendrickson W A & Teeter M M.** Structure of the hydrophobic protein crambin determined directly from the anomalous scattering of sulphur. *Nature* 290:107-13, 1981. USN, Naval Res. Lab., Washington, DC; Boston Univ., Dept. Chem., MA.
2	15	10	27 (11)	**Hexem J G, Frey M H & Opella S J.** Influence of ^{14}N on ^{13}C NMR spectra of solids. *J. Amer. Chem. Soc.* 103:224-6, 1981. Univ. Pennsylvania, Dept. Chem., Philadelphia, PA. *83-0381
4	20	23	47 (8)	**Hoffmann R.** Theoretical organometallic chemistry. *Science* 211:995-1002, 1981. Cornell Univ., Dept. Phys. Sci., Ithaca, NY. 82-0365
1	13	11	25 (8)	**Holt E M, Whitmire K H & Shriver D F.** The role of metal cluster interactions in the proton-induced reduction of CO. The crystal structures of [PPN] [$HFe_4(CO)_{12}C$] and $HFe_4(CO)_{12}(\eta^2\text{-}COCH_3)$. *J. Organomet. Chem.* 213:125-37, 1981. Oklahoma State Univ., Dept. Chem., Stillwater, OK; Northwestern Univ., Dept. Chem., Evanston, IL. *83-0906
6	11	8	25 (11)	**Ireland R E & Daub J P.** Synthesis of chiral subunits for macrolide synthesis: the Prelog-Djerassi lactone and derivatives. *J. Org. Chem.* 46:479-85, 1981. Caltech, Chem., Labs., Pasadena, CA. *83-0739
1	12	18	31 (12)	**Iwasaki M, Toriyama K & Nunome K.** Electron spin resonance study of electronic and geometrical structures of $C_2H_6^+$ and other simple alkane cations at 4.2 K: possible evidence for Jahn-Teller distortion. *J. Amer. Chem. Soc.* 103:3591-2, 1981. Govt. Ind. Res. Inst., Nagoya, Japan. 83-4091
8	16	9	33 (15)	**Jorgensen W L.** Transferable intermolecular potential functions for water, alcohols, and ethers. Application to liquid water. *J. Amer. Chem. Soc.* 103:335-40, 1981. Purdue Univ., Dept. Chem., West Lafayette, IN. *83-2762

A	B	C	D	E
10	15	5	30 (8)	**Jorgensen W L.** Transferable intermolecular potential functions. Application to liquid methanol including internal rotation. *J. Amer. Chem. Soc.* 103:341-5, 1981. Purdue Univ., Dept. Chem., West Lafayette, IN. *83-2762
4	16	7	27 (12)	**Kametani T & Nemoto H.** Recent advances in the total synthesis of steroids via intramolecular cycloaddition reactions. *Tetrahedron* 37:3-16, 1981. Tohoku Univ., Pharm. Inst., Sendai, Japan. *83-0184
3	11	19	33 (9)	**Kende A S & Rizzi J P.** A stereospecific total synthesis of aklavinone. *J. Amer. Chem. Soc.* 103:4247-8, 1981. Univ. Rochester, Dept. Chem., NY. *83-0437, #317082
0	14	12	26 (10)	**Lewis N S & Wrighton M S.** Electrochemical reduction of horse heart ferricytochrome c at chemically derivatized electrodes. *Science* 211:944-7, 1981. MIT, Dept. Chem., Cambridge, MA. *83-0189, #309720
1	17	33	51 (25)	**Lippmaa E, Magi M, Samoson A, Tarmak M & Engelhardt G.** Investigation of the structure of zeolites by solid-state high-resolution ^{29}Si NMR spectroscopy. *J. Amer. Chem. Soc.* 103:4992-6, 1981. Estonian Acad. Sci., Inst. Chem. Phys. Biophys., Tallinn, USSR; Acad. Sci. GDR, Ctrl. Inst. Phys. Chem., Berlin-Aldershof, GDR. 82-2800. 83-3408
2	14	20	36 (5)	**Maier W F & Schleyer P V R.** Evaluation and prediction of the stability of bridgehead olefins. *J. Amer. Chem. Soc.* 103:1891-900, 1981. Friedrich-Alexander Univ., Inst. Org. Chem., Erlangen, FRG. 83-2227
0	29	24	53 (22)	**Martin V S, Woodard S S, Katsuki T, Yamada Y, Ikeda M & Sharpless K B.** Kinetic resolution of racemic allylic alcohols by enantioselective epoxidation. A route to substances of absolute enantiomeric purity. *J. Amer. Chem. Soc.* 103:6237-40, 1981. MIT, Dept. Chem., Cambridge, MA. 82-2637, 83-3714, #319775
6	21	11	38 (12)	**Masamune S, Hirama M, Mori S, Ali S A & Garvey D S.** Total synthesis of 6-deoxyerythronolide B. *J. Amer. Chem. Soc.* 103:1568-71, 1981. MIT, Dept. Chem., Cambridge, MA. 82-1995, #329948
1	16	26	43 (18)	**McLafferty F W.** Tandem mass spectrometry. *Science* 214:280-7, 1981. Cornell Univ., Dept. Chem., Ithaca, NY. 83-1302
5	19	19	43 (8)	**McNeal C J & Macfarlane R D.** Observation of a fully protected oligonucleotide dimer at m/z 12637 by ^{252}Cf-plasma desorption mass spectrometry. *J. Amer. Chem. Soc.* 103:1609-10, 1981. Texas A&M Univ., Dept. Chem., College Station, TX. 82-0768, 83-0072
1	26	15	42 (2)	**Moore R E & Bartolini G.** Structure of palytoxin. *J. Amer. Chem. Soc.* 103:2491-4, 1981. Univ. Hawaii, Dept. Chem., Honolulu, HI. 82-2922, 83-4502, #331728
8	10	13	31 (5)	**Nishizawa M, Yamada M & Noyori R.** Highly enantioselective reduction of alkynyl ketones by a binaphthol-modified aluminum hydride reagent. Asymmetric synthesis of some insect pheromones. *Tetrahedron Lett.* 22:247-50, 1981. Nagoya Univ., Dept. Chem., Japan. *83-0486, #315535
1	24	24	49 (21)	**Noufi R, Frank A J & Nozik A J.** Stabilization of n-type silicon photoelectrodes to surface oxidation in aqueous electrolyte solution and mediation of oxidation reaction by surface-attached organic conducting polymer. *J. Amer. Chem. Soc.* 103:1849-50, 1981. Solar Energy Res. Inst., Photoconvers. Res. & Photovolt. Compound Semicond. Progrm. Branches, Golden, CO. 82-1104
0	14	15	29 (21)	**Noyori R, Murata S & Suzuki M.** Trimethysilyl triflate in organic synthesis. *Tetrahedron* 37:3899-910, 1981. Nagoya Univ., Dept. Chem., Japan. *83-2123
6	18	11	35 (13)	**Noyori R, Nishida I & Sakata J.** Erythro-selective aldol reaction via tris-(dialkylamino)sulfonium enolates. *J. Amer. Chem. Soc.* 103:2106-8, 1981. Nagoya Univ., Dept. Chem., Japan. *83-1406, #333419
4	7	18	29 (10)	**Ohno A, Shio T, Yamamoto H & Oka S.** Reduction by a model of NAD(P)H. 30. Proof for the electron-proton-electron-transfer mechanism. *J. Amer. Chem. Soc.* 103:2045-8, 1981. Kyoto Univ., Inst. Chem. Res., Japan. 83-4668, #333413
2	11	19	32 (9)	**Ohno A, Yamamoto H & Oka S.** Reduction by a model of NAD(P)H. 29. Kinetics and isotope effects for the reduction of substituted trifluoroacetophenone. *J. Amer. Chem. Soc.* 103:2041-5, 1981. Kyoto Univ., Inst. Chem. Res., Japan. 83-4668, #333412
3	16	12	31 (17)	**Ohno M, Kobayashi S, Iimori T, Wang Y-F & Izawa T.** Synthesis of (*S*)- and (*R*)-4-[(methoxycarbonyl)methyl]-2-azetidinone by chemicoenzymatic approach. *J. Amer. Chem. Soc.* 103:2405-6, 1981. Univ. Tokyo, Fac. Pharm. Sci., Japan. 82-2624, #331721
7	8	12	27 (8)	**Osamura Y, Schaefer H F, Gray S K & Miller W H.** Vinylidene: a very shallow minimum on the C_2H_2 potential energy surface. Static and dynamical

A	B	C	D	E
				considerations. *J. Amer. Chem. Soc.* 103:1904-7, 1981. Univ. Texas, Dept. Chem. & Inst. Theor. Chem., Austin, TX; Univ. California, Lawrence Berkeley Lab., Berkeley, CA. *83-2057
1	12	13	26 (12)	**Ozin G A, McIntosh D F, Mitchell S A & García-Prieto J.** Methane activation. Photochemical reaction of copper atoms in solid methane. *J. Amer. Chem. Soc.* 103:1574-5, 1981. Univ. Toronto, Lash Miller Chem. Labs. & Erindale Coll., Canada; Mexican Petrol. Inst., Mexico. 83-3652, #329952
7	14	4	25 (2)	**Paquette L A, Balogh D W, Usha R, Kountz D & Christoph G G.** Crystal and molecular structure of a pentagonal dodecahedrane. *Science* 211:575-6, 1981. Ohio State Univ., Evans Chem. Lab., Columbus, OH. 82-1925, #308814
0	11	16	27 (4)	**Paterson Y, Rumsey S M, Benedetti E, Nemethy G & Scheraga H A.** Sensitivity of polypeptide conformation to geometry. Theoretical conformational analysis of oligomers of α-aminoisobutyric acid. *J. Amer. Chem. Soc.* 103:2947-55, 1981. Cornell Univ., Baker Lab. Chem., Ithaca, NY; Univ. Napoli, Inst. Chem., Italy. *83-0507
3	16	10	29 (4)	**Pirrung M C.** Total synthesis of (±)-isocomene and related studies. *J. Amer. Chem. Soc.* 103:82-7, 1981. Univ. California, Dept. Chem., Berkeley, CA. *83-1125, #322661
8	14	10	32 (1)	**Pouget J P.** Diffuse X ray studies of one-dimensional organic metals. *Chem. Scripta* 17:85-91, 1981. Univ. Paris XI, Lab. Phys. Solid-State, Orsay, France. 82-0558
0	6	19	25 (9)	**Pross A, DeFrees D J, Levi B A, Pollack S K, Radom L & Hehre W J.** Theoretical approach to substituent effects. Structures and stabilities of carbanions XCH_2^-. *J. Org. Chem.* 46:1693-9, 1981. Australian Natl. Univ., Res. Sch. Chem., Canberra, Australia; Univ. California, Dept. Chem., Irvine, CA. *83-1525
0	14	23	37 (31)	**Raghavachari K, Whiteside R A, Pople J A & Schleyer P V R.** Molecular orbital theory of the electronic structure of organic molecules. 40. Structures and energies of C_1-C_3 carbocations, including effects of electron correlation. *J. Amer. Chem. Soc.* 103:5649-57, 1981. Carnegie-Mellon Univ., Dept. Chem., Pittsburgh, PA; Friedrich-Alexander Univ., Inst. Org. Chem., Erlangen, FRG. 83-2634
3	16	17	36 (7)	**Ramdas S, Thomas J M, Klinowski J, Fyfe C A & Hartman J S.** Ordering of aluminium and silicon in synthetic faujasites. *Nature* 292:228-30, 1981. Univ. Cambridge, Dept. Phys. Chem., UK; Univ. Guelph, Guelph-Waterloo Ctr. Grad. Work Chem., Ontario, Canada. 82-2800
0	15	15	30 (8)	**Rinehart K L, Gaudioso L A, Moore M L, Pandey R C, Cook J C, Barber M, Sedgwick R D, Bordoli R S, Tyler A N & Green B N.** Structures of eleven zervamicin and two emerimicin peptide antibiotics studied by fast atom bombardment mass spectrometry. *J. Amer. Chem. Soc.* 103:6517-20, 1981. Univ. Illinois, Sch. Chem. Sci., Urbana, IL; Victoria Univ. Manchester, Inst. Sci. Technol.; VG Anal. Ltd., Altrincham, UK. 83-0072, #320289
5	11	10	26 (5)	**Rokach J, Young R N, Kakushima M, Lau C-K, Seguin R, Frenette R & Guindon Y.** Synthesis of leukotrienes—new synthesis of natural leukotriene A_4. *Tetrahedron Lett.* 22:979-82, 1981. Merck Frosst Labs., Dorval, Quebec, Canada. *83-1164
3	12	20	35 (11)	**Rondan N G, Paddon-Row M N, Caramella P & Houk K N.** Nonplanar alkenes and carbonyls: a molecular distortion which parallels addition stereoselectivity. *J. Amer. Chem. Soc.* 103:2436-8, 1981. Louisiana State Univ., Dept. Chem., Baton Rouge, LA; Univ. Pittsburgh, Dept. Chem., PA. *83-0204
0	17	18	35 (15)	**Rubinstein I & Bard A J.** Polymer films on electrodes. 5. Electrochemistry and chemiluminescence at nafion-coated electrodes. *J. Amer. Chem. Soc.* 103:5007-13, 1981. Univ. Texas, Dept. Chem., Austin, TX. 82-0169, 83-3898
2	15	20	37 (15)	**Scandola F, Balzani V & Schuster G B.** Free-energy relationships for reversible and irreversible electron-transfer processes. *J. Amer. Chem. Soc.* 103:2519-23, 1981. CNR, Photochem. React. Coordin. Compounds Excited States Res. Ctr., Ferrara; Photochem. High Energ. Radiat. Inst., Bologna; Univ. Ferrara, Inst. Chem. "G. Ciamician," Italy; Univ. Illinois, Sch. Chem. Sci., Urbana, IL. 83-3598
4	8	13	25 (8)	**Scheller K H, Hofstetter F, Mitchell P R, Prijs B & Sigel H.** Macrochelate formation in monomeric metal ion complexes of nucleoside 5'-triphosphates and the promotion of stacking by metal ions. Comparison of the self-association of purine and pyrimidine 5'-triphosphates using proton nuclear magnetic resonance. *J. Amer. Chem. Soc.* 103:247-60, 1981. Univ. Basel, Inst. Inorg. Chem., Switzerland. *83-0324

A	B	C	D	E
6	13	10	29 (8)	**Schultz A J, Brown R K, Williams J M & Schrock R R.** Low-temperature neutron diffraction studies of C-H-metal interactions in two tantalum-neopentylidene complexes: $[Ta(CHCMe_3)(PMe_3)Cl_3]_2$ [T = 110K] and the first alkylidene/olefin complex, $Ta(\eta^5\text{-}C_5Me_5)(CHCMe_3)(\eta^2\text{-}C_2H_4)(PMe_3)$ [T = 20 K]. *J. Amer. Chem. Soc.* 103:169-76, 1981. Argonne Natl. Lab., Chem. Div., IL; Brookhaven Natl. Lab., Dept. Chem., Upton, NY; MIT, Dept. Chem., Cambridge, MA. •83-0446
5	9	11	25 (3)	**Sharp P R, Holmes S J, Schrock R R, Churchill M R & Wasserman H J.** Tungsten methylidyne complexes. *J. Amer. Chem. Soc.* 103:965-6, 1981. MIT, Dept. Chem., Cambridge, MA; SUNY, Dept. Chem., Buffalo, NY. •83-0446
3	19	16	38 (28)	**Shigehara K, Oyama N & Anson F C.** Electrochemical responses of electrodes coated with redox polymers. Evidence for control of charge-transfer rates across polymeric layers by electron exchange between incorporated redox sites. *J. Amer. Chem. Soc.* 103:2552-8, 1981. Caltech, Arthur Amos Noyes Lab., Pasadena, CA. 82-0169
4	22	11	37 (12)	**Shinkai S, Nakaji T, Ogawa T, Shigematsu K & Manabe O.** Photoresponsive crown ethers. 2. Photocontrol of ion extraction and ion transport by a bis (crown ether) with a butterfly-like motion. *J. Amer. Chem. Soc.* 103:111-5, 1981. Nagasaki Univ., Fac. Eng., Japan. 82-3147, 83-9190
9	12	4	25 (8)	**Smith A B & Jerris P J.** Total synthesis of (±)-modhephene. *J. Amer. Chem. Soc.* 103:194-5, 1981. Univ. Pennsylvania, Dept. Chem.; Monell Chem. Senses Ctr., Philadelphia, PA. •83-1125, #322676
5	11	18	34 (8)	**Smith G D, Pletnev V Z, Duax W L, Balasubramanian T M, Bosshard H E, Czerwinski E W, Kendrick N E, Mathews F S & Marshall G R.** Crystal structures and conformational calculations of fragments of alamethicin containing aminoisobutyric acid. *J. Amer. Chem. Soc.* 103:1493-501, 1981. Med. Fdn. Buffalo, Inc., NY; Washington Univ., Sch. Med., St. Louis, MO. •83-0507
5	20	10	35 (9)	**Steinmetz G R & Geoffroy G L.** Stepwise reduction of CO to CH_4 on a triosmium cluster face. Preparation and characterization of $Os_3(CO)_{11}CH_2$. *J. Amer. Chem. Soc.* 103:1278-9, 1981. Pennsylvania State Univ., Dept. Chem., University Park, PA. 82-1189
1	12	16	29 (6)	**Stenkamp R E, Siecker L C, Jensen L H & Sanders-Loehr J.** Structure of the binuclear iron complex in metazidohaemerythrin from *Themiste dyscritum* at 2.2 Å resolution. *Nature* 291:263-4, 1981. Univ. Washington, Depts. Biol. Struct. & Biochem., Seattle, WA; Portland State Univ., Dept. Chem., OR. 83-7935
2	19	25	46 (26)	**Tauster S J, Fung S C, Baker R T K & Horsley J A.** Strong interactions in supported-metal catalysts. *Science* 211:1121-5, 1981. Exxon Res. Eng. Co., Corporate Res. Labs., Linden, NJ. 82-0735, 83-1064
5	17	11	33 (7)	**Theopold K H & Bergman R G.** Synthesis and reactions of a binuclear cobalt bridging methylene (μ-CH_2) complex. Conversion to μ-CH_2 Rh/Co and Rh/Rh complexes and methylene transfer to ethylene involving activation by a second metal complex. *J. Amer. Chem. Soc.* 103:2489-91, 1981. Univ. California, Dept. Chem., Berkeley, CA. 82-0591
6	11	9	26 (5)	**Trost B M & Klun T P.** Chirality transfer via organopalladium chemistry. A synthesis of optically active vitamin E side chain from D-glucose. *J. Amer. Chem. Soc.* 103:1864-5, 1981. Univ. Wisconsin, Dept. Chem., Madison, WI. •83-3440. #333385
0	16	16	32 (11)	**Tulip T H & Thorn D L.** Hydridometallacycloalkane complexes of iridium. Unassisted intramolecular distal C-H bond activation. *J. Amer. Chem. Soc.* 103:2448-50, 1981. Dupont Co., Ctrl. Res. Dev. Dept., Wilmington, DE. •83-0209, #331745
2	15	14	31 (10)	**Tullius T D & Lippard S J.** *cis*-Diamminedichloroplatinum(II) binds in a unique manner to oligo(dG)·oligo(dC) sequences in DNA—a new assay using exonuclease III. *J. Amer. Chem. Soc.* 103:4620-2, 1981. Columbia Univ., Dept. Chem., New York, NY. •83-1294
4	22	20	46 (11)	**Tunuli M S & Fendler J H.** Aspects of artificial photosynthesis. Photosensitized electron transfer across bilayers, charge separation, and hydrogen production in anionic surfactant vesicles. *J. Amer. Chem. Soc.* 103:2507-13, 1981. Texas A&M Univ., Dept. Chem., College Station, TX.
10	16	9	35 (2)	**Uemura D, Ueda K, Hirata Y, Naoki H & Iwashita T.** Further studies on palytoxin. II. Structure of palytoxin. *Tetrahedron Lett.* 22:2781-4, 1981. Shizuoka Univ., Fac. Liberal Arts.; Univ. Ryukyus, Dept. Gen. Educ., Naha;

A	B	C	D	E
				Meijo Univ., Fac. Pharm., Nagoya; Suntory Inst. Bioorg. Res., Osaka, Japan. 82-2922, #315956
2	12	22	36 (13)	**Watson W H, Galloy J, Bartlett P D & Roof A A M.** Double-bond deformation in two crystalline derivatives of *syn*-sesquinorbornene ($\Delta^{4a,8a}$-octahydro-1,4,5,8-dimethanonaphthalene). *J. Amer. Chem. Soc.* 103:2022-31, 1981. Texas Christian Univ., Dept. Chem., Fort Worth, TX. *83-0204, #333418
1	16	20	37 (5)	**Wengrovius J H, Sancho J & Schrock R R.** Metathesis of acetylenes by tungsten (VI)-alkylidyne complexes. *J. Amer. Chem. Soc.* 103:3932-4, 1981. MIT, Dept. Chem., Cambridge, MA. *83-0446
0	18	23	41 (28)	**West R, Fink M J & Michl J.** Tetramesityldisilene, a stable compound containing a silicon-silicon double bond. *Science* 214:1343-4, 1981. Univ. Wisconsin, Dept. Chem., Madison, WI; Univ. Utah, Dept. Chem., Salt Lake City, UT. 83-1039, #321653
2	13	12	27 (12)	**Willner I, Otvos J W & Calvin M.** Photosensitized electron-transfer reactions in colloidal SiO_2 systems: charge separation at a solid-aqueous interface. *J. Amer. Chem. Soc.* 103:3203-5, 1981. Univ. California, Dept. Chem. & Lawrence Berkeley Lab., Berkeley, CA. *83-3476
0	12	13	25 (7)	**Wudl F.** Three-dimensional structure of the superconductor $(TMTSF)_2AsF_6$ and the spin-charge separation hypothesis. *J. Amer. Chem. Soc.* 103:7064-9, 1981. Bell Labs., Murray Hill, NJ. 83-2192
1	13	37	51 (33)	**Yoshifuji M, Shima I, Inamoto N, Hirotsu K & Higuchi T.** Synthesis and structure of bis(2,4,6-tri-*tert*-butylphenyl)diphosphene: isolation of a true "phosphobenzene." *J. Amer. Chem. Soc.* 103:4587-9, 1981. Univ. Tokyo, Fac. Sci.; Osaka City Univ., Fac. Sci., Japan. 83-1039, #317108
6	16	9	31 (8)	**Zakett D, Schoen A E, Cooks R G & Hemberger P H.** Laser-desorption mass spectrometry/mass spectrometry and the mechanism of desorption ionization. *J. Amer. Chem. Soc.* 103:1295-7, 1981. Purdue Univ., Dept. Chem., West Lafayette, IN; Union Carbide Corp., Nucl. Div., Oak Ridge, TN. 82-0768

have an uncanny way of tracking these elusive boundaries. Indeed, with all the trouble such distinctions create, I wonder why we struggle to maintain the fiction that there is something called pure chemistry. In Table 2, we indicate the total number of papers published in 1982 or 1983 (same year as the prefix in Column A) for each front—a very large number indeed for these cross-disciplinary topics.

In Table 3, we have provided the research front information for those papers that are covered by our new *Chemistry Citation Index* (*CCI*) research fronts. We'll have more to say about the *CCI* later. In the meantime, however, it is too involved to explain here why the *CCI* uncovers research fronts not reported in our more general *SCI* scheme. There is no end to the way you can divvy up the science pot. If you can't wait to hear more, let me know, and I'll send you a preprint of a paper that will soon appear to celebrate the silver anniversary issue of the *Journal of Chemical Information and Computer Sciences*, another American Chemical Society journal.[8]

If this is your first encounter with a most-cited papers study, then you might want to retrieve the August 29, September 19, and November 14, 1983 issues of *CC*,[2,3,9] in which we discussed the 1981 life and physical sciences and 1980 chemistry most-cited papers. Or, you can refer to *Essays of an Information Scientist*,[10] in which you will find dozens of similar lists. There never seems to be the time or space to publish enough of these studies to satisfy every reader.

I mentioned earlier that we included the 1984 citations for each paper in Table 1. This was not a trivial task, but I felt that it was appropriate since we were already into 1985. Most of the papers in the study "peaked" in 1983, but there are a few interesting exceptions. These include papers by K. Shigehara, N. Oyama, and F.C. Anson, California Institute of Technology (Caltech), Pasadena; K. Raghavachari, Carnegie-Mel-

Table 2: The 1982 *SCI*® and 1983 *SCI/SSCI*® research fronts that contain at least two of the 1981 most-cited pure and synthetic chemistry papers as core documents. A=number. B=name. C=number of 1981 most-cited chemistry papers included in the core of each research front. D=total number of core documents/1982 or 1983 documents citing the core (according to the year of the front designated by the prefix in column A).

A	B	C	D
82-0169	Use of polymer-coated electrodes	3	24/136
82-0591	Hydrocarbon synthesis over Fischer-Tropsch catalysts; hydrogenation of carbon monoxide over ruthenium, nickel and other metal catalysts	2	19/230
82-0754	Photosensitizers, electron transfer agents and other factors of photochemical water cleavage in artificial photosynthetic systems	2	41/300
82-0768	Fast atom bombardment and secondary ion mass spectrometry of involatile biomolecules	4	16/179
82-1149	Photoelectrochemistry with colloidal semiconductor catalysts applied to water photolysis and other solar energy conversion systems	2	2/32
82-1189	Synthesis and catalytic properties of transition metal formyl complexes	2	13/147
82-1995	Stereoselective and enantioselective synthesis of alcohols from aldehydes via aldol condensations and other reactions	2	5/59
82-2800	High-resolution SI-29 NMR of zeolites and other aluminosilicates	2	4/46
82-2922	Stereochemistry and synthesis of palytoxins and other marine natural products	2	3/32
83-0072	Techniques and applications of fast atom bombardment in desorption and secondary ion mass spectrometry	3	38/379
83-1039	Synthesis, X-ray crystal structure and reactions of stable unsymmetrically-substituted diphosphines	2	14/107
83-1064	Fischer-Tropsch synthesis of hydrocarbons and alcohols via the hydrogenation of carbon monoxide on supported iron catalysts	3	35/376
83-1380	Structural assignment and other aspects of multinuclear 2-dimensional nuclear magnetic resonance spectroscopy	2	59/541
83-3652	Synthesis via the activation of oxygen and carbon-hydrogen bonds using metalloporphyrins and related compounds as catalysts	2	23/223
83-4668	Synthesis and reductions and other electron transfers of NADH and NADPH models	2	8/75

Table 3: The 1982-1983 *CCI*® research fronts that contain at least two of the 1981 most-cited pure and synthetic chemistry papers as core documents. A=number. B=name. C=number of 1981 most-cited chemistry papers included in the core of each research front. D=total number of core documents/1982 and 1983 documents citing the core.

A	B	C	D
83-0189	Spectroelectrochemistry and other electrochemistry of horse heart cytochrome *c* and other biological redox systems	2	25/150
83-0204	Theory of stereoelectronic control in Diels-Alder reactions of norbornenes and related systems	3	47/238
83-0446	Synthesis, structure and mechanistic studies of tungsten catalysts for olefin metathesis and polymerization	3	39/302
83-0507	Synthesis and conformational analysis of alamethicin fragments and other polypeptides containing alpha aminoisobutyric acid residues	2	52/168
83-0906	Synthesis and characterization of transition metal carbides and related clusters with encapsulated atoms	2	14/146
83-1125	Synthesis of sesquiterpenes and other natural products via organometallic mediated cycloadditions	2	55/234
83-1525	Abinitio study of the structure of carbanions and silyl anions in the gas phase	2	5/62
83-2153	Stereoselective asymmetric synthesis via aldol condensations with enolates	2	10/130
83-2762	Theory and statistical studies of the structure and dynamics of water, methanol and other liquids	2	7/47

lon, Pittsburgh, and colleagues; and S.J. Tauster and coworkers, Exxon, Linden, New Jersey. This last one, and a paper by R. West, University of Wisconsin, Madison, and colleagues, appeared in *Science*, which is not where you usually expect to see many superstar chemistry articles. We have listed the other journals that published two or more articles in Table 4.

Table 4: The 12 journals represented in the list of the 103 1981 pure and synthetic chemistry papers most cited in 1981-1983. The numbers in parentheses are the impact factors for the journals. (1981 impact factor equals the number of 1981 citations received by the 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 that appears in the list.

Journal	Number of Papers
J. Amer. Chem. Soc. (4.26)	74
Science (6.24)	7
Tetrahedron (1.68)	4
Tetrahedron Lett. (1.90)	4
J. Org. Chem. (1.94)	3
Nature (7.19)	3
J. Organomet. Chem. (1.89)	2
Org. Magn. Resonance (1.29)	2
Biomed. Mass Spectrom. (1.61)	1
Chem. Scripta (.46)	1
Israel J. Chem. (1.45)	1
Org. Mass Spectrom. (1.53)	1

Science, in fact, accounted for seven papers in this study. This is a high percentage of the chemistry papers that appear in *Science*, which is dominated by biomedical and biochemistry papers. So undoubtedly, the chemistry articles selected by *Science* are already "hot" areas of research reported in review papers.

Indeed, Stuyvesant High School alumnus Roald Hoffmann has appeared several times in these essays.[11,12] He turns up again, this time with a review paper, also in *Science*. This paper is quite relevant to his Nobel award and was cited in his acceptance speech.[13] Hoffmann shared the 1981 Nobel Prize with Kenichi Fukui of Japan for their work in applying quantum mechanics theories to predict the course of chemical reactions. Hoffmann also received the National Medal of Science recently.

My organic chemistry professor, Melvin Calvin of the US, and Peter Mitchell (UK), both of whom received Nobel Prizes for chemistry, are also on the list. Calvin won in 1961 and Mitchell in 1978.

I want to mention two other key points about this study. Eleven of the papers were published by chemists at Japanese institutions—a record and probably a harbinger of more to come. But none were published in Japanese journals. Also, six of the papers came from the Massachusetts Institute of Technology (MIT), Cambridge. The various campuses of the University of California account for nine papers in Table 5, which ranks the institutional affiliations for the 317 authors in this study.

These authors, incidentally, are from 13 different countries (see Table 6). Authors from the US led the list, appearing in 66 papers. Japan, as mentioned earlier, had 11; Canada, 8; the UK, 7; Switzerland, 5; the Federal Republic of Germany, 4; and Australia, 3. France and Italy each account for two papers, and the German Democratic Republic (GDR), Mexico, the Netherlands, and the USSR each list one.

The paper from the USSR was coauthored with East German scientists and received the third highest number of citations from 1981 to 1983—51. Its authors, E. Lippmaa, M. Magi, A. Samoson, M. Tarmak, and G. Engelhardt, are from the Institute of Chemical Physics and Biophysics, Estonian Academy of Sciences, Tallinn, and the Central Institute of Physical Chemistry, Academy of Sciences of the GDR, Berlin-Aldershof. This group also coauthored a paper on silicates[14] in our study of most-cited chemistry papers of 1980. Both papers were published in *JACS*. It is always interesting to observe the selection of Russian articles that appear in international journals. They seem to represent the cream of Soviet research. This is a trend we want to encourage, and follows the pattern of publication in Japan, France, and other countries.

JACS also published the most-cited and second most-cited papers, based on the 1981-1983 data. This should not

Table 5: The institutional affiliations of the authors in the list of papers in descending order of the number of times they appear in Table 1.

Univ. California, CA		9
Berkeley	7	
Davis	1	
Irvine	1	
MIT, Cambridge, MA		6
Caltech, Pasadena, CA		5
Univ. Texas, Austin, TX		5
Brookhaven Natl. Lab., Upton, NY		4
Cornell Univ., Ithaca, NY		4
Ecole Polytech. Fed. Lausanne, Switzerland		4
Friedrich-Alexander Univ., Erlangen, FRG		4
Univ. Washington, Seattle, WA		4
Victoria Univ. Manchester, UK		4
Nagoya Univ., Japan		3
Purdue Univ., West Lafayette, IN		3
Argonne Natl. Lab., IL		2
CNR, Italy		2
Bologna	1	
Ferrara	1	
Kyoto Univ., Japan		2
Louisiana State Univ., Baton Rouge, LA		2
Northwestern Univ., Evanston, IL		2
NRC Canada, Ottawa, Canada		2
Solar Energy Res. Inst., Golden, CO		2
Texas A&M Univ., College Station, TX		2
Union Carbide Corp.		2
Oak Ridge, TN	1	
South Charleston, WV	1	
Univ. Illinois, Urbana, IL		2
Univ. Oxford, UK		2
Univ. Pennsylvania, Philadelphia, PA		2
Univ. Pittsburgh, PA		2
Univ. Tokyo, Japan		2
Univ. Toronto, Canada		2
Univ. Wisconsin, Madison, WI		2
Washington Univ., St. Louis, MO		2
Acad. Sci. GDR, Berlin-Aldershof, GDR		1
Australian Natl. Univ., Canberra, Australia		1
Bell Labs., Murray Hill, NJ		1
Boston Univ., MA		1
Broken Hill Proprietary Co., Ltd., Clayton, Australia		1
Carnegie-Mellon Univ., Pittsburgh, PA		1
Columbia Univ., New York, NY		1
Crystalytics Co., Lincoln, NE		1
Dupont Co., Wilmington, DE		1
Estonian Acad. Sci., Tallinn, USSR		1
Exxon Res. Eng. Co., Linden, NJ		1
Govt. Ind. Res. Inst., Nagoya, Japan		1
Med. Fdn. Buffalo, Inc., NY		1
Meijo Univ., Nagoya, Japan		1
Merck Frosst Labs., Dorval, Quebec, Canada		1
Merck, Sharp & Dohme Res. Labs., Rahway, NJ		1
Mexican Petrol. Inst., Mexico City, Mexico		1
Michigan State Univ., East Lansing, MI		1
Monell Chem. Senses Ctr., Philadelphia, PA		1
Nagasaki Univ., Japan		1
Ohio State Univ., Columbus, OH		1
Oklahoma State Univ., Stillwater, OK		1
Osaka City Univ., Japan		1
Pennsylvania State Univ., University Park, PA		1
Phillips Petrol. Co., Bartlesville, OK		1
Portland State Univ., OR		1
Shizuoka Univ., Japan		1
State Univ., Leiden, the Netherlands		1
Suntory Inst. Bioorg. Res., Osaka, Japan		1
SUNY, Buffalo, NY		1
Texas Christian Univ., Fort Worth, TX		1
Tohoku Univ., Sendai, Japan		1
Univ. Adelaide, Australia		1
Univ. Basel, Switzerland		1
Univ. British Columbia, Vancouver, Canada		1
Univ. Cambridge, UK		1
Univ. Colorado, Boulder, CO		1
Univ. Ferrara, Italy		1
Univ. Guelph, Ontario, Canada		1
Univ. Hawaii, Honolulu, HA		1
Univ. London, UK		1
Univ. Louis Pasteur, Strasbourg, France		1
Univ. Michigan, Ann Arbor, MI		1
Univ. N. Carolina, Chapel Hill, NC		1
Univ. Napoli, Italy		1
Univ. Nebraska, Lincoln, NE		1
Univ. Ottawa, Canada		1
Univ. Paris, Orsay, France		1
Univ. Rochester, NY		1
Univ. Ryukyus, Naha, Japan		1
Univ. Utah, Salt Lake City, UT		1
Univ. Wales, Swansea, UK		1
Univ. Waterloo, Ontario, Canada		1
USN, Washington, DC		1
VG Analyt. Ltd., Altrincham, UK		1

come as a surprise since the list is dominated by *JACS* papers. The most-cited paper is by John T. Groves and colleagues, University of Michigan, Ann Arbor. It discusses the preparation and characterization of a new high-valent iron-porphyrin complex. V.S. Martin and colleagues, MIT, authored the second most-cited paper, which is on prochiral allylic alcohols. It received 53 cites.

In our lists of most-cited scientific papers, multiauthored works are the rule. This study is no exception. Only 12 papers had one author; 24 had two; 20, three; 22, four; 17, five; 4, six; 1, seven; 1, nine; and 2 had 10. Twenty-six of

Table 6: National affiliations of the authors of the 1981 pure and synthetic chemistry papers most cited in 1981-1983, in order of the total number of papers in 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	66	5	Australia, FRG, Italy, UK
Japan	11		
Canada	8	2	Mexico, UK
UK	7	3	Canada, FRG, US
Switzerland	5		
FRG	4	2	UK, US
Australia	3	1	US
France	2		
Italy	2	2	US
GDR	1	1	USSR
Mexico	1	1	Canada
The Netherlands	1		
USSR	1	1	GDR

these appeared on more than one paper—18 on two; 6 on three; and 2 on four.

Some authors, such as Hoffmann, not only appear in multiple papers in a single study, but also show up in many different studies.[11,12] Leo A. Paquette has also regularly appeared in these lists.[12,15] He authored a paper in this study on a pentagonal dodecahedrane. Certain classic papers and methods are also frequently referenced. In this study, a paper by Robert E. Ireland and John P. Daub, Caltech, discusses the Prelog-Djerassi lactone and derivatives. Vladimir Prelog and Carl Djerassi have each commented on several *Citation Classics* ™ for *CC*.[16-19]

This concludes our discussion of pure and synthetic chemistry papers. The second part of this essay will cover physical, analytical, and inorganic chemistry articles. It will be published in the next few months, as will another separate essay in which we will discuss the physical chemistry-chemical physics connection.

* * * * *

My thanks to Abigail Grissom and Janet Robertson for their help in the preparation of this essay.

REFERENCES

1. **Garfield E.** *Index Chemicus* goes online with graphic access to three million new organic compounds. *Current Contents* (26):3-10, 25 June 1984.
2. --------------. The 1981 articles most cited in 1981 and 1982. 2. Physical sciences. *Current Contents* (46):5-15, 14 November 1983.
3. --------------. The 1980 chemistry articles most cited in 1980-1982. *Current Contents* (35):5-15, 29 August 1983.
4. **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.
5. **Borgarello E, Kiwi J, Pelizzetti E, Visca M & Gratzel M.** Photochemical cleavage of water by photocatalysis. *Nature* 289:158-60, 1981.
6. **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.
7. **Rinehart K L.** Fast atom bombardment mass spectrometry. *Science* 218:254-60, 1982.
8. **Garfield E.** A history of citation indexes for chemistry: a brief review. *J. Chem. Inform. Comput. Sci.* (In press.)
9. --------------. The 1981 articles most cited in 1981 and 1982. 1. Life sciences. *Current Contents* (38):5-15, 19 September 1983.
10. --------------. *Essays of an information scientist.* Philadelphia: ISI Press, 1962-1984. Vols. 1-6.
11. --------------. Were the 1981 Nobel prizewinners in science, economics, and literature anticipated by citation analysis? *Essays of an information scientist.* Philadelphia: ISI Press, 1983. Vol. 5. p. 551-61.
12. --------------. The 300 most-cited authors, 1961-1976, including co-authors at last. Parts 1;2;3B;3C. *Essays of an information scientist.* Philadelphia: ISI Press, 1980. Vol. 3. p. 538-50; 587-612; 701-22.
13. **Hoffmann R.** Building bridges between inorganic and organic chemistry. (Nobel lecture.) *Angew. Chem. Int. Ed.* 21:711-24, 1982.

14. **Lippmaa E, Magi M, Samoson A, Engelhardt G & Grimmer A-R.** Structural studies of silicates by solid-state high-resolution ^{29}Si NMR. *J. Amer. Chem. Soc.* 102:4889-93, 1980.
15. **Garfield E.** The 1,000 contemporary scientists most-cited 1965-1978. Parts 1;2a;3. *Essays of an information scientist.* Philadelphia: ISI Press, 1983. Vol. 5. p. 269-78; 428-36; 591-606.
16. **Budzikiewicz H, Djerassi C & Williams D H.** Citation Classic. Commentary on *Mass spectrometry of organic compounds.* San Francisco: Holden-Day, 1967. 690 p. *Current Contents/Physical, Chemical & Earth Sciences* 22(34):18, 23 August 1982.
17. **Djerassi C.** Citation Classic. Commentary on *J. Amer. Chem. Soc.* 83:4013-8, 1961. *Current Contents/Physical, Chemical & Earth Sciences* 22(42):22, 18 October 1982.
18. **Prelog V.** Citation Classic. Commentary on *Experientia* 12:81-94, 1956. *Current Contents/Physical, Chemical & Earth Sciences* 22(50):18, 13 December 1982.
19. --------------. Citation Classic. Commentary on *Experientia* 16:521-3, 1960. *Current Contents/Physical, Chemical & Earth Sciences* 24(30):12, 23 July 1984 and *Current Contents/Engineering, Technology & Applied Sciences* 15(30):12, 23 July 1984.

To identify the papers discussed in these most-cited studies of chemistry, we use several ISI® products. *Current Abstracts of Chemistry and Index Chemicus®* (*CAC&IC®*), available in print and online as *Index Chemicus Online*, provides graphic abstracts of the current chemical literature reporting new organic compounds and new synthetic methods. Each abstract provides bibliographic information, the author's summary, and a reaction flow for each new compound indexed. *CAC&IC* abstracts flag certain types of scientific data such as biological activities, analytical techniques, new synthetic methods, explosive reactions, and the level of experimental detail given in the article. *Index Chemicus Online* covers all the compounds reported in *CAC&IC*, including structural diagrams for all new compounds, including intermediates.

The flag or alert to new synthetic methods tells the reader that the paper and the new method that it describes are also abstracted in *Current Chemical Reactions®* (*CCR®*). *CCR* is a separate ISI monthly publication that covers new and newly modified reactions and syntheses as they are reported in the literature. In addition to bibliographic data, *CCR* also provides reaction flow diagrams for these methods along with the experimental details given in the article.

The newest of our chemical indexes is the *Chemistry Citation Index* (*CCI*). *CCI* is a subset of the *Science Citation Index®* (*SCI®*). It covers the chemistry literature from 1978 to 1983. Three distinct sets of research fronts and hierarchical clusters are accessible through the *CCI*, each produced using two years of *CCI* data. This database will soon be available online. If you are interested in obtaining more information about it, and ISI's other chemistry products, contact Keri Luiso, Chemical Information Division, Marketing, ISI, 3501 Market Street, Philadelphia, PA 19104, or call toll-free, 1-800-523-1850.