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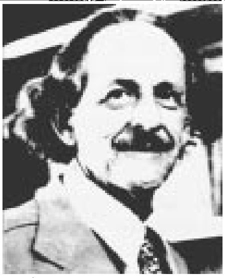

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The Most-Cited 1986 Physical-Sciences Articles: Ozone, Comet Halley, and Continued Interest in Superstrings and Superconductivity

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This study of the 106 1986 physical-sciences articles most cited in 1986 and 1987 shows a number of trends based on research-front activity. Among these are intense interest in superstring theories, which attempt to mathematically combine current descriptions of gravity, electromagnetic radiation, and nuclear bonding forces into a single grand unified theory. Also evident is continued strong interest in inorganic materials that become superconductors of electricity at relatively high temperatures; factors affecting the ozone content of the Earth's atmosphere; and quasicrystals, a new phase of solid matter. Data concerning the composition of comets Halley and Giacobini-Zinner, their atmospheres, and the mechanics of their orbits also attracted great attention.

We regularly identify and discuss papers in chemistry, the physical sciences, and the life sciences that become highly cited shortly after publication. We have already examined the 1985 chemistry articles most cited from 1985 to 1987,[1] while our most recent study concerned the 1986 life-sciences articles most cited in 1986 and 1987.[2]

This essay is devoted to the 1986 physical-sciences articles that were most cited in 1986 and 1987. The 106 papers in the Bibliography received an average of 66 citations each—15 in 1986 and 51 in 1987. The 10 least-cited papers received 36 citations each—the threshold for inclusion. The median number of citations to papers in this study, however, is 51.

As has been our custom, we must remind readers that the papers included in these studies are not necessarily the only ones of significance produced in these fields within this time frame. Many papers of equal or greater importance may start out more slowly, achieving *Citation Classic*®[3] status only in the fullness of years. The papers in this study might be termed "early bloomers," identifying the "hottest" topics in a field. Indeed, in our biweekly newspaper *THE SCIENTIST*®,[4,5] we try to pick up these "hot" papers as early as possible.

Research Fronts

In addition to gross citation counts, another, more refined indicator that the papers in this study are on the cutting edge of research is their incorporation into ISI®'s research fronts. As we have explained before, research fronts are identified by pairs of earlier papers, regardless of year of publication, that are cited together by later papers from a specific year. There are 34 papers that are core to both 1986 and 1987 research fronts; 36 papers are core to 1986 fronts, while 92 others are core to 1987 fronts. Thus, only about 32 percent of the papers in this study were core to 1986 fronts and continued as core documents in 1987; 87 percent show up in 1987 research fronts. This demonstrates that the "incubation time" for ideas in the physical sciences is short, indeed.

Incidentally, 12 papers—or 11 percent—are not included in the core of any research front. This should not be taken as a sign, however, that they are not on the cutting edge of research. In fact, they may be the harbingers of *really* hot fields—so far ahead of their time that there are not enough other, related papers being cited with them, as yet, to establish the co-citation thresholds needed for our clustering algorithms. Thus, papers such as the review of particle properties by M. Aguilar-Benitez, Nuclear Energy Commission, Madrid, Spain, and colleagues, which accumulated 124 citations in the first three quarters of 1988 for a total of 233, may not become core to a research front until others absorb this 350-page milestone work.

Table 1 lists the 1986 and 1987 research fronts that have at least four papers from the Bibliography among their core documents. It should be noted, however, that there are a number of significant research fronts that have less than four of the papers from this study in their cores and thus do not appear in Table 1. For example, three papers are core to the front on "Superstring models, low-energy phenomenology of some supersymmetric E_6-breaking patterns, and extra gauge bosons in E_6" (#86-0706), which has a total of 38 core papers and 736 citing documents. Among them is a discussion of the mass limits of E_6 superstrings by V. Barger, University of Wisconsin, Madison, and colleagues; the others are noted later in this essay.

As in our study of the most-cited 1985 physical-sciences papers,[6] high-energy physics—once a dominant feature of our annual studies—is absent from the list of titles in Table 1. Instead, dominating Table 1—and, indeed, the entire study—are fronts pertaining to strings and superstrings. Six of the fronts in Table 1 and 38 of the 106 papers in the Bibliography deal with superstring theory, either directly or indirectly.

By far the largest front in Table 1, both in terms of citing documents and in the number of papers from this year's Bibliography in its core, is entitled "Superstring models, extra E_6 neutral gauge bosons in ep collisions, intermediate mass scales, and heterotic string theory" (#87-0709). Fourteen of the papers in the Bibliography help form the core of this massive front, identified by over 700 published papers. The prominence of superstrings in this study is even more impressive when you realize that, as recently as our study of the most-cited 1983 physical-sciences papers,[7] not a single research front or paper contained the words *string* or *superstring* in their titles!

Superlatives: Superstrings and Superconductivity

Superstring theories are currently the only promising means of mathematically combining the force of gravity with the electroweak theory and quantum chromodynamics in a grand unified theory that describes all the forces of nature as differing facets of a single, fundamental phenomenon.[8] Superstring theories have been around for several years but, as evidenced by last year's study, came into their own only recently, with the breakthrough paper by Michael B. Green, Queen Mary College, University of London, UK, and John H. Schwarz, California Institute of Technology, Pasadena, who in 1985 demonstrated that one particular variant of superstring theory was free of mathematical anomalies.[9]

Superstring theorists conceive of elementary particles as one-dimensional, extended "strings" instead of spatial points. Nevertheless, we perceive them as the familiar subatomic particles that most children learn of in school (as well as the less-familiar, exotically named objects discovered by modern high-energy physics). The shape of strings—whether they are "open," like a curve, or "closed," like a loop—and the various resonances they produce when they vibrate account for the differences between particles.[10]

Four of the top five most-cited papers in this study concern superstrings. David J. Gross, Jeffrey A. Harvey, Emil Martinec, and Ryan Rohm, Joseph Henry Laboratories, Princeton University, New Jersey (a group facetiously known as the Princeton String Quartet), continued their work on heterotic strings. The theory combines features from Green and Schwarz's work with certain tenets from other theories in nothing less than an attempt to describe the underlying relationship between all the physical phenomena of the universe. Their short paper on this subject in 1985 was the most-cited paper in last year's study, receiving 304 citations in two years.[11] In this study the quartet's considerably expanded, full-fledged theory received 219 citations (63 in 1986 and 156 in 1987), making it the second most-cited paper in the list. And, through

Table 1: The 1986 and 1987 ISI® research fronts that include at least four of the most-cited 1986 physical-sciences papers as core documents. A = number of Bibliography papers that are core to each research front. B = total number of core documents. C = total number of citing papers published for the year designated by the prefix.

Number	Name	A	B	C
86-0324	Comet Giacobini-Zinner, ice particles in cometary atmospheres, and dust halo formation at comets	7	43	238
86-1604	Antarctic ozone, polar stratospheric clouds, and stratosphere during 1979-1984	4	11	75
86-1690	String field theory, gauge invariant actions of free closed superstring field theories, and covariant spectrum	4	20	202
87-0012	Cosmic strings, large-scale peculiar velocities, and two-component dark matter universe	4	41	477
87-0295	Two-dimensional conformal field theory, modular invariance in superconformal models, and critical behavior of self-dual Z(N) spin systems	5	25	377
87-0542	Comet P/Halley, modeling Halley, and Alfvenic turbulence in the solar-wind flow	11	57	387
87-0703	Bosonic string, leading divergences in multiloop closed superstring amplitudes, and covariant higher spin vertex operators	4	14	358
87-0709	Superstring models, extra E_6 neutral gauge bosons in ep collisions, intermediate mass scales, and heterotic string theory	14	41	708
87-1355	Icosahedral quasicrystals, decagonal phase of Al-Mn alloy, and diffraction patterns	5	44	372
87-1691	String field theory, higher spin gauge bosons, and BRS invariant vertex of Neveu-Schwarz-Ramond superstring	9	29	297
87-1810	Antarctic ozone hole, stratospheric layers, and changing atmospheric trace gases	4	41	310
87-2611	Scanning tunneling microscopy, atomic resolution in aqueous solutions, and unoccupied electronic states of a graphite surface	6	34	334

the first three quarters of 1988, it received 87 additional citations. It is also core to both research front #86-0706 and #86-0709. Another member of the quartet, Martinec, is among the authors of this year's fourth most-cited paper, on supersymmetry and superstrings, while the fifth most-cited paper, by physicists Warren Siegel and Barton Zwiebach, University of California, Berkeley, concerns string and gauge theories. Martinec, incidentally, is now at the University of Chicago, while Rohm is affiliated with Boston University. Harvey discussed superstring theory in a guest piece in *THE SCIENTIST* last summer.[12]

The third most-cited paper is by Edward Witten, then of the Joseph Henry Laboratories but now affiliated with the Institute for Advanced Study, also in Princeton. A discussion of the interactions of superstrings under the constraint of supersymmetry (which relates bosons, or particles with spins that can be expressed in whole numbers, to fermions, particles with spins expressed in half integers), Witten's paper was cited 172 times in 1986 and 1987 and 65 times through September 1988.

Witten, a 1982 MacArthur fellow who was featured in an article on superstrings in the *New York Times Magazine* in 1987,[13] has consistently been among the most prolific authors in our physical-sciences studies over the last few years. This year is no exception. With eight papers, he not only leads all other authors, but doubled the number of papers he had in last year's study. All were published in *Nuclear Physics B* and all concern some aspect of superstring theory. Two were coauthored with a member of the Princeton String Quartet—one with Gross and one with Harvey. On four papers, Witten is the sole author; among them is a discussion of (SU)3 holonomy that is core to both research front #86-0706 and #87-0709. Incidentally, two of those papers—on "Non-commutative geometry and string field theory" and "Interacting field theory of open superstrings"—are among the documents forming the core of the 1987 research front entitled "String field theory, higher spin gauge bosons, and BRS invariant vertex of Neveu-Schwarz-Ramond superstring" (#87-1691).

Possibly due to the activity in superstrings, most of which was published in *Nuclear Physics B*, that journal replaced *Physical Review Letters* at the top of the list of journals in Table 2, which ranks the 26 journals that published the papers in this year's Bibliography. *Nuclear Physics B*, published by Elsevier, leads the list with 26 papers; *Physical Review Letters*, appearing in second place for the first time, has 17 papers. Another dominant journal, *Physics Letters B*, has 14 papers but was displaced by *Nature*, which has 16. Another result of the superstring activity—and the dominance of this field by researchers affiliated with Princeton—is that, with 14 occurrences, Princeton University is first among the institutions listed by the authors in this year's Bibliography. It is also interesting to note that the number of appearances for the USSR—nine—is the highest total for that country since we have been conducting these studies (see Table 3).

Also probably influenced by the number of papers on string theory (many of which have only a handful of authors each) and the dearth of high-energy physics papers (which can have as many as 100 or more authors) is that the number of authors per paper in this year's study has dropped compared to figures from previous years. As Table 4 shows, only 1 paper has as many as 40 authors, while the number of papers with 4 authors or less is 80. This continues a trend evident last year: while the average number of authors per paper in our 1983 study was over 11, the average last year was just under 4 and this year is not quite 5.

The most-cited paper in the study, however, concerns not superstrings but superconductivity, a phenomenon in which virtually all resistance to the passage of electrical current disappears; tremendously useful in numerous ways, the practical application of superconductivity was previously limited by the extremely low temperatures—near absolute zero—at which it appeared. However, the paper by Karl Alex Müller and Johannes Georg Bednorz, IBM Zurich Research Laboratory, Rüschlikon, Switzerland, presented evidence of superconductivity that occurred at temperatures well above the previous limit in a system of barium, lanthanum, copper, and oxygen. For this breakthrough, Bednorz and Müller were awarded the 1987 Nobel in physics.

Although we have discussed this paper in detail elsewhere,[14] it is worth noting that its two-year citation-count total of 664 is the highest ever achieved for a paper included in our annual physical-sciences studies; moreover, it received a phenomenal 1,051 additional citations through September 1988. It is the only paper in this study to appear in the core of the research front on "High-T_c superconductors, band electronic structure, and doped orthorhombic La_2CuO_4" (#87-0892), which has a total of 28 core documents and almost 1,100 citing papers.

The work of Bednorz and Müller is among that of three other Nobelists included in this year's Bibliography. A paper on some of the physical characteristics of a graphite

Table 2: The 26 journals that published the papers listed in the Bibliography. The numbers in parentheses are the 1986 impact factors for the journals. (The 1986 impact factor equals the number of 1986 citations received by the 1984-1985 articles in a journal divided by the number of articles published by the journal during that same period.) Data were taken from the 1986 *JCR*®. The figures at the right indicate how many papers from each journal appear in the Bibliography.

Journal	Number of Papers
Nucl. Phys. B (4.89)	26
Phys. Rev. Lett. (6.54)	17
Nature (15.25)	16
Phys. Lett. B (3.53)	14
Phys. Rev. D—Part. Fields (2.61)	4
Astrophys. J. (3.70)	3
Science (12.44)	3
Commun. Math. Phys. (2.54)	2
* Phil. Mag. B (2.13)	2
Phys. Rep.—Rev. Sect. Phys. Lett. (7.01)	2
Phys. Rev. B—Condensed Matter (3.28)	2
Acta Crystallogr. A—Found. Crys. (2.01)	1
Comments Condens. Matter Phys. (N/A)	1
Comments Nucl. Part. Phys. (N/A)	1
** Europhys. Lett. (N/A)	1
IBM J. Res. Develop. (0.83)	1
J. Appl. Phys. (1.75)	1
J. Chem. Phys. (3.30)	1
J. Statist. Phys. (2.39)	1
J. Magn. Resonance (2.79)	1
Nuovo Cimento C—Geophys. Space (0.56)	1
Phys. Rev. A—Gen. Phys. (2.36)	1
Prog. Theor. Phys. (1.76)	1
Rev. Mod. Phys. (27.03)	1
Rev. Sci. Instr. (1.08)	1
Z. Phys. B—Condens. Matter (1.75)	1

* Previously Phil. Mag. Lett.
** Started publication in 1986

Table 3: National locations of the institutional affiliations listed by authors in the Bibliography, according to total appearances (column A). B=number of papers coauthored with researchers affiliated with institutions in other countries. C=national locations of institutions listed by coauthors.

Country	A	B	C
US	76	18	Austria, Belgium, Denmark, Finland, France, FRG, Israel, Italy, The Netherlands, Spain, Switzerland, UK, USSR
Switzerland	16	7	Denmark, Finland, France, FRG, Italy, Spain, UK, US
UK	12	8	Belgium, Denmark, Finland, France, FRG, Italy, The Netherlands, Spain, Switzerland, US
FRG	11	11	Belgium, Denmark, Finland, France, Hungary, Italy, The Netherlands, Spain, Switzerland, UK, US, USSR
France	9	6	Belgium, Czechoslovakia, FRG, Hungary, Italy, Switzerland, UK, US, USSR
USSR	9	4	Austria, Czechoslovakia, France, FRG, Hungary, US
Japan	4	0	
Italy	3	3	Belgium, Denmark, France, FRG, Switzerland, UK, US
Denmark	2	2	FRG, Italy, Switzerland, UK, US
Finland	2	2	FRG, Italy, Spain, Switzerland, UK, US
Hungary	2	2	Czechoslovakia, France, FRG, USSR
Israel	2	2	US
The Netherlands	2	2	FRG, UK, US
Spain	2	2	Finland, FRG, Switzerland, UK, US
Austria	1	1	US, USSR
Belgium	1	1	France, FRG, Italy, UK, US
Czechoslovakia	1	1	France, Hungary, USSR

surface and two others on microscopy techniques were coauthored by Gerd Binnig, IBM Zurich Research Laboratory, and colleagues. Binnig shared the 1986 physics prize with Ernst Ruska, Fritz Haber Institute of the Max Planck Society, Berlin, Federal Republic of Germany, and Heinrich Rohrer, also of the IBM Zurich lab; Rohrer is among Binnig's coauthors on two papers. Hans A.

Table 4: The number of authors per paper for the 1986 physical-sciences articles most cited in the *SCI®*, 1986-1987.

Number of Authors per Paper	Number of Papers
40	1
38	1
29	1
23	1
19	2
18	1
17	1
12	2
11	2
8	1
6	4
5	9
4	14
3	21
2	26
1	19

Bethe, Newman Laboratory of Nuclear Studies, Cornell University, Ithaca, New York, and the Institute for Theoretical Physics, University of California, Santa Barbara, who won the prize in 1967, is the sole author of a paper on solar neutrinos. Incidentally, Binnig and Rohrer's paper on the surface characteristics of graphite was published in *Europhysics Letters*, which began publication in 1986; this is its first appearance in one of our annual physical-sciences studies.

Comets Halley and Giacobini-Zinner

Another major topic in this year's study concerns the composition of comets and their atmospheres and the mechanics of their orbits around the Sun. A minor subject in previous studies, the upsurge in cometary research was undoubtedly spurred by the return in 1986 of Halley's comet on its 76-year orbit. Indeed, "comet Halley" has never before appeared in the title of an article in any of our previous studies. This year, however, 11 papers are core to the 1987 front on "Comet P/Halley, modeling Halley, and Alfvenic turbulence in the solar-wind flow" (#87-0542).

Most of these papers concern observations made with various instrument packages carried by the European Space Agency's *Giotto* spacecraft, which encountered comet Halley from March 11 through March 15, 1986. Results included evidence verifying the concept of the cometary nucleus as a "dirty snowball," measurements of the interaction of the solar wind with the comet's atmosphere, and spectrographic measurements of the comet's chemical, elemental, and isotopic composition. Other observations were made by the USSR's *Vega 1* and *Vega 2* spacecraft, which encountered comet Halley from March 4 through March 11, 1986. They provided the first direct measurements of the physical and chemical properties of cometary dust, and even transmitted television close-ups of comet Halley back to Earth.

Another comet, Giacobini-Zinner, visited the Earth's vicinity about a year earlier than Halley and also drew scientific interest. Seven papers are core to the 1986 front entitled "Comet Giacobini-Zinner, ice particles in cometary atmospheres, and dust halo formation at comets" (#86-0324). They include two papers describing the results of experiments conducted aboard the *International Cometary Explorer* spacecraft, which rendezvoused with comet Giacobini-Zinner on September 11, 1985. One instrument package made measurements of the magnetic field surrounding the comet, while another, like observations later made of comet Halley by *Giotto*, recorded the interaction of the solar wind with the cometary environment.

Quasicrystals and the Ozone Layer

Another subject that has emerged recently and has experienced continued interest—as evidenced by this year's Bibliography—is the study of quasicrystals, a new phase of solid matter never seen prior to 1984.[15] As we noted in last year's study,[6] although molten metal normally cools into a crystalline form, certain alloys, when cooled very rapidly, form ordered atomic structures with three-dimensional, icosahedral (20-sided) symmetry. D. Shechtman, Department of Materials Engineering, Israel Institute of Technology, Haifa, and colleagues seemed to have grown such an alloy solid in 1984.[16] However, what so intrigues crystallographers about this structure is that icosahedral symmetry is impossible for crystals and thought to be impossible for any solid. And in fact, although quasicrystals possess a regular, crystalline formation along some axes of their rotation, they lack the periodic arrangement of atoms in *all* directions that characterizes true crystals.[17-20]

Nevertheless, the structure of this "forbidden" icosahedral "quasicrystal" has been studied by mathematicians and others. Among those who have addressed this problem are Dov Levine and Paul J. Steinhardt, University of Pennsylvania, Philadelphia, who coined the term "quasicrystal," proposed the leading model to explain icosahedral alloys, and were the first to compute the diffraction pattern for such a crystal.[21] They refine their definition of quasicrystals and their structure in a paper included in the Bibliography. The paper is among five in the Bibliography that are core to the 1987 research front entitled "Icosahedral quasicrystals, decagonal phase of Al-Mn alloy, and diffraction patterns" (#87-1355).

Another topic that surfaced among the papers in last year's study[6] and reappears this year concerns the possible breakdown of the layer of ozone—a relatively rare form of oxygen—in the Earth's upper atmosphere. Ozone helps protect life on the surface from the harmful effects of radiation by absorbing a significant portion of the Sun's ultraviolet rays. It is broken down both by natural action and by pollutants, and many atmospheric scientists are alarmed by evidence in recent years that seems to support the conclusion that the ozone layer is being rapidly depleted or even destroyed.[22]

Virtually all observers agree that total atmospheric ozone content over Antarctica, particularly in the spring, has fallen precipitously since 1975. Antarctic ozone has been monitored by the British Antarctic Survey, Cambridge, UK, since 1957.[23] Controversy has erupted over whether this decrease is due to man-made pollutants or is an artifact of atmospheric circulation over the Antarctic.

Four papers in the list shed some light on this controversy and are core to the 1987 research front entitled "Antarctic ozone hole, stratospheric layers, and changing atmospheric trace gases" (#87-1810). Among these works—all letters to the editor of *Nature*—is a paper by R.S. Stolarski and colleagues, Laboratory for Atmospheres, National Aeronautics and Space Administration/Goddard Space Flight Center, Greenbelt, Maryland, which presents data from the *Nimbus 7* satellite that provide global measurements of ozone since 1978; according to the authors, these data not only confirm the reported decline in ozone, but show it to be regional in extent. Another paper, by Susan Solomon, Aeronomy Laboratory, National Oceanic and Atmospheric Administration, Boulder, Colorado, and colleagues, attributes the depletion of ozone to interactions between ozone, chlorine, and polar stratospheric clouds.

What the Future May Hold

The paper by B.A. Smith, University of Arizona, Tucson, and colleagues concerns the analysis of the atmosphere and ring system of Uranus, based on data from the *Voyager 2* flyby of that planet in 1986. In two years' time, we can expect more studies based on *Voyager* data, since that probe will pass close to Neptune in 1989 before it departs the Solar System forever.

The completion of the Superconducting Super Collider, now scheduled to begin construction in 1989 in Texas, may restore papers by the high-energy-physics community to our annual studies—as well as provide badly needed help in investigating unproven ideas in particle physics.

Further breakthroughs in superconducting materials that function at even higher temperatures are certain to appear in next year's study, and advances in materials science as a result of the study of quasicrystals may appear a few years down the road. As usual, however, only time will tell.

* * * * *

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A	B	C	D	Bibliographic Data
9	42	51	17	**Aaronson M, Bothun G, Mould J, Huchra J, Schommer R A & Cornell M E.** *A distance scale from the infrared magnitude/H I velocity-width relation. V. Distance moduli to 10 galaxy clusters, and positive detection of bulk supercluster motion toward the microwave anisotropy. Astrophys. J.* 302:536-63, 1986. 87-0012
9	27	36	16	**Affleck I.** Exact critical exponents for quantum spin chains, non-linear σ-models at $\sigma=\pi$ and the quantum Hall effect. *Nucl. Phys. B* 265:409-47, 1986. 87-0294
13	53	66	25	**Affleck I.** Universal term in the free energy at a critical point and the conformal anomaly. *Phys. Rev. Lett.* 56:746-52, 1986. 87-0295
7	102	109	124	**Aguilar-Benitez M, Porter F C, Hernandez J J, Montanet L, Crawford R L, Schubert K R, Roos M, Tornqvist N A, Hohler G, Barnett R M, Hinchliffe I, Lynch G R, Rittenberg A, Trippe T G, Wohl C G, Yost G P, Armstrong B, Wagman G S, Manley D M, Shimada T, Gopal G P, Primack J, Hayes K G, Schindler R H, Shrock R E, Eichler R A, Frosch R, Roper L D & Trower W P.** Review of particle properties. *Phys. Lett. B* 170:1-350, 1986. *86-1154
5	43	48	17	**Alvarez-Gaume L, Ginsparg P, Moore G & Vafa C.** An O(16) × O(16) heterotic string. *Phys. Lett. B* 171:155-61, 1986. 87-0709
1	35	36	29	**Alvarez-Gaume L, Moore G & Cumrun V.** Theta functions, modular invariance, and strings. *Commun. Math. Phys.* 106:1-40, 1986. 87-0709
24	29	53	17	**Audier M & Guyot P.** Al_4Mn quasicrystal atomic structure, diffraction data and Penrose tiling. *Phil. Mag. B* 53:L43-L51, 1986. 86-0523, 87-1355
10	60	70	22	**Balsiger H, Altwegg K, Buhler F, Geiss J, Ghielmetti A G, Goldstein B E, Goldstein R, Huntress W T, Ip W-H, Lazarus A J, Meier A, Neugebauer M, Rettenmund U, Rosenbauer H, Schwenn R, Sharp R D, Shelley E G, Ungstrup E & Young D T.** Ion composition and dynamics at comet Halley. *Nature* 321:330-4, 1986. 86-0324, 87-0542
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Note: Through an oversight, our recent discussion of highly cited papers from *Reviews of Modern Physics* (*Current Contents*, Number 26, June 27, 1988) failed to include in the figure and discussion of the most recent highly cited papers a 1982 paper by Tsuneya Ando, Alan B. Fowler, and Frank Stern: Electronic properties of two-dimensional systems (*Rev. Mod. Phys.* 54:437-672, 1982). This review, which was the most recent paper in our study, has now been cited in over 1,000 publications.