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# The impact of *Solid State Communications* in view of the ISI Citation data

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**Abstract**

Bibliometric techniques (i.e. citation analysis) are used to evaluate the impact and standing of *Solid State Communications* (SSC) among its competitor journals covering the field of condensed matter. In most cases, the analysis covers all issues dating back to the journal's inception in 1963. In some cases, however, the analysis only covers articles published after 1973 because of limited access to the previous data under the available search system. A listing of the most cited articles appeared in SSC since its inception is given. Several of them include Nobel laureates among their authors. An analysis of the articles which remained uncited is also presented. Bibliometric data from the Institute for Scientific Information (ISI) such as the Journal Impact Factor (JIF), the Citing Half-Life as well as the Cited Half-Life are compared with those for other journals covering condensed matter and related fields. Furthermore, an analysis of the impact according to the countries of origin of authors is presented. A discussion of the results exhibited in Tables and Figures is given.


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*Keywords:* A. Bibliometric analysis; D. Citations; D. Journal Impact

## 1. Introduction

Citations in the actual sense are common practice in scientific literature since the middle of the 19th century. Metaphorically speaking, the citation network of scientific articles is the glue that links publications with related content. The number of citations is seen as a direct measure for the (documented) resonance or the impact an article, a journal or a scientist has generated so far [1]. Although the number of citations cannot be equated with the final importance or quality of a single article, citation data are frequently used for research evaluation. In contrast to expert advisory committees, not only a few but a large number of anonymous scientists within a field of research are involved when using such an evaluation tool. The question as to what extent citation data can be consulted to determine research quality has been debated extensively and will therefore not be discussed further here [2,3]. Citation data are based on the Citation Indexes produced by the Institute for Scientific Information (ISI) in Philadelphia. This article is focused on the Science Citation Index (SCI).

A scientific journal can be considered as an appropriate unit for bibliometric analysis. It has a well-defined scope with specific publication characteristics and is associated with a specific group of authors and readers [4,5]. The journal *Solid State Communications* (SSC) has been published now for 40 years. This may raise the question of both the journal output and impact as a whole and the resonance of single SSC articles within the scientific community. It might also be of interest to know how the citations are distributed and how long SSC articles are remembered. Furthermore, the country dependent share of articles and impact might provide a more detailed insight. The following investigation can be seen as a brief case study

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for a scientific journal on the basis of the SCI. It seems reasonable to publish it in that same journal and not in a subject specific bibliometric or scientometric journal, where it would be largely hidden from the authors and readers of SSC articles.

SSC arose from discussions between Elias Burstein (the founding editor), Harvey Brooks (the editor of the Journal of Physics and Chemistry of Solids) and Robert Maxwell (the then owner of Pergamon Press). They recognized the need, in the middle of the 'cold war', for a truly international rapid publication journal covering the whole field of Condensed Matter Science: authors from the communist countries found it difficult to obtain permission from their governments to publish articles in the international journals of the West. Accordingly, SSC was launched as an international journal with a board of editors which contained a Soviet scientist (Prof. Zhdanov) and a Czechoslovak scientist (Prof. Tauc). Speed of publication was achieved largely through the device of 'camera ready manuscripts'.

## 2. Methodology

The search options available under STN International (http://www.stn-international.de), in particular some functions for carrying out statistical investigations, have made it possible to perform extensive citation analyses [6]. The findings presented herein result from using the database SciSearch (SCI under STN International). Such analyses are neither possible with the CD-ROM version of the SCI nor with the Web of Science (WoS), the search platform provided by ISI directly. The SCI under STN International, unfortunately, covers only the period past 1974 and not past 1945 like the WoS. The data from STN International were completed, when possible, by using specifically selected WoS data (see e.g. Fig. 1 and Table 6).

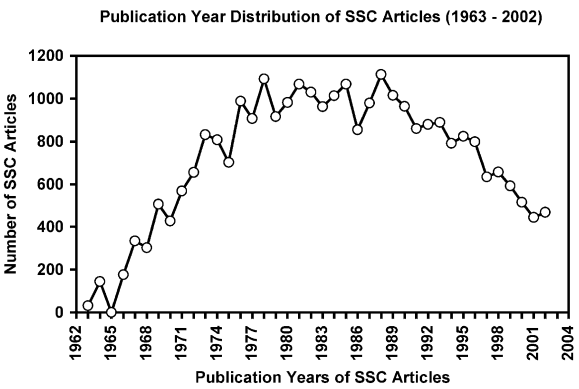


Fig. 1. Distribution of SSC articles versus the publication year (1963–2002). Up to the present (17.02.03), there are 28,827 SSC articles in the WoS (3977 published before 1974).

## 3. SSC articles—the numbers

After the launching of the journal in 1963 the number of published manuscripts increased nearly linearly from 1963 to 1978, reaching a saturation at around 1000 articles per year. They fluctuated around this number till 1989 when the number of manuscripts began to decrease, reaching less than 500 in the year 2002 (see Fig. 1). The onset of the decrease in 1989 is likely to be related to the collapse of the 'iron curtain' when barriers for publication in western journals fell. Actually authors from the former and the few remaining communist countries were even encouraged to publish in the West as a proof for their scientific prowess. A strong effort from the board of editors to keep up the acceptance standards led then to a decrease in the number of accepted manuscripts which has continued to the present day.

The increasing pressure for publishing in only a few, highly prestigious journals, in particular the competition from the American Physical Society (APS) journals, might be one reason for the decrease. The launching of a number of closely related journals (Physical Review B—Rapid Communications, Nature: Materials) must also have contributed. We hear that several measures are being implemented by editors and publishers to reverse this disturbing trend.

The data of Table 1 show that the SSC articles published since 1963 are almost exclusively journal articles (about 98%) but not other ISI document types. SSC is a typical so called 'letter-journal' (like Physical Review Letters). However, SSC articles are classified by ISI as 'articles' (not as letters), whereas 'letters to the editor' are classified as 'letters'. Another measure originally implemented to create a truly international journal was to allow publication in several languages (beside English usually German, French and Russian). This was facilitated by the use of 'camera ready manuscripts'. According to Table 2, many French authors published in French till 1995. This policy was discontinued in 1996 when 'camera ready' was phased out and largely replaced by electronic manuscripts. More than 99% of all SSC articles have been written in English.

The number and percentage of SSC articles and articles

Table 1
Document types of SSC articles (1963–2003)

| # Documents | % Documents | SCI document type |
|---|---|---|
| 27,824 | 96.52 | ARTICLE (letter article) |
| 431 | 1.50 | CONFERENCE (proceeding) |
| 426 | 1.48 | ERRATA |
| 53 | 0.18 | REPRINT |
| 28 | 0.10 | EDITORIAL |
| 11 | 0.04 | BIOGRAPHY |
| 10 | 0.03 | NOTE |
| 6 | 0.02 | GENERAL REVIEW |
| 3 | 0.01 | LETTER (letter to the editor) |
| 28,827 | 100.00 | ALL DOCUMENTS |

Table 2
Original languages of SSC articles (1963–2003)

| # Documents | Documents (%) | SCI document type |
|---|---|---|
| 28,575 | 99.13 | ENGLISH |
| 229 | 0.79 | FRENCH |
| 21 | 0.07 | GERMAN |
| 2 | 0.01 | RUSSIAN |
| 28,827 | 100.00 | ALL DOCUMENTS |

citing SSC articles from the 20 countries most frequently publishing in SSC or citing SSC articles are listed in Tables 3 and 4, respectively. Both tables show basically the same frequency rankings. The countries of origin are assigned to all authors of SCI documents and not only to the first authors, resulting in an overlap of the shares. The analysis of document types and author countries of SSC articles is restricted to the time period since the beginning of 1974 because of limited access to the previous data under the available search system.

Tables 3 and 4 bear witness to the fact that SSC has become a truly international journal. Beside the 20 countries mentioned there, authors from additional 80 countries have published in the journal. It is worthwhile to note that the countries in Table 3 appear also in Table 4. One can therefore conjecture that the listing roughly corresponds to a ranking of the countries according to their physics production. In order to test this conjecture, we look at the corresponding ranking by countries given in the ISI Essential Science Indicators (ESI) for all fields of physics. It follows closely that in Table 3.

Co-citations (here: the simultaneous citation of SSC with other journals) by the same citing articles may be estimated to find out the degree of relationship of SSC to other journals. Table 5 shows the ranking of SSC co-cited journals in publication year 2002 only. The journal PRB, at the top of the table, was co-cited 43,219 times in 6373 citing articles with at least one citation of a SSC article (76.35% of all articles citing SSC articles).

## 4. The impact of SSC articles

The overall impact of all SSC articles since 1963 and the 30 most frequently cited SSC articles (also since 1963) were determined by citation analysis (see Table 6). SSC articles were cited altogether 355,690 times, that is more than 12 citations per article on average. Note that according to the ISI Essential Science Indicators (ESI) the average number for physics articles from 1992 till now is 6.78 citations per article. The most cited SSC article since 1963, published by P.A. Lee et al. in 1974 (see top of Table 6), accumulated 804 citations until the date of search. Five articles in this list were authored or co-authored by scientists who received the Nobel Prize. The listing of Table 6 implies no real ranking of SSC articles as articles published in different years accumulated their citations in different time periods and thus cannot be easily compared concerning their overall impact.

As mentioned above, Table 6 contains five articles authored or co-authored by Nobel laureates (Anderson,

Table 3
Countries of authors (first authors and co-authors) of SSC articles (1974–2003). We have listed only the first 20 most contributing countries out of a total of about 100 countries

| Running number | Number of SSC articles | Percent SSC articles | Countries of authors |
|---|---|---|---|
| 1 | 5284 | 21.26 | USA |
| 2 | 2875 | 11.57 | GERMANY |
| 3 | 2803 | 11.28 | JAPAN |
| 4 | 2712 | 10.91 | FRANCE |
| 5 | 1446 | 5.82 | INDIA |
| 6 | 1240 | 4.99 | PEOPLES REP OF CHINA |
| 7 | 1176 | 4.73 | USSR |
| 8 | 1032 | 4.15 | ITALY |
| 9 | 943 | 3.79 | ENGLAND |
| 10 | 934 | 3.76 | CANADA |
| 11 | 715 | 2.88 | POLAND |
| 12 | 662 | 2.66 | SWITZERLAND |
| 13 | 623 | 2.51 | BRAZIL |
| 14 | 509 | 2.05 | RUSSIA |
| 15 | 499 | 2.01 | NETHERLANDS |
| 16 | 453 | 1.82 | SPAIN |
| 17 | 376 | 1.51 | SOUTH KOREA |
| 18 | 369 | 1.48 | BELGIUM |
| 19 | 342 | 1.38 | ISRAEL |
| 20 | 333 | 1.34 | SWEDEN |

Table 4
Countries of authors (first authors and co-authors) of SSC citing articles (1974–2003). We have listed only the first 20 most contributing countries out of a total of about 120 countries. Note that all countries in this table are also on Table 3, in approximately the same order

| Running number | Number of citing SSC articles | Countries of authors |
|---|---|---|
| 1 | 46,954 | USA |
| 2 | 26,304 | JAPAN |
| 3 | 24,459 | GERMANY |
| 4 | 19,201 | FRANCE |
| 5 | 9738 | ENGLAND |
| 6 | 8771 | USSR |
| 7 | 7118 | RUSSIA |
| 8 | 7034 | INDIA |
| 9 | 6736 | ITALY |
| 10 | 6479 | PEOPLES REP OF CHINA |
| 11 | 5317 | POLAND |
| 12 | 5221 | CANADA |
| 13 | 4306 | SWITZERLAND |
| 14 | 3936 | SPAIN |
| 15 | 3893 | NETHERLANDS |
| 16 | 2993 | SWEDEN |
| 17 | 2641 | BRAZIL |
| 18 | 2449 | ISRAEL |
| 19 | 2175 | SOUTH KOREA |
| 20 | 2120 | BELGIUM |

De Gennes, Heeger, Störmer, Tsui). When looking at all articles published in SSC since 1963 we find 166 with Nobel laureates as co-authors (Alferov, Anderson, Binnig, Brokhouse, Esaki, Giaever, Kroemer, Rohrer, Schriefer, von Klitzing, Tsui, and the twice laureate Bardeen). This is a fact that has already been pointed out by ISI for all fields of chemistry (five among the 30 most cited) and physics (three among the 30 most cited). It is interesting that the majority of the laureates do not appear in Table 6. In order to give a qualitative feeling for the meaning of the highest number of citations (804) in Table 6 we recall that the Nobel winning Physical Review Letters articles by von Klitzing et al. and by Tsui and Störmer et al. have been cited 1600 and 1200 times, respectively.

Table 5
Ranking of SSC co-cited journals in publication year 2002 (only journals with more than 1000 SSC co-citations)

| # | # Co-citations | # Citing articles | Co-citations (%) | Journal title |
|---|---|---|---|---|
| 1 | 43,219 | 6373 | 76.35 | PHYS. REV. B |
| 2 | 23,307 | 4888 | 58.56 | PHYS. REV. LETT. |
| 3 | 11,866 | 8340 | 99.92 | SOLID STATE COMMUN. |
| 4 | 10,051 | 3003 | 35.98 | APPL. PHYS. LETT. |
| 5 | 7426 | 2939 | 35.21 | J. APPL. PHYS. |
| 6 | 5085 | 1548 | 18.55 | J. CHEM. PHYS. |
| 7 | 4577 | 2170 | 26.00 | NATURE |
| 8 | 4042 | 1943 | 23.28 | SCIENCE |
| 9 | 3850 | 851 | 10.20 | SURF. SCI. |
| 10 | 3660 | 1933 | 23.16 | PHYS. REV. |
| 11 | 3478 | 1916 | 22.95 | J. PHYS.-CONDENS. MATTER |
| 12 | 3420 | 1447 | 17.34 | J. PHYS. SOC. JPN |
| 13 | 2931 | 935 | 11.20 | J. AM. CHEM. SOC. |
| 14 | 2244 | 942 | 11.29 | CHEM. PHYS. LETT. |
| 15 | 2241 | 866 | 10.37 | J. MAGN. MAGN. MATER. |
| 16 | 2218 | 1264 | 15.14 | PHYSICA B |
| 17 | 2026 | 610 | 7.31 | PHYSICA C |
| 18 | 1865 | 1109 | 13.29 | PHYS. STATUS SOLIDI B |
| 19 | 1738 | 515 | 6.17 | SYNTH. MET. |
| 20 | 1699 | 1086 | 13.01 | J. PHYS. C: SOLID STATE |

Table 6
The top 30 most frequently cited SSC articles (1963–2003)

| Running number | Number of citations at the date of search | Abbreviation of the cited publications |
|---|---|---|
| 1 | 804 | LEE P.A., 1974, V14, P703 |
| 2 | 750 | JEPSEN O., 1971, V9, P1763 |
| 3 | 728 | SLEIGHT A.W., 1975, V17, P27 |
| 4 | 721 | BASKARAN G.[a], 1987, V63, P973 |
| 5 | 684 | COLEMAN L.B., 1973, V12, P1125 |
| 6 | 664 | VARMA C.M., 1987, V62, P681 |
| 7 | 635 | SPEAR W.E., 1975, V17, P1193 |
| 8 | 625 | BRANDT M.S., 1992, V81, P307 |
| 9 | 562 | RICHTER H., 1981, V39, P625 |
| 10 | 550 | LUCOVSKY G.[b], 1965, V3, P299 |
| 11 | 521 | DEGENNES P.G.[a], 1972, V10, P753 |
| 12 | 519 | GAJ J.A., 1979, V29, P435 |
| 13 | 517 | EKIMOV A.I., 1985, V56, P921 |
| 14 | 510 | BECHGAARD K., 1980, V33, P1119 |
| 15 | 427 | TACHIKI M., 1989, V70, P291 |
| 16 | 424 | HERMANSON J., 1977, V22, P9 |
| 17 | 413 | CAMPBELL I.H., 1986, V58, P739 |
| 18 | 401 | DEGENNES P.G.[a], 1963, V1, P132 |
| 19 | 398 | LUCOVSKY G., 1979, V29, P571 |
| 20 | 389 | GUNN J.B., 1963, V1, P88 |
| 21 | 388 | DISCHLER B., 1983, V48, P105 |
| 22 | 341 | WEISBUCH C., 1981, V38, P709 |
| 23 | 328 | MATTHEISS L.F., 1987, V63, P395 |
| 24 | 319 | CINI M., 1977, V24, P681 |
| 25 | 312 | FEIGL F.J., 1974, V14, P225 |
| 26 | 312 | STORMER H.L.[a], 1979, V29, P705 |
| 27 | 305 | EISENBERGER P., 1979, V29, P481 |
| 28 | 289 | DEGENNES P.G.[a], 1968, V6, P163 |
| 29 | 284 | GIVORD D., 1984, V51, P857 |
| 30 | 281 | SCHRODER U., 1966, V4, P347 |

Number of publications: 28,827, number of publications cited: 24,878 (86.3 %), time window of publications: 1963–2003, number of citations: 355,690 (including self citations), time window of citations: 1963–2003, citations per article: 12.34, date of search: 2003-2-17.

[a] Article authored or co-authored by at least one Nobel laureate.

[b] A highly cited article from G. Lucovsky (SSC V3 P299 1965) is registered in WoS only as reprint (publication year 1993). This article received 438 citations in the time period from 1965 to 1992 (from ISI data established in 1992) and 112 citations since 1992 (from SciSearch under STN International). Thus, this article was cited altogether 550 times since publication.

## 5. The citation distribution

The analysis of large ensembles of publications (like those from individual scientists, research groups, research institutes or journals) always shows a highly uneven or skewed citations distribution [7]. A large fraction of citations is concentrated on a small fraction of publications. For example 75% of all citations within the 8000 journals covered by the ISI citation indexes are concentrated on 1000 journals only. In contrast to the normal bell-shaped (Gaussian) distribution, the mean value and the most frequent value differ considerably. Such an extremely skewed distribution in scientific literature was discussed 1934 by S.C. Bradford, a British librarian. Bradford found that only a small fraction of scientific journals are significant; this was later named Bradford's Law [8]. At the same time a linguist (K. Zipf) found similar skewed distributions when analyzing the frequency of words in texts [9]. A sociologist (V. Pareto) had already found in 1897 such a highly skewed distribution when analyzing the income of the population of nations [10].

The SSC articles are no exception (see Figs. 2 and 3): A small fraction of them produce a large fraction of citations (e.g. the top 10% most frequently cited articles received 50% of all citations). This means that the impact of the journal is dominated by a relatively small number of highly cited articles. Only a minor fraction of SSC articles are cited anywhere near the journal mean (about 12 citations per article). Actually only articles with the same age (or at least with comparable age) should be considered in such an analysis. However, it was shown that the broad age distribution of an ensemble of journal articles from a larger time period does not have a significant effect on the skewness of their citation distribution [7].

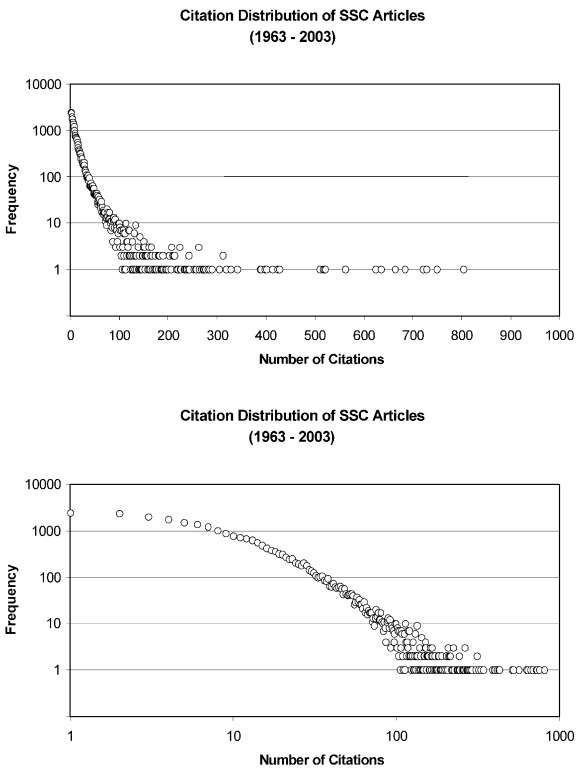


Fig. 2. Citation distribution of SSC articles (1963–2003): frequency of SSC articles as function of their overall citation numbers. One circle may indicate one single article (see the top articles to the right) or many hundred or thousand articles with the same citation count (see the low cited articles to the left). Fig. 2(a) is a semilog plot, Fig. 2(b) a log–log plot.

Fig. 2(a) and (b) (a semilog plot and a log–log plot) shows the already mentioned fact, common to most journals and fields of science, that only a few publications contribute to the bulk of citations. The citations of most articles, if cited at all, fall in the 1–10 range as seen clearly in Fig. 2(b). This has been taken as evidence for the incorrectness of the so

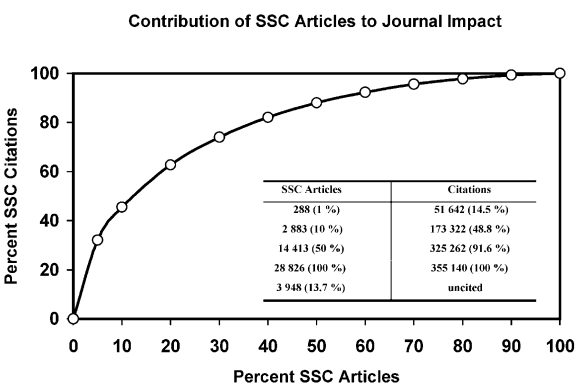


Fig. 3. Cumulative contribution of SSC articles (1963–2003) to the overall journal impact.

called Ortega hypothesis (Ortega y Gasset: The Revolt of the Masses), which asserts that science progresses largely through the contributions of a large number of mediocre scientists. The large impact of only a small number of publications indicates that science is dominated by a network of rather few outstanding scientists [11].

## 6. Experimental versus theoretical articles

The question of whether experimental and theoretical articles reach substantially different mean citation counts has been repeatedly asked. For a preliminarily answer 1234 SSC articles (theory) and 977 SSC articles (experiment) with comparable age distribution were selected by title word searching: the theoretical articles received 11.8 citations per article and the experimental articles received 12.8 citations per article (see for comparison the overall value of 12.3 citations per article). Thus, there is no significant difference between experiment and theory in the case of SSC articles. But this question is of general interest and can only be answered on the basis of larger ensembles of articles (not only of articles from a single journal).

## 7. Citation histories of articles

Some interesting information is obtained from the time dependence of the citations. This time dependence for a single article is sometimes called its citation history and may be viewed as the ‘sales Figure’ of that article. Each publication develops its own life span as it is being cited (see Figs. 4–6). With time, the citations per year (citation rate) develop in a similar pattern for many publications: The citations generally do not increase substantially until 1 year after publication. They normally reach a maximum after about 2 or 3 years and then usually decrease, accumulating citations at a lower level. The peak position depends on the research discipline and is shifted to about 4 years in the case of technical sciences. This mean citation pattern, with a distinctive peak several years after publication followed by a decay, can also be found for some highly cited articles.

Fig. 7 shows the overall citation history of all SSC articles published during 1975. Its form is rather canonical, exhibiting a maximum 2 years after publication and then decaying slowly to reach a near steady state at a low level. Note the bumps between 1986 and 1990 corresponding to the citations of the high-temperature superconductivity article of Sleight et al. (see Fig. 5). A different pattern is also found rather frequently: Highly cited articles sometimes do not reach their citation rate maximum until many years or even decades after publication. Some highly cited articles show a distinctive time delay, being nearly ignored for many years, others become highly cited immediately after publication. Figs. 4–6 show typical citation history

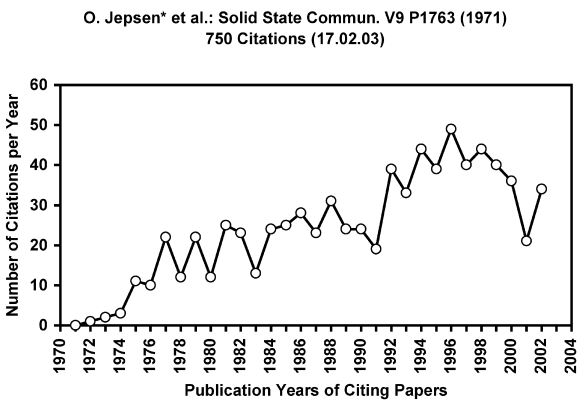


Fig. 4. Citation history of SSC article from citation rank 2 (the first author name of the article in Fig. 4 (O. Jepsen) was misspelled in the journal (O. Jepson). The article has been cited with the correct author name (most frequently) and the misspelled one as well. The total number of citations given here was determined by checking both author versions in the references.

patterns for highly cited articles which deviate from the mean citation pattern.

Fig. 4 corresponds to the article by O. Jepsen et al. entitled 'The Electronic Structure of h.c.p. Ytterbium'. This very important contribution remained nearly unnoticed from 1971 to 1974. The number of citations per year began to grow, on the average linearly (with wide fluctuations) till the present day. It describes, with application to Ytterbium, a general technique to calculate cross-sectional areas and other Fermi surface properties. The ever increasing citations per year reports the wide use this technique has found.

Quite a different pattern is shown in Fig. 5. The corresponding article by Sleight et al. entitled 'High-Temperature Superconductivity in the $BaPb_{1-x}Bi_xO_3$ System' reflects 'high-temperature superconductivity', meaning only up to 13 K. Its citation rate remained low till 1981. The discovery of high-temperature superconductivity in the cuprates brought renewed interest in the phenomenon of superconductivity in the perovskite-like bismuthates:

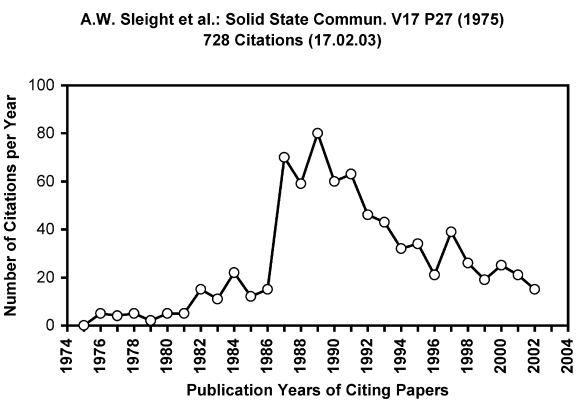


Fig. 5. Citation history of SSC article from citation rank 3.

$Ba_{0.96}K_{0.4}BiO_3$ has a $T_c > 40$ K. Correspondingly, the number of citations grew from 5 in 1980 to 80 in 1989. Beyond this year it fell slowly in the conventional way.

Fig. 6 shows the citation history of the article 'The Resonating Valence Bond State and High-Tc Superconductivity—A Mean Field Theory' by Baskaran, Zou and Anderson (Nobel laureate). The citations grew rapidly from 1987 to 1988 to decay more sharply than usual after 1989. When the article appeared it represented one of the few theories of high-temperature superconductivity. The rapid growth of the number of (not generally accepted) theories led to the rapid decay in the citation rate.

Compared to the mean citation pattern in Fig. 7 the citations of highly cited articles are usually delayed in time: Fig. 8 shows the total citation history of the 10 most frequently cited SSC articles from 1975 (all articles from 1975 with more than 100 citations up to the present). The secondary peak between 1987 and 1989 is due to the highly delayed citations of the article of Sleight et al. from 1975 (see Fig. 5). Consequently, outstanding publications can hardly be discovered by the use of citation analysis shortly after their publication (when there may be a great need for such information because of possible appointments, promotions, etc.). That is why, in addition to bibliometric data, qualitative evaluation by peers with high expertise in the specific field of research is essential.

Fig. 7 raises the question of the long-term impact of SSC articles. The SSC articles published during the 5 years time period between 1975 and 1979 were checked for their citedness past 1995 and 2000, respectively: 46.2% of the at least 15 years old SSC articles were cited within the time window 1995–2003 and 27.5% of the at least 25 years old SSC articles were cited past 2000. The SSC articles published only in the year 1975 show a similar citedness: 45.1% of the at least 25 years old SSC articles were cited within the time window 1995–2003 and 26.1% were cited past 2000. This considerable long-term impact shows that aging of scientific publications might be slower than often assumed.

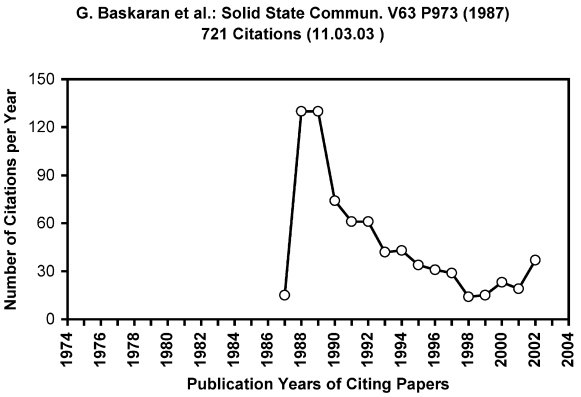


Fig. 6. Citation history of SSC article from citation rank 4. This article has been co-authored by P.W. Anderson, Nobel laureate.

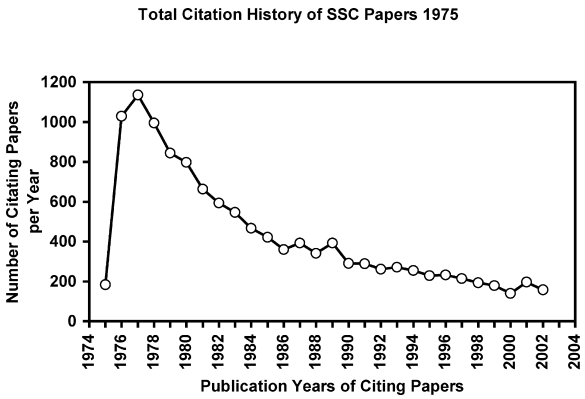


Fig. 7. Total citation history of SSC articles published during the year 1975.

## 8. The Cited Half-Life

Beside analyzing the time dependent citations of a single article or those of the journal within a specific publication year (see Fig. 7) one may look at the age distribution of SSC articles (published in any year) cited by any other articles during publication year 2002 only. Fig. 9 shows the overall age distribution of those SSC articles published since 1974, which were cited once or more during 2002 only (9637 of 24,850 SSC articles): the 2 years old SSC articles (published during the year 2000) dominate. The inclusion of the pre-1974 SSC articles (not possible under STN International, see above) can be expected to cause no substantial difference in the graph.

Beside the Journal Impact Factors (JIFs), which are published yearly in the Journal Citation Reports (JCR) by the ISI (see below), the Cited Half-Life and the Citing Half-Life are given [12]. The Cited Half-Life is defined by ISI as 'The number of journal publication years, going back from the current year, that account for 50% of the total citations given by the citing journal in the current year. Cited Half-Life is a measurement used to estimate the impact of a journal. ISI developed this calculation to provide an indicator as to the long-term value of source items in a single journal publication.'

From the data in Fig. 9 the average Cited Half-Life of SSC articles cited during the year 2002 only can be estimated to be about 10 years (JCR-2001: $>$ 10.0 years). We find within the subject category Physics, Condensed Matter in JCR-2001 ten journals with a Cited Half-Life larger than 10 years, among them—without relative ranking—SSC and Advances in Physics. Note that Physical Review B has a Cited Half-Life of 6.8 years, Physical Review Letters 6.0 years and Nature 6.9 years. We conclude from these numbers that if an SSC article is cited at all, its citation rate is more stable with time than that of journals with higher citation rates.

## 9. The Citing Half-Life

Instead of looking at the age distribution of SSC articles (see Fig. 9) one may look at the age distribution of the references cited therein. Here we define as references articles cited within SSC publications and as citations the SSC articles cited elsewhere. From the point of view of SSC articles, citations can be regarded as passive (performed by colleagues) whereas references are active (performed by authors of SSC articles). Fig. 10 shows the overall reference age distribution within SSC articles published during 2002: The 1 and 2 years old references dominate. The graph is approximately a mirror image of that of Fig. 7, as may be expected. The selection processes are similar but seen from different perspectives: in one view the community selects SSC articles for citing them, in the other the authors of SSC articles select articles of the community (from any journals) as references.

The oldest reference cited in SSC articles from 2002 was published in 1903 (outside the frame of Fig. 10). The oldest reference cited by SSC articles since 1974 is a link to Johannes Kepler (publication year 1611), cited by M.Y.

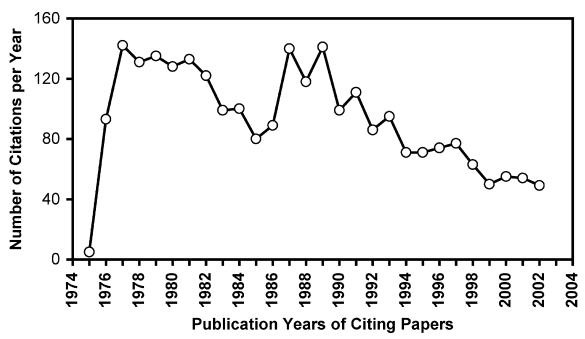


Fig. 8. Total citation history of the 10 most cited SSC articles only, published during the year 1975 (all articles with more than 100 citations).

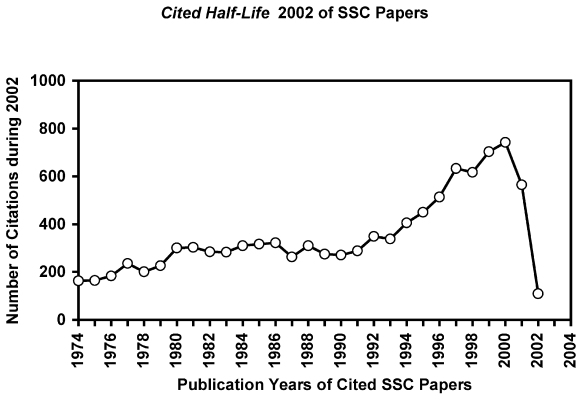


Fig. 9. Age distribution of SSC articles cited by others during 2002 only.

Azbel in SSC V91 P687 (1994). There are altogether 85 pre-1900 references in SSC articles since 1974 (out of approximately half a million references). Some of these, however, mention a wrong publication year and refer to more recent publications.

These references belong to the non-negligible fraction of erroneous citations, which can be usually observed (errors in publication year, volume and/or starting page number): Based on the citation variants of frequently cited articles it can be shown that on average about 5% of all references are incorrect with regard to the numerical data they contain (volume, starting page, and publication year). A certain fraction of articles contain errors in the authors names and/or addresses, causing an additional loss of citations.

There are 8327 references within the 468 SSC articles published during 2002. That is about 18 references per article. During the same time (2002) SSC articles were cited altogether 8385 times. Thus, the number of citations of other articles (published in any journal) received from SSC articles approximately equals the number of citations of SSC articles received from other articles. From the data in Fig. 10 the Citing Half-Life of SSC articles published during the year 2002 can be estimated to be about 7 years (JCR-2001: 7.0 years).

The Citing Half-Life is defined by ISI as 'The number of journal publication years, going back from the current year, that account for 50% of the total citations (references) given by the citing journal in the current year. ISI developed this calculation to provide an indicator of the subtle changes in scope of a publication over the course of time. Evaluation of this factor can provide information on the cross-disciplinary nature of research in a specific field of interest.'

The Cited Half-Life provides information about the citation of SSC articles by other articles and reflects how long SSC articles are remembered in the scientific community. The Citing Half-Life reflects the citation practice of SSC authors concerning other articles and informs about the timeliness of the publications cited within SSC articles. Both Cited Half-Life and Citing Half-Life inform about the aging of publications. From the point of view of SSC articles, the Cited Half-Life can be regarded as passive (performed by colleagues) whereas the Citing Half-Life is active (performed by authors of SSC articles).

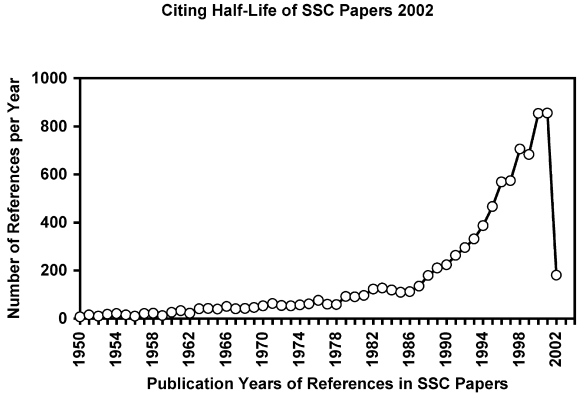


Fig. 10. Age distribution of references within SSC articles published during the year 2002 only.

## 10. The uncitedness

A considerable fraction of scientific articles remains uncited for many years after publication [13–15]. These articles are not cited even by their own authors! They disappear in the scientific archives without any (documented) impact. The chance of an article not being cited in the first decade after publication to be highly cited later is extremely low. However, some cases of delayed recognition concerning the citations of pioneering articles can be found. A large number of the uncited articles belong to conference proceedings, which are usually cited only if at all until the corresponding archival journal publications appear. Furthermore, the very recent publications had hardly a chance to accumulate citations because they have not yet been noticed by potential authors.

Fig. 11(a) shows the time dependent cumulative percentage of uncitedness of SSC articles published during the years 1975 and 1995. For example in 1980 about 10% of the SSC articles published in 1975 were not cited at all until that year. Within the year of publication more than 80% of the SSC articles remained uncited. The following years the uncitedness decreased to a constant value of about 5%. We can therefore conclude that articles not being cited in the first years after publication have only little chance to be cited at all. Fig. 11(b) shows the percentage of uncitedness within single years. For example in 1980 about 50% of the SSC articles published in 1975 were not cited in that specific year. The minimum of uncitedness around 1977 of the articles published during the year 1975 occurs at about the same time as the citation history maximum of these articles (see Fig. 7).

The uncitedness of journals anti-correlates with their Journal Impact Factors (see below). Thus the degree of uncitedness after a period of some years might be used in addition (or instead of) the JIFs to quantify the impact of journals. Table 7 shows the percentage of uncitedness 8 years after publication of two journals (SSC and PRB) from ISI subject category Physics, Condensed Matter. For comparison: a high-impact letter journal (PRL) and a low-impact journal (CJP) both from category Physics, Multidisciplinary. Note the following comment about the meaning of uncitedness from David Pendlebury (ISI): 'a certain level of uncitedness in journal literature is probably more an expression of the process of knowledge creation and dissemination than any sort of measure of performance. A trend towards more or less uncitedness, however, might be meaningful.' [15].

## 11. More information

The citing publications of SSC articles can be further analyzed. Table 8 shows the top 20 citing journals of SSC articles since 1974. The journal Physical Review B (PRB) dominates with nearly 26,000 articles (about 25% of all PRB articles) citing one or more SSC articles since 1974. Table 9 shows the top 20 classification categories of the citing journals of SSC articles since 1974. The less frequent subject categories of citing articles (end of Table 9, not listed here) give some idea about the impact within research disciplines outside that of the cited journal. The impact of SSC is indeed very broad. This conclusion can be expected to apply to the whole field of condensed matter science.

## 12. The Journal Impact Factor

Scientific journals can be ranked by their Journal Impact Factors (JIFs), which are published yearly in the Journal Citation Reports (JCR) by the ISI since 1975. To establish the JIFs the publications of a journal are taken into consideration over a period of 2 years and their citations are determined over the following year. The number of citations is then divided by the number of citable publications (articles and general reviews) in the 2

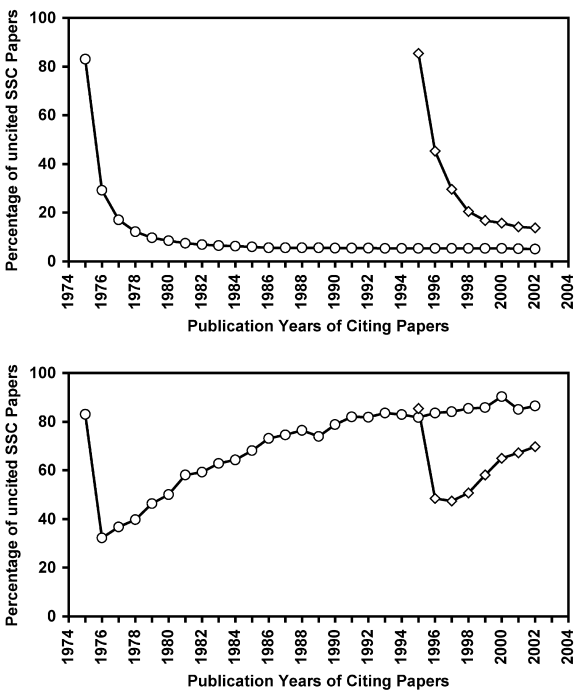


Fig. 11. (a) Time dependent percentage of uncitedness of SSC articles (cumulative) from publication years 1975 (circles) and 1995 (squares). (b) Time dependent percentage of uncitedness of SSC articles (per year) from publication years 1975 (circles) and 1995 (squares).

Table 7
Percentage of uncitedness 8 years after publication of four journals (JIFs from JCR-2001)

| Publication year | Citation Time Window | % Uncited PHYS. REV. LETT. JIF = 6.668 | % Uncited PHYS. REV. B JIF = 3.070 | % Uncited SOLID STATE COMMUN. JIF = 1.381 | % Uncited CZECH. J. PHYS. JIF = 0.345 |
|---|---|---|---|---|---|
| 1975 | 1975–1982 | 0.67 | 3.1 | 6.9 | 56.3 |
| 1980 | 1980–1987 | 0.93 | 3.9 | 5.8 | 37.9 |
| 1985 | 1985–1992 | 0.90 | 3.6 | 8.8 | 38.3 |
| 1990 | 1990–1997 | 0.91 | 3.6 | 12.1 | 41.6 |
| 1995 | 1995–2002 | 0.86 | 4.1 | 13.7 | 50.0 |

Table 8
Top 20 citing journals of SSC articles since 1974 out of about 180,000 different journals. We have added the actual JIFs from the ISI JCR-2001 (see parentheses behind the journal titles)

| Running number | Number of citing articles at the date of search | Citing journals |
|---|---|---|
| 1 | 25,983 | PHYSICAL REVIEW B-CONDENSED MATTER (3.070) |
| 2 | 12,268 | SOLID STATE COMMUNICATIONS (1.381)[a] |
| 3 | 6631 | JOURNAL OF APPLIED PHYSICS (2.128) |
| 4 | 4761 | PHYSICAL REVIEW LETTERS (6.668) |
| 5 | 4621 | SURFACE SCIENCE (2.189) |
| 6 | 4232 | JOURNAL OF PHYSICS-CONDENSED MATTER (1.611) |
| 7 | 4181 | PHYSICA STATUS SOLIDI B-BASIC RESEARCH (0.873) |
| 8 | 4035 | JOURNAL OF THE PHYSICAL SOCIETY OF JAPAN (1.628) |
| 9 | 3786 | PHYSICA C (0.806) |
| 10 | 3629 | PHYSICAL REVIEW B (3.070)[b] |
| 11 | 3599 | JOURNAL OF MAGNETISM AND MAGNETIC MATERIALS (1.329) |
| 12 | 3415 | APPLIED PHYSICS LETTERS (3.849) |
| 13 | 3005 | JOURNAL OF PHYSICS C-SOLID STATE PHYSICS (–) |
| 14 | 2622 | SYNTHETIC METALS (1.158) |
| 15 | 2598 | PHYSICA B (0.663) |
| 16 | 2241 | JOURNAL OF NON-CRYSTALLINE SOLIDS (1.363) |
| 17 | 2027 | JOURNAL OF CHEMICAL PHYSICS (3.147) |
| 18 | 2023 | PHYSICA STATUS SOLIDI A-APPLIED RESEARCH (1.025) |
| 19 | 1897 | FIZIKA TVERDOGO TELA (–) |
| 20 | 1656 | PHYSICS LETTERS A (1.220) |

[a] Journal self-citations.
[b] PRB journal title since 2000.

preceding years. The current JIF-2001 of SSC, for example, considers the publications from 1999 and 2000 and their citations only in the year 2001.

The JIFs are determined by Journal Title Matching: for calculating the JIFs-2001 the references from all articles published in the year 2001 in any journal are considered. It is determined how often a specific journal name/journal title occurs (in all the different citing variations) in combination

Table 9
Top 20 classification categories of SSC citing journals since 1974 out of about 80 ISI subject categories

| Running number | Number of citing articles at the date of search | ISI subject categories |
|---|---|---|
| 1 | 147,113 | PHYSICS |
| 2 | 24,571 | CHEMISTRY |
| 3 | 21,273 | MATERIALS SCIENCE |
| 4 | 4959 | METALLURGY & MINING |
| 5 | 4220 | ENGINEERING |
| 6 | 3862 | CRYSTALLOGRAPHY |
| 7 | 3063 | OPTICS |
| 8 | 2033 | SPECTROSCOPY |
| 9 | 1752 | METALLURGY & METALLURGICAL ENGINEERING |
| 10 | 1707 | POLYMER SCIENCE |
| 11 | 1567 | NUCLEAR SCIENCE & TECHNOLOGY |
| 12 | 1513 | INSTRUMENTS & INSTRUMENTATION |
| 13 | 1246 | MULTIDISCIPLINARY SCIENCES |
| 14 | 1163 | ELECTROCHEMISTRY |
| 15 | 448 | MINERALOGY |
| 16 | 400 | ENERGY & FUELS |
| 17 | 310 | MICROSCOPY |
| 18 | 309 | MECHANICS |
| 19 | 241 | BIOCHEMISTRY & MOLECULAR BIOLOGY |
| 20 | 232 | MATHEMATICAL METHODS |

with the reference publication years 1999 or 2000. This number of citations is divided by the number of citable publications of that journal published in the years 1999 and 2000.

Alternatively, the JIFs could be determined by Citation Matching: the exact references to the articles from a specific journal within 1999 or 2000 could be matched with all references in the year 2001. The method of Journal Title Matching has the advantage that erroneous citations are included, since the first author name and the numerical reference data are not taken into consideration. The method of Citation Matching works more selectively and, correspondingly, provides lower citation numbers.

The ISI formula for calculating JIFs indicates the mean number of citations per year of a typical article from a specific journal about 2 years after publication. The highly skewed distribution of citations to the articles of a journal (see Figs. 2 and 3) makes mean citation values questionable. The JIFs are largely contributed by only a small fraction of highly cited articles. In particular, high JIFs are generated by exceptionally few high impact articles [16]. The majority of articles of all journals (including high impact journals) are cited only a few times, if at all.

The JIFs are therefore not representative for the mass of articles in a given journal: less influential articles are overestimated and more influential articles are underestimated. That is why the JIF of a journal should not be taken as a measure of impact or quality of articles published in it, although it often is when the institutions do not have access to detailed bibliometric data. Such a practice leads to unreasonable pressure to publish in journals which may not be the most suitable ones for the work at hand. There is a kind of 'one-way correlation:' the high impact of a few articles helps a journal to reach a high JIF—publication of a certain article in a high impact journal does not cause distinctly higher citation numbers [17–20].

As illustration the JIF-2001 was determined for SSC by both methods. First the above procedures were used both including all SSC articles as done by ISI. Then the top 100 most cited articles (out of 1089 articles in 1999 or 2000, that is less than 10%) were removed. The SSC JIF drops back from 1.33 to 0.80 and from 1.20 to 0.69, respectively (see Table 10).

The time dependent JIF of SSC shows a significant decrease from about 2.0 to about 1.5 between 1975 and the present (see Fig. 12). The peak between 1987 and 1991 can be attributed to the discovery of the phenomenon of high-temperature superconductivity towards the end of 1986 and the great interest it generated. At that time some highly cited SSC articles were published which received their citations immediately after publication because of the interest in that field. Both effects enhanced the JIF of that period rather significantly and left a conspicuous imprint in its time dependence. The journal introduced a separate heading to place articles in this field in 1987. This policy was discontinued in 1993 when interest in the field returned to the normal one for other aspects of condensed matter.

Table 10
SSC Journal Impact Factor (JIF-2001) with top100 most cited articles included and excluded (CM: Citation Matching, JTM: Journal Title Matching)

| | Articles (1999 + 2000) | Citations (2001) | JIF-2001 (CM) | JIF-2001 (JTM) |
|---|---|---|---|---|
| All SSC articles | 1089 | 1312/1445 | 1.20 | 1.33[a] |
| Top100 excl. | 989 | 687/792 | 0.69 | 0.80 |

[a] The ISI determined JIF-2001 for SSC is 1.381—the small difference may result from slightly different time windows and/or small differences in journal coverage between JCR and SciSearch.

The steady JIF decrease of SSC first seems to indicate a decrease in the quality of the journal as measured by its impact. However, the short citation time window in the standard JIF formula affects the JIFs in a specific way: The JIF is very sensitive to the amount of citations a journal collects within the first few years after publication. The portion of immediately received citations could be time dependent. As a rough check, two 'JIFs' were determined on the basis of a 5 years citation time window (instead of only 1 year as done by ISI). The 1974 and 1975 SSC articles were compared with the 1994 and 1995 articles. Within 20 years the alternatively defined JIF decreased only by 5.6%, whereas the ISI-defined JIF decreased by about 25% (see Fig. 12). Accordingly, the JIF decrease of SSC does not correspond to a decrease in the number of citations SSC papers received but to a spread in time of these citations.

## 13. Country dependent impact

It may be assumed that SSC articles of authors from different countries contribute differently to the overall SSC impact as expressed by the JIF. Unfortunately, the method of Journal Title Matching does not allow to process country

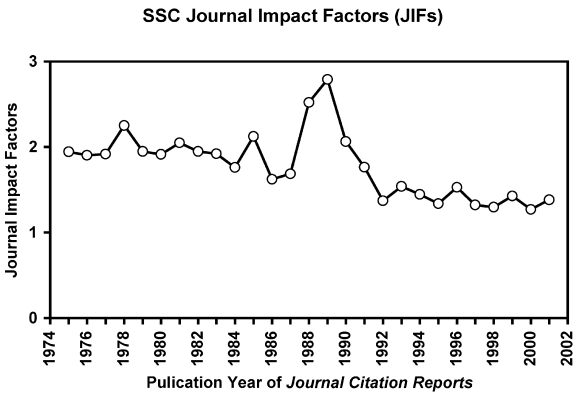


Fig. 12. Time dependent SSC Journal Impact Factors (JIFs) from ISI Journal Citation Reports (CJR).

Table 11
Country dependent SSC impact as citing articles per SSC article (publication and citation time windows according to ISI JIF-2001)

| Country of author | Articles 1999 + 2000 | Articles 1999 + 2000 (%) | Citing articles 2001 | Citing articles 2001 (%) | Citing articles per article |
|---|---|---|---|---|---|
| All Countries | 1089 | 100.00 | 1190 | 100.00 | 1.093 |
| USA | 168 | 15.43 | 202 | 16.97 | 1.202 |
| Japan | 156 | 14.33 | 176 | 14.79 | 1.128 |
| Germany | 132 | 12.12 | 253 | 21.26 | 1.917 |
| PR of China | 130 | 11.94 | 130 | 10.92 | 1.000 |
| France | 118 | 10.84 | 166 | 13.95 | 1.407 |
| India | 92 | 8.45 | 79 | 6.64 | 0.859 |
| Russia | 75 | 6.89 | 111 | 9.33 | 1.480 |
| South Korea | 71 | 6.52 | 58 | 4.87 | 0.817 |
| Italy | 48 | 4.41 | 64 | 5.38 | 1.333 |
| Brazil | 47 | 4.32 | 21 | 1.76 | 0.447 |
| England[a] | 46 | 4.22 | 90 | 7.56 | 1.957 |
| Poland | 45 | 4.13 | 51 | 4.29 | 1.133 |
| Spain | 29 | 2.66 | 56 | 4.71 | 1.931 |
| Canada | 25 | 2.30 | 12 | 1.01 | 0.480 |
| Switzerland | 17 | 1.56 | 22 | 1.85 | 1.294 |

[a] Without Scotland and Wales.

related sub-JIFs. The method of Citation Matching, however, makes it possible, whereas the lower absolute impact values do not affect the comparison of relative values. Table 11 shows the portion of SSC articles and their impact in terms of citing articles (instead of citations) for 15 countries. The narrow time windows of the standard JIF formula leads to low publication and citation numbers as well. About 1000 SSC articles from 2 publication years are distributed over about 100 countries, thus yielding poor statistics. The use of citing articles rather than citations is justified by the fact that they differ here by a constant factor of about 1.1. The low citation numbers for several countries are not very satisfying.

Alternatively, both the publications and citations since 1995 (included) were taken into account. Table 12 shows the portion of SSC articles, their impact and uncitedness since 1995 of 15 countries (those with more than 100 SSC articles). The countries of all authors (not only the first

Table 12
Number and percentage of SSC articles, impact and uncitedness since 1995 of 15 countries with more than 100 SSC articles—ranked by number of SSC articles

| Country of author | Articles | Articles (%) | Citations | Citations (%) | Citations per article | Uncited articles | Uncited articles (%) | Citations per art. ranking | ESI[a] ranking (Physics) |
|---|---|---|---|---|---|---|---|---|---|
| All countries | 5034 | 100.00 | 22 101 | 100.00 | 4.39 | 1466 | 29.12 | | |
| USA | 826 | 16.41 | 5289 | 23.93 | 6.40 | 214 | 25.91 | 2 | 1 |
| Japan | 663 | 13.17 | 3681 | 16.66 | 5.55 | 163 | 24.59 | 4 | 3 |
| PR of China | 653 | 12.97 | 1778 | 8.04 | 2.72 | 251 | 38.44 | 13 | 12 |
| Germany | 595 | 11.82 | 3626 | 16.41 | 6.09 | 110 | 18.41 | 3 | 2 |
| France | 522 | 10.37 | 2674 | 12.10 | 5.12 | 130 | 19.91 | 5 | 4 |
| India | 390 | 7.75 | 1078 | 4.88 | 2.76 | 132 | 33.85 | 12 | 16 |
| Russia | 358 | 7.11 | 1426 | 6.45 | 3.98 | 92 | 25.70 | 10 | 7 |
| South Korea | 249 | 4.95 | 478 | 2.16 | 1.92 | 105 | 42.17 | 15 | 20 |
| Italy | 211 | 4.19 | 1005 | 4.55 | 4.76 | 46 | 21.80 | 7 | 6 |
| Poland | 188 | 3.73 | 753 | 3.41 | 4.01 | 49 | 26.06 | 9 | 14 |
| England | 182 | 3.62 | 767 | 3.47 | 4.21 | 49 | 26.92 | 8 | 5 |
| Brazil | 178 | 3.54 | 435 | 1.97 | 2.44 | 70 | 39.33 | 14 | 21 |
| Spain | 122 | 2.42 | 618 | 2.80 | 5.07 | 19 | 15.57 | 6 | 11 |
| Canada | 105 | 2.09 | 378 | 1.75 | 3.60 | 35 | 33.33 | 11 | 9 |
| Switzerland | 101 | 2.01 | 728 | 3.29 | 7.21 | 13 | 12.87 | 1 | 8[b] |

[a] See ISI Essential Science Indicators (ESI) 1992–2002.
[b] The low ESI physics ranking of Switzerland is somewhat surprising as Switzerland usually belongs to the top class.

authors) are taken into account. Articles with authors from different countries are counted once for each country (overlap). Both the citations per article and the degree of uncitedness correlate with other citation rankings. A few countries like PR of China, India and South Korea publish about the same number of SSC articles as the leading countries. The impact of their articles, however, is rather low and their portion of uncitedness exceeds 40%.

Table 12 displays the impact factors separated by countries, together with the ranking of the countries in Physics extracted from the ISI Essential Science Indicators (ESI). While some degree of correlation between the citations per article and the ranking of the individual countries appears, the correlation is not, like in other cases discussed before, one-to-one. The USA, for instance is number 1 in the ESI, while the rank by citations in SSC is number 2. This reflects the overwhelming dominance of the journals of the national research societies of the USA, probably not only as a choice of publication vehicle (active mode) but as a choice of citation vehicle (passive mode). England is number 8 according to citations and number 5 in ESI ranking, whereas Germany occupies number 3 by citations and number 2 by ESI ranking. The lowest places by citations are given to China, India, South Korea, Canada and Brazil. With the exception of Canada these are all developing countries. The ranking of Canada (number 11) is rather surprising. We note, however, that its ESI ranking (number 9) is also not particularly high.

## 14. Conclusions

We have presented a rather exhaustive bibliometric analysis of Solid State Communications. The results contain considerable information concerning the ranking of the journal and its evolution with time since its inception in 1963. Many of the results obtained are not limited to the journal: they can be carried over to most journals in the field of condensed matter and also, in some cases, to the general field of physics and even beyond.

## Note added in proof

While this article was being printed, the JIFs for 2002 were released by the ISI. We are happy to announce that *Solid State Communications* has climbed from 1.381 in 2001 to 1.671, a good 40th Anniversary present.

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