

**A STUDY OF THE EFFECT OF A MAJOR BREAKTHROUGH
IN SUPERCONDUCTIVITY
IN THE DISTRIBUTION OF PAPERS OF MAJOR JOURNALS**

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ABSTRACT

Within a few months in 1986 and 1987, physicists and the general public witnessed a major breakthrough in the science and technology of superconductivity. This was followed by a dramatic increase in research activities and publications. The authors of this article studied the impact of a scientific breakthrough on the total number of research articles and the distribution of these articles listed in *Science Citation Index* from 1986 to 1988 were sorted and tabulated according to the journal and the time period.(i.e. each quarter of the year) the article first appeared. Our data shows some journals experienced dramatic increases in number of publications during this three year period while others experienced no significant change. Seventeen journals were selected to exemplify the time variation of publication activity. They were chosen primarily because of the substantial number of articles, and secondly because of the significant changes in the number of articles these journals produced.

Introduction

Libraries facing serial cutbacks, in light of the lack of legislative funding from state governments, will have tough choices to make. When it comes to choosing which serials to keep and which to discontinue, how can a

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comes to choosing which serials to keep and which to discontinue, how can a librarian best make an informed decision? There are several fields of study which have numerous journals covering a given topic. The science of physics, for example, has several different publications which cover this particular field of study. By searching Science Citation Index on CD-ROM and other science orientated databases, librarians can determine which journals give the best coverage of a certain field. For the purposes of our research, Science Citation Index on CD-ROM (known as SCI-CD throughout the rest of this article) was chosen as the source for journals on the topic of Superconductivity.

Background of Superconductivity

Since its first discovery in 1911 by Dutch physicists Kamerlingh Onnes and Gilles Holst, superconductivity has been a fascinating subject of study. Superconductors offer no electric resistance, and can carry large electric current without any power loss. When the temperature of some metals or metallic alloys is lowered toward absolute zero (0 K), these materials become superconducting. The temperature below which materials become superconducting is called the Transition temperature (T_c).

Superconductors also have unique magnetic properties: they can generate extremely high magnetic fields which are used in magnetic levitation of fast trains as well as detect, control, and utilize weak magnetic fields which are used to detect magnetic fields generated by human brain activity. These marvelous properties were not fully exploited because until 1986 the highest transition temperature was 23.2K and therefore required sophisticated and cumbersome refrigeration (most commonly liquid helium). In 1986, Muller and Bednorz first discovered superconductivity in ceramic oxides $T_c = 35K$. A few months later, Chu et. al. pushed the highest T_c to near 91K and needed only liquid nitrogen as coolant, which was cheaper and easier to handle. The significance of this breakthrough in superconductivity has been constantly compared to the invention and development of transistors and semiconductors and microprocessors which brings us powerful and inexpensive computers. These new computers ushered in rapid information retrieval and space exploration. The era of high- T_c superconductors was born (the highest T_c today is about 120K about 180 Celsius degrees below room temperature, and 120K is much higher than 23K).

The new superconducting materials and the huge increase of superconducting temperature (T_c) fanned the hopes that new superconductors could be found shortly at room temperature or above, and could be widely used in power distribution, transportation, medical scanning, etc. with substantial improvements in efficiency and accessibility. Furthermore, the search for new superconductors seems to be open to anyone. For a while, there seemed to be no known recipe and the "trial and error" approach to finding new superconductors did not require complex or expensive equipment. These expectations and the exciting climate created a large burst of published documents in 1987. A few new journals devoted to superconductivity were created, and some established publications started new sections for articles about superconductivity only, while others carried on business as usual.

This sudden burst of activity and the subsequent slow down in the number of articles published on the topic offered an excellent situation: (1) to study the time dynamics (activity vs. time) of the growth of the published papers; (2) to examine the dynamics of citation frequency of a few benchmark papers; (3) to investigate the effects on the time dynamics of the relative activity of established journals by the creation of new journals and new special sections on superconductivity; and (4) to investigate the changes in the measurement of the performance of other nations due to the easy access to search for new superconducting materials. The impact of the event itself, the scientific breakthrough in superconductivity, was studied.

Each of the studies requires further research on superconductivity literature over a long period of time in order to form a clearer and more convincing pattern of which journal best covers a scientific activity. For our research, however, we planned to concentrate on the changes of the research articles produced by various journals. It is important to continue the study of publications on the experiments and research activities concerning superconductivity in order to provide an effective measurement of research activities by the United States and other countries in this field.

Objectives

1. To understand information dissemination patterns in a well defined time period before and after a major scientific breakthrough (e.g. transistor, synthetic fiber, laser, etc.) or, in this case, superconductivity.

2. To investigate the changes in the research publications by different nations caused by the easy access to research on new superconducting materials.

3. To collect data and lay out the foundations for the long term studies.

Hypothesis

1. The easy access to research of new superconducting materials has opened doors for other nations to participate in the new technology and as result of this, the publishing performance has become less dominated by the United States.

2. The creation of new journals and new special sections about superconductivity will affect the ranking of journals by citation count or by impact factor.

Research Methodology

First, in order to determine which journals in the field of Physics had publications about superconductivity, we searched SCI-CD for the current literature, 1986 through 1988 on superconductivity. We then compiled the number of citations of each term (i.e. superconductive, superconductivity, superconducting, superconductor, and superconductors) found in the current literature and derived the total number of citations for each year dealing with superconductivity. We counted the number of citations for each term, and then tallied the total number of citations found for each year. The total number of papers on superconductivity from the journals for each year examined provided a reasonable measurement of the activity in the field for that year. Next, we created a list of all the different journals found having papers on this topic and divided the total number of papers for a particular year into four quarters. Then we took the average activity of three consecutive quarters as the average activity of the middle quarter and plotted this in two graphs (see Figure 1). The time dynamics (activity vs time) of this activity in the first year of research (the time period before the major breakthrough) was, in some cases quite different from the other time periods examined (see Table 1). Some journals such as Solid State Communications showed an almost astronomic increase in the number of articles on superconductivity while some other journals such as Physical Review Letters only showed small, incremental changes in the number of articles published

Figure 1
Publication Activity of Selection Journals

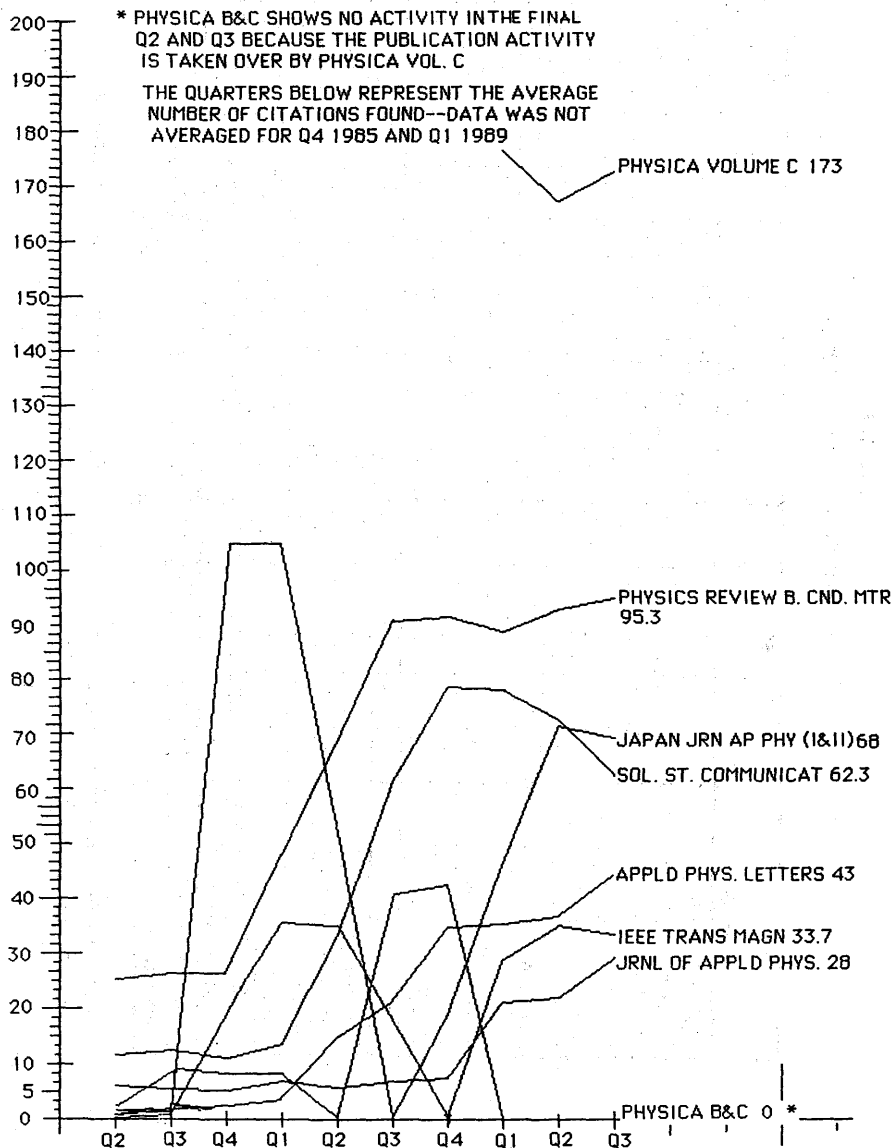


TABLE 1
Quarterly Activity of 17 Journals

Journals	1988				1987				1986				T	
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4		
	T	T	T	T	T	T	T	T	T	T	T	T		
Applied Physics letters	1	4	5	2	12	6	6	33	23	68	37	30	62	175
Cryogenics Europhys Letters	3	8	3	7	21	5	7	15	11	38	5	12	4	16
Europhys Letters	0	2	3	4	5	8	8	12	8	36	9	11	1	0
Fizika Nizkikh Temp	12	18	9	3	42	3	10	26	3	42	15	13	14	8
Fizika Tverdogo Tela	3	5	9	2	19	7	8	5	6	26	10	11	18	4
IEEE Trans-Magnetics	0	0	1	3	4	52	53	0	0	105	4	83	18	0
Japan J. Appl. Phys. (I&II)	6	3	2	1	12	307	2	1	3	313	50	90	72	42
J. Applied Physics	9	5	6	5	25	4	8	4	6	22	12	44	8	32
J. Low Temp. Physics	4	10	8	3	25	10	4	6	13	33	11	7	4	5
J. Phys. C-Solid State Phys.	0	3	2	2	7	0	3	12	11	26	12	19	10	8
J. Phys. Soc. Japan	6	3	7	0	16	8	6	14	18	46	14	7	15	0
Phys. Letters A.	6	4	2	5	17	8	9	8	14	39	17	13	11	15
Phys. Rev. B-Cond. Matter	25	26	25	29	105	26	88	92	93	299	93	81	107	98
Physical Review Letters	10	9	12	7	38	15	25	11	15	68	11	17	6	12
Physica B&C*	4	3	2	21	30	1	2	2	117	122	0	0	0	0
Physica C	0	0	0	0	0	0	0	0	0	0	9	411	68	40
Solid State Communications	13	10	9	14	46	8	21	72	80	181	83	64	68	55
Z. Phys. B-Cond.Matter	1	1	4	2	8	2	7	19	15	43	17	9	17	4
Total of 17 Journals	103	114	109	106	432	470	267	332	436	1507	418	929	471	401
Total Articles (SCI)					873					1931				4162

* Superconductivity articles were published in *Physica B & C*. In March 1988, *Physica C* started as an independent volume devoted to superconductivity only.

on this same topic. Also of interest, several journals from this particular time period had only a few articles on superconductivity before the major breakthrough, yet these same journals later showed a great increase in the number of articles on this topic.

Out of all the journals which were cited for articles on superconductivity, seventeen were selected due to the higher number of articles published per quarter or due to the high increase in published articles. For each of these journals, average activities for three consecutive quarters were calculated and tabulated (see Figure 2 and Table 2). The three quarter's averages were used to smooth out seasonal variations in order to provide better indications of a trend.

Figure 2
Publication Activity of 17 Journals Averaged

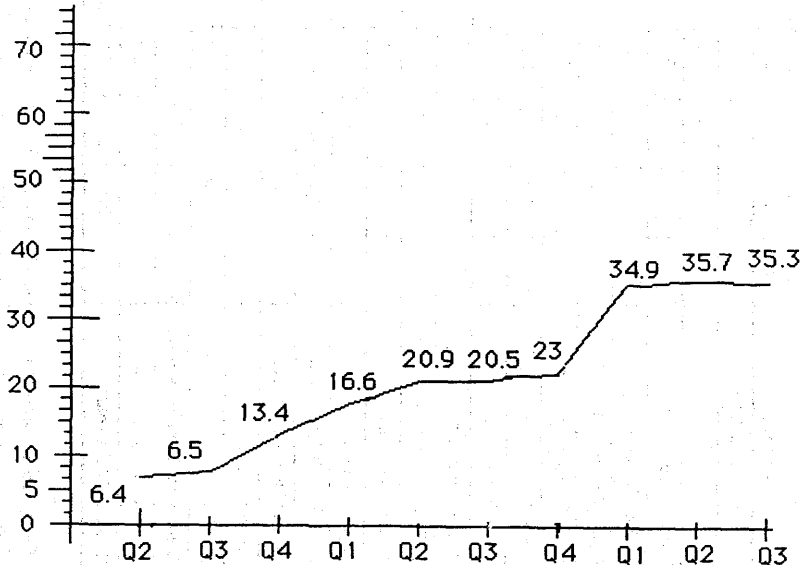


TABLE 2
Average Quarterly Activity of 17 Journals

Journals	1986				1987				1988			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4*
Applied Physics Letters		3.3	3.7	4.3	4.7	15	20.7	34	35	38	43	
Cryogenics		4.7	6	5	6.3	9	11	10.3	9.3	7	10.7	
Europy Letters		1.7	1.7	3.7	5.3	9.3	9.3	9.7	9.3	7	4	
Fizika Nizkikh Temp		13	10	5	5.3	13	13	14.7	10.3	14	11.7	
Fizika Tverdogo Tela		5.7	5.3	6	5.7	6.7	6.3	7	9	13	11	
IEEBE Trans-Magnetics		0.3	1.3	18.7	36	35	17.1	1.3	29	35	33.7	
Japan J. Appl. Phys. (I&II)		3.7	2	103	103	103	2	18	47.7	70.7	68	
J. Applied Physics		6.7	5.3	5	5.7	5.3	6	6.7	20.7	21.3	28	
J. Low Temp. Phys.		7.3	7	7	7	6.7	7.7	10	10.3	7.3	5.3	
J. Phus. C-Solid State Phys.		1.7	2.3	1.3	1.7	5	8.7	11.7	14	13.7	12.3	
J. Phys. Soc. Japan		5.3	3.3	5	4.7	9.3	12.7	15.3	13	12	7.3	
Phys. Letter A		4	3.7	5	7.3	8.3	10.3	13	14.7	13.7	13	
Phys. Rev. B-Cond. Matter		25.3	26.7	26.7	47.7	68.7	91	927	89	93.7	95.3	
Physical Review Letters		10.3	9.3	11.3	15.7	17	17	12.3	14.3	11.3	11.7	
Physica B & C		3	8.7	8	8	1.7	40.3	42.7	0	0	0	
Physica C		0	0	0	0	0	0	0	0	0	0	
Solid State Communications		10.7	11	10.3	14.3	33.7	61	78.3	75.7	71.7	62.3	
Z. Phys. B-Cond. Matter		2	2.3	2.7	3.7	9.3	13.7	17	13.7	14.3	10	
Total of 17 Journals		108.7	109.6	228	282.1	356	348.4	395	594	606.7	600.3	

*Q4 data is not available because Q1 data of 1989 is needed to calculate the average.

** Superconductivity articles were published in *Physica B & C*. In March 1988, *Physica C* started as an independent volume devoted to superconductivity only.

Major Findings

1. The seventeen selected journals published a major portion of research articles listed in SCI-CD on superconductivity. The percentages were 49.5% in 1986, 77.9% in 1987, and 53.3% in 1988.

2. In three years, the total activity of the seventeen journals increased nearly 500%, and *Physics Review B*, the standard bearer of condensed matter physics in the last few decades, increased by nearly 300% (from 25 to 95 articles) and remained a major publisher.

3. *Physica B&C*, *Japan Journal of Applied Physics*, *Solid State Communication*, *Applied Physics Letters*, and *IEEE Transactions on Magnetics* all experienced dramatic increases in activity and joined *Physics Review B* as major publishers in this field.

4. *Fizika Nizkikh Temperature*, *Journal of Low Temperature Physics*, and *Physics Review Letters* (one of the most prestigious physics journals) showed no significant increase in activity on superconductivity, while the rest of the journals saw the number of articles published at least doubled.

Conclusions

The number of research publications increased dramatically after a major breakthrough.

Physica, a prestigious European Physics journal, split its sections B&C into two volumes, and devoted *Physica* volume C, starting in March 1988, to superconductivity. *Physica* became the leader in publishing articles on superconductivity in 1988.

After this preliminary study, there are many related areas that can be expanded upon, such as bibliometrics and citation analysis on the subject of superconductivity. Also the period of observation can be extended for longer duration, so that a much clearer more accurate picture of the time dynamics of each journal's relative activity will emerge.

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