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ANALYSIS OF CONDENSED MATTER PHYSICS RECORDS IN DATABASES

Science and Technology Indicators in Condensed Matter Physics

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United Nations Educational Scientific and Cultural Organization
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ANALYSIS OF CONDENSED MATTER PHYSICS RECORDS IN DATABASES

Science and Technology Indicators in Condensed Matter Physics

Claus-D. Hillebrand[1]

Abstract

An analysis of the literature on Condensed Matter Physics, with particular emphasis on High-Temperature Superconductors, was performed on the contents of the bibliographic database International Nuclear Information Systems (INIS). Quantitative data were obtained on various characteristics of the relevant INIS records such as subject categories, language and country of publication, publication types, etc. The analysis opens up the possibility for further studies, e.g. on international research co-operation and on publication patterns.

MIRAMARE - TRIESTE

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Introduction

Condensed matter physics publications are stored in bibliographic databases such as the International Nuclear Information System (INIS). The objective of this study is to quantify and analyze bibliographic records on condensed matter physics which include High-Temperature Superconductor in INIS (hereafter simply referred to condensed matter physics records) to offer an overview of the developments in this research field. For the first time a scientometric study (p. 9) has been performed to investigate a selected field of science and technology and the INIS database has been used as a source of data. A variety of science and technology indicators are retrieved. Possible applications of this study are outlined. The scope of condensed matter physics records in INIS is described in the Categories section. (A description of INIS database is given in the Annex.)

Condensed matter physics lies within the INIS scope and represents about 6% of the whole INIS database (more than 113,300 condensed matter physics records were entered in the period from 1970 to mid-1998). In this field, there is an input of 5000-6000 records every year. Figure 1 shows the time development of these records over the publication years for the last 28 years. The grey column represents the number of High-Temperature Superconductor records, which are part of the condensed matter physics records. In the 1970's, the increase in the number of records was due to the start-up of INIS. In the 1980's, there were 4000-9000 records per year. The increase of the number of records after the mid-80s was due to the discovery of Müller and Bednarz's superconductor and the new research activities, which followed this discovery. The peak was in 1989. In the 90's, the number of records per publication year totalled between 6000-7000. Between 1989 and 1993 the number of records per year experienced a steady decrease. The input for the last 2-3 years is still continuing as the input preparation of each publication represents an extra step. The dashed lines indicate the projection of input for the last two years.

Six Member States provide about 74% of the INIS input in condensed matter physics, Figure 2. Condensed matter physics records come from 69 different input centres (INIS members, which include also International Organizations), in the period between 1970 and mid-1998. The number of countries and international organizations in which condensed matter physics documents were published totals 69 between 1970 and mid 1998. It is to be noted that the number of publications per country reflects the concentration of scientific publishing houses in those countries rather than research activities (see Author section).

Language

About 70% of all documents related to condensed matter physics are published in English. This includes translated publications. These are mainly published in the United States of

America (USA) and therefore, the INIS centre in USA provides these records. Translated records represent nearly 10% of the input from USA. Of all the authors listed in the condensed matter physics records, roughly 66% are from non-English speaking countries. There are altogether condensed matter physics records in 35 different languages (see Fig. 3). Russian represents about 19% and Portuguese about 3% of all documents.

Categories

INIS records are categorized according to the INIS Subject Categories and scope descriptions arranged in conformity with the International Classification System for Physics developed by the International Council for Scientific and Technical Information. The physics category scheme was changed in 1992. For that reason, the following analysis mainly covers the period from 1992 until mid-1998, with more than 29 400 records. The main subject category of interest is **Physics of Condensed Matter**, the subcategories (in bold characters) are: **Nuclear Techniques in Condensed Matter Physics; Solid-State Plasma; Interactions between Beams and Condensed Matter; Quantum Physics Aspects of Condensed Matter**, (respective subfields) Superconductivity; Basic superconductivity studies; Superconducting devices; Superfluidity; Other topics in quantum fluids and solids: see Annex: INIS Subject Scope: condensed matter physics Subject Categories in INIS see Table I.

In the period from 1992 until mid 1998, the subject fields with the highest number of records were quantum physics aspects of condensed matter (G6400) including many records related to High-Temperature Superconductivity and superconductivity (G6410) and nuclear techniques in condensed matter physics (G6100), interactions between beams and condensed matter (G6300) (Figure 4).

The time development of records within the subfields in general shows a small fluctuation in the yearly number of records in physics of condensed matter within the considered time period (1991-1996). The number of superconductivity records of the publication year 1994 depicts a prominent peak. The number of records of the subject categories: nuclear techniques in condensed matter physics and interactions between beams and condensed matter alternates from year to year. The years with a high number of records usually coincide with the publication of biannual conferences. This is in accordance with the total number of records vs. publication year (see Figure 1).

The multidisciplinary nature of the INIS database allows the study of correlation between scientific disciplines. For each record, up to three subject categories can be assigned, if the record covers more than one subject field. The condensed matter physics records with second and third categories have the following subject fields assigned (listed in order of importance) chemistry, materials and earth sciences (Category B) with 80% of all assignments, other physics (category G), engineering and technology (category E) with 9% each, Figure 5.

In other physics fields (Category G), there are second and third categories assignment in general physics, atomic and molecular physics, plasma physics and fusion.

Publication Types

The record type (e.g. journal articles, reports, books, miscellaneous, patents) and literary type (e.g., short-communications, conferences, numerical data, progress reports) of each record entry is indicated in the database. This allows the publishing format to be characterized (see Table II).

Journal articles represent about 71% of all records, reports 10%, books 10%, miscellaneous 9% and patents 0.1% (see Figure 6). The percentage of journal records seems high when compared with other physics disciplines. This may be due to the high number of research groups in condensed matter physics located at universities where small and medium size experiments can be done and these apparatus are similar (not device specific as large scale machines). Therefore, and as the readership of these documents is large the research results are published in journals. Also, under journal articles one can find a high number of conference contributions, numerical data and short communications (see Figure 7, records with two publication types). The "miscellaneous" type is often used for progress reports, listing of numerical data and dissertations. The high number of book records results from the publication format of some conference proceedings in which each contribution counts as a book record. The input of patents covered has been somewhat erratic over the years. This has to do with the change of patent record copyright in some countries and the difficulty of converting records from patent to bibliographic databases. Anyhow, the number of patent records in condensed matter physics is low when compared with other physics fields. No logical explanation thereof has been found.

The number of journal records in percentage is higher (about 40%) in the field of condensed matter physics than in plasma physics and fusion R&T, whereas in the latter the number of report and patent records is higher.

The time development of publication types gives an indication of research activities. The number of journal articles varies about 20-25% from year to year. The number of journal records per publication year entered in the INIS database averages around 3000. The number of records has fluctuated around this number over the last 20 years. The years 1980, 1989 and 1994 have an exceptionally high number of journal records. The number of book records has increased since 1990. The number of report records has not changed over the last 20 years. It has to be noted that the number of reports made available on the Internet increased and some research centers have changed their research program. The frequency of book records over the publication years is very irregular; the reason probably being due to the irregular choice of formats in publishing conference proceedings.

Authors

The country tag in the author field indicates, better than the country in which the document has been published, the actual national research activities. More than 56% of the authors come from six countries (with more than 5% per country) see Figure 8. The distribution of authors according to country is different from the distribution of input countries because in some of these there is a high concentration of science publishing houses. The number of different countries from which authors are publishing totals 130. About 48% of the publications have at least one author of the document who is affiliated with a university.

Journal Statistics

Journal articles on condensed matter physics are published in more than 1500 different journals and represent more than 55% of all condensed matter physics records in INIS. The number of condensed matter physics relevant records can be found in core 'condensed matter physics' journals and in 'general physics' journals as well as in national physics journals and in neighboring disciplines. The few core journals have a high number of records and concentrate more than 50% of all journal records. A detailed analysis can be performed in a specific study on condensed matter physics journals in which the most frequent and average page number per journal articles can be determined.

Also a profile of the main journals can be plotted against the condensed matter physics subfields. The profiles allow the comparison of the scope of each journal. The list of condensed matter physics journals, a ranking of journals by number of records (which is a function of publication years, input years, articles published per year and scope) can be compared with the list of the Science Citation Index (SCI) of the Institute of Scientific Information (Philadelphia, USA). The comparison made in Fusion R&T shows that, for instance, the scope of the SCI list in Fluids and Plasmas (not controlled fusion itself) is broad but does not cover certain fields such as material studies and engineering, etc. Furthermore, the Fusion Technology journals are not separated from Fusion Research journals in the SCI list. That means that the publications of nuclear physicists are not totally covered by the SCI Plasma Physics Category.

Keywords and Free Text

A common feature of a bibliographic database is the subject indexing of records by assigning of keywords. As the subject index is used in books, each database record is complemented by a list of 'controlled terms' (keywords, or in INIS terminology - descriptors) which are chosen to describe better the content, concepts, methods and models. These descriptors are scientific and technical words listed in the INIS Thesaurus, which also defines relationships (e.g. hierarchical, affinitive, etc.) to other descriptors. The descriptors are used for the retrieval of documents. Descriptors are assigned to each input record by indexers working in each INIS centre. Descriptors in condensed matter physics records in INIS database indicate that the main emphasis of the records is on condensed matter physics.

The descriptor "oxygen" is a controlled term, which is listed in the INIS Thesaurus.

An alternative retrieval tool is the search by "free text" (that is, natural language-words and phrases occurring in all textual fields, including titles and abstracts). The free text can be a scientific term, which appears in the title or abstract and is not necessarily a descriptor, but, nevertheless, can be used for retrieval. In addition to the use of descriptors, "non-standard keywords" (in INIS terminology - free text terms) are permitted to be input in another indexing field and allow flexibility of indexing and searching. Newly proposed descriptors are usually accepted with a delay of several months. The free text "Luttinger" is e.g. such a term.

In the condensed matter physics records, some elements of the periodic table have a high frequency (number of records) (in order of importance) such as oxygen, copper, yttrium, barium, silicon, helium, iron etc. (Table III).

Outlook

This analysis of Condensed Matter Physics records in INIS database contains many tables and graphs, which form the basis of this summary, and provides more detailed information. A basic analysis was performed aimed at different interest groups such as the scientific and technology community, science publishers and editors, librarians and science managers.

In the study, additional information on science and technology indicators and trends is also shown as well as information on Condensed Matter Physics related publications and their formats. Further, more advanced and focused analyses and evaluation of the data for some of these interest groups are also possible. The analysis opens the possibility of further studies, e.g. the co-operation between different institutions and countries, mapping publication patterns, highlighting scientific co-operation, development of human resources and journal structure etc.

Scientometric studies can assist in analysis and formulation of science and technology policy by mapping changes in research activities, providing thematic and strategic analysis of relative position of research communities; sketching profiles of activities and performance of countries and institutions.

Conclusion

The number of publications in Condensed Matter Physics reflects the development in this field especially the research efforts in the High-temperature superconductivity.

The number of frequency of periodic elements also reflects the elements in this field.

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- Socio-Economic Research on Fusion, International Institute for Applied Systems Analysis, Laxenburg, July 1998; In Proc. of SERF : Fusion : Perspectives from Economics, Politics and Public Opinion, ed. F. Schinner, Nov 1998.

A review on publications in Fusion Energy, International Fusion Energy Conference, Yokohama, Japan, Oct. 1998.

ANNEX

Table I

Condensed Matter Physics Subject Categories in INIS

- G6000 Physics of Condensed Matter G3000
- G6100 Nuclear Techniques in Condensed Matter Physics
- G6200 Solid-State Plasma
- G6300 Interactions Between Beams and Condensed Matter
- G6400 Quantum Physics Aspects of Condensed Matter
- G6410 Superconductivity
- G6411 Basic Superconductivity Studies
- G6412 Superconducting Devices
- G6420 Superfluidity
- G6430 Other Topics in Quantum Fluids and Solids

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About INIS Database

The decentralized multidisciplinary bibliographic database of the IAEA is a part of **INIS** which was created in 1970 and is administered by the INIS Section of the IAEA with the purpose of collecting and disseminating information on science and technology through its Member States.

INIS has 120 Members including 18 International Organizations which provide records on science and technology documents published in the states where the 120 INIS members are located. Records of documents are provided to INIS in English, along with the titles in the language of origin. All countries and international organizations participating in the Nuclear Reaction Data Centre network are also INIS Members. (United States of America, Japan, Russia, China, Germany, Hungary, Ukraine, NEA/DB - OECD, NDS-IAEA.)

The main INIS fields of scope are: (i) chemistry, materials and earth sciences; (ii) life and environmental sciences; (iii) isotopes, isotope and radiation applications; (iv) engineering and technology; (v) other aspects of nuclear and non-nuclear energy; (vi) physics.

The largest subject category is physics with about one third of all records, followed by engineering and technology with one fourth. Chemistry, material and earth sciences as well as life and environmental sciences represent about one fifth each.

ANNEX

Definition of Scientometrics and Bibliometrics

The terms bibliometrics and scientometrics were introduced almost simultaneously by Pritchard and by Nalimov and Mulchenko in 1969. While Pritchard explained the term bibliometrics as the application of mathematical and statistical methods to books and other media of communication, Nalimov and Mulchenko defined scientometrics as the application of those quantitative methods which deal with the analysis of science viewed as an information process. According to these interpretations, scientometrics is restricted to the measurement of science communication, whereas bibliometrics is designed to deal with more general information processes. The at best fuzzy distinction between the two has virtually disappeared over the course of the last three decades and, today, the terms are more or less synonymous. Meanwhile, the term infometrics has come to replace the originally broader specialty of bibliometrics.

(Source: 2nd European Report on Science and Technology Indicators, Dec. 1997, page 111, EC-Luxembourg, EUR17639.)

ANNEX

Table II

Publication Types

Records types:

J	Journals
R	Reports
B	Books
I	Miscellaneous
P	Patents

Literary Types:

E	Short Communication
N	Numerical Data
V	Computer Program Description
X	Nonconventional Literature
Y	Progress Reports
U	Dissertations
K	Conference
Z	Bibliography

ANNEX

Table III

Frequency of Periodic Elements in Condensed Matter Physics Records (since 1992) (total 29447).

	Alphabetic Order		Number of Records
0	Actinium	7717	Oxygen
1566	(Aluminium or Aluminum)	5645	Copper
10	Americium	2860	Yttrium
190	Antimony	2702	Barium
839	Argon	2641	Silicon
866	Arsenic	2289	Helium
3	Astatine	2272	Iron
2702	Barium	1956	Carbon
0	Berkelium	1669	Hydrogen
149	Beryllium	1566	(Aluminium or Aluminum)
1092	Bismuth	1193	Strontium
0	Bohrium	1171	Nitrogen
611	Boron	1092	Bismuth
174	Bromine	1059	Lead
363	Cadmium	1000	Nickel
268	(Caesium or Cesium)	999	Calcium
999	Calcium	949	Gallium
10	Californium	887	(Niobium or Columbium)
1956	Carbon	866	Arsenic
363	Cerium	839	Argon
470	Chlorine	799	Titanium
396	Chromium	707	Lanthanum
483	Cobalt	615	Tin
5645	Copper	611	Boron
2	Curium	600	Silver
0	Dubnium	557	Gold
137	Dysprosium	548	Indium
0	Einsteinium	524	Phosphorus
150	Erbium	510	(Sulphur or Sulfur)
183	Europium	504	Fluorine
0	Fermium	495	Platinum
504	Fluorine	483	Cobalt
8	Francium	473	Lithium
253	Gadolinium	470	Chlorine
949	Gallium	429	Zinc
422	Germanium	422	Germanium
557	Gold	408	Uranium
65	Hafnium	396	Chromium
0	Hassium	390	Neodymium
2289	Helium	374	Manganese

ANNEX

Table III - continued

Alphabetic Order		Number of Records	
133	Holmium	371	Sodium
1669	Hydrogen	363	Cadmium
548	Indium	363	Cerium
243	Iodine	336	Potassium
33	Iridium	331	Tellurium
2272	Iron	329	Magnesium
167	Krypton	316	Zirconium
707	Lanthanum	308	Deuterium
0	Lawrencium	289	Molybdenum
1059	Lead	286	Thallium
473	Lithium	273	(Tungsten or Wolfram)
68	Lutetium	270	Xenon
329	Magnesium	269	Selenium
374	Manganese	268	(Caesium or Cesium)
0	Meitnerium	256	Praseodymium
0	Mendelevium	253	Gadolinium
178	Mercury	243	Iodine
289	Molybdenum	224	Vanadium
390	Neodymium	210	Neon
210	Neon	209	Palladium
19	Neptunium	202	Tantalum
1000	Nickel	190	Antimony
887	(Niobium or Columbium)	183	Europium
1171	Nitrogen	178	Mercury
0	Nobelium	174	Bromine
8	Osmium	167	Krypton
7717	Oxygen	150	Erbium
209	Palladium	149	Beryllium
524	Phosphorus	147	Samarium
495	Platinum	137	Dysprosium
16	Plutonium	133	Holmium
2	Polonium	125	Ytterbium
336	Potassium	121	Rubidium
256	Praseodymium	110	Ruthenium
4	Promethium	90	Terbium
3	Protactinium	90	Thulium
14	Radium	71	Rhodium
14	Radon	68	Lutetium
31	Rhenium	65	Hafnium
71	Rhodium	57	Scandium
121	Rubidium	45	Thorium
110	Ruthenium	33	Iridium
0	Rutherfordium	31	Rhenium
147	Samarium	31	Tritium

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Table III - continued

Alphabetic Order		Number of Records	
57	Scandium	19	Neptunium
0	Seaborgium	16	Plutonium
269	Selenium	14	Radium
2641	Silicon	14	Radon
600	Silver	11	Technetium
371	Sodium	10	Americium
1193	Strontium	10	Californium
510	(Sulphur or Sulfur)	8	Francium
202	Tantalum	8	Osmium
11	Technetium	4	Promethium
331	Tellurium	3	Astatine
90	Terbium	3	Protactinium
286	Thallium	2	Curium
45	Thorium	2	Polonium
90	Thulium	0	Actinium
615	Tin	0	Berkelium
799	Titanium	0	Bohrium
273	(Tungsten or Wolfram)	0	Dubnium
0	Ununbium	0	Einsteinium
0	Ununnilium	0	Fermium
0	Unununium	0	Hassium
408	Uranium	0	Lawrencium
224	Vanadium	0	Meitnerium
270	Xenon	0	Mendelevium
125	Ytterbium	0	Nobelium
2860	Yttrium	0	Rutherfordium
429	Zinc	0	Seaborgium
316	Zirconium	0	Ununbium
308	Deuterium	0	Ununnilium
31	Tritium	0	Unununium

ANNEX

Figure Captions

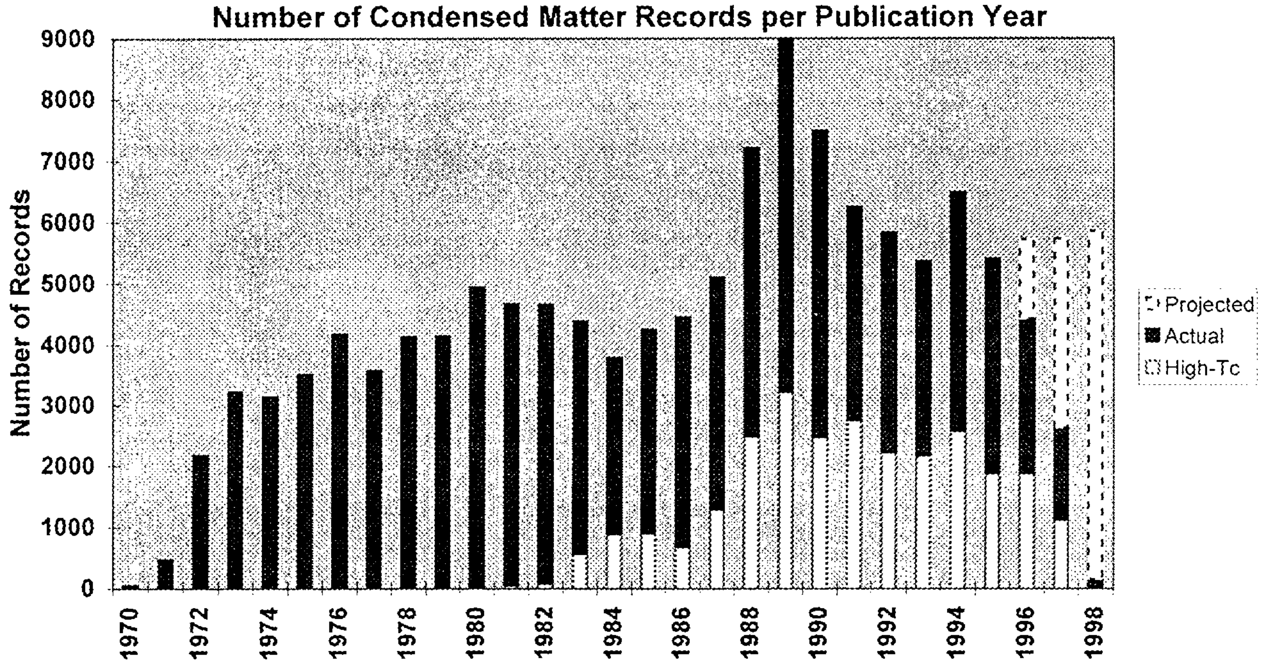
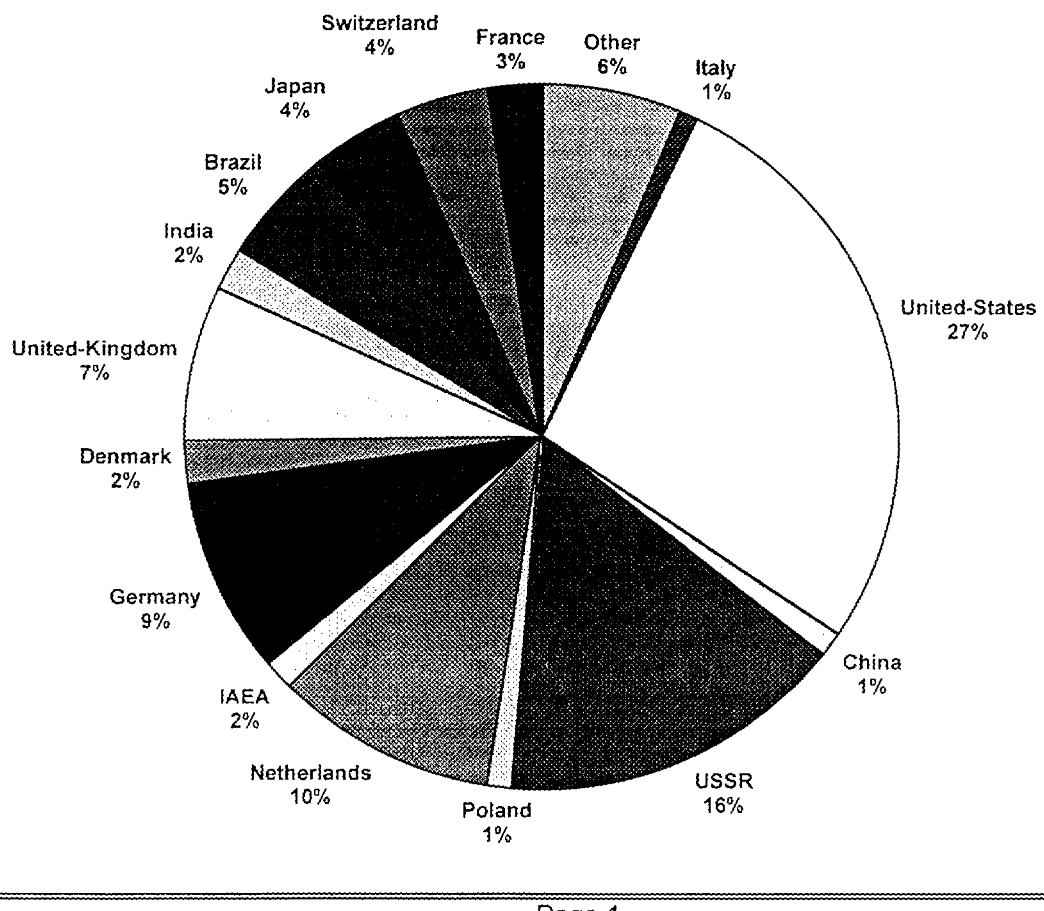
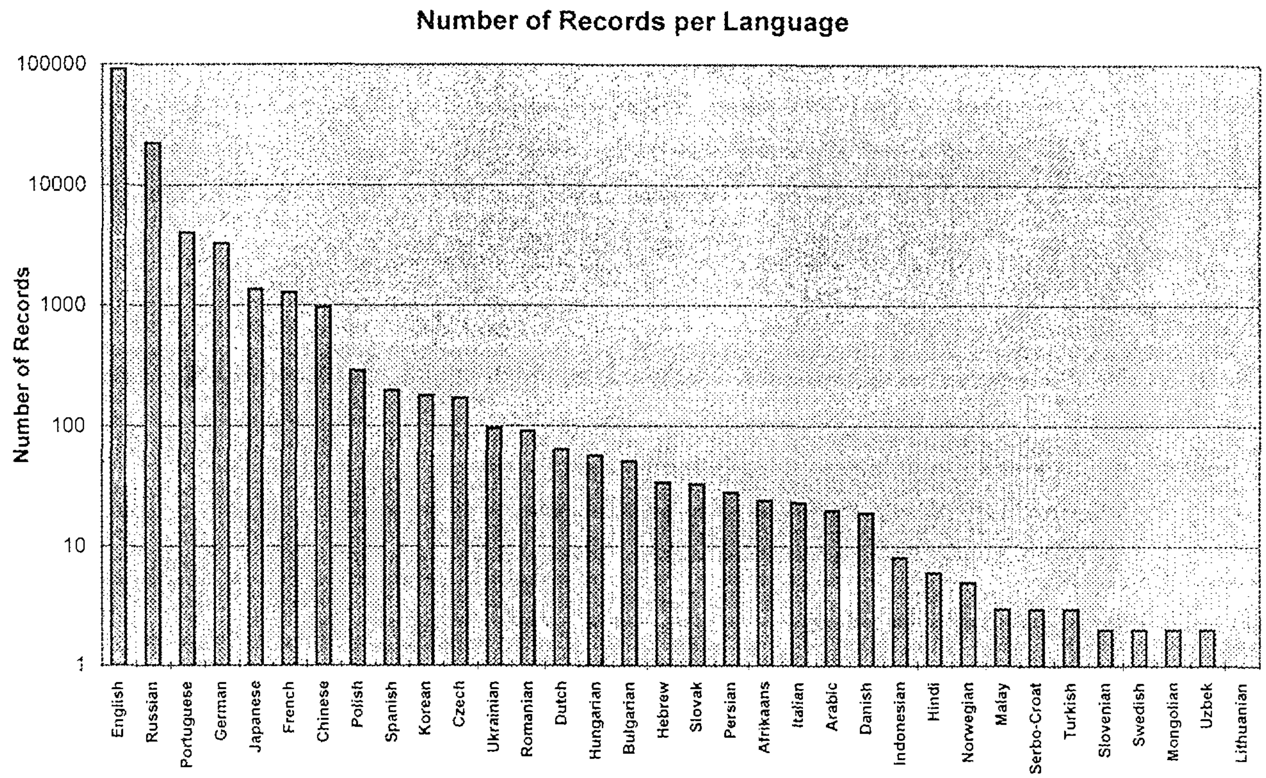


Fig. 1

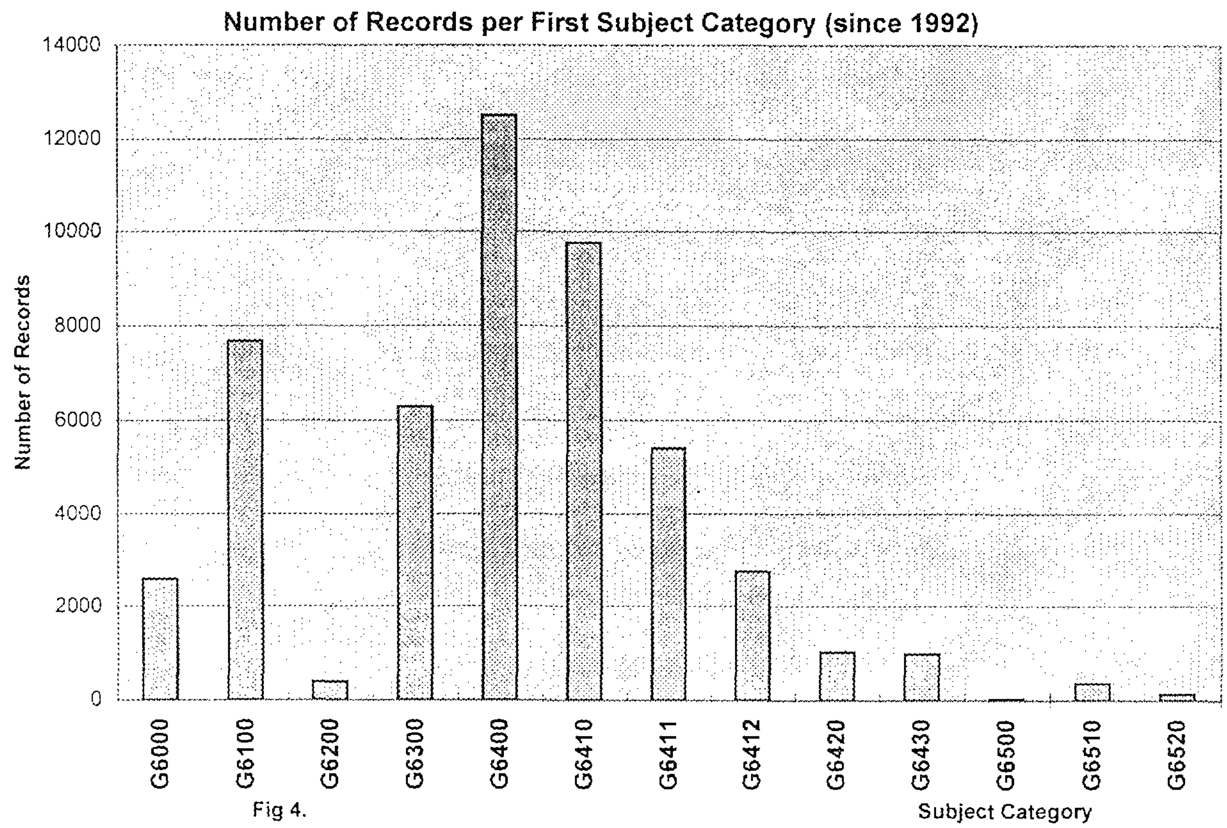
Number of Condensed Matter Physics Records per Input Country Fig.2





Number of Records per Language
Number of Records
100000
10000
1000
100
10
1
English
Russian
Portuguese
German
Japanese
French
Chinese
Polish
Spanish
Korean
Czech
Ukrainian
Romanian
Dutch
Hungarian
Bulgarian
Hebrew
Slovak
Persian
Afrikaans
Italian
Arabic
Danish
Indonesian
Hindi
Norwegian
Malay
Serbo-Croat
Turkish
Slovenian
Swedish
Mongolian
Uzbek
Lithuanian
Language

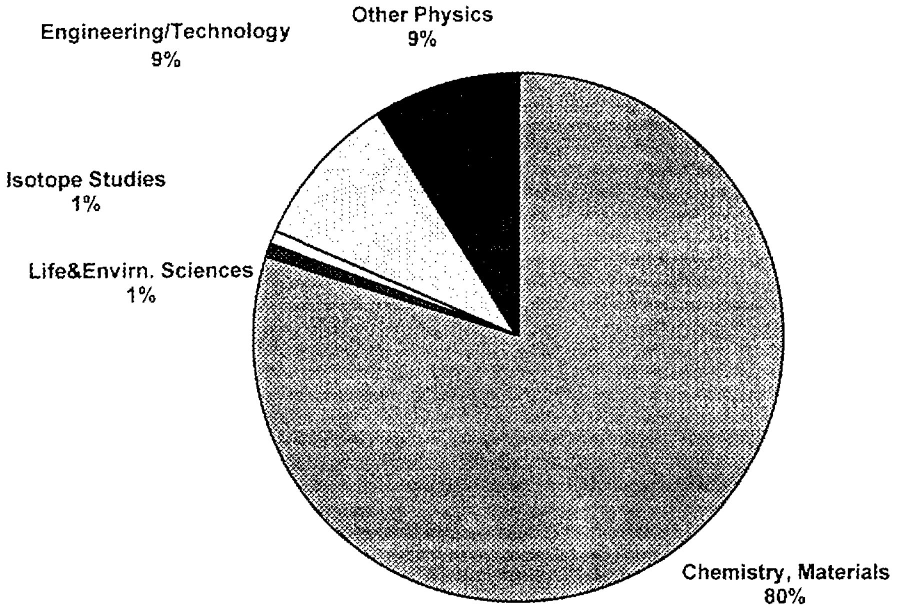
Fig.3



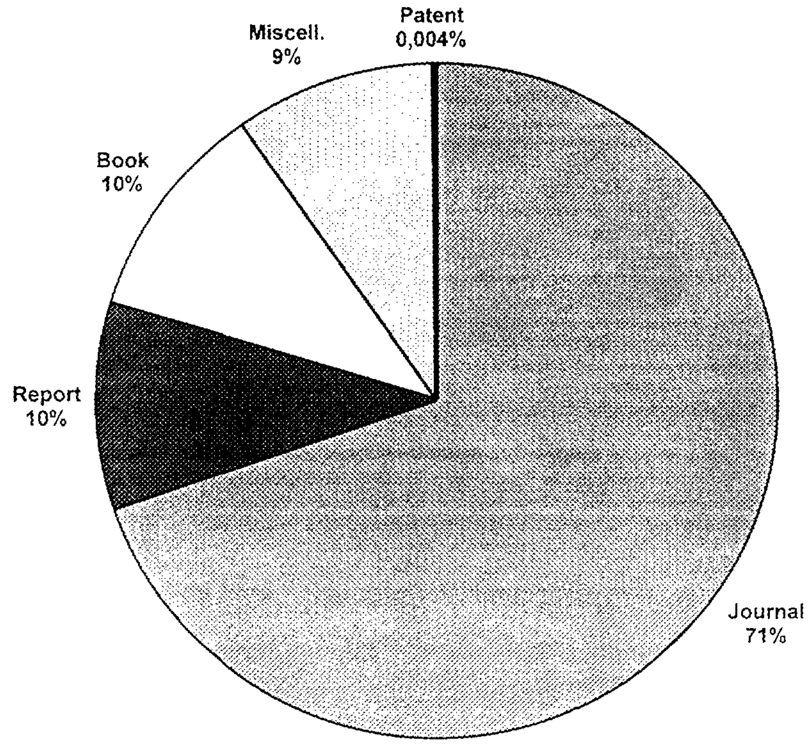
Number of Records per First Subject Category (since 1992)
Number of Records
14000
12000
10000
8000
6000
4000
2000
0
G6000
G6100
G6200
G6300
G6400
G6410
G6411
G6412
G6420
G6430
G6500
G6510
G6520
Subject Category

Fig 4.

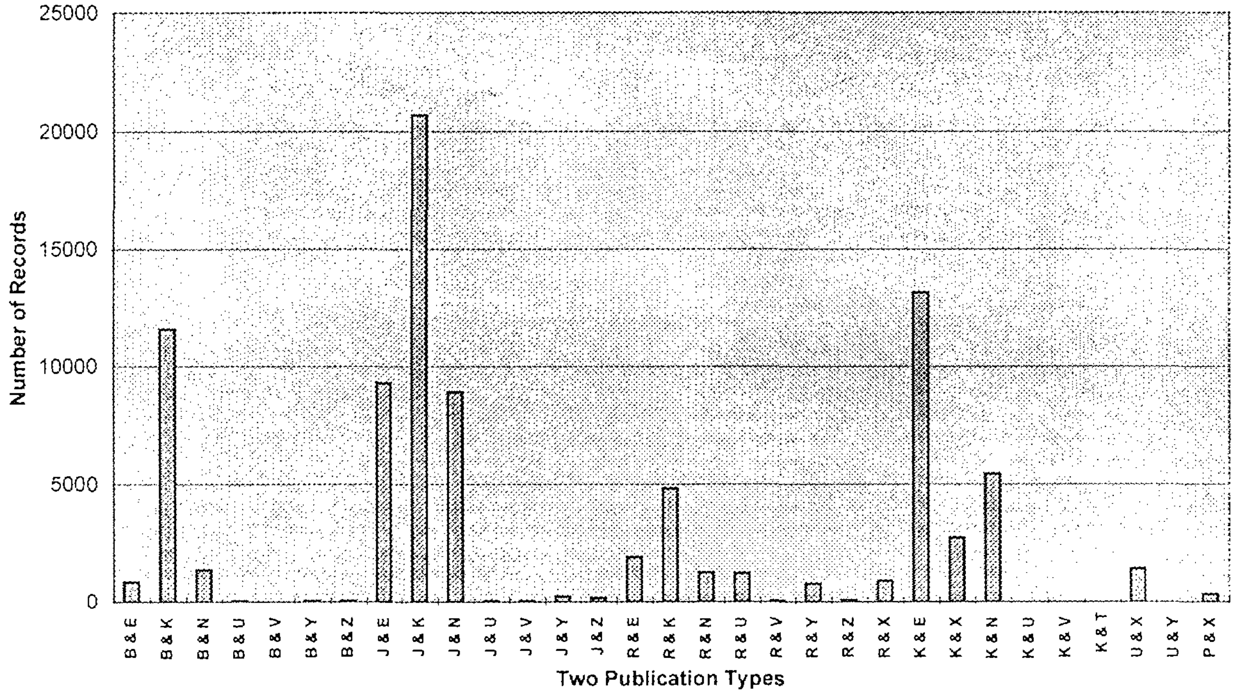
Number of Records (%) per Primary Subject Category **Fig.5**



Number of Records (%) per Publication Type **Fig.6**



Number of Records with two Publication Types **Fig. 7**



Number of Records distribution of authors according to country **Fig.8**