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PUBLICATION AND CITATION PATTERNS IN THE LITERATURE OF LIQUID CRYSTALS WITH SPECIAL REFERENCE TO THE CONTRIBUTION OF INDIA, CANADA, JAPAN, UNITED KINGDOM AND THE SOVIET UNION‡,+

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From an analysis of bibliographic data on 430 journal articles on liquid crystals covered in *Physics Abstracts* 1976 and the 4729 citations to them up to the end of 1987, we have identified the geographic origin, the prominent institutions, language and journal-wise distribution of the papers, the citedness of these papers, and the distribution of citations as a time series for the highly cited papers. We have also analysed the 126 papers published by authors from India, Canada, Australia, Israel, Japan and the United Kingdom and covered in *Physics Abstracts* 1978, and the 1154 citations to them up to 1987. Unlike in most other high tech areas of physics, in LC research the difference in performance between the USA and the other leading countries is not very pronounced. Publication data from 1976, 1978 and 1985 reveal that LC literature is on the rise and that the percentage share of the Soviet Union is rising fast and that of the USA is on the decline.

Introduction

Although science is universal, its practice in different parts of the world is not distributed uniformly. In fact the world distribution of science (in terms of research papers produced annually by different countries) is even more skewed than the world distribution of economic entities such as GNP and national income. Perhaps the late Professor Michael *Moravcsik* had the clearest perception of this reality of inequitable distribution of science; he had also understood better than anyone else the implications of this skewed distribution and the need to bring in the culture of original scientific research into countries and societies which are not as well endowed scientifically as the advanced countries of the West at the moment.[1] Fortunately for

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many of us in the Third World – or the LDCs as our countries have come to be know in the literature – Mike was not a mere academic. Both by his voluminous and lucid writing and by correspondence and personal meetings not only did he initiate several laudable efforts to raise the level of science done in the LDCs but also enthused many LDC scholars to take up both the study and practice of science development.

This paper is about the unequal distribution of research efforts in one small subfield of physics, viz. liquid crystals. Our main interest was to see how well does India perform in this high-tech area of physics. To see India's performance in perspective, we decided to look at the performance of three other middle-level countries, viz. Canada, Israel and Australia, whose scientific enterprise in terms of R&D budget, number of scientists and technologists engaged in R&D activity, infrastructural facilities for carrying out research, etc. is comparable to that of India[2]. At the next level, we wanted to compare the performance of the middle-level countries with those of two advanced countries, viz. the island economies of the United Kingdom and Japan. Thus, in this paper we have first given a detailed account of the publication and citation patterns in the world literature of liquid crystals and followed it up with comments on the publication output and citation impact of six selected countries. At the end we have also commented upon the patterns of literature citations received by papers published by Japanese and Soviet scientists both of whom use both national and overseas journals.

This paper is a part of our continuing effort to understand how well research performed in the periphery gets assimilated in mainstream science performed in advanced countries through a study of the distribution of publication and citation patterns in the literature of different fields. In the first of this series we looked at pre-high T_c super-conductivity research:[3-5] in another paper we have examined the publication and citation patterns in the literature of holography;[6] we are currently looking at the literature of lasers.

Liquid crystals are materials that have properties and characteristics of both liquids and crystalline solids. Several thousand compounds have liquid-crystalline phases in their pure states. Many biological materials, such as cell membranes, also display liquid crystalline behaviour. Since liquid crystals have both the ability to flow and the anisotropy of crystals, they display many properties of great interest and, often, of practical importance.[7]

It was in 1888, a little over a century ago, that the study of liquid crystals began when the Austrian botanist Friedrich Reinitzer found that on progressive heating the solid cholesteryl benzoate first turned into a murky and turbid liquid and later into a

clear liquid. However, it was his friend O. Lehmann who discovered that the turbid liquid actually displayed optical anisotropy as do solid crystals, and coined the name "liquid crystal" to describe the state of matter which can both flow like a liquid and retain anisotropy. In 1922, G. Friedel provided the classification scheme, which is still used, and the study of liquid crystals continued fairly strongly into the 1930s. The renewed interest in this area owes much to Prof. Glen H. Brown of Kent State University who organised a series of international conferences starting from the sixties. Because of the enormous theoretical interest in the nature – structure and behaviour – of these materials and the tremendous applications in optical, electro-optical and display devices, there has been a continuing interest in liquid crystals.[7] First rate theoreticians like the French professor de Gennes[8] have contributed extensively in this area. At least two Indians have contributed monographs.[9,10]

Although the growth of liquid crystals literature is not as explosive as the literature of high T_c superconductivity, its growth rate is fairly high. And as far as we know, neither scientometricians nor science policy scholars have analysed the literature of liquid crystals. It is against this background we thought the time was appropriate to analyse the patterns of geographical distribution of research papers, journals and languages used, and citations to these papers in literature.

Methodology

We scanned three volumes (79, 81 and 88) of *Physics Abstracts* (*PA*) covering the years 1976, 1978 and 1985 and recorded all entries in liquid crystals. The entires made included *PA* abstract number, name and initials of the first (or the sole) author (which were necessary for checking the citations to the papers from the *Science Citation Index*), the number of authors, the title of the journal (or the document, if a non-journal item), year, volume and page. Whenever a language code was indicated it was also noted. We covered not only all the entries under the section "Liquid crystals" (Section 7.130 in *PA* 1976, section 61.30 in *PA* 1978, and section 41500 in *PA* 1985) but included for our analysis all entries under the terms 'liquid crystal devices', 'nematic liquid crystals', 'smectic liquid crystals', 'liquid crystal display', 'liquid crystal phase transformations', etc. We scanned for relevant entries under the section "Display technology" also.

With the help of the Citation Index section of *SCI* we noted citations up to 1987 to each one of the documents from the 1976 *PA* and to the journal articles originating in six countries, viz. Australia, Canada, India, Israel, Japan and the

United Kingdom, covered in the 1978 *PA*. No citation data were collected for the 1985 *PA* papers.

The technique used is similar to that described in our earlier papers on the world distribution of the literature of superconductivity[3] and holography.[6] The technique of using publication data obtained from a comprehensive abstracting service in combination with citation data obtained from *SCI* lends itself readily for different purposes such as comparing the impact of superconductivity research done in different countries,[4,5] and estimating the impact of physics literature produced in Israel[11] and the international impact of India's contribution in different subfields of science such as electrochemistry[12] and reproductive endocrinology.[13] In fact, using a comprehensive abstracting service such as *Chemical Abstracts*, *Biological Abstracts* or *Physics Abstracts* to collect data on publications in a chosen field is better than using the SCI's Corporate Author and Permuterm Subject Index sections for the simple reasons that SCI's coverage of journals is highly selective. Also, the method often used to arrive at estimates of national contributions to different disciplines – as is being done at Computer Horizons, Inc. and at the Hungarian Academy of Sciences – by assigning whole journals to subdisciplines and disciplines cannot give figures for national contributions to subdisciplines (and specific research fronts) as accurate as figures arrived at by examining data from a comprehensive abstracting service at the individual document (abstract) level. Hence the controversy on whether to use the raw *SCI* data[14] or the *SCI*-CHI (constant journal set) data[15] is irrelevant when we want to measure the national outputs in small subfields such as liquid crystals.

Analysis

The world distribution of the literature of liquid crystals as seen from *Physics Abstracts* 1976, 1978 and 1985 is given in Table 1a. Table 1b gives the numbers of citations received by the 1976 *PA* journal articles of different countries up to 1987 and the distribution of these papers according to the number of citations they have received.

Table 1a
World distribution of liquid crystals literature in 1976, 78 and 85

Sl No.	Country (by first author)	1976 No. of papers	%	1978 No. of papers	%	1985 No. of papers	%	Total No. of papers (1976+78+85)	% of total
1	USA	89(85)	19.52	125(118)	21.19	135(131)	17.31	349(334)	19.11
2	USSR	59(59)	12.94	109(109)	18.47	168(167)	21.54	336(335)	18.40
3	France	71(67)	15.57	89(87)	15.08	94(91)	12.05	254(245)	13.91
4	Japan	52(50)	11.40	53(53)	8.98	68(68)	8.72	173(171)	9.47
5	India	32(31)	7.02	25(25)	4.24	42(39)	5.38	99(95)	5.42
6	Germany*	26(21)	5.70	32(30)	5.42	38(33)	4.87	96(84)	5.26
7	UK	31(29)	6.81	31(30)	5.25	32(29)	4.10	94(88)	5.15
8	Italy	14(13)	3.07	21(21)	3.56	32(32)	4.10	67(66)	3.67
9	Poland	5(5)	1.10	9(9)	1.53	22(20)	2.82	36(34)	1.97
10	The Netherlands	7(7)	1.54	12(12)	2.03	11(10)	1.41	30(29)	1.64
11	Israel	6(6)	1.32	8(8)	1.36	15(14)	1.92	29(28)	1.59
12	Yugoslavia	8(5)	1.75	9(8)	1.53	12(11)	1.54	29(24)	1.59
13	Canada	9(9)	1.97	8(8)	1.36	11(11)	1.41	28(28)	1.53
14	Bulgaria	5(5)	1.10	13(13)	2.20	9(8)	1.15	27(26)	1.48
15	Switzerland	11(11)	2.41	4(3)	0.68	9(9)	1.15	24(23)	1.31
16	Hungary	7(3)	1.54	6(1)	1.02	10(6)	1.28	23(10)	1.26
17	China	-	-	1(1)	0.17	16(16)	2.05	17(17)	0.93
18	Czechoslovakia	1(1)	0.22	1(1)	0.17	13(13)	1.67	15(15)	0.82
19	Sweden	2(2)	0.44	3(3)	0.51	8(8)	1.03	13(13)	0.71
20	Romania	1(1)	0.22	6(6)	1.02	5(4)	0.64	12(11)	0.66
21	Spain	-	-	-	-	6(6)	0.77	6(6)	0.33
22	Australia	1(1)	0.22	2(2)	0.34	2(2)	0.26	5(5)	0.27
23	Other countries 8(1976),12(78),11(85)	14(14)	3.07	17(17)	2.88	16(13)	2.05	47(44)	2.57
24	Unknown	5(5)	1.10	6(6)	1.02	6(6)	0.77	17(17)	0.93
	Total	456(430)		590(571)		780(747)		1826(1748)	

Parantheses denote journal articles only.
* *PA* does not distinguish between Federal Republic of Germany and the German Democratic Republic.

Less than 35 countries account for the entire literature of liquid crystals, and three countries account for half of the literature. The United States of America and the Soviet Union are the most prolific publishers of liquid crystals research papers, followed by France, Japan, India, Germany and the United Kingdom. China appears to have entered the field only recently. Unlike in most other fields of physics (such as holography) and science overall, the US share of the world's literature of liquid crystals is not unduly large. Nor is the citation impact of US produced liquid crystals

Table 1b
World distribution of citations to 1976 *PA* journal papers in liquid crystals

Sl No.	Country (by first author)	No. of journal articles (PA 1976)	No. of citations (1975-1987)	Citations/ paper	No. of 1976 PA journal papers receiving x citations during 1975-87				
					x=0	1-4	5-10	11-20	>20
1	USA	85	1218	14.33	12	18	22	13	20
2	USSR	59	419	7.10	9	24	12	10	4
3	France	67	760	11.34	8	14	19	16	10
4	Japan	50	291	5.82	6	18	18	7	1
5	India	31	235	7.58	1	11	9	8	2
6	Germany	21	163	7.76	4	5	7	3	2
7	UK	29	703	24.24	2	3	3	11	10
8	Italy	13	197	15.15	4	2	3	2	2
9	Poland	5	42	8.40	1	1	1	2	-
10	The Netherlands	7	78	11.14	1	2	-	2	2
11	Israel	6	57	9.50	-	3	1	1	1
12	Yugoslavia	5	35	7.00	-	2	2	1	-
13	Canada	9	112	12.44	-	2	3	2	2
14	Bulgaria	5	22	4.40	1	3	-	1	-
15	Switzerland	11	232	21.09	-	2	2	2	5
16	Hungary	3	19	6.33	-	-	3	-	-
17	Czechoslovakia	1	1	1.00	-	1	-	-	-
18	Sweden	2	28	14.00	1	-	-	-	1
19	Romania	1	1	1.00	-	1	-	-	-
20	Australia	1	3	3.00	-	1	-	-	-
	8 other countries	14	105	7.50	7	4	1	-	2
	Unknown	5	8	1.60	4	-	1	-	-
	Total	430	4729	10.99	61	117	107	81	64

literature distinctly high. In fact, papers from the UK were cited on an average much more often. Authors from the UK accounted for about 6.7% of LC journal articles (in *PA* 1976), but these papers went on to win 14.9% of all citations won by PA 1976 LC papers up to 1987. The corresponding figures for the USA-based authors are 19.8% of published papers and 25.8% of citations won. And the figures for the Soviet Union are 13.7% of published journal articles and 8.86% of citations. Incidentally, Soviet Union's citation impact in this field (number of citations per paper over 12 years) is higher than her citation impact in holography, superconductivity, lasers, etc. The share of the Soviet Union is increasing steadily and in fact in 1985 USSR published more LC papers than even the USA. India's share of LC papers, at about 5.4% of the world's output in 1985, is much higher than her share of the world's physics and chemistry literatures as seen from *PA* and *Chemical Abstracts*.

Significantly, the citation impact of Indian work in liquid crystals is also much higher than that of Indian work in science as a whole and in high-tech subfields of physics such as lasers, holography and superconductivity. Other middle-level countries are not prolific publishers of LC papers; however, the limited amount of work published from Canada is well cited. Switzerland published very little, but of high impact. Only three countries, viz. USA, UK and France, had at least ten journal papers in 1976 *PA* which went on to win more than 20 citations up to 1987.

Bulk of the LC literature has appeared in journals. In Table 2 we give the numbers of citations won by different kinds of documents. Bulk of the non-journal items are conference papers, but these were not cited very well. A book carrying a chapter on liquid crystals, *Hydrodynamic fluctuations, broken symmetry and correlation functions,* by D. *Forster* (Benjamin, Inc.), 1975, which was covered in 1976 *PA* had won about 400 citations up to 1987. This is in contrast to what we observed in the literature of holography where books (and chapters in books) are hardly cited. We hasten to add that only a fraction of the 400 or so citations would have been to the chapter or liquid crystals.

Table 2
Distribution of citations of non-journal items

Sl No.		No. of items			Total	No. of citations of 1976 items
		1976	1978	1985		
1	Reports (Hungary)	4	5	4	13	1
2	Papers from conferences, meetings, etc.	16	10	26	52	4
3	Books	6*	3	3	12	477
4	Theses	-	1	-	1	-
	Total	26	19	33	78	482

*One book having Abst. No.28789/76 had one chapter on liquid crystals. In *SCI* citations were displayed under page number and chapter number. The chapter number of the article on liquid crystals is not known and so we do not know how many of the 403 citations to this book are for the chapter on liquid crystals.

Table 3 lists 18 institutions which have published at least seven journal articles in liquid crystals as seen from 1985 *PA*. Two Indian, one Chinese, two Italian, one Japanese, one Israeli, three French, one British, three US, two Soviet, one Bulgarian and one Yugoslav laboratories have active groups. The French groups at Orsay and Talence, the group at the Soviet Academy's Institute of Crystallography and the one at AT & T Bell Laboratories are the most prolific.

Table 3
Distribution of liquid crystal journal papers by institution (Only institution contributing 7 or more papers in 1985 are included)

Sl No.	Univ./Institute with country	No. of papers
1	Lab de Phys de Solides, Universite de Paris-Sud, Orsay, France	35
2	Institute of Crystallography, Acad of Sci, Moscow, USSR	16
3	AT & T Bell Laboratories, Murray Hill, NJ, USA	12
4	Centre de Recherches Paul Pascal, Domaine Univ, Talence, France	12
5	Institute of Physics, Acad Sinica, Beijing, China	12
6	Raman Research Institute, Bangalore, India	12
7	Tokyo Institute of Technoogy, Tokyo	12
8	J Stefan Inst, Edvard Kardelj University of Ljubljana, Yugoslavia	10
9	L D Landau Institute of Theoretical Physics, Moscow, Acad of Sci, USSR	10
10	University of Southampton, Southampton, UK	10
11	Universita di Calabria, Italy	9
12	Nagarjuna University, Andhra Pradesh, India	9
13	Brandeis University, USA	8
14	Padernborn University, France	8
15	Pisa University, Italy	8
16	Institute of Solid State Physics, Acad of Sci, Sofia, Bulgaria	7
17	Weizmann Institute of Science, Rehovot, Israel	7
18	Massachusetts Institute of Technology, Cambridge, MA, USA	7
	Total	204

Table 4 lists alphabetically the journals often used for publishing work on liquid crystals. More than 250 journals were used to publish over 1740 papers in the three years (430 papers in 107 journals in 1976; 571 papers in 124 journals in 1978, and 747 papers in 150 journals in 1985). Of these at least nine journals had an impact factor greater than 2.00 (*JCR* 1985) and four had an impact factor greater than 3.00. Undoubtedly, *Molecular Crystals and Liquid Crystals* (GBR) is the premier journal in the field. Other prominent journals are *Journal de Physique* (FRA), *Journal of Chemical Physics* (USA), *Molecular Crystals and Liquid Crystals Letters* (GBR), *Physical Review A* (USA), *Annales de Physique* (FRA), *Physical Review Letters* (USA), and the Russian journal *Kristallografiya* (SUN). At least 15% of the papers published in the three years have appeared in letters journals. *Molecular Crystals and Liquid Crystals Letters* continues to be the most often used letters journal. While *Physical Review Letters* (USA) is becoming more prominent, the importance of *Physics Letters A* (NLD) and *Solid State Communications* (USA) is on the decline. *Journal of Chemical Physics* appears to have become a vehicle for LC papers only recently.

Table 4
List of journals reporting liquid crystals research

Sl No.	Journal	Impact factor (1985 JCR)	No. of papers 1976	78	85	Total
1	Akust Zh (SUN)	–	2	6	5	13
2	Ann Phys (FRA)	0.520	-	55	1	56
3	Appl Phys Lett (USA)	3.587	8	6	3	17
4	Chem Phys Lett (NLD)	2.294	10	6	9	25
5	Ferroelectrics (GBR)	0.859	1	1	34	36
6	Fiz Tverdogo Tela (SUN)	0.601	9	12	8	29
7	J Appl Phys (USA)	1.921	14	4	8	26
8	J Chem Phys (USA)	3.095	24	25	22	71
9	J Mag Resonance (USA)	3.196	3	7	5	15
10	J Phys (FRA)	1.181	19	25	36	80
11	J Phys Chem (USA)	3.048	-	-	14	14
12	J Phys Lett (FRA)	2.732	12	9	20	41
13	J Phys Soc Jpn (JPN)	1.631	7	5	9	21
14	Jpn J Appl Phys (JPN)	0.551[c]	12	14	13[a]	39
15	Kristallografiya (SUN)	0.529	10	19	22	51
16	Kvantovaya Elektron, Moskva (SUN)	0.802	4	5	3	12
17	Mol Cryst & Liq Cryst (GBR)	1.243	61	85	96	242
18	Mol Cryst & Liq Cryst Lett (GBR)	–	7	37	22	66
19	Mol Phys (GBR)	0.398	8	9	12	29
20	Opt Commun (NLD)	1.587	5	4	3	12
21	Opt & Spectrosk (SUN)	0.403	2	1	8	11
22	Phys Lett A (NLD)	1.206	21	16	7	44
23	Phys Rev A (USA)	2.354	10	13	38	61
24	Phys Rev Lett (USA)	6.912	9	14	29	52
25	Pisma v Zh Eksp & Teor Fiz (SUN)	–	3	8	8	19
26	Polymer (GBR)	1.697	-	2	10	12
27	Solid State Commun (USA)	2.123	14	6	1	21
28	Ukr Fiz Zh (SUN)	0.231	-	10	6	16
29	Vysokomol Soedin Ser A (SUN)	0.483	-	1	9	10
30	Z Naturforsch Teil A (DEU)[b]	0.879	8	3	11	22
	Other journals(224 titles)	–	147	163	275	588
	Total		430	571	747	1748

a – Putting Part I and II together.
b – Formely: *Z. Naturforsch A.*
c – Impact factor is for *Jpn J. Appl. Phys. Part I.*

Close to 10% of the journal articles in 1985 have appeared in journals with impact factors higher than 3.00, and about 10% of the 1985 LC papers have appeared in journals with a 1985 impact factor between 2.00 and 3.00. In all the three years considered journals published from the UK published the largest number of papers in this field, followed by US, Soviet, French and Dutch journals. Japanese and

German journals also contributed substantially to the literature of liquid crystals (Table 5). The steady increase in the Soviet share is clearly seen. The citation impact of articles published in US journals is found to be much higher than that of articles published in journals from other countries. US journals accounted for about 23.5% of LC papers in 1976, but these papers had won close to 40% of citations won by all 1976 LC papers up to 1987. However, none of the US journals is fully devoted to liquid crystals or even crystallography! British journals also account for a higher percentage of citations (29.1%) than percentage of papers (24.4%).

Table 5
Distribution of articles by country of publication

Sl No.	Journal country	No. of papers				Citation of 1976 PA papers	Citations/ papers
		1976	78	85	Total		
1	UK	105	159	208	472	1378	13.12
2	USA	101	106	172	379	1853	18.35
3	USSR	55	102	147	304	412	7.49
4	France	43	98	69	210	399	9.28
5	The Netherlands	39	32	30	101	265	6.80
6	Japan	34	31	31	96	140	4.12
7	Germany	24	19	37	80	197	8.21
8	India	5	5	8	18	33	6.60
9	Poland	-	3	9	12	-	-
10	Czechoslovakia	2	1	8	11	1	0.50
11	Canada	5	-	5	10	41	8.20
12	Italy	3	2	5	10	1	0.33
13	Denmark	8	-	1	9	6	0.75
14	Romania	-	5	2	7	-	-
15	China	-	-	6	6	-	-
16	Bulgaria	2	1	-	3	3	1.50
17	Switzerland	-	1	2	3	-	-
18	Australia	-	1	1	2	-	-
19	Brazil	2	-	-	2	0	0
20	Hungary	-	-	2	2	-	-
21	Korea	1	1	-	2	0	0
22	Sweden	-	1	1	2	-	-
	7 other countries	1	3	3	7	0	0
	Total	430	571	747	1748	4729	

About three-fourths of the LC journal literature appears in English. The share of the Russian language article is on the rise (Table 6), again indicating the growing Soviet interest in this area.

Table 6
Distribution of liquid crystal papers by language

Sl No.	Language	*PA* 1976 No. of papers	%	*PA* 1978 No. of papers	%	*PA* 1985 No. of papers	%	Total	% of total
1	English	329	76.51	425	74.43	569	76.17	1323	75.70
2	Russian	55	12.80	102	17.86	147	19.68	304	17.40
3	French	24	5.58	24	4.20	16	2.14	64	3.66
4	Japanese	11	2.56	8	1.40	4	0.54	23	1.32
5	German	5	1.16	7	1.23	4	0.54	16	0.92
6	Chinese	-	-	-	-	4	0.54	4	0.23
7	Italian	3	0.70	1	0.18	-	-	4	0.23
8	Czech	2	0.47	-	-	1	0.13	3	0.17
9	Rumanian	-	-	2	0.35	-	-	2	0.11
10	Spanish	-	-	-	-	2	0.27	2	0.11
11	Korean	-	-	1	0.18	-	-	1	0.06
12	Norwegian	1	0.23	-	-	-	-	1	0.06
13	Polish	-	-	1	0.18	-	-	1	0.06
	Total	430		571		747		1748	

Citedness of LC papers

The 430 journal articles covered in *PA* 1976 (a few of them bearing a publication date of 1975) were cited 4729 times up to the and of 1987 as seen from *SCI*. 46 of these papers are cited at least 25 times, 11 of them being cited 50 times or more (Table 7a). At the other extreme, 48 papers have gone uncited, and another 117 received less than five citations in the thirteen-year period 1975-1987. The cumulative number of citations is plotted as a function of the number of papers in Fig. 1.

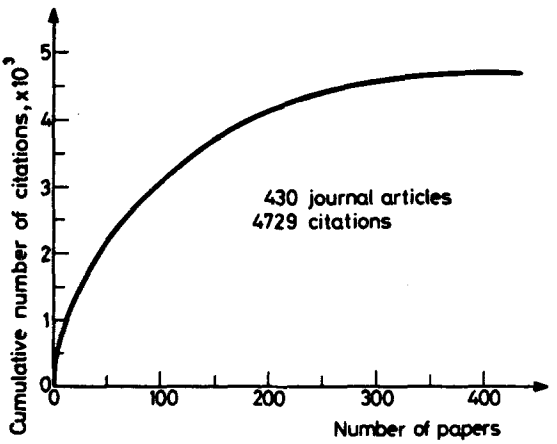

Fig. 1. Plot of cumulative number of citations vs number of LC papers covered in *PA* 1976. The 430 journal articles went on to win 4729 citations up to 1987 as seen manually from *SCI*

Table 7a
Citedness of liquid crystal papers of 1976 *PA*

No. of times cited (1975-87) (A)	No. of papers (B)	No. of citations (A X B)	No. of times cited (1975-87) (A)	No. of papers (B)	No. of citations (A X B)
0	61	0	27	1	27
1	30	30	28	5	140
2	37	74	29	2	58
3	28	84	30	3	90
4	22	88	31	2	62
5	22	110	32	1	32
6	24	144	34	1	34
7	14	98	35	2	70
8	19	152	36	2	72
9	14	126	38	3	114
10	14	140	39	1	39
11	12	132	41	1	41
12	11	132	42	1	42
13	7	91	43	1	43
14	9	126	48	2	96
15	16	240	49	1	49
16	4	64	50	1	50
17	7	119	54	1	54
18	7	126	59	1	59
19	5	95	60	1	60
20	3	60	61	2	122
21	8	168	72	1	72
22	6	132	83	1	83
23	3	69	114	1	114
24	1	24	131	1	131
25	3	75	198	1	198
26	3	78			
				430	4729

Table 7b gives data on the citedness of LC papers from six countries, viz. the UK, Japan, Canada, India, Israel and Australia, covered in *PA* 1978. There were 126 papers, all of them put together winning 1154 citations up to the end of 1987. Seven papers had won more than 25 citations each, and on the other hand 22 papers had not been cited even once and 41 were cited less than five times.

Table 7b
Citedness of liquid crystal papers of Australia, Canada, India, Israel, Japan and UK (1978 *PA* data)

No. of times cited (1977-87) (A)		No. of papers (B)	No. of citations (A X B)
0		22	0
1		9	99
2		15	30
3		8	24
4		9	36
5		9	45
6		9	54
7		6	42
8		3	24
9		4	36
10		4	40
11		3	33
12		4	48
13		4	52
14		2	28
15		1	15
16		1	16
17		1	17
20		2	40
23		1	23
24		2	48
29		1	29
41		1	41
45		1	45
49		1	49
52		1	52
59		1	59
219		1	219
	Total	126	1154

We see from Table 1b that 29 *PA* 1976 papers from the UK had won on an average more than 24 citations each up to 1987, and 50 Japanese papers had won citations at the average rate of 5.82. In Table 8 we categories the 1978 *PA* papers from the six countries according to the number of citations won during 1978-1987. Clearly, the United Kingdom has published more highly cited papers than the others. In terms of number of citations per paper, however, Canada comes out on top and India follows not far behind. Again, although Japan has published a very large number of papers these have not been cited as often as the Canadian, British and

Indian LC papers. Israel's record in LC research, unlike her record in superconductivity, holography and physics research as a whole, is rather poor.

Table 8
Number of 1978 *PA* journal papers of Australia, Canada, India, Israel, Japan, and UK receiving X citations during 1975-87

Sl No.	Country	No. of papers	No. of citations	Citation/ paper	X=0	1-4	5-10	11-20	>20
1	Australia	2	17	8.50	-	1	-	1	-
2	Canada	8	123	15.38	-	2	1	4	1
3	India	25	308	12.32	10	6	5	3	1
4	Israel	8	37	4.63	-	4	3	1	-
5	Japan	53	276	5.21	11	20	16	4	2
6	UK	30	393	13.1	1	8	10	5	6

Japanese, British and Indian researchers have contributed 12, 21 and eight papers respectively to letters journals in the three years studied.

In Table 9 we give data on the multiplicity of authorship of LC journal articles for the world as a whole and for the six selected countries. In general, papers by two and three authors predominate, followed by single author papers.

Table 9
Multiplicity of authorship (Only journal articles were taken)

No. of authors	World				First author country																
					Australia			Canada			India			Israel			Japan			UK		
	1976	78	85	Total	1976	78	85	76	78	85	76	78	85	76	78	85	76	78	85	76	78	85
1	105	137	143	385	-	1	2	2	-	4	14	7	8	-	2	4	9	5	11	10	7	2
2	149	211	239	599	1	1	-	2	4	6	12	10	14	3	5	3	17	18	16	9	10	11
3	111	121	168	400	-	-	-	2	3	1	5	2	5	3	1	5	18	19	18	4	6	12
4	49	64	110	223	-	-	-	3	1	-	-	2	8	-	-	2	6	8	13	5	7	3
5	12	26	55	93	-	-	-	-	-	-	-	3	3	-	-	-	-	3	6	1	-	1
6	2	7	19	28	-	-	-	-	-	-	-	1	1	-	-	-	-	-	2	-	-	-
7	2	5	13	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
Total	430	571	747	1748	1	2	2	9	8	11	31	25	39	6	8	14	50	53	68	29	30	29

Highly cited papers

The distribution of citations to highly cited 1976 *PA* journal papers as a time series is presented in Table 10. Only papers which were cited at least thirty times up to 1987 are included. There are 14 papers from the USA, 6 from the UK, four from

France and two each from the Soviet Union and Switzerland. The supremacy of the USA is not as pronounced in liquid crystals as in superconductivity and holography. Also to be noted is the absence of Japan and the four middle level countries, viz. India, Canada, Israel and Australia, in this list. The only Third World country to find a place is Venezuela.

Table 10
Distribution of citations of highly cited papers as a time series
(Only papers cited 30 or more times are considered)

Sl No.*	1975	76	77	78	79	80	81	82	83	84	85	86	87	Total	Country
1	-	-	24	28	25	22	17	18	16	12	16	8	12	198	GBR
2	-	5	17	20	12	12	13	9	7	13	7	9	7	131	USA
3	-	4	4	5	11	10	12	11	9	16	19	6	7	114	ITA
4	1	4	7	3	7	10	6	8	13	2	5	8	9	83	GBR
5	1	3	9	10	4	6	3	2	9	10	7	6	2	72	FRA
6	-	4	9	6	1	3	5	7	8	5	6	4	3	61	CHE
7	-	2	2	7	4	3	11	5	11	5	4	0	7	61	FRA
8	-	4	4	8	7	5	5	4	5	2	7	4	5	60	USA
9	-	2	12	9	6	3	4	6	2	4	6	3	2	59	VEN
10	-	3	7	10	4	6	11	3	1	4	1	1	3	54	USA
11	-	1	3	2	3	3	6	4	12	7	3	2	4	50	CHE
12	-	1	2	5	4	1	9	7	5	2	4	4	5	49	USA
13	-	-	4	10	4	1	3	6	5	5	6	1	3	48	USA
14	-	2	7	5	5	5	5	6	3	2	2	2	4	48	USA
15	2	2	2	10	9	3	3	3	1	3	1	3	1	43	USA
16	-	1	6	8	5	2	5	4	3	3	0	3	2	42	GBR
17	1	4	4	4	2	0	6	2	4	3	5	5	1	41	USA
18	-	1	3	5	4	5	2	1	3	5	3	5	2	39	SUN
19	-	-	7	7	3	2	3	0	2	7	4	1	2	38	USA
20	-	3	4	7	2	3	4	1	4	5	3	1	1	38	FRA
21	-	-	3	6	8	2	1	4	3	1	3	3	4	38	USA
22	-	6	9	8	4	1	1	2	1	1	0	0	3	36	USA
23	-	2	1	8	3	3	3	3	4	3	1	4	1	36	FRA
24	-	1	1	2	3	6	4	4	3	4	5	0	2	35	SUN
25	1	1	9	2	7	2	2	2	4	2	1	1	1	35	USA
26	-	-	3	1	2	8	2	5	3	5	2	2	1	34	GBR
27	-	1	6	6	4	2	3	2	2	3	0	2	1	32	USA
28	-	-	3	5	4	2	1	2	2	3	4	3	2	31	GBR
29	-	1	1	10	7	2	1	3	0	3	1	0	2	31	FRA
30	-	1	8	5	5	4	3	2	1	1	0	0	0	30	USA
31	-	2	2	0	0	5	4	5	3	2	4	3	0	30	DEU
32	1	2	2	7	3	6	2	2	2	1	1	1	0	30	GBR
Total	7	63	185	229	172	148	160	143	151	144	131	95	99	1727	

* Bibliographic details of 1-32 (Only first author names are given).

Table 10 (cont.)

Abst No		
81400/76	1	A.G. LEE, *Nature*(GBR), 262 (1976)545.
63974/76	2	R.G. PRIEST, *Phys Rev B* (USA), 13 (1976)4159.
9123/76	3	A. ROVIELLO, *J Polym Sci Polym Lett*(USA), 13 (1975)455.
13377/76	4	G.R. LUCKHURST, *Mol Phys*(GBR), 30 (1975)1345.
5326/76	5	A.J. DIANOUX, *Mol Phys* (GBR), 30 (1975) 1181.
14399/76	6	R. BLINC, *J Chem Phys* (USA), 63 (1975) 3445.
39982/76	7	G. RYSCHENKOW, *J Chem Phys* (USA), 64 (1976) 404.
44814/76	8	D.E. MARTIRE, *J Chem Phys* (USA), 64 (1976) 1456.
30495/76	9	A. WULF, *J Chem Phys* (USA), 64 (1976) 104.
61292/76	10	H. BIRECKI, *Phys Rev Lett* (USA), 36 (1976) 1376.
54052/76	11	J. NEHRING, *J Appl Phys* (USA), 47 (1976) 850.
21739/76	12	I. HALLER, *Prog Solid State Chem* (GBR), 10 (1975) 103.
72997/76	13	J. PROST, *J Appl Phys* (USA), 47 (1976) 2298.
44799/76	14	J. KUSHICK, *J Chem Phys* (USA), 64 (1976) 1362.
1550/76	15	K. MIYANO, *Phys Rev A*(USA), 12 (1975)615.
86814/76	16	M. DAVIES, *J Chem Soc Faraday Trans II* (GBR), 72 (1976)1447.
13382/76	17	P.E. CLADIS, *Phys Rev Lett* (USA), 35 (1975) 1283.
79284/76	18	L.M. BLINOV, *Kristallografiya* (SUN), 20 (1975) 1245.
36227/76	19	L.J. YU, *Phys Rev Lett* (USA), 36 (1976) 388.
57438/76	20	P. MANNEVILLE, *J Phys* (FRA), 37 (1976) 285.
72136/76	21	M.A. COTTER, *Mol Cryst & Liq Cryst* (GBR), 35 (1976) 33.
53427/76	22	S. BLAHA, *Phys Rev Lett* (USA), 36 (1976) 874.
65024/76	23	Y. POGGI, *Phys Lett A* (NLD), 57 (1976) 53.
13384/76	24	S.A. BRAZOVSKII, *Zh Eksp & Teor Fiz*(SUN), 69 (1975)979.
35346/76	25	P.H. KEYES, *J Chem Phys*(USA), 63 (1975)5006.
83404/76	26	W.A. CROSSLAND, *J Phys D*(GBR), 9 (1976)2001.
93427/76	27	Y.R. LIN-LIU, *Phys Rev A*(USA), 14 (1976)445.
76401/76	28	G.R. LUCKHURST, *J Chem Soc Faraday Trans II*(GBR), 72 (1976)996.
68448/76	29	S. NAGAI, *J Phys*(FRA), 37 (1976)769.
79269/76	30	R.G. PRIEST, *J Chem Phys*(USA), 65 (1976)408.
5332/76	31	S. HESS, *Z Naturforsch A*(DEU), 30A (1975)1224.
26760/76	32	J.W. EMSLEY, *Mol Phys*(GBR), 30 (1975)1913.

Suprisingly, only one of these 32 papers had appeared in *Molecular Crystals and Liquid Crystals*. In contrast, *Journal of Chemical Physics* accounted for seven and *Molecular Physics* three. Six of these highly cited papers were published in letters journals and one in *Nature*.

A breakdown of Table 10 into three groups of articles according to the number of citations received yields the data in Table 11. The first line for each set of articles gives the total number of citations they received; the figures in the second line are calculated by considering the 1977 total as equal to 100 to allow comparison. The normalized data are presented graphically in Fig. 2. Unlike what was observed in the citation spread of highly cited superconductivity[3] and holography papers[6], the trend for highly cited liquid crystals papers remains the same for all the three groups.

Table 11
Total citations received by thres groups of articles, 1975-87 (papers from *PA* 1976; citations up to 1987)

	1975	76	77	78	79	80	81	82	83	84	85	86	87
15 Articles	2	21	62	79	59	53	36	38	37	46	32	26	22
cited 30-39													
times			100	127	95	85	58	61	60	74	52	42	35
14 Articles	5	33	78	97	65	51	82	67	82	57	57	46	51
cited 41-83													
times			100	124	83	65	105	86	105	73	73	59	65
3 Articles	0	9	45	53	48	44	42	38	32	41	42	23	26
cited 114-198													
times			100	118	107	98	93	84	71	91	93	51	58

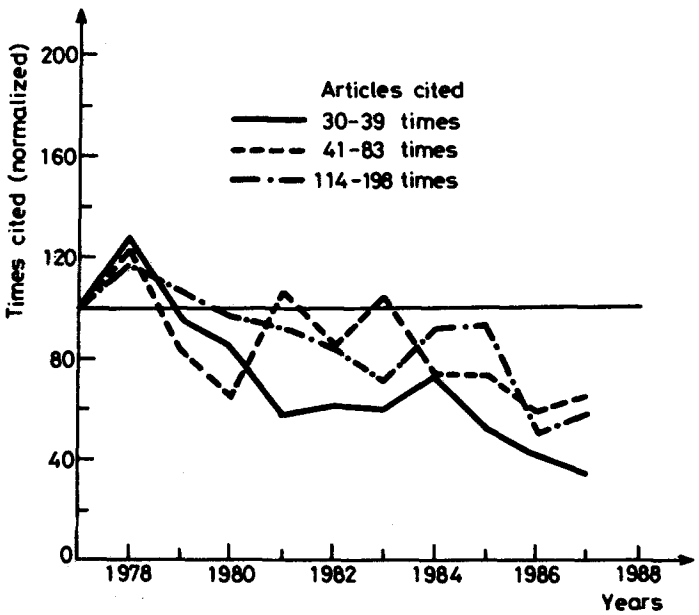

Fig. 2. Citation spread during the years 1977-1987 for highly cited LC journal papers covered in *PA* 1976

Table 12 gives the distribution of 1978-1987 citations to 1978 papers from the four middle-level countries and the two island economies as a time series. Twelve papers have received 20 or more citations. Six of these are from the UK and three from Canada. Israel and Australia have drawn a blank. Mostly US, British and French journals are used. That Canada which has published only eight papers is represented with three moderately cited papers is noteworthy.

Table 12
Distribution of citations of highly cited papers (as a time series) of Australia, Canada, India, Israel, Japan and UK of 1978 *PA*
(Only papers cited 20 or more times are considered)

Sl No.*	1978	79	80	81	82	83	84	85	86	87	Total	Country
1	8	16	26	28	32	23	20	26	20	20	219	IND
2	4	11	4	11	6	6	1	5	8	3	59	GBR
3	2	2	6	6	9	6	3	4	11	3	52	GBR
4	-	3	1	7	4	11	11	7	3	2	49	JAP
5	-	11	6	6	4	5	3	4	3	3	45	CAN
6	-	1	2	3	5	4	7	6	5	8	41	GBR
7	1	4	5	4	4	4	2	2	2	1	29	GBR
8	-	1	3	2	0	2	2	6	1	7	24	JAP
9	-	3	1	3	5	3	3	2	0	4	24	GBR
10	1	5	6	4	1	3	2	0	1	0	23	GBR
11	2	2	2	1	9	3	1	0	0	0	20	CAN
12	-	1	6	3	4	3	2	1	0	0	20	CAN
Total	18	60	68	78	83	73	57	63	54	51	605	

*Bibliographic details of 1-12 (Only first author names are given).

	Abstract No.	
1	14279/78	S. CHANDRASEKHAR, *Pramana* (IND), 9 (1977) 471.
2	22644/78	R.G. HORN, *J Phys* (FRA), 39 (1978)105.
3	60377/78	D.A. DUNMUR, *Mol Cryst & Liq Cryst* (GBR), 45 (1978) 127.
4	75532/78	S. NAEMURA, *Appl Phys Lett* (USA), 33 (1978) 1.
5	68405/78	J.H. DAVIS, *J Magn Resonance* (USA), 29 (1978) 191.
6	43219/78	M.G.J. GANNON, *Philos Mag A* (GBR), 37 (1978) 117.
7	63671/78	J.W. EMSLEY, *Mol Phys* (GBR), 35 (1978) 1499.
8	39527/78	K. YOSHINO, *Jpn J Appl Phys* (JAP), 17 (1978) 597.
9	26428/78	R.G. HORN, *J Phys* (FRA), 39 (1978) 167.
10	42902/78	J.W. GOODBY, *Mol Cryst & Liq Cryst Lett* (GBR), 41 (1978) 183.
11	10126/78	J.L. DION, *Appl Phys Lett* (USA), 31 (1977) 490.
12	56953/78	D.A. PINK, *Phys Lett A* (NLD), 66A (1978) 157.

Tables 13a and 13b give respectively data on the citedness of journal articles published by Japanese scientists and covered in *PA* 1976 and 1978 respectively, classified under articles in Japanese and non-Japanese (entirely English language) journals. Of the 30 papers in Japanese journals in *PA* 1976 eight were in Japanese language, and six of them went uncited, one was cited in two subsequent papers published in Japanese journals, and one was cited once in a non-Japanese journal. In all the 24 papers which were cited at all were cited 65 times in Japanese journals and 70 times in non-Japanese journals.

Table 13a
Distribution of citations to papers published from Japan

Sl No.	Phys Abstr Number (1976)	Journal	Citations in Japanese journals	Citations in Non-Japanese journals	Citations in Total world
Articles in Japanese journals					
1	13374	Jpn J Appl Phys	13	8	21
2	39984	J Phys Soc Jpn	12	3	15
3	25942	J Phys Soc Jpn	7	5	12
4	39986	Jpn J Appl Phys	1	8	9
5	5323	Jpn J Appl Phys	3	6	9
6	79273	Jpn J Appl Phys	5	4	9
7	13381	Prog Theor Phys	2	4	6
8	39985	J Phys Soc Jpn	5	1	6
9	53018	Jpn J Appl Phys	1	5	6
10	79281	Sci Pap Inst Phys & Chem Res	3	2	5
11	57571	J Phys Soc Jpn	0	5	5
12	93424	Jpn J Appl Phys	1	4	5
13	79275	Jpn J Appl Phys	1	3	4
14	86812	Jpn J Appl Phys	2	2	4
15	9093	J Phys Soc Jpn	3	1	4
16	79274	Jpn J Appl Phys	0	2	2
17	87737	Jpn J Appl Phys	1	1	2
18	53019	Jpn J Appl Phys	0	2	2
19	2505*	Oyo Buturi	2	0	2
20	57573	Prog Theor Phys	1	1	2
21	68489	J Phys Soc Jpn	1	1	2
22	72134	Jpn J Appl Phys	1	0	1
23	90759	Oyo Buturi	0	1	1
24	65022*	J Acoust Soc Jpn	0	1	1
	Six other papers*		0	0	0
	Total		65	70	135
Articles in Non-Japanese journals (entirely in English language)					
25	44820	Mol Cryst & Liq Cryst	6	14	20
26	61296	Solid State Commun	5	10	15
27	1548	Appl Phys Lett	2	13	15
28	90749	Mol Cryst & Liq Cryst	0	13	13
29	1549	J Sound & Vib	0	13	13
30	60917	J Magn Resonance	0	10	10
31	72127	Appl Phys Lett	0	9	9
32	13378	Mol Cryst & Liq Cryst	1	8	9
33	61297	Solid State Commun	6	2	8
34	72128	Appl Phys Lett	0	7	7
35	45754	Chem Phys Lett	1	6	7
36	76486	J Sound & Vib	0	6	6
37	72141	Mol Cryst & Liq Cryst	0	5	5
38	68493	Mol Cryst & Liq Cryst	0	5	5
39	49378	J Chem Phys	0	3	3
40	3445	Mol Cryst & Liq Cryst	0	3	3
41	68496	Mol Cryst & Liq Cryst	0	3	3
42	26859	Electron Lett	0	2	2
43	50400	Phys Lett A	0	2	2
44	80282	J Appl Phys	1	0	1
	Total		22	134	156

* Articles in Japanese language.

Table 13b
Distribution of citations to papers published from Japan

Sl No.	Phys Abstr Number (1978)	Journal	Citations in Japanese journals	Citations in Non-Japanese journals	Citations in Total world
Articles in Japanese journals					
1	39527	Jpn J Appl Phys	12	12	24
2	26432	Jpn J Appl Phys	0	16	16
3	14444	J Phys Soc Jpn	3	12	15
4	75812	Jpn J Appl Phys	4	8	12
5	8780	Jpn J Appl Phys	0	8	8
6	46871	Jpn J Appl Phys	0	7	7
7	26431	Jpn J Appl Phys	1	5	6
8	75537	Jpn J Appl Phys	0	6	6
9	83724	Jpn J Appl Phys	2	4	6
10	59739	J Phys Soc Jpn	3	2	5
11	87804	Jpn J Appl Phys	5	0	5
12	34430	Jpn J Appl Phys	0	2	2
13	56461	Jpn J Appl Phys	1	1	2
14	87774	Jpn J Appl Phys	1	1	2
15	1980	J Phys Soc Jpn	2	0	2
16	68467*	Technol Rep Osaka Univ	0	2	2
17	95002*	Kobunski Ronbunshu	0	2	2
18	30536	Jpn J Appl Phys	0	1	1
19	43834	Bull Res Lab Precis Mach & Electron	0	1	1
20	22413*	Oyo Buturi	1	0	1
21	43857*	Oyo Buturi	0	1	1
22	18356	Technol Rep Kyushu Univ	0	1	1
23	Nine papers(3 in Japanese)		0	0	0
	Total		35	92	127
Articles in Non-Japanese journals (entirely in English language)					
24	75532	Appl Phys Lett	1	48	49
25	9948	Polymer	0	12	12
26	59218	Mol Cryst & Liq Cryst	1	9	10
27	52530	Mol Cryst & Liq Cryst Lett	0	9	9
28	72457	J Chem Phys	1	8	9
29	1981	J Magn Resonance	0	9	9
30	42899	Mol Cryst & Liq Cryst	0	7	7
31	34605	Phys Lett A	0	7	7
32	22831	Mol Cryst & Liq Cryst Lett	0	5	5
33	75816	Phys Lett A	0	5	5
34	6007	Electron & Commun Jpn	0	5	5
35	1973	J Colloid & Interface Sci	0	4	4
36	71843	Mol Cryst & Liq Cryst	0	3	3
37	59744	Mol Cryst & Liq Cryst	0	3	3
38	47234	Mol Cryst & Liq Cryst Lett	0	3	3
39	87611	Appl Phys Lett	0	3	3
40	26434	Mol Cryst & Liq Cryst	0	2	2
41	6635	J Sound & Vib	0	2	2
42	27184	J Electrochem Soc	0	1	1
43	9950	Pure & Appl Chem	0	1	1
44	2255	Mol Cryst & Liq Cryst	0	0	0
45	14274	Carbon	0	0	0
	Total		3	146	149

* Articles in Japanese language.

The 31 Japanese journal articles in *PA* 1978 (four of them in Japanese language) were cited 35 times in Japanese journals and 92 times in non-Japanese journals up to 1987. The 20 non-Japanese journal articles (all of them written in English) by authors from Japanese laboratories and covered in *PA* 1976 were cited 22 times in Japanese journals and 134 times in non-Japanese journals. Again, the 22 papers in non-Japanese journals written by authors from Japan and covered in *PA* 1978 were cited 146 times up to 1987 in non-Japanese journals and only three times in Japanese journals. Thus, irrespective of whether a paper is published in a Japanese journal or a non-Japanese journal, on an average, a paper from Japan is likely to be quoted more often in non-Japanese journals. Which is to say that science in Japan, particularly Japanese liquid crystals research, does not suffer from the 'island effect' of geographical insularity identified in certain areas of research in India by *Arunachalam* and *Markanday*.[2]

In Table 14, we present data on papers from the Soviet Union covered in *PA* 1976. There were 55 papers published in Soviet journals and four in non-Soviet journals. For 42 Soviet journal papers *PA* has given details of English translation also. The other 13 papers are also available in English and the translated versions of these articles might have won a few citations. But we have missed them as PA did not give bibliographic details. These 55 papers received 298 citations up to 1987 in Soviet journals and only 114 citations in non-Soviet journals, and 15 of them had won ten or more citations. Clearly, work published in Soviet journals, even when much of it is available in English translation, does not seem to get assimilated easily in the mainstream (English language) literature of science.

That papers published in Soviet journals are by and large quoted in Soviet journals is by now well known, although scantily documented. *Narin* et al.[16] were among the earliest to draw attention to this fact, and we have also noted this tendency, although from small populations of papers, in our analysis of the literatures of superconductivity[3] and holography.[6] *Braun* and coworkers have shown in many papers that both the observed and expected citation rates of Soviet research is very low.[17] However, the citation record of Soviet Union's liquid crystals work appears to be better than the citation record of her work in other areas. At least 15 Soviet papers in our sample (from *PA* 1976) had won ten or more citations up to 1987.

Table 14
Distribution of citations to papers published from the Soviet Union

Sl No.	Phys Abstr Number (1976)	Journal	Citations in Soviet journals	Non-Soviet journals	Total world
Russian					
1	79284	Kristallografiya	25	14	39
2	13384	Zh Eksp & Theor Fiz	20	15	35
3	13385	Zh Eksp & Theor Fiz	17	9	26
4	61299	Zh Eksp & Theor Fiz	24	1	25
5	57575	Kristallografiya	15	5	20
6	79283	Kristallografiya	11	6	17
7	79282	Kristallografiya	11	6	17
8	40860	Kristallografiya	14	2	16
9	83408	Zh Eksp & Theor Fiz	13	2	15
10	78831	Zh Struckt Khim	8	6	14
11	61300	Zh Eksp & Theor Fiz	12	2	14
12	62241	Fiz Tverdogo Tela	7	6	13
13	1552	Kristallografiya	5	7	12
14	720	Kvantovaya Elektron Moskva	9	2	11
15	2495*	Zh Eksp & Theor Fiz	10	0	10
16	1553*	Zh Eksp & Theor Fiz	8	1	9
17	94005*	Zh Eksp & Theor Fiz Piasma	7	2	9
18	65026	Fiz Tverdogo Tela	9	0	9
19	35357*	Zh Eksp & Theor Fiz	7	1	8
20	72150*	Zh Eksp & Theor Fiz Piasma	4	3	7
21	35355	Pisma v Zh Tekh Fiz	7	0	7
22	13386*	Zh Eksp & Theor Fiz	7	0	7
23	1554*	Zh Eksp & Theor Fiz	6	0	6
24	49000	Fiz Tverdogo Tela	4	2	6
25	10255	Kristallografiya	1	4	5
26	90763	Teor & Mat Fiz	1	3	4
27	5327	Opt & Spekrosk	3	1	4
28	10306	Fiz Tverdogo Tela	3	1	4
29	39950	Pisma v Zh Tekh Fiz	4	0	4
30	47456	Kvantovaya Elektron, Moskva	4	0	4
31	10336*	Zh Eskp & Teor Fiz Pisma	4	0	4
32	17633	Kvantovaya Elektron, Moskva	3	0	3
33	17628	Kolloidnyi Zh	2	1	3
34	30503	Akust Zh	1	2	3
35	77685	Akust Zh	2	1	3
36	68499	Zh Eksp & Teor Fiz	2	1	3
37	36281	Opt & Speaktrosk	1	1	2
38	14487	Fiz Tverdogo Tela	1	1	2
39	35922*	Pisma v Zh Tekh Fiz	2	0	2
40	5331	Fiz Tverdogo Tela	1	1	2
41	5330	Fiz Tverdogo Tela	1	1	2
Six + one*(seven papers having one citation each			3	4	7
Five other + two*(seven) papers having zero citation			0	0	0
	Total		298	114	412

Table 14 (cont.)

Sl No.	Phys Abstr Number (1976)	Journal	Citations in Soviet journals	Citations in Non-Soviet journals	Total world
English					
42	9094	Mol Cryst & Liq Cryst	2	3	5
43	39988	Phys Status Solidi A	1	1	2
44	68492	Mol Cryst & Liq Cryst	0	0	0
45	9091	Acta Crystallogr A	0	0	0
	Total		3	4	7

* Details of English translation were not given in *Phys Abstr.*

Conclusion

We have surveyed the world literature of liquid crystals as seen from *PA* 1976 and the journal literature of LC from two advanced island economies, viz. UK and Japan, and four middle-level countries, viz. Canada, India, Israel and Australia, as seen from *PA* 1978. Based on publication and citation counts, we have rated the performance of different countries. Wherever possible, we have compared our data on LC literature with the literatures of other high-tech areas of physics such as superconductivity and holography. We find that the difference in status between USA and the other leading countries is not as wide in LC as in some other areas, that Canada's papers in LC are well cited although the publication output itself is meagre, and that India and Soviet Union have better citation impact in this area than in many others. The United Kingdom is among the top performers of LC research. One thing that is difficult to explain is the poor citation impact of Japanese LC work. Japan published a lot and her technological superiority is undoubted. And yet her publications are not cited very often, and certainly not commensurate with her technological status.

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