MOSSBAUER EFFECT STUDIES—SOME DEDUCTIONS FROM A BIBLIOMETRIC ANALYSIS

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Bibliometric analysis of papers in 'Mossbauer Effect' as covered in the Physics Abstracts has been carried out over a period of more than two decades since its discovery. The analysis leads to the following significant deductions:— (i) The growth curve of applications in this field tends towards a saturation as the Silver Jubilee of the 'Mossbauer Effect' approaches. (ii) The growth curves papers published in the branches of physics, chemistry, metallurgy and instrumentation tend to saturation level. But activity in the new branches of biology and archeology is expected to pick up. (iii) USA followed by USSR tops the countries publishing in this field; India occupies the 7th rank. (iv) Major portions of the contributions from India is from the universities and the academic institutions. Research in this field was not initiated for nearly a decade after its discovery in the national laboratories of India and the contributions from the defence research establishments is almost nil. (v) English language is found to be the best lingua franca for quick and wide dissemination of scientific information.

INTRODUCTION

Active research workers spend considerable amount of their time in survey of literature in those branches of science of their interest. For efficient programming of any research project, continuous collection of new information and proper evaluation of such information are musts. Considerable saving of time and labour in such activities has not accrued to research workers because of new innovations and techniques developed by the 'information science'. Selective dissemination indexes (SDI) from computer stored information is a typical example of such services.

Information science has found applications in such fields as science policy planning, evaluation of scientific projects, survey and forecasting of growth of different branches of science, etc. Viewed from the angle of this new branch of science, any research activity can be defined as a search for new information in the light of available information.

Information science has a good impact on the modern industrial world because of its indispensability in the development of new technologies, updating of existing technologies or evolving appropriate technologies. It is said that the wide gap in the living standards of people in the developed and developing countries can be reduced considerably by the use of techniques of information science in the developing countries, since one of the bottle necks in the progress of the developing countries is lack of information about appropriate technologies.

Bibliometric analysis is one of the techniques followed in the information science to evaluate the growth of research in any field. Periodical assessment of growth rates in different fields of research will have value to research workers because they will indicate which branches of science are indicating tendencies of rapid growth in future. Just as the correct choice of a profession by a young man early in his career decides to a large extent his final material success in life, the correct choice of the field of research activity by a scientific team also is largely responsible for the prestige of the team in the scientific work. "The early bird catches the worm" is true in the scientific activity as in any other activity.
Hence Bibliometric analysis of the growth of research papers in different branches of physics will yield valuable clues to physicists for planning their research activities. Our group is engaged in such studies and an overall view of research in different branches of physics in India, as perceived from a literature analysis of the entries in the 'Physics Abstracts' over an year was presented in a paper entitled, "Physics Research in India - A Bird's Eye View" (1). The need for further studies in depth confining to select branches was stressed and the intention of our group to carry out such studies was indicated in this paper. This paper was followed by another on the media choice for publication by Indian Physicists (2). Analysis of some select branches of physics like the solid state physics, nuclear physics, resonance phenomena, crystallography, spectroscopy, etc. are in progress and the findings of such analysis will follow in due course.

Meanwhile, it was noticed that the 'Mössbauer Effect' has been an active field of research all over the world over several years. Hence it was felt that it would be very useful to make an analysis of its rate of growth in different branches and in different countries and with special references to India. Since the Silver Jubilee of its discovery is to be celebrated in 1983, it would be interesting to make an attempt to forecast the nature of growth of this field of physics. With this as one of the aims in view, a project was undertaken to compile and analyse information about the papers published in Mössbauer Effect. The data required for the analysis reported here are taken from this project report. The project report has been submitted by the second author for the Associateship in Information Science, Insdoc, New Delhi (3).

2. GROWTH OF PAPERS IN MOSSBAUER EFFECT STUDIES

Even though the discovery of Mössbauer Effect was first reported in 1958, significant number of papers got published in this field from 1960. The cumulative frequency distribution over the years of the published papers is shown in Fig.1. It appears from Curve 1 in Fig.1 that the growth curve is having a steep positive gradient in the 19th year. To confirm whether the growth curve really indicates a rapid growth in the future also, it is necessary to make a close analysis of the rate of change of growth with the years. In scientific field, sudden spurts in publication of papers followed by lull periods is common, because the organizations of seminars and symposia act as catalysts for preparation of papers. Hence to average out these spurts, it is necessary to compute the number of papers published in successive periods of fixed duration and also to compare the increase over successive periods of same duration. Such an analysis is reported in Table 1 for periods of 3 and 6 years. It is seen that erratic fluctuations exist in the number of papers published when the duration of analysis is 3 years. For example, while the entries in col.7 show a smooth change, those in col.6 do not indicate a smooth change. This is more evident from a comparison of data Col.8 and 9 where increases in successive periods of 3 and 6 years are reported. From the entries of Col. 8 corresponding to the years 1976 and 1977, one may infer that the number of papers per year have decreased. This wrong deduction is rectified from the corresponding entries in Col.9, which show that there is no fall in the number of papers per year. But there has been a fall in the increase observed in successive years. The increase in successive periods of 6 years duration is found to decrease from 1712 in 1975 to 1403 in 1976, to finally reach 969 in 1977. These data also indicate the necessity in such statistical studies to make analysis based on data over long periods for useful inferences to be made.

3. GROWTH OF PAPERS IN DIFFERENT BRANCHES

Mössbauer Effect has found application in several fields of science and we classified the papers published for nearly a decade (1968-1976) from a perusal of the key-words in the titles under five categories, viz. physics, chemistry, metallurgy, instrumentation and biology. The yearly variation of the number of papers in each branch is shown in Fig.2. It is seen that the branches, physics and chemistry which have been showing a steady and steep growth upto 1974, show declining activity after 1974. Since Mössbauer Effect Studies prior to 1968 were predominantly confined to the physics and chemistry branches, our above deduction is justified even though in Fig.1, data prior to 1968 are not portrayed. Another significant observation is that the growth curve of the physics and chemistry branches are closely parallel. This shows that there may exist a correlation between the studies in the two branches. Perhaps, the results of studies in one branch induces further studies in the other branch. Studies in the branch metallurgy have reached a peak during 1973-74 after which a fall in the number of papers published is evident. Perhaps, this indicates that there is not much scope for further research in this field. Even though the number of papers published in each year in the branch instrumentation has not been considerable, the output has been steady. It can be surmised that further activity
## Table 1. Analysis of Growth of Papers published in Mossbauer Effect Studies

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<tr>
<th>Year</th>
<th>No. of papers published with country of origin</th>
<th>Total</th>
<th>Cumulative Total</th>
<th>No. of papers published in preceding 3 years</th>
<th>No. of papers published in preceding 6 years</th>
<th>Increase in successive periods of 3 years</th>
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**Fig. Cumulative Frequency Distribution.**

**RANGRAJAN & BHATNAGAR**
Table: 2. Share of Different Countries to the Contribution to Mossbauer Spectroscopy

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Yearwise contribution of only the first 14 countries arranged according to the number of publications contributed are reported in the above Table. The total contributions from the other countries, who have contributed at least a total of ten papers in 1968-1977 are as follows:

- Rumania 50; Belgium 46; Denmark 42; Brazil 32;
- Sweden 29; Switzerland 29; Czechoslovakia 20; Greece 18;
- Finland 17; Yugoslavia 16; Bulgaria 15; Korea 13;
- Austria 12; Newzealand 10.
in this branch will continue to be steady. The curve corresponding to biology branch shows that the activity is nearly steady even though the number of papers published during the whole period of analysis (1968-76) is small. The yearly analysis of data regarding papers originating from different countries in the different branches reveal that studies in this branch have been initiated only recently in USA and USSR, the two countries leading in scientific research. Hence it is justified in predicting that there will be good activity in this branch in the near future. Mossbauer Effect has recently found application in archeology and it can be surmised that more papers may be published in this new branch.

4. COUNTRIES CONTRIBUTING TO MOSSBAUER EFFECT STUDIES

The share of different countries on the total number of papers in different years is shown in Table 2. It is seen that USA followed by USSR not only occupy the top positions, the total contributions from the two countries account for 40% of the total. Not only Germany (FDR and GDR combined) has the third rank in the number of papers published, the output from Germany is double that from UK which occupies the next rank. Number of countries around Germany have contributed more papers in this field than in other fields of physics. This observation clearly reveals that the 'effect of proximity' does play a considerable role in inducing people to take interest in developments in their neighbourhood even in scientific research. Brazil and Korea have contributed 32 and 13 papers, numbers considerably more than the number of contributions to other fields of physics from these countries. The obvious reason is that schools of research might have been set up by some visiting scientists from a developed country. It is no surprise that contributions from a large number of developing countries and countries from the oil-rich Middle East are insignificant and that developed countries of the West account for major portion of the output, since such is the trend observed in all other scientific and technical fields. Hence it is clear that schools of studies in Mossbauer Effect are confined to a few developed countries. India is a unique example, though a developing country, yet having active schools of research in this field.

5. ANALYSIS OF CONTRIBUTIONS FROM INDIA

It is gratifying to note that despite the low per capita income and difficulties in getting facilities in research and limited job opportunities, Indian scientists could keep up their tempo of research even in a recent field as 'Mossbauer Effect'. While answering why India has taken efforts to launch an artificial satellite despite conditions of poverty in the country, our Prime Minister, Smt. Indira Gandhi, pointed out that this would show the world that India, even though may be poor in material wealth, is rich enough in intellectual calibre, inventive genius and ability to chalk out and work gigantic plans. The fact that India ranks seventh in the order of nations contributing to the 'Mossbauer Effect' studies justifies the faith our Prime Minister has in Indian scientists.

With a view to knowing the locations of the research schools, the institutionalwise breakup of published papers is shown in Table 3. Of the 216 papers, published in the decade, 93 are from universities. If the contributions from the IITs, BARC and TIFR are added to this, it is evident that 85% of the total contributions are from this group. Analysis made by Miss Poonam Bhatnagar has shown that research activity is confined to a few centres. The analysis of Rangarajan et al also revealed that active research in physics is confined to a few centres. The yearwise analysis of outputs has indicated that while there is a regular flow of papers from the BARC, TIFR and IIT Kanpur, the output from the universities is erratic. Output of papers from the National Laboratories have started only after 1968, indicating research in this field at these laboratories was not initiated for nearly a decade after the discovery. Even though Mossbauer Effect studies have great relevance to material science, it is surprising that no research paper from the Defence Research Establishments has been included in the Physics Abstracts.

6. ENGLISH LANGUAGE - THE EFFECTIVE VEHICLE FOR SCIENCE COMMUNICATION

The discovery of Mossbauer Effect was first reported in a German journal in 1958. World wide interest in this study was initiated only after 1960 following the publication confirming the results in US Journal. A comparison of the rates of growth of papers in the two fields of research where considerable activity is observed over several years, viz. the 'Raman Effect' and the 'Mossbauer Effect' is made in Table 4.

It is seen that active research work has been taken up at several centres within a short period after the discovery of Raman Effect, as is evident from the fact that the number of papers published in the first years are 58, 233, 416, 603 and 778. In case of Mossbauer Effect the corresponding numbers are a few, 38, 74, 141 and 204. However, after the 12th year, the cumulative number of papers published...
### Table: 3. Institutional Distribution of Papers from India

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### Table: 4. Comparison of Growth of Raman Spectroscopy and Mossbauer Spectroscopy during First Two Decades

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in Mossbauer Effect exceeds that for Raman Effect. The initial lag in the follow-up studies is obviously due to the lack of wide and quick dissemination of information about this discovery in the Scientific Community. This obviously is due to the discovery being reported in a journal not published in English. This significance to developing countries, viz. that English language is the best vehicle for quick and wide dissemination of scientific information.

REFERENCES
