Authorship patterns in physics literature: An informetric study on citations in doctoral theses of the Indian Institute of Science

K.G. Sudhier Pillai
Librarian, Department of Communication & Journalism, University of Kerala, Kariavattom Campus, Thiruvananthapuram – 695 581, Kerala, E-mail: kgsudhier@gmail.com

Presents a case study of the trends in authorship pattern and collaborative research in physics with a sample of 11,412 journals and 1,328 book citations appended in the physics doctoral dissertations awarded by the Indian Institute of Science, Bangalore during 1999-2003. The study found that team research is preferred in the field of physics rather than solo research. The average number of authors per journal articles was 3 and for books it was 1.69. The degree of collaboration in different years was calculated and the average value of it for journals was 0.08 and 0.44 for books. The authorship collaboration is more in journal articles than in books. The study concluded that authorship pattern, the degree of collaboration and the average number of authors were different in journals and in books.

Introduction
Authorship trend and collaborative research are important facets of informetrics / bibliometrics studies. The authorship pattern, one of the prime aspects of citation analysis mainly deals with the kind of authors, nature and degree of collaboration among them and collaborative trend of authors.

Multiple authorship has been a characteristic feature of the modern science and there has been a consistent trend towards increased collaboration in all the branches of sciences. Collaboration and team work are among the most important necessities of scientific and technological work today. In recent period, there is a trend towards collaboration in research in almost all pure and applied sciences and it is different from one subject to another.

Twentieth century has seen collaborative research trend among scientists working in groups within and across the geographic boundaries of a country, which enhanced the ability of scientists to put in their intellect in their respective domains of specialization. Collaboration is inevitable in natural sciences and multidisciplinary areas to make significant advances and breakthroughs, as stated by Macrina1.

It has been found that a large number of collaborative studies have been reported in the field of science and technology than in social science and humanities. It is generally seen that patterns and magnitude of collaboration differ with discipline and period covered in the study. Studies have also shown that there is considerable change in the authorship pattern of books and journal articles.

Collaboration in research is said to have taken place when two or more scientists work together on a scientific problem or project and contribute their, physical and mental efforts. Price was among the first to observe that multi-authored papers are steadily increasing with simultaneous reduction in single authored papers2. His observations were based on sampling of Chemical Abstracts for the period of 1910-1960.

Harsanyi3, Joshi and Maheswarappa4 have made thorough review of the literature on multi-authorship studies and Udofia5 has made a review of authorship pattern on African trypanosomiasis research literature.

A large number of studies have been conducted to analyse and interpret the trends in collaborative authorship in different disciplines. Kumbar, Harinarayana and Tejaswini6, Krishna and Kumar7 and Farhat8 have studied the authorship trend in the field of agriculture science. Bandyopadhyay9 has studied the authorship collaboration in physics, philosophy and political science. The author also analysed the authorship pattern of
different disciplines such as mathematics, physics, mechanical engineering, philosophy and political science. Vimala and Reddy investigated the authorship trend in zoology. Collaborative research in psychology in India was studied by Sangam. Vijay studied the Indian food science and technology literature and Rana and Agarwal analysed the Indian wildlife and fisheries literature. Visakhi and Srivastava studied the collaborative authorship of statistical science. Other similar studies include Tiew, Ivanisevic and Sapunar, Kannappanavar and Vijayakumar and Raina, Gupta and Khandari.

The purpose of the present study is to determine the collaborative research trends in physics literature cited by the physicists of Indian Institute of Science (IISc), Bangalore in their doctoral theses.

Objectives
The objectives of the present study are to find out the trend of research collaboration in the field of physics. These include:

- to examine the nature of authorship pattern in the physics journals and books
- to study the single vs multi-authored papers and average number of authors; and
- to determine the degree of collaboration of physics literature

Methodology
The study has been carried out by collecting 11,412 journal citations and 1,328 book citations from 71 doctoral theses in physics awarded from Indian Institute of Science, Bangalore during 1999-2003. With a view to identify the extent of research conducted by individuals in collaboration with each other, the number of authors mentioned in the journals and books were recorded, analysed and tabulated for making observations.

Subramanyam proposed a mathematical formula for calculating author’s degree of collaboration in a discipline. The degree of collaboration among authors is the ratio of the number of multi-authored papers published to the total number of papers published in a discipline during certain period of time. The degree of collaboration (collaboration coefficient) among authors is measured mathematically as:

\[
c = \frac{N_m}{N_m + N_s}
\]

Where, \(c\) = degree of collaboration

\(N_m\) = number of multi authored papers

\(N_s\) = number of single authored papers

Analysis and results

Authorship pattern of journal articles

Table 1 highlights the analysis of the authorship pattern of journal articles as observed in this study.

The analysis reveals that, 20.40% of the articles are contributed by single authors and two author contributions account for 27.62%. The study shows that more and more articles are being contributed under joint authorship. Alternatively, it can be said that there is an increasing trend towards multiple authorship. It can be inferred from the analysis that physicists are in favour of team research.

Though team research is preferred by researchers in physics, it can be seen that maximum number of papers are two authored and there is a decreasing trend in the number of authors in team research as depicted in Fig. 1.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>No. of Authors</th>
<th>No. of Articles</th>
<th>%</th>
<th>Cum %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2328</td>
<td>20.40</td>
<td>20.40</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>3152</td>
<td>27.62</td>
<td>48.02</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>2360</td>
<td>20.68</td>
<td>68.70</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>1575</td>
<td>13.80</td>
<td>82.50</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>890</td>
<td>7.80</td>
<td>90.30</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>459</td>
<td>4.02</td>
<td>94.32</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>269</td>
<td>2.36</td>
<td>96.68</td>
</tr>
<tr>
<td>8</td>
<td>8+</td>
<td>379</td>
<td>3.32</td>
<td>100.00</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>11,412</td>
<td></td>
<td>100.00</td>
</tr>
</tbody>
</table>
Table 2—Degree of collaboration as seen in journal articles

<table>
<thead>
<tr>
<th>Year</th>
<th>Single authors</th>
<th>%</th>
<th>Multi authors</th>
<th>%</th>
<th>Total no. of articles</th>
<th>Degree of collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>855</td>
<td>21.86</td>
<td>3057</td>
<td>78.14</td>
<td>3912</td>
<td>0.78</td>
</tr>
<tr>
<td>2000</td>
<td>296</td>
<td>19.73</td>
<td>1204</td>
<td>80.27</td>
<td>1500</td>
<td>0.80</td>
</tr>
<tr>
<td>2001</td>
<td>532</td>
<td>18.06</td>
<td>2413</td>
<td>81.94</td>
<td>2945</td>
<td>0.82</td>
</tr>
<tr>
<td>2002</td>
<td>325</td>
<td>20.77</td>
<td>1240</td>
<td>79.23</td>
<td>1565</td>
<td>0.79</td>
</tr>
<tr>
<td>2003</td>
<td>320</td>
<td>21.48</td>
<td>1170</td>
<td>78.52</td>
<td>1490</td>
<td>0.79</td>
</tr>
<tr>
<td>Total</td>
<td>2328</td>
<td>20.40</td>
<td>9084</td>
<td>79.60</td>
<td>11412</td>
<td>0.80 (Mean)</td>
</tr>
</tbody>
</table>

The degree of author collaboration

The degree of collaboration in different years is calculated as per the equation proposed by Subramanyam and is presented in the Table 2. The degree of collaboration over the years from 1999 to 2003 is calculated and it varies from 0.78 to 0.82. The mean value is found to be 0.80.

The single vs multi-authored papers are also seen in the Table 2 with their percentage of contributions. During the period of study the share of multi-authored papers are around 80%. This shows that the collaborative research is more predominant in the field of physics. The average number of authors per journal citations is found to be 3.

Table 3—Authorship pattern in books

<table>
<thead>
<tr>
<th>Sl. no.</th>
<th>No. of authors</th>
<th>No. of books</th>
<th>%</th>
<th>Cum %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>749</td>
<td>56.40</td>
<td>56.40</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>393</td>
<td>29.59</td>
<td>85.99</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>104</td>
<td>7.83</td>
<td>93.82</td>
</tr>
<tr>
<td>4</td>
<td>4+</td>
<td>82</td>
<td>6.18</td>
<td>100.00</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1328</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>

Authorship study reveals that single authorship pattern secures the highest position, followed by the double authors and triple authors respectively. The single authorship books which secure the highest position account for 749 (56.40%) citations and two-authorship contributions take the credit of having 393 (29.59%) citations. Here the remaining 14% of the book citations are by more than two authors. Three-author books account for 7.83% (104) and more than three author books are 6.18% (82). It has to be observed that single-author books are frequently cited in the IISc theses and it amounts to more than 56% of the total books.
It can be seen that in the case of authorship of journal articles, the result is different. The result of the authorship study shows there is an increasing trend towards multiple authorship of journal articles. But in the case of books, more books are being contributed by single authors. The authorship trend graph (Figure- 3) shows that there is a trend towards the single authorship in physics books.

### Degree of collaboration of books

The collaborative trend among the authors of books cited by the researchers of IISc are given in the Table 4. In the year 2002 the degree of collaboration is found to be 0.26 and in other years it is almost the same as the mean value is 0.44.

The average number of authors of books is found to be 1.69 during the period of study.

The analysis shows that 749 (56.40%) books are contributed by single authors and 579 (43.60%) by multiple authors. It is seen that single vs multi-authored author trend is almost same in all the years. The single-authored books are maximum (73.95%) in the year 2002.

Figure 4 is the diagrammatic representation of the single vs multiple authors of books in different years. In all the years the single-authored books are higher than the multi-authored ones.

It is seen from the study that the degree of collaboration in journal articles is 0.80, while it is 0.44 in the case of books. So it can be inferred that collaboration is more in journal articles than in books.

### Conclusion

The authorship trend and the degree of collaboration of journal articles and books cited by the physicists of IISc in their doctoral theses are studied. The degree of collaboration of journal articles is found to be 0.80 and for books it is 0.44. The single author contribution of journal articles are 20.40%, while multi-authored papers contribute 79.60% of the total citations. In the case of
books, the single author contributions are 56.40% and multi-author contributors 43.60%. The study revealed that team research is predominant in journal articles while solo research is the trend in the case of books. The average number of authors per journal article is 3 and per book is 1.69.

According to Arora and Pawan21 ‘increase in multiple authorship and collaboration between researchers is an indication of growing professionalism in different fields’. The collaboration and team work are among the most important necessities of scientific and technological work today.

Multi-authored articles have usually higher citation frequencies than single authored ones, but this relation does not hold good in all cases. According to Rousseau it seems favourable (in the sense of receiving more citations) for a small university in a small country, to collaborate with scientists from abroad.

Further studies are required to establish inter-disciplinary and inter- institutional collaboration of physicists. Studies can also be done in the area of co-authorship and bibliographic coupling of Physics literature in the national and international level.

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References