

ABSTRACT: The Inter-University Centre for Astronomy and Astrophysics (IUCAA) is an autonomous institution set up by the University Grants Commission (UGC) of India to promote the nucleation and growth of active groups in astronomy and astrophysics at Indian universities. It was established in 1988 at Pune, India. IUCAA aims to be a centre of excellence within the university sector for teaching, research and development in astronomy and astrophysics. To highlight IUCAA Associates program and associates output during their tenure as an associate, we decided to study its academic scientific output of IUCAA Associates during 2003-2013. This paper is an Informetric analysis of 1009 papers published by IUCAA associates from 2003 to 2013, downloaded from the institute's website, annual reports and ADS. There is no doubt that collaboration is a common phenomenon in research. This paper examined the collaborative strength and patterns of authorship among IUCAA associates, covering a period of 10 years. The results of the data were analyzed based on the number of articles published per year, pattern of authorship and the collaborative degree and strength of authors. The study shows that majority of the associates preferred to publish research papers in joint authorship. Out of 1009 articles, 950 (93.32%) are joint works while only 68 (6.68%) are single authored works. The degree of author's collaboration was also calculated to be 0.93, while the mean numbers of single authored and joint authored article are 6.68 and 93.32 respectively. Further, the study investigated highly prolific authors and highly preferred journals by the IUCAA associates during the study period.

BACKGROUND: The Inter-University Centre for Astronomy and Astrophysics (IUCAA) is an autonomous institution set up by the University Grants Commission (UGC) of India to promote the nucleation and growth of active groups in astronomy and astrophysics at Indian universities. It was established in 1988 at Pune, India. IUCAA aims to be a centre of excellence within the university sector for teaching, research and development in astronomy and astrophysics.

One important component of IUCAA's academic activities is the Associateships Programme, under which a faculty member of an Indian university or a post-graduate department in a college can visit IUCAA for periods of short and long durations over a span of three years to develop his or her interest and expertise in Astronomy and Astrophysics (AGA). The Associateships Programme has been designed to promote mobility and, to this end, the travel and local living expenses of an associate for these visits will be borne by IUCAA as per its rules. The associate will continue to carry out the existing commitments at his or her parent organization. However, since IUCAA has been created by the UGC as a field station for these activities, it is expected that those visiting IUCAA under this programme will be treated as on duty by their respective organizations. Applications are invited for associateships for tenure of three years starting from August 1, every year¹.

Scientific productivity in the form of intellectual contributions and communicated in written form is commonly considered to be fundamental importance to scientific career advancement. Research productivity in higher education is gaining importance for the past two decades in India. In the last two decades, there has been an unprecedented growth of scientific studies in different fields mainly because the government and private organizations that invest large amount of money for research and development activities need accountability (Varghese & Rajan, 2009). IUCAA associates published their research papers in national/international journals during the tenure of associateships programme. In this study, we have selected only those papers which were published by IUCAA associates not regular faculty, postdoc and research scholars of IUCAA. This study assess research publication trend among IUCAA Associates during 2003-2013 and their analysis of authorship pattern and degree of collaboration.

OBJECTIVE OF THE STUDY: The present study aimed to analyze the publication trends of IUCAA Associates with the following objectives:

- To examine the growth of scientific productivity in term of research papers during 2003-2013 by the IUCAA Associates during his/her tenure,
- To examine and analyse the authorship pattern in scientific research in IUCAA.
- To study the proportion of single authored papers as against multi authored papers,
- To determine the degree of collaboration among IUCAA Associates in scientific research,
- To identify the prolific authors having large number of publications.
- To identify the types of communication channels preferred
- Shift in the quality of research among IUCAA Associates measured in terms of impact factor per paper, citations received per paper as per ADS.

MATERIALS AND METHODS: The study is based on raw bibliographical and publication data for the period 2003-2013. All the bibliographical details of publications of IUCAA Associates retrieved from Annual Reports and ADS database and scanned. Then the data elements were transferred to spread sheet application. After validation, the data was analyzed as per the objectives of the study. The degree of collaboration is calculated using the formula given by K. Subramanyam.

SCOPE AND LIMITATION: The scope of present study is limited to the study of scientometric analysis of IUCAA associates research publications during the period of 2003-2013. Research papers published in national / international journals during 2003-2013. Regular faculties, postdocs and research scholars have not been covered in this study.

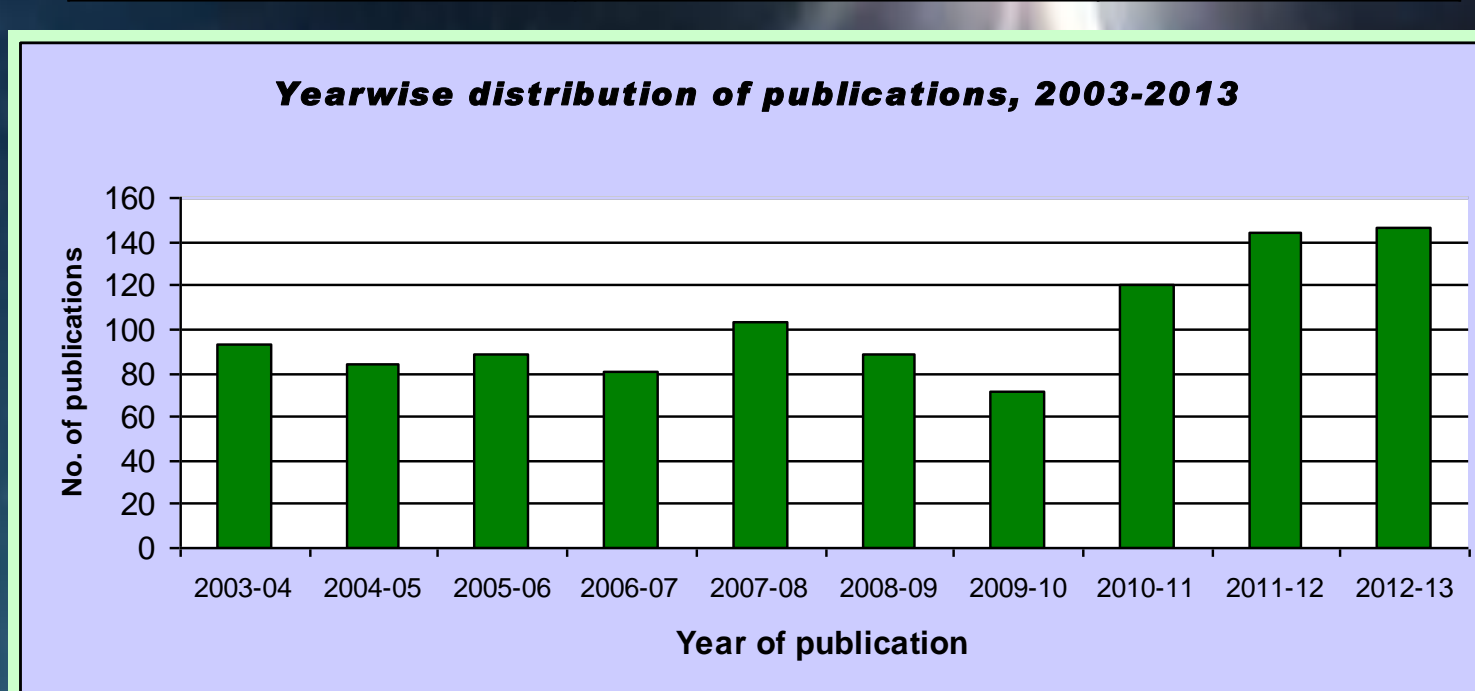
REVIEW OF LITERATURE: A number of quantitative studies based on Scientometric techniques have been reported to evaluate the research productivity of individuals, institutes, countries etc. There are many studies that have been done in the past on authorship pattern and collaboration. According to Mail et al. (2010)⁴, there has been tremendous growth in the number and overall percentage of co-authored publications in the entire field of science. The first co-authored scientific paper was published in 1665 by Lukkonen et al. Price and Beaver found that the most productive members were also most collaborative in the literature of oxidative phosphorylation and terminal electron transport. Sharma⁹ has conducted a study on 2603 research articles published by Central Potato Research Institute (CPRI) during 1991-2007, who collected the data from annual reports of CPRI and the journal of Indian Potato Association. The study found that most of the scientists preferred to publish research papers in joint authorship (82.67%) having 0.82 degree of collaboration and also shows no uniform pattern of literature growth. Jayashankar, Ramesh Babu and Rajendran has conducted a study on 1282 research articles published by the scientists of CSIR-Central Electro Chemical Research Institute during the period 2000-2009. It was found that 2009 was the most productive year with 194 articles. This study also shows that collaborative research was dominant with the highest degree of collaboration being 0.98. Further, the study investigated authorship pattern, highly prolific authors and highly preferred journals by the scientists of CSIR-CECRI. As can be seen from the foregoing, not many studies have been conducted on UGC research centre and Universities especially on astronomy and astrophysics.

ANALYSIS AND DISCUSSIONS:

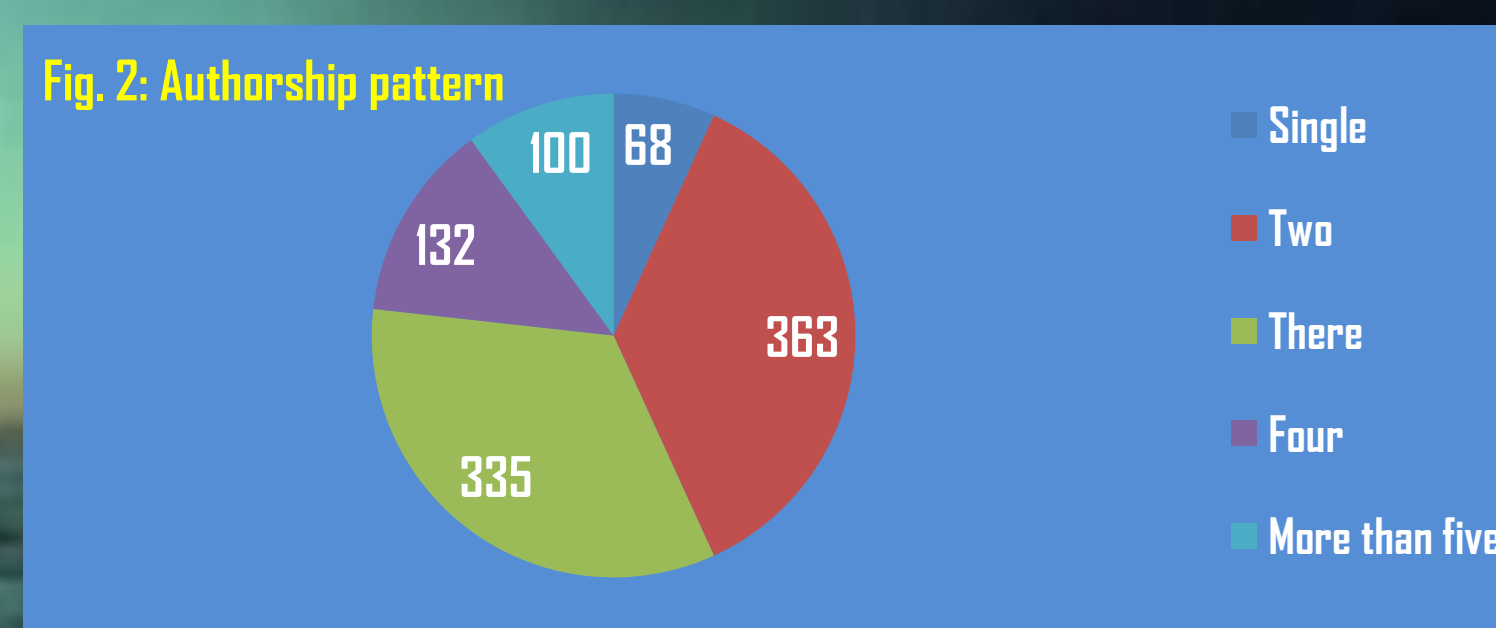
Year-wise growth of publication: Table 1 presents the growth of IUCAA associates research publication during 2003 to 2013. The year 2011-12 (14.27%) was more productive in relation to the number of publications. The less productive year was 2009-10. Although no definite pattern of literature growth can be ascertained from table 1, but it appear that contemporary factors like number of associates visited to IUCAA. It is also shows that average number of publication per year was 101.

Table 1: Year wise distribution of article publication from 2003-13

S.No.	Publication year	Total article published	Percentage(%) of 1009
1	2003-04	93	9.22
2	2004-05	84	8.33
3	2005-06	88	8.72
4	2006-07	81	8.03
5	2007-08	103	10.21
6	2008-09	88	8.72
7	2009-10	71	7.04
8	2010-11	120	11.89
9	2011-12	144	14.27
10	2012-13	137	13.58
Total		1009	100



Authorship Pattern: Table 2 and figure 2 & 3 shows authorship pattern reveals that majority of IUCAA associates preferred to published the research results in joint authorship (93.3%) than individually (Single authorship 6.68%). However, the degree of joint author gradually decreased with increase in number of authors (two 53.66%; three 32.91%; four 13.75% and more than five 1%). This shows that associates have a tendency to publish their research work with two or three authorship. This may be due to close cooperation among the academicians and scientists and also for the sake of getting maximum career benefit from their publications.



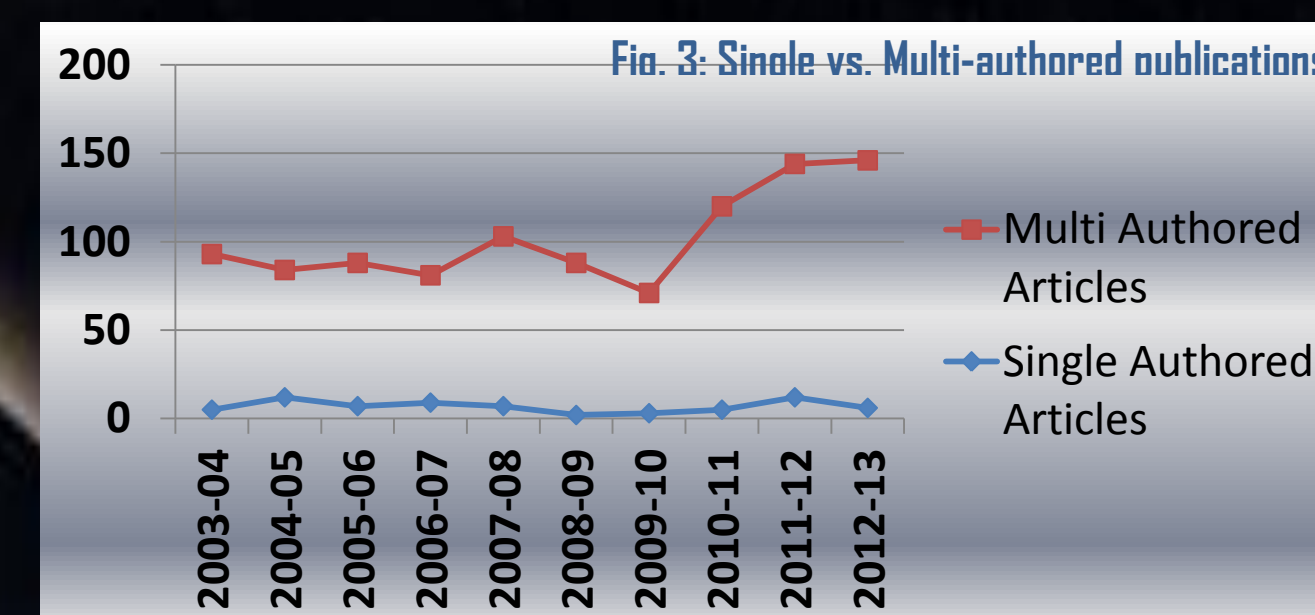
Degree of Author's Collaboration: Various methods have been proposed to calculate the degree of research collaboration. Here, in this study the formula proposed by K. Subramanyam (1983) has been used.

The degree of collaboration with using formula is 0.93. Thus, in the study of the degree of collaboration (C) during the overall 10 years (2003-2013 is 0.93. Table 3 presents the year-wise productivity of both single authored and multi-authored papers during the study period. It indicate that the multi-authored papers were on increase from 85.72% in 2004-05 to 97.73% in 208-09, As a result, single authored papers decreased in the same period from 12% to 2%. The table 3 also represents the Yearwise number of multi-authored articles and their degree of collaboration. This implies that collaboration is on a high side in the IUCAA Associates publication during in the under study.

TABLE 3 YEAR-WISE DISTRIBUTION OF AUTHORSHIP PATTERN AND DEGREE OF COLLABORATION

Year	Total No. of Articles	No. of Single Authored Articles	% of Articles	No. of Multi Authored Articles	% of Articles	Degree of Collaboration
2003-04	93	5	5.38	88	94.62	0.95
2004-05	84	12	14.28	72	85.72	0.86
2005-06	88	7	7.95	81	92.05	0.92
2006-07	81	9	11.11	72	88.89	0.89
2007-08	103	7	6.80	96	93.20	0.93
2008-09	88	2	2.27	86	97.73	0.98
2009-10	71	3	4.22	68	95.78	0.96
2010-11	120	5	4.17	115	95.83	0.96
2011-12	144	12	8.33	132	91.64	0.92
2012-13	137	6	4.10	140	95.89	1.02
Total	1009	68		950		0.94

The analysis of table 3 shows that in the 10 years of period, the multi-authorship articles are higher and predominant on single authorship. The multi-authored articles 140 were highest in the year 2010. It is seen that the multi-authorship trend and collaborative study is increasing gradually in IUCAA research.



Highly Prolific Ten IUCAA Associates: During the year 2003-2013, 396 IUCAA associates have been contributed papers in AA. The average number of papers per author was 2.55. Among the prominent associates contributing to AA as a IUCAA Associates, 10 Authors were identified as most productive and they have published more than 20 papers during 2003-2013. Of these 10 most productive authors, two were affiliated to Jadavpur University, Kolkata and North Bengal University, Siliguri and one each to Bengal Engg. & Science, Hindu Post-Graduate College, Government College of Engineering and Ceramic Tech. University, Cochin University of Science and Technology Kochi, Lovely Professional University, Jalandhar and Jamia Millia Islamia New Delhi

Name	Affiliation	TP	TC	ACPP
Debnath, U	Department of Mathematics, Bengal Engg. and Science University	109	694	3.67
Chakraborty, Subenoy	Department of Mathematics, Jadavpur University	85	463	5.45
Pradhan, A.	Hindu Post-Graduate College	80	756	9.45
Rahman, F.	Department of Mathematics, Jadavpur University	66	266	4.03
Ray, Saibal	Government College of Engineering and Ceramic Tech. Kolkata	51	332	6.50
Kuriakose, V.C.	Cochin University of Science and Technology Kochi	43	94	2.18
Paul, B. C.	Department of Physics, North Bengal University, Darjeeling District Siliguri	28	178	6.35
Chandra, Suresh	Lovely Professional University, Jalandhar	25	22	1.13
Ghosh, S. G.	Centre for Theoretical Physics, Jamia Millia Islamia, New Delhi	23	95	4.13
Nandi, K. K.	North Bengal University, Darjeeling District Siliguri	20	160	8

TP- Total papers TC- Total Citations ACPP- Average Citation per paper

These 10 authors together have contributed 530 papers, with an average contribution of 53 papers per author and accounting for a 52.53% share in the cumulative publication output during 2003-2013. The most prolific authors were Debnath, U, who tops the list with 109 papers out of 1009 during 2003-2013, followed by Chakraborty Subenoy, with 85 papers out of 1009 during 2003-2013. The details list of 10 highly productive authors is given in table 4. These authors have together received an average of 6.07 citations per paper for the total papers. Three authors out of ten have scored higher citations per paper than the average citations per author. These were A Pradhan with 9.45 citations per paper, followed by Saibal Ray (6.50 citations per paper) and B.C.Paul (6.35 citations per paper).

Research Communication in Ten High Productive Journals: The top ten of productive Indian and foreign journals together contributed the 520 research papers on astronomy and astrophysics, which accounts for 51.54% share in the cumulative publications output during 2003-2013. Of these 10 journals, only one journal was an Indian journal, contributing a 3.07% share and nine were international journals, contributing a 47.75% share in the total publications output during 2003-2013. This trend of Indian authors publishing their papers in non-Indian journals particularly in astronomy/ astrophysics field is once again confirmed as reported by earlier study by Verma RK, 2009 in an analysis of publications trend as reflected in Indian Science Abstracts. The top two journals in terms of publications are Astrophysics and Space Science (88 papers and having 2.046 impact factor) and International Journal of Theoretical Physics (76 papers and having 1.086 impact factor). The details are presented in table 5.

Rank No.	Name of Journal	Publication Country	Total papers (share %)	Impact factor (2012)
1	Astrophysics and Space Science	USA	88(8.72)	2.064
2	IJTP	USA	76(7.53)	1.086
3	Physical Review D	USA	68(6.74)	4.691
4	IJMPD	USA	67(6.64)	1.03
5	MNRAS	USA	59(5.85)	4.9
6	General Relativity and Gravitation	USA	40(3.96)	1.902
7	Modern Physics Letter A	Singapore	38(3.76)	1.075
8	Pramana	India	31(3.07)	0.562
9	Astronomy and Astrophysics	France	27(2.67)	04.179
10	Physics Letter B	Netherlands	26(2.57)	05.083

CONCLUSION: This paper can be concluded by saying that IUCAA associates do publish research papers in joint authorship to a certain extent (with two or three authors). There is team spirit and collaborative approach in research as majority of research publications have been brought out in joint authorship and where degree of collaboration is also quite high among the associates working therein. This is a healthy sign for research among IUCAA Associates.