

## THE ROLE OF SCIENTIFIC JOURNALS IN DEVELOPING COUNTRIES THE CASE OF PHYSICS IN LATIN AMERICA

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### ABSTRACT

Firstly several reviews published in Latin America countries, especially Argentina, are studied measuring the flow of publications in Physics within the historical context. The impact of publications in Physics in Latin America on the total world mainstream body of publications is discussed on the basis of recent research. Stress is laid on the strategical necessity of reviews to provide the means of publishing the outstanding contributions in the field without these suffering any form of discrimination. Various possibilities are discussed, some of which have already put into practice, especially the dilemma between short and full-length articles. The relevant indicators for the subsequent measuring and evaluation of scientific knowledge in the area are examined together with the possible political and social consequences that enhanced visibility of research in the region would bring about. In this connection the role of supernational organisations in the editing of these reviews is discussed.

### RESUME

*Plusieurs revues publiées dans des pays latino-américains sont étudiées en vue de mesurer rétrospectivement le flux des publications en physique. L'impact de ces revues latino-américaines dans le domaine de la physique sur la science mondiale est discuté à partir de travaux récents. On insiste sur la nécessité stratégique pour les revues de publier des travaux de bonne qualité. Plusieurs possibilités pour cela sont discutées, dont certaines ont déjà été mises en pratique, notamment en ce qui concerne le choix entre articles courts et longs. Les indicateurs de mesure et d'évaluation dans ce domaine sont évoqués ainsi que les conséquences que pourrait entraîner une plus grande visibilité. Dans ce contexte on évoque le rôle d'organisations supranationales dans la publication de ces revues.*

### INTRODUCTION

In this note we shall discuss the feasibility of editing a Latin American Physics journal, on a par with other international publications in the field, whose purpose

would be to reflect scientific production in the region. To this effect we shall analyze data related to the history of publications in Physics in Latin America. In the first part of our study the scope of the editorial activities examined will be limited exclusively to Argentina, whilst in the second we propose to treat the data on scientific production in the whole of Latin America for the period 1981 - 1985.

## HISTORICAL RETROSPECT

Under the name "Contribución al estudio de las ciencias físicas y matemáticas", a top quality scientific journal was published in Argentina between 1914 y 1931. The publication was divided into two series, "Mathematical & Physical" and "Technical", the first being devoted to works of pure science and the second to works which had an application in engineering. Only those scientists who were members of staff of the Faculty of Physico-Mathematical Sciences of the University of La Plata and those visitors who had carried out their research using the infrastructure of the said Faculty were able to publish in the journal.

During this period a total of five volumes, each some 500 pages in length were published in the "Mathematical & Physical" series. The journal was a faithful mirror of the research activities in the La Plata Institute of Physics. An examination of the general index shows that the articles are the work of very few authors, an outstanding contribution being that of Richard Gans who between the years 1914 and 1925 appears as the author of 32 articles dealing principally with subjects in the fields of Optics and Electromagnetic Theory. Only 28 authors published in the five volumes of the journal, among these figured the first graduates in physics of La Plata University: José Collo, Teofilo Isnardi and Ramón Loyarte. The majority of the articles, both Gans' and his disciples, were also published in German scientific journals as they dealt with highly advanced research topics. The journal made a comeback after 1935 and then reappeared under a new and less illustrious name, completely separated from the previous tradition -the publication of the Faculty came to be known simply as Revista.

During the period 1914-1925 the number of articles on Physics which appeared in "Análes de la Sociedad Científica Argentina" was very limited, whereas those which appeared in the Buenos Aires "Revista del Centro de Estudiantes" were decidedly didactic. It could be held that "Contribución" defined a fresh territory by its clearly scientific and research orientation. We should also mention the publications of the Instituto Nacional del Profesorado Secundario in Buenos Aires, as well as those carried out in the Institute of Physics of the National University of Tucuman from 1927 onwards.

A text by Teofilo Isnardi, in 1943, which was devoted to the relationship between scientific research, university and industry in Argentina clearly reveals the failure of physics, implemented some four decades before, and its difficulties

due to the lack of funds (1). According Isnardi, the number of Argentine physicists was a mere fifteen, which for the population of the country at the time signified the ratio of one physicist per million inhabitants. At that same time, physicists in the United States represented an approximate proportion of one physicist per 10000 inhabitants. Furthermore, both in Buenos Aires and La Plata, the kind of professional life of the university staff made it impossible to envisage high level scientific production. Since there were no full time positions, the professors found themselves compelled to occupy various chairs, generally in different institutions, with the result that a large proportion of their time was absorbed by their teaching activities themselves and their journeys from one workplace to another.

The first publications of the "Nucleo de Física", the immediate predecessor of the Asociación Física Argentina (AFA), began to appear around 1942 in the journal of the Unión Matemática Argentina, whose director was José Babini. Articles on physics' topics also appeared in the "Revista Tucumana" and in "Mathematicae Notae". Both these journals, which are still published today, appeared in the 1940s. Subsequent efforts in Argentina have been made, but no scientific journal devoted to Physics research topics has ever reached the standard of "Contribución".

Using the repository compiled by Small (2) on the discipline of Physics between 1920 and 1929, Pyenson and Singh have produced an interesting study of the state of physics in peripheral countries during this period (3). At this time there were only 9 Argentine physicists who had obtained PhDs. Between them they published 73 articles in foreign journals and an indication of the impact they achieved is given by their receiving 135 citations. Small's work however does not treat the articles published in "Contribución". A comparison with the scientific production of Argentina and that of India and Canada reveals that the two latter countries achieved a higher standard of excellence, occupying more higher roles than Argentina. As for the rest of Latin America its contribution to the world of physics research during this period was negligible.

Research work and studies in Physics in Latin America only developed in a continuous fashion after the end of World War II with the creation of Research Councils and full time university staff posts some thirty years ago which in several countries gave rise to the usual exponential growth (4).

## RECENT SITUATION OF PHYSICS IN LATIN AMERICA

The first comprehensive study of research in mainstream science published in Latin America which we have knowledge of was carried out by Frame (5) who examined publications produced by Latin American countries appearing in the 1973, 1974 and 1975 editions of the Science Citation Index. During this period the contribution of Latin America was about 1.1% of the world papers' production.

Marcel Roche and Yajaira Freites have studied the specific case of Venezuela as regards the production and flow of information, although also including comments on other Latin American countries (6). Their work is based on the 1980 Science Citation Index. In this year Brazil was top of the league with 1551 articles, followed by Argentina with 1042, Mexico with 787 and Chile with 702. All these figures are significantly below the levels reached by developed countries, even when the population factor is taken into account. One should note that the Science Citation Index, which reproduces the abstracts of articles appearing in more than 3000 journals, evaluates only a score of Latin American journals.

In 1984, Garfield published two articles based on the 1978 Science Citation Index (7). According to this author in the year 1978 Latin America published 1% of the total world production with an impact of only 2.9 for the period 1978 - 1982 as compared for example with Australia which was producing 2% with an impact of 4.4 at the same time. In this study, as well as providing a variety of statistics on where scientists publish, in what languages they write and the impact of their publications, Garfield also gives interesting information on cluster research under which heading he identifies the current areas of Latin American research.

Flores Valdes and Pimienta de Rubio (8) have carried out a comprehensive study of research in Physics in Latin America basing their work on the periodical "Bibliografía Latinoamericana" which has been published by the Centro de Información Científica y Humanística of the National University of México (UNAM) since 1981. Their study takes into account articles published in journals outside the region whose first author works in a Latin American institution, without taking into account contributions to scientific meetings and books. The error margin due to omission is high and in some cases - for some Argentinian, Brazilian and Mexican institutions - the authors have estimated it when the total number of publications was ascertained on the basis of annual reports. The decision they took was to multiply the data obtained by a factor of two. While this is considerable in terms of the absolute value of the quantities measured, is not significant as regards the estimation of tendencies.

The number of articles published by each country between 1981 and 1985 is as shown in table 1. They also show that out of the nine institutions which during the period produced more than 100 articles, five are Brazilian (University of Sao Paulo, University of Campinas, Federal University of Pernambuco, Centro Brasileiro de Pesquisas Físicas), two are Mexican (UNAM and IPN) and two are Argentine (CONEA and University of La Plata). It is obvious that the Brazilian scientific institutions are also somewhat decentralized whilst their Argentine and Mexican counterparts are almost exclusively concentrated in the capital cities of these countries.

The most recent information that we have at hand is the comprehensive set of indicators published by Schubert, Glanzel and Braun in Scientometrics (9). We

shall make use of this data which covers the period 1981-1985 to provide a brief survey of the current state of scientific research in Latin America.

Table 1. Number of articles published in Physics per country (1981-1985)

	1981	1982	1983	1984	1985	Total
Brazil	285	265	271	320	339	1480
Argentina	121	117	129	170	170	707
Mexico	95	126	107	156	134	618
Venezuela	35	47	64	43	34	223
Chile	17	13	27	1	1	20
Cuba	2	4	5	2	6	19
Uruguay	0	0	1	2	4	7
Peru	0	1	2	0	1	4
CostaRica	0	1	0	1	0	2
Ecuador	0	0	0	1	0	1
Total	561	578	611	740	725	3215

Source: Flores et al.

This volume of *Scientometrics* contains a compilation of data taken from the *Science Citation Index* database of the Institute for Scientific Information (ISI). The study includes 3711 journal titles which appear at least once in the database during the period under consideration. The scientific publications, which consist of articles, reviews, notes and letters have been divided into five major fields: Life Sciences, Physical Sciences, Chemistry, Engineering and Mathematics. The indicators used are the usual publication and citation counts, citation rates per paper, observed citation rates, expected citation rate and relative citation rate. A further interesting indicator is also used, the average citation rate to papers cited higher than average.

Table 2 gives us an idea of the scientific production of the region over the five year period under consideration by indicating those countries which produced more than 50 publications during this time.

As in the case of the previous studies, we observe that five countries dominate the field of scientific production and that for all of these, the observed citation rate is low when compared with the world value, which amounts to 3.11 for these five years. During the period under consideration, the publication count of the entire world, all science fields combined, reached the figure of 1,918,188 publications. It is interesting to remind the Latin American figures for academic productivity (1.12% of world share with 1.57 observed citation rate) with that of some other countries: Israel for instance represents 1.06% of world production by itself and shows a 2.69 observed citation rate; Australia represents 2.23% of world production and 2.82 citation rate; Switzerland has 1.22 of world share and 4.56 observed citation rate.

Table 2. Academic productivity per million in habitants 1981-1985\*

	Papers	Population	Papersp/m.	Obs. Cit. Rate
Brasil	6987	136	51.4	1.45
Argentina	5396	30	179.9	1.54
Mexico	3335	78	48.4	1.89
Chile	2813	12	234.4	1.56
Venezuela	1395	17	82.1	1.76
Colombia	303	29	10.4	1.61
Cuba	270	10	27.0	0.83
CostaRica	175	3	58.3	1.40
Uruguay	152	3	50.7	2.03
Peru	136	20	6.8	0.85
Guatemala	86	8	10.8	1.77
Panama	77	2	38.5	2.48

\*Population figures for the year 1985.

Source: Schubert et alii.

Although the previous statistics have justifiably been criticized, for example by J. Gaillard (10), for taking into consideration only mainstream research and for leaving aside a very important part of the scientific production in developed countries, they do however give a clear indication of the low contribution of Latin American research on the international scale.

Let us now return to the principal field of our study. The world publication count for Physics is 370612 with an average citation rate of 3.44 and an outstanding citation rate of 11.43. The following table gives the relevant values for the six countries in the region which published more than fifty papers in Physics during the period 1981 - 1985.

Table 3. Volume of Physics Research in Latin America (1981-1985)

	Public. Count	World Share	Cit. Count	World Share	Cit. Rate (exp)	Cit. Rate (obs)	Cit. Rate (rel)	Act. ind.	Attr. Ind.
Brazil	1933	0.52	3491	0.27	3.46	1.81	0.52	1.43	1.61
Argentina	1063	0.29	1811	0.14	3.35	1.70	0.51	1.02	1.02
Mexico	822	0.22	2002	0.16	3.64	2.44	0.67	1.28	1.48
Chile	386	0.10	1585	0.12	3.97	4.11	1.03	0.71	1.68
Venezuela	316	0.0	9657	0.05	3.26	2.08	0.64	1.17	1.25
Cuba	53	0.01	37	0.00	1.80	0.70	0.39	1.02	0.77

Table 4. Volume of Physics Research in Latin America (1981-1985)

	Publ. Count	World Share	Cit. Count	World Share	Cit. Rate (Exp)	Cit. Rate (Obs)	Cit Rate (Rel)	Act. ind.	Attr. ind.
<b>Astronomy and Astrophysics</b>									
Chile	177	0.76	1324	1.28	5,37	7.48	1.39	5.29	17.36
Brazil	121	0.53	210	0.20	3.29	1.74	0.53	1.46	1.20
Argentina	102	0.45	208	0.20	3.38	2.04	0.60	1.59	1.45
Mexico	59	0.26	328	0.32	4.42	5.56	1.26	1.49	3.00
<b>Atomic Molecular and Chemical Physics</b>									
Argentina	159	0.49	451	0.31	4.21	2.84	0.67	1.74	2.20
Brazil	154	0.47	380	0.26	4.08	2.47	0.61	1.30	1.52
Mexico	94	0.29	318	0.22	5.06	3.38	0.67	1.66	2.36
<b>Acoustics</b>									
Argentina	75	0.88	52	0.39	1.17	0.69	0.59	3.13	2.80
<b>Applied Physics</b>									
Brazil	130	0.29	183	0.14	3.16	1.41	0.45	0.80	0.82
Mexico	68	0.15	84	0.06	3.17	1.24	0.39	0.87	0.61
Argentina	59	0.13	51	0.04	2.22	0.86	0.39	0.47	0.28
<b>Cristallogr</b>									
Brazil	51	0.39	77	0.29	2.51	1.51	0.60	1.06	1.70
<b>Instruments and Instrumentation</b>									
Brazil	73	0.41	61	0.24	1.42	0.84	0.59	1.11	1.40
<b>Math.Phys</b>									
Mexico	58	1.23	202	1.55	2.37	3,48	1.47	7.07	14.65
Brazil	53	1.12	89	0.68	2.67	1.68	0.63	3.08	4.03
<b>Nuclear Physics</b>									
Brazil	130	0.75	193	0.36	3.60	1.48	0.41	2.05	2.13
Argentina	107	0.61	182	0.34	3.93	1.70	0.43	2.18	2.45
<b>Optics</b>									
Argentina	51	0.48	50	0.22	2.25	0.98	0.44	1.72	1.56
<b>Physics of Condensed Matter</b>									
Brazil	488	1.22	920	0.71	3.76	1.89	0.50	3.36	4.18
Argentina	125	0.31	197	0.15	3.92	1.58	0.40	1.11	1.09
Mexico	106	0.27	213	0.16	4.55	2.01	0.44	1.53	1.55
Venezuela	86	0.22	238	0.18	3.87	2.77	0.71	2.96	4.45
<b>Physics of Particles and Fields</b>									
Brazil	101	0.92	179	0.32	5.07	1.77	0.35	2.4	1.89

The values obtained by Flores and Pimienta de Rubio are only 30% below the values shown in the Table 3. Their position of a factor 2 is understandable if we consider papers out of the mainstream because generally the institutions include titles of this kind in their reports.

Table 4 gives the presence of Latin American countries in the different areas of Physics. Only countries with 50 or more publications in each area figure in the table.

The analysis of these indicators shows that Argentina has a proportion of papers in Physics of 19.3% which is very close to the world proportion figure (19%), while Brazil shows a very high proportion (28.1). The latter figure is almost certainly related to the decision taken some twenty years ago whereby scientific research was given priority funding. Mexico with figures of 24.1% and Venezuela with 22.2% also show high proportional numbers.

These indicators show that in the case of Argentina, Brazil and Mexico the subfield of Applied Physics is one characterized by low activity and low attractivity. The implication for the desired technological derivations of physics research are evident and in consonance with the lack of technological development in each case.

Physical subjects of high activity and high attractivity in Argentina are Atomic and Molecular Physics, Optics and Nuclear Physics and Nuclear Science and Technology, the latter two being related to the activities of the CONEA (National Atomic Energy Commission), an institution whose budget has during the course of its existence at times permitted a high number of research projects to be carried out.

## CONCLUSION: SOME EXPERIENCES IN SCIENTIFIC COMMUNICATION IN LATIN AMERICA

There is a general agreement in the Latin American Physics' community on the necessity of a high level Latin American journal of Physics (11). It would seem that a letters journal would be the most suitable form of journal to produce. The FELASOFI (Confederation of National Societies of Physics of Latin American Countries) is studying the possible issue of such a journal given that it is seen as necessary to support existing national journals whose interest is beyond doubt primordial. Some representatives however favour the idea of a review journal and their choice appears well justified; good review journals are read by a great number of people, indeed they appears in the statistics as the most cited of all the journals.

Local authorities in the region must be brought to realize not only the necessity for the technological revolution in their countries, but also that this will not be able to be carried out without basic research in a broad range of fields. It is essential to point out the vast sums of money earmarked for top level scientific institutes in the developed world.



At the present moment there are various examples of national journals which serve the dual useful purpose of connecting up researchers and of disseminating new ideas. The most important as regards circulation are the "Revista Mexicana de Física", "Revista Brasileira de Física" and "Acta Científica Venezolana". The former of these journals was founded in 1952, is a quarterly publication which represents 700 pages per year. It is included in Physics Abstracts, Mathematical Reviews, Bulletin Signaletique, Physics Briefs, Chemical Abstracts, but not in ISI. During the period 1982 - 1986, 46% of the articles were devoted to research, 21% to teaching, 11% to book reviews, 10% to history and philosophy, 7% to instrumentation and 5% to academic policy. The journal subjects each article presented for publication to the opinion of a referee, the rate of articles rejected is about 40% of the articles submitted (12). The range and diversity of the topics published in this journal distinguish the journal from other international publications, but one wonders whether these very characteristics do not in fact serve to provide it with a comfortable niche in Mexican society; undoubtedly the "Revista Mexicana de Física" carries out the highly useful role of disseminating ideas, both among scientists and students.

Economists in the region have begun to realize the need for technological change, but very often they only envisage the possibility of technological transfer without understanding how essential the deep need is becoming. We consider that in strictly economic terms there is a need for home-grown science and technology to be used as instruments for development, applying technical and scientific discoveries to the requirements of industry. In particular there should be specialization in certain problems which are included in technological-scientific projects involving various countries in the region with the object of achieving a first attempt of participation in the cycle of the production of new goods, thus circumventing the high price which normally must be paid for patents and the obstacles which are usually associated with the protection of know-how in monopolistic practices.

These projects should be accompanied by fundamental scientific research, not of course in isolated havens but in constant contact with teams of applied researchers. Within such a framework physics research is of fundamental importance. In order to train effectively an invisible college of Latin American physicists it is essential to have journals in which the results of their publications may appear and preventing scientific authors from suffering the evils of intellectual isolation and thus boosting their self-esteem.

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