

Ministério da Ciência e Tecnologia

**Scientific Evaluation of the Instituto Nacional de Matemática
Pura e Aplicada and its Relevance**

June 9 – 13,2003

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Scientific Evaluation of the Instituto Nacional de Matemática Pura e Aplicada and its Relevance

June 9 – 13,2003

International Scientific Committee – Comissão Técnico-Científica

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Clovis Gonzaga – Universidade Federal de Santa Catarina - UFSC
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George Papanicolaou – Stanford University, USA
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Terry Rockafellar – University of Washington, USA

1. Preamble

The Instituto Nacional de Matemática Pura e Aplicada - IMPA is fifty-one years old. It is not the oldest center for mathematics in Brazil; the mathematics department at the University of São Paulo is about fifteen years older. Nevertheless, IMPA is presently recognized abroad as the leading center for mathematics in Brazil — indeed in all of Latin America — and as one of the foremost centers in the world.

IMPA's mission is research oriented: to promote current activity in research, to train the next generation of researchers, and to educate future university professors of mathematics who have experience in research and can identify and encourage mathematical talent with potential in research.

Two-and-a-half-years ago, the formal status of IMPA has changed to become a “social organization”, an institution associated to the Ministry of Science and Technology, which is still public in terms of objectives and accountability but with a more flexible administration. IMPA is now under contract to the Brazilian government to achieve preestablished goals. IMPA's new status requires an interministerial evaluation of its activities every six months by a Brazilian committee. This committee has consistently given IMPA the highest possible rating. However, IMPA has also an international profile and importance. So it is appropriate that IMPA be evaluated as well by an international committee like ours, composed of three Brazilian members and two foreign members coordinating a team of six.

During our visit we were provided with facts and figures about IMPA's research endeavors, academic programs, and support structure. On the first day, we met with the Director, Jacob Palis, the Scientific Coordinator, Marcelo Viana, the Teaching Coordinator, Arnaldo Garcia, and the Computing Coordinator, Roberto Beauclair. Subsequently, we interviewed nine professors and three students. Our discussions were frank and far-ranging. The cooperation of everyone at IMPA contributed greatly to the evaluation process.

As the rest of the report will show, we are highly impressed by the quality and extent of IMPA's scientific activities and supporting facilities. Without reservation, we can vouch for IMPA's excellence and promise for the future.

2. Research activities

The scientific activities at IMPA revolve around research at the highest international level, combined with PhD programs of great importance for Brazil and Latin America, and MSc programs which feed into them. A further dimension is seen in recently added MSc programs that have direct significance for technological development in Brazil, but also offer a way of attracting new students into mathematical research, while serving as a vehicle for the transfer of advanced scientific knowledge.

Many areas of research are represented at IMPA. Before describing them individually, we wish to emphasize that the overall quality of the work going on in these areas is indeed very high. This is attested to, in particular, by the numerous publications, including a large number of articles accepted by top international journals.

Among the research areas, first mention must go to the theory of smooth dynamical systems because of its long and well-established tradition at IMPA, its special prominence as seen from abroad, and its continued growth and vitality. The current research group in this area is very talented, and its activities are adding greatly to IMPA's reputation. Research in the allied area of holomorphic dynamics and complex foliations likewise is making an outstanding contribution. So, globally, dynamics is an area in which IMPA has emerged as one of the two or three best centers in the world. Another subject with a strong tradition at IMPA is differential geometry. It has sparked the creation of remarkably many other groups in this area all across Brazil, an entire community which now interacts extensively.

In several other fields, IMPA is making notable contributions even though the activities are more recent in origin, or involve fewer individuals. Research in algebraic geometry and number theory, for example, is well known and thriving. The group working in partial differential equations is young and very energetic, and is helping to uphold an area of broadly appreciated importance. The probability group, also very young, has high visibility in the world outside and is functioning besides as a bridge toward applications.

Expansion in coverage of applied mathematics has become a major target in the past few years, and we commend IMPA for these efforts. One result has been the formation of a splendid group in fluid dynamics, which is widely admired from abroad and conducts interdisciplinary research in Brazil and elsewhere. The group in optimization is a strong focus of activities which connect and enhance the research scene in optimization at other locations in Brazil and is moving in part toward involvements in applications to the power industry and, perhaps, finance. In computer graphics, there is a broad agenda of research on current topics in a highly competitive and fast-moving international environment. Their successes in the face of such challenges, and the availability of modern laboratory facilities, are clearly attracting students. In the important area of mathematical economics, only one individual is now on the scene, but research is nonetheless proceeding at a very good pace and is winning recognition from outside.

3. Relevance to Brazilian Mathematics and Science

In Brazil, the impact of IMPA has been, and continues to be very substantial. Since its inception in 1952, it has played an essential role in developing mathematical sciences in the country. The history of mathematical sciences in Brazil is divided into two distinct periods. Before IMPA, mathematics consisted of a few scattered individuals who could not set up a national format for the development of research and high-level teaching. IMPA's founders recognized this strong need, and addressed the problem. They were clairvoyant and ultimately very successful.

IMPA is now among the foremost research institutions in the world, and moreover is unique in its impact on mathematics throughout its country. It provides leadership, and sets standards for research at world levels. It organizes and contributes to promote colloquia, meetings, workshops and summer schools both at IMPA and throughout Brazil. This has been a major force in promoting research activity. A good example of this is the Brazilian research group in differential geometry, which was built up by IMPA and now has major schools throughout the country. Its annual colloquia and summer schools are organized by IMPA. In 1963 the subject was practically nonexistent in Brazil, whereas now dozens of differential geometers publish research papers in major journals. This is only one of many areas where IMPA has been effective on such a level.

Because of its prestige, the many meetings organized by IMPA attract some of the world's most prominent mathematicians. In this way, an invaluable resource is provided to students and researchers here.

IMPA has recently taken initiatives in several new areas of research. It serves as a force in the development of these areas in Brazil.

IMPA is a key player in recruiting and training young mathematicians who will become teachers in Brazilian universities. It produces about one fifth of the PhD's in mathematics in Brazil each year. It has several master's programs which serve to train but also to find new talent.

Of course IMPA does very much to foster national and international ties. This is confirmed, for instance, by the many long-term visits by mathematicians, both foreign and Brazilian, both junior and senior.

IMPA is involved with mathematics education at many levels. It has a long-standing program of writing graduate and undergraduate texts in Portuguese. It now has a nearly complete collection of textbooks for the undergraduate courses throughout the country. In addition it is now running a program of continuing education for secondary school teachers.

Another important resource provided by IMPA is its library, which is one of the finest in the world. This library is available to mathematicians throughout Brazil. Journal articles can be accessed easily and are sent overnight anywhere in the country through an agreement with the Brazilian Mathematical Society and the project COMUT of the Ministries of Education and Science and Technology – CAPES, IBICT, SESU and FINEP.

IMPA also houses and supports many important activities. One, for example, is the Brazilian Mathematical Society, whose headquarters and administrative staff are located at IMPA. This implies support to the Brazilian Mathematical Olympiads at various levels, and also the distribution of publications of the Brazilian Mathematical Society. In the case of the Olympiads, strong personal efforts have been made by some of the professors at IMPA

IMPA organizes and hosts every other year the Brazilian Mathematical Colloquium. More than one thousand Brazilian and foreign participants come to this meeting, which combines surveys of hot research areas, special session seminars in many fields, and both elementary and advanced courses addressing the most active topics in mathematics.

The committee and especially its foreign members are impressed by the richness of IMPA's summer activities, compared with the mathematical desert that departments in the USA and Europe become during this period. These include many elementary courses for young students for all of Brazil and many short post-doctoral visits for researchers who are thus able to start to pursue collaboration with IMPA's mathematicians and among themselves.

An important recent development for mathematics in Brazil is the establishment of a Millenium Institute. This is the only such Institute in Mathematics in the country. Its importance stems from the fact that it brings together most of the best Brazilian Mathematical centers in a joint effort to foster mathematical activities. IMPA is serving as the main node of this virtual institute of excellence.

4. International Significance

As a top-level center for mathematical research, IMPA has a significant role also in Latin America beyond Brazil, and in contributing to scientific progress worldwide. We see strong evidence that this role is being filled remarkably well. No other country in the region has a comparable institute, and IMPA therefore widely attracts researchers and students, furnishing key opportunities for scientific contacts and advanced learning. In this way, Brazil is able to provide a kind of leadership that befits the largest country and economy on the continent and, of course, creates ties that are beneficial in all directions.

For instance, we note that scholars trained at IMPA have generated active mathematical groups in Uruguay, Chile and elsewhere, even outside Latin America, as in Portugal, and these groups have in turn sent new generations of students to Brazil to carry on with the process. The many international meetings that IMPA puts together on current research issues serve to disseminate the latest knowledge continent-wide. Further, they provide a platform for Latin Americans to showcase their activities and accomplishments.

The international visibility and prestige of IMPA make it attractive to young Brazilian and Latin American scholars, and competitive against prominent institutions in Europe and North America. IMPA acts, therefore, as a counterweight to the brain drain that is so costly to developing nations. It is an important effect that IMPA's excellence has. In fact, IMPA has consistently been able to create a reverse flow of sorts, in which research mathematicians from Europe and North America, both junior and senior, come to Brazil to give courses and participate in research projects and seminars.

5. Perspectives

IMPA has been leading in the many ways explained in detail in the previous sections, and there is every reason to believe IMPA will continue to do so in the future; indeed, IMPA will certainly increase its positive influence. However, there are several directions in which the committee feels that IMPA should develop further.

First of all, IMPA now graduates around twelve PhDs per year, and we believe the number should be increased to around sixteen. There is already a great need for more strong mathematicians in Brazil than are now available. In the next few years, there could well be openings for at least 200 professors of mathematics in the federal universities alone. To graduate an additional four PhDs, IMPA must admit around six more students per year. It now has the capacity in faculty and facilities to do so. Moreover, it now accepts twenty students out of an applicant pool of 100 to 150, and another twenty or more applicants meet the same high admissions standards. The limiting factor is the number of scholarships. The committee recommends strongly that IMPA should be provided with stable resources that ensure the availability of the needed six more scholarships.

Secondly the committee feels that the MSc programs well deserve to be continued. The new offerings in finance and energy are off to a good start and are contributing to the interdisciplinary activities at IMPA.

Finally, the committee sees the need for gradual expansion in the size of the faculty, both in pure and applied mathematics. IMPA should add resources in the areas of algebraic geometry, probability, computer graphics, fluid dynamics, and mathematical economics. In addition, IMPA should try to invest in the currently unrepresented areas of algorithms, combinatorics, and especially modern mathematical statistics. The committee feels that IMPA must be provided with the financial resources to enable it to be ready to hire a strong candidate when one appears in these areas.