Americas Prize Nomination

Introduction

For us, the undersigned of this presentation, it is a pleasure, an honor, and a pride to present the Group of Dynamic Systems of the Institute of Pure and Applied Mathematics (IMPA) of Rio de Janeiro Brazil (starting now GSDIMPA); conformed, over the years by mathematicians: Mauricio Matos Peixoto, Jacob Palis Jr., Ricardo Mañé, Welington Celso de Melo, Marcelo Viana, Carlos Gustavo Moreira, Enrique Pujals, and Artur Avila to award the Americas Prize in recognition of its extraordinary work to benefit the development of research in the field of Dynamic Systems, and for its enormous work in favor of cooperation and collaboration between mathematicians from America in that area in particular, and in mathematics in general.

History

This group began its productive activity in the Structural Stability Theory during the 1950s, with the works of Peixoto¹ (41 publications and 373 citations in Mathematical Reviews, from now on MR; 10 doctoral students and 73 descendants in The Mathematics Genealogy Project², from now on TMGP); and, with the graduation of the first four doctors (two fully trained at IMPA³ and two in co-tutoring with Brown University⁴).

The initial work slowed down during the 1960s and resumed at the end of the decade due to Palis' returning (72 publications and 2244 citations in MR; 41 doctoral students and 281 descendants in TMGP). Palis is undoubtedly one of the most significant engines of the development of mathematics in Latin America (after this AL) and, the historical leader of the GSDIMPA. His research field is initially developed in the theory of structural stability and then partly as a complement to it; that is, in the study of the persistence properties of real unstable dynamical systems (mainly diffeomorphisms and vector fields).

His work, in the development of the theory of dynamic systems and in the collaboration and cooperation between mathematicians of the world, in general, and of America, in particular, is enormous and has received various awards⁵. An example is that he started the dynamic systems seminar upon returning to IMPA in late 1968. This seminar has now more than 50 years of uninterrupted work.

At the beginning of 1970, Palis formalized dynamic systems studies at IMPA, with their respective training courses and seminars. His first three students were Pedro Mendes (doctorate in 1972, from now doc. in), 11 publications and 73 citations in MR); Welington de Melo (doc. in 1972, 49 publications and 1837 citations in MR; seven doctoral students and 38 descendants in TMGP) and Ricardo Mañé (doc. in 1973, 52 publications and 2,679 citations in MR; 11 doctoral students and 30 descendants in TMGP).

Palis students include Marcelo Viana (doc. in 1990, 74 publications and 2444 citations in MR; 40 doctoral students and 87 descendants in TMGP), Carlos Gustavo Moreira (doc. in 1993, 83 publications and 537 citations in MR; nine students and ten descendants in TMGP), Enrique Pujals (doc. in 1996, 59 publications and 1069 citations in MR; 20 doctoral students and 23 descendants in TMGP).

Among Welington de Melo's students is Artur Avila (doc. in 2001, 85 publications and 1658 citations in MR; six students in TMGP; 2014 Fields medal).

The GSDIMPA has played an essential role in developing research in Brazil and in several Latin American countries, not only in dynamic systems. Indeed, this group was the driving force behind IMPA, which, in turn, is the institution with the most outstanding development in mathematics within the south of Ecuador and, consequently, is the benchmark institution for Brazilian mathematics. In this role, it has been a significant engine for developing and disseminating research in the different states of Brazil and in various Latin American countries, particularly in Chile, Uruguay, Venezuela, and Mexico, among others.

Regarding Brazil, we can point out that has entered the IMU in group I in 1954; it was promoted, successively, in 1978 (group II); 1981 (group III); 2005 (group IV), and 2018 (group V), where it shares a place with the most developed countries in mathematics in the world. In this sense, it is worth remembering that the first meaningful mathematical event in Brazil was the Salvador Symposium on dynamical systems, organized by Palis and which brought together mathematicians at the level of G. Reeb, S. Smale, R. Thom, and E.C. Zeeman. This Congress had its Proceedings, edited by Peixoto, and in which there are works by J. Guckenheimer, J. Hale, M. Hirsch, J. Martinet, and G. Reeb, J. Mather, J. Moser, S. Newhouse, RC Robinson, H. Rosenberg, W. Thurston, D. Saari, S. Smale, and M. Shub, among others. Early on, this Congress reflects Palis' desire to internationalize Brazilian mathematics at an excellent level and promote it within the world's most developed.

¹ Attached his CV

² Numbers 20, 21, 22, 23, 24 on Peixoto's CV

³ Doctoral Thesis found in numbers 10 and 11 on Peixoto's CV

⁴ Doctoral Thesis found in numbers 3 and 8 on Peixoto's CV

⁵ Attached his CV, see pages 4, 5 and 6

With a determined action from Palis, in the 1970s; from de Melo, Mañé and Palis in the 1980s; from de Melo, Mañé, Moreira, Palis, Pujals, and Viana in the 1990s; deMelo, Moreira, Palis, Pujals and Viana in the 2000s and 2010s; different students were attracted and, throughout those years, the IMPA School of Dynamic Systems was built.

This School enticed a large number of Brazilians and Latin Americans, but also young mathematicians from other latitudes, such as C. Bonatti, J. Bourgain, JP Francoise, JM Gambaudo, E. Ghys, K. Khanin, LL Lions, M. Lyubich, M. Martens, C. McMullen, S. van Strien, JC Yoccoz. Furthermore, established mathematicians such as V. Arnold, M. Atiyah, S. Donalson, A. Douady, P. Erdos, M. Herman, JL Lions, J. Milnor, D. Mumford, S. Novikov, J. Sinai, D. Sullivan, among others, from different parts of the world went there to participate.

The actions of the GSDIMPA were not only restricted to the IMPA or the Rio de Janeiro area. The group members have always been willing to contribute to the research development in other centers, with the subsequent natural collaboration and cooperation. As a result of this work, research groups on dynamic systems and master's and doctorate programs were developed in Brazil's different states. In the same way, since the 1970s, the GSDIMPA has carried out and supported more than 200 specialized conferences in Brazil, managing the fundings with various sources. During the last 50 years, this work has been fundamental in increasing the number of doctoral programs in Brazil.

Influence on Research and Collaboration with and mathematicians and counties from Brazil.

Several of the researchers, former students at the GSDIMPA, became leaders in their respective centers. Some of them are Ali Tahzibi (doc. in 2002; 27 publications and 229 citations in MR; 4 doctoral students); Artur Lopes (doc. 1977, 105 publications and 766 citations in MR; 11 doctoral students); Daniel Smania (doc. in 2001, 24 publications and 160 citations in MR; 6 doctoral students); Genesio Lima dos Reis (doc. in 1978; 4 publications and 20 citations in MR.); Lorenzo Díaz (doc. in 1990, 68 publications and 1638 citations in MR; 5 doctoral students); María José Pacifico (doc. in 1980, 67 publications and 861 citations in MR; 12 doctoral students and 14 descendants in TMGP) and Vilton Pinheiro (doc. in 2000, 16 publications and 160 citations in MR; one doctoral student)

As can be noted, during the 64-year path that took Brazil from IMU classification group I to group V, the GSDIMPA has played a fundamental role, not only because of its great scientific productivity and its work in terms of academic collaboration and cooperation but also for its excellent work in strengthening mathematics in that country.

Moreover, the influence of GDSIMPA is not only limited to Brazil. Also, its work was of first importance for the beginning or sustained of the development of research in the dynamic systems field, and other branches of mathematics in general, in Argentina, Chile, Uruguay, Paraguay, Bolivia, Peru, Ecuador, Colombia, Venezuela, Cuba, Costa Rica and Mexico. We will point out Chile, Mexico, Uruguay, and Venezuela cases, and we will do this by indicating people and events.

Influence on Research and Collaboration with and mathematicians from other countries in the region Chile

Among the students or descendants of the GSDIMPA, we can find Rodrigo Bamón (doc. in 1983, 21 publications and 106 citations in the MR; two doctoral students), Víctor Guiñez (doc. in 1984, 23 publications and 126 citations in the MR; one doctoral student), Rafael Labarca (doc. in 1985, 30 publications and 142 citations in the MR., one doctoral student) and Sergio Plaza (doc. in 1988, 45 publications and 189 citations in the MR, three doctoral students). They are the main responsible for forming the Dynamic System Group in Chile during the 1980s and 1990s, with the GSDIMPA supports.

Several dynamic systems schools were held those years (with Proceedings published in Lectures Notes in Math. or Pitman Research Notes in Math.). Also, many students were at the master's level and some at the doctoral level. Within the last decade, new generations of Chilean mathematicians working in the field joined forces with various groups from abroad, including the GSDIMPA, to establish a strong national group.

There has been a fruitful and productive collaboration between the group members and with mathematicians from America and Europe. It is possible to say that they are reaching a significant scientific level, which is reflected in the amount and quality of publications (in journals as Annals of Math., Inventiones Math., Acta Math., Duke Math. Journal, Math. Annalen, Communications in Math. Physics, Ergodic Th. And Dyn. Sys., among others), and in the creation of several doctoral programs within the country.

We highlight that two members of this group were invited as speakers at the Special Session on Dynamic Systems and Ordinary Differential Equations at the last International Congress of Mathematicians, held in 2018. The group has organized more than 30 international conferences throughout Chile during the last ten years⁶. For example, in 2015, the Global dynamics beyond uniform hyperbolicity conference was organized in Chile, one of the world's leading dynamics systems conferences.

⁶ see <u>http://www.dynamicalsystems.cl/events</u>

Members of this group are in charge of two active research seminars in the field, the mathematics older seminar in the country named Seminario de Sistemas Dinámicos de Santiago⁷, and the Seminario de Dinámica Porteña⁸. Nowadays, this group is formed by 30 researchers and 25 students from diverse institutions in Chile.

Mexico

We can point out that the GSDIMPA, throughout its existence, has influenced mathematics in that country. In the beginning, Alberto Verjovsky (doc. in 1973, 76 articles and 486 citations in MR; ten doctoral students and 12 descendants in TMGP) despite obtained his doctorate at Brown University, made prolonged stays at IMPA under the tutelage of Peixoto, and with a close relationship with Jacob Palis. Verjovsky creates the first link in a long chain that lasts until the present.

In the 80s, Xavier Gómez Mont (doc. in 1978, 52 articles and 420 citations in MR., 17 doctoral students and 28 descendants in TMGP) and José Seade (doc. in 1980, 85 articles and 717 citations in MR., nine doctoral students, and 11 descendants), although not being formal students of the GDSIMPA, they recognize themselves strongly influenced by its members.

This chain continues with Renato Iturriaga (doc. in 1993, 30 articles and 541 citations in MR; one doctoral student and two descendants in TMGP) and Gonzalo Contreras (doc. in 1990, 32 articles, 769 citations in MR, three doctoral students and four descendants in TMGP); both received their doctorate under Mañé's tutelage. Although Contreras is a native of Peru, he has developed his career in Mexico since 1998.

Years later, some Mexicans were doctoral students at IMPA. Among them, we can highlight Aubin Arroyo (doc. 2002; 10 articles and 65 citations in MR.), who was guided by Palis and Pujals, and Pablo Dávalos de la Peña (3 articles and 19 citations in MR) student of Pujals.

Uruguay

Among the students or descendants of the GSDIMPA we can find Jorge Lewowicz (doc. in 1966, 23 publications and 158 citations in MR; three doctoral students and five descendants in TMGP), Roberto Markarian (doc. in 1990, 40 publications and 514 citations in MR; three doctoral students in TMGP) whom together with José Luis Massera (50 publications and 740 citations in MR) are the main people in charge of the training of the Grupo de Sistemas Dinámicos in Uruguay (after the dictatorship end).

This group is currently constituted of more than 20 researchers and 25 students in the field. Over the years, they have built, with the initial support of the GSDIMPA, close academic relationships with institutions and mathematicians from Brazil, Argentina, Chile, Venezuela, Mexico, USA, France, and other countries.

Venezuela

We can point out that Jorge Lewowicz's forced exile took him to Venezuela, and there he developed his activity at the Universities of Zulia in Maracaibo and Simón Bolívar in Caracas. There he established a group on dynamic systems, in which several Venezuelan mathematicians were trained.

Lewowicz's relationships with the GSDIMPA allowed some of them to became students at IMPA. Among others, we can name Rafael Ruggiero (doc. in 1989, 43 publications and 167 citations in MR; five doctoral students in TMGP), Leonardo Mora (doc. in 1991, 16 publications and 173 citations in MR.), Neptalí Romero (doc. in 1992, 21 publications and 102 citations in MR, three doctoral students in TMGP), José Martin-Rivas (doc. in 1992, five publications and three citations in MR.), Carlos Morales (doc. in 1994, 114 publications and 867 citations in MR; 10 doctoral students and 11 descendants in TMGP), Fernando Sánchez-Salas (doc. in 1998, nine publications and 19 citations in MR).

Mora, Romero, Martin-Rivas, and Sánchez reorganized, in 1991, the group of dynamic systems in Venezuela, organizing meetings, seminars, and international meetings, writing books and scientific works. They remained in activity until about four years ago. Nowadays, unfortunately, its performance looks precarious, as the only active group, at present, is the one at Universidad Centroccidental Lisandro Alvarado de Barquisimeto. Ruggiero and Morales remained in Brazil, and there they have collaborated with the development of dynamic systems in Brazil.

⁷ see <u>http://www.dynamicalsystems.cl/seminars</u>

⁸ see <u>http://ima.ucv.cl/seminarios-permanentes/dinamica-portena/</u>

Abroad

In other regions, especially in the USA, France, and China, the GDSIMPA also has had a significant impact.

Firstly, because of the training of researchers, such as J. Bochi (doc. in 2001, 45 articles and 609 citations in MR; one doctoral student in TMGP) and F. Rodriguez Hertz (doc. in 2001, 40 articles and 431 citations in MR; two doctoral students in TMGP) both working in the USA, C. Matheus (doc. in 2004, 53 articles and 321 citations in MR; one doctoral student in TMGP) working in France, R. Ures (doc. in 1993, 31 articles and 463 citations in MR; one doctoral student in TMGP) working in China.

Secondly, it has also influenced various mathematicians' research, both in their research topics and through their interactions with people from the IMPA. We highlight the cases of J-C. Yoccoz (doc. in 1985, 69 articles and 1551 citations in MR; 14 doctoral students and 26 descendants in TMGP, Fields Medal 1994), E. Ghys (doc. in 1979, 90 articles and 2361 citations in MR; 20 doctoral students and 53 descendants in TMGP), both in France; V. Kaloshin (doc. in 2001, 65 articles and 647 citations in MR; one doctoral student in TMGP), A. Wilkinson (doc. in 1995, 45 articles and 839 citations in MR; nine doctoral students), both in the USA; L. Wen (doc. in 1986, 35 articles and 541 citations in MR; 12 doctoral students and 15 descendants in TMGP), J. Rodriguez Hertz (doc. in 1999, 29 articles and 294 citations in MR; one doctoral student in TMGP) and S. Gan (doc. in 1997, 36 articles and 386 citations in MR; four doctoral students) in China, to name a few.

Final words

Finally, we can point out that the group of mathematicians described, along with others not mentioned here, and trained under the auspices of the GSDIMPA, develop various collaborative activities. They worked and work for holding meetings, congresses, and exchange of researchers and students, in favor of the development of research in dynamical systems, particularly, and mathematics, in general. Furthermore, several mathematicians mentioned above promoted the creation of the Mathematical Union of Latin America and the Caribbean (UMALCA), counting themselves among its directors from the beginning; and/or have participated in the gestation and promotion of the Mathematical Congress of the Americas (MCA).

This nomination was made and signed by

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