

Brazil-Canada Cooperation in Natural Sciences, Mathematics and Engineering: present scenario and perspectives in the Federal University of Bahia

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Resumo: A cooperação internacional Brasil-Canadá para pesquisa científica em Ciências Naturais, Matemática e Engenharia foi o tema da nossa mesa-redonda no IX Congresso Internacional da Associação Brasileira de Estudos Canadenses (ABECAN). Apresentamos o quadro atual da cooperação em pesquisa científica nessas áreas, na Universidade Federal da Bahia (UFBA) com o objetivo de desenvolver um programa institucional mais sistemático, com a ajuda da Assessoria para Relações Internacionais da UFBA, a fim de aumentar o intercâmbio tanto entre docentes, quanto entre alunos.

Abstract: The international cooperation Brazil-Canada for Scientific Research in Natural Sciences, Mathematics and Engineering was the subject of our round table in IX International Congress of Associação Brasileira de Estudos Canadenses (ABECAN). We present the current scenario of scientific research collaboration on those areas at Federal University of Bahia (Universidade Federal da Bahia – UFBA) with the aim of developing a more systematic institutional program with the help of office for International Affairs of UFBA in order to increase both staff faculty and student exchange.

1 – Introduction

According to the records of the federal research agency CAPES (Coordenação de Aperfeiçoamento do Ensino Superior), Brazilian international cooperation in Natural Sciences, Mathematics and Engineering corresponds to 70% of all research areas in Brazil. However, the number of graduate

courses in Brazilian institutions on these areas sums only to 32%. This reflects intrinsic features of these areas as the research subjects have universal character. At the same time, it hints that the number of graduate students in these areas is under-represented in comparison to staff exchange.

In this scenario, the recent initiative of Canadian and Brazilian governments to negotiate an agreement in science and technology is an important step for increasing the international cooperation Brazil-Canada as it opens that possibility for student exchange between these countries. The main purposes of this agreement, discussed in a workshop promoted by Canada Embassy in March 2007, the main topics are to reinforce areas of cooperation (vaccines, renewable energy, etc) and to stimulate new areas. In July 2007, during the visit of general governor of Canada, Michaëlle Jean, to Brazil, the terms of the agreement Brazil-Canada in Science and Technology was reinforced again in a meeting at UFBA with the general governor, which was attended by several members of ABECAN.

Brazilian international cooperation and graduate courses in all research areas is not evenly distributed among the different regions of Brazil: 60% is concentrated in the Southeast region, while the share of the Northeast region where Federal University of Bahia (UFBA), is located, amounts to 13%. Regarding the Canada cooperation, UFBA develops collaboration with researchers of several Canadian universities in many areas such as Physics, Chemistry, Mathematics, Biology and Engineering. In the next sections, we present some data on UFBA – Canadian Universities cooperation and summarize the recent scenario and perspectives for increasing the exchange in Physics, Mathematics, Biology and Engineering.

2 – UFBA–Canadian Universities Cooperation

(by Roberto F. S. Andrade)

The Royal College of Bahia, founded by the Jesuits in the sixteenth century, was the institution that gave origin to the Federal University of Bahia. After the creation of the School of Medicine (1808) the first higher education institution in Brazil,

many other isolated units were founded in the nineteenth and twentieth centuries, like the Polytechnic School (1896). Finally in 1946, these independent institutions were finally united to form the Federal University of Bahia. From 1950 to 1970, many installations were added including the Institutes of Mathematics, Physics, Chemistry and Biology. During this period, the undergraduate courses were consolidated. From 1970 to 1990, the graduate courses were consolidated. Today, the Federal University of Bahia includes 65 different undergraduate courses with 21000 students and 81 graduate courses at master and doctorate levels with 3000 students, as well as research and community-related activities (<http://www.aai.ufba.br>).

The cooperation between UFBA and Canadian Institutions is very active, and a large number of programs and agreements has been signed. Bellow we list those institutions: Université de Sherbrooke, Université Laval, Uninersité du Quebec à Trois Rivières, Université du Québec à Montreal, York University, Mc Master University, CREPUQ agreement.

Many researchers with permanent position in UFBA cooperate with researchers of Canadian institutions, some of which without a formal agreement through the Office of International Affairs. Based on the Lattes Plataform Curriculum Vitae (CV) data bank (<http://lattes.cnpq.br>), our office identified 26 members of UFBA staff that have done PhD or have had a post-doctoral position in Canadian Universities. The partial list, including only the names of researchers from Natural Sciences, Mathematics and Engineering, is:

ANTONIO CEZAR CASTRO LIMA	Engineering	Post-doctoral	McMaster University	2001-2002
BLANDINA FELIPE VIANA	Biology	Post-doctoral	University of Guelph	2003-2004
JORGE MARIO CARVALHO MALBOUISSON	Physics	Post-doctoral	University of Alberta	2003-2004
LUIZ ROGERIO PINHO DE ANDRADE LIMA	Engineering	Post-doctoral	McGill University	2001-2003
LUIZ ROGERIO PINHO DE ANDRADE LIMA	Engineering	PhD	Université Laval	1995-2000
LUIZ ROGERIO PINHO DE ANDRADE LIMA	Engineering	Post-doctoral	Concordia University	2003-2004
MARIA CECILIA AZEVEDO ESPERIDIAO	Chemistry	Post-doctoral	University of Waterloo	1997
SUANI TAVARES RUBIM DE PINHO	Physics	Post-doctoral	University of Alberta	2001-2002
THIERRY CORREA PETIT LOBAO	Mathematics	Post-doctoral	University of Alberta	2001-2002

Unfortunately the data with respect to student exchange is completely different. From 2002 to 2004, only 3 Canadian students came to study in UFBA. From 2002 to 2006, only 3 students from UFBA went to study in Canadian universities. The reason of the incipient student exchange is mainly the absence of financial support. In this sense, the agreements between the institutions may reduce the taxes for the courses.

3 – Cooperation in pure and applied Mathematics (by Thierry C. Petit Lobão and Suani T. R. Pinho)

The collaboration in Pure and Applied Mathematical Sciences between researchers of UFBA and of University of Alberta (UofA) has started in 2001. The research areas are Non-Commutative Algebra (Pure Mathematics) and Mathematical Biology (Applied Mathematics). The Brazil-Canada collaboration in Non-Commutative Algebra has started in 1980,

involving researchers of UofA and Universidade de São Paulo (USP). In Mathematical Biology, beside the collaboration with UofA, started in 2001, recently (July 2007) new contacts were done with researchers of University of British Columbia (UBC) through a visit promoted by the Pacific Institute for the Mathematical Sciences (PIMS).

3.1 – Researchers

The research group of Non-Commutative Algebra has established a solid cooperative program. It is formed by the following researchers: Sudarshan K. Sehgal, Gerald Cliff, Mazi Shirvani, Al Weiss (UofA); Edgar Goodaire, Mike Parmenter (Memorial University of Newfoundland); Cesar Pocino Milies, Jairo Gonçalves, Michael Dokuchaev, Vitor O. Ferreira, Raul A. Ferraz (USP); Guilherme Leal (UFRJ); Thierry Petit Lobao (UFBa).

The researchers involved in Mathematical Biology are starting to form a research group: Herb Freedman (UofA); Suani Pinho, Roberto Andrade (UFBa); Flora Bacelar (IMEDEA, Spain); Rachel Kuske (UBC).

3.2 – Universities and Research Centers

The institutions involved in the collaboration for both Pure and Applied Mathematics are: Department of Mathematical and Statistical Sciences, University of Alberta (UofA), Pacific Institute for the Mathematics Studies (PIMS), Banff International Research Station for Mathematical Innovation and Discovery (BIRS).

The institutions involved in the collaboration in Pure Mathematics are: Department of Mathematics and Statistics, Memorial University of Newfoundland; Instituto de Matemática e Estatística, Universidade de São Paulo (USP); Instituto de Matemática, Universidade Federal do Rio de Janeiro (UFRJ); Instituto de Matemática, Universidade Federal da Bahia (UFBa).

The institutions involved in the collaboration in Applied Mathematics are: Applied Mathematics Institute, University of

Alberta (UofA); Institute of Applied Mathematics, University of British Columbia (UBC); Instituto de Física, Universidade Federal da Bahia (UFBa).

3.3 – Research Areas

The research areas are the following:

3.3.1 – Non-Commutative Algebra Group Rings

3.3.2 – Mathematical Biology Mathematical modeling of cancer

3.4 – Results

There are regular visits between researchers of UofA and USP since 1980. There is also an effort of researchers from UFBa, involved in the projects, to keep regular visits to UofA as well as receiving the researchers of UofA in UFBa. More recently, it was possible to make this proposal actual. In 2007, we have visited UofA, and in 2008, Prof. Freedman and Prof. Sehgal have visited us in UFBa for the first time. From now on, our aim is to visit UofA every other year. Some Brazilian PhD students will spend some months doing their PhD program in UofA.

The results of these research programs are:

3.4.1 – Organization of Conferences

Since 2004, every other year there is a workshop, held in Ubatuba, São Paulo, Brazil, untitled “Groups, Rings and Group Rings” attended by researchers on Brazil and on Canada.

3.4.2 – Publications

Since 1980, at the beginning of the project in Non-Commutative Algebra, there are many papers and some books (see data base about our publications, or the Lattes CV) published by the group in that subject.

Regarding the project in Mathematical Biology, since 2002, some papers (see the Lattes CV) were published up to now. More recently, due to the regular visits, the number of papers is increasing as well as the number of researchers involved in the project.

3.5 – Students

There are some initiatives of programs for student exchange done by the Pacific Institute for the Mathematics Studies (PIMS). It is joined by five important universities of Western Canada (Simon Fraser University, University of Alberta, University of British Columbia, University of Calgary, University of Victoria). In 2005, the University of Washington joined these five universities. The role of PIMS is to promote research, to strength collaboration, enhance education in mathematics as well as to create strong mathematical partnerships and links within Canada and with organizations in other countries, mainly on the nations of the Pacific Rim and Latin America (<http://www.pims.math.ca>).

Recently PIMS has signed bilateral agreements with institutions in Chile (Centro de Modelamiento Matematico) and Mexico (UNAM and CINVESTAV). During our last visit in Canada, we made contact with PIMS' director, Prof. Alejandro Adem, who expressed their interest in extending these connections to Brazil. He recognizes Brazil as a leader in scientific research in Latin America. Some initial conversations were done in order to sign an agreement between PIMS and UFBA. Under such agreements PIMS can offer: participation in summer schools and conferences organized by PIMS; reciprocal support for short visits by young scholars; iii) postdoctoral opportunities at PIMS universities; iv) organization of joint events.

Another initiative of the Mathematicians in Canada is the Pacific Rim Mathematical Association – PRIMA (<http://www.primath.org/>). It is an association of mathematical sciences institutes, departments and societies from around the Pacific Rim, established in 2005 with the aim of promoting and facilitating the development of mathematics throughout that

region. Although it was originated around the Pacific Rim, special attention will be paid to encouraging membership and developing activities with countries in Latin America, including Brazil.

3.6 – Contact

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4 – Cooperation in theoretical physics (by Ademir E. Santana)

Researchers from Brazil and Canada have established a solid collaborative research program, concerned mainly with Mathematical Physics, Quantum Field Theory and their applications to numerous problems in Physics, since 1994. Over this period, the collaboration has involved post-Doctoral fellows and students working towards MSc and Ph.D. degrees. It has attracted researchers from Israel, India, Korea, Japan and Uzbekistan, as well as from other groups in Brazil. Every year we hold a meeting in Canada for two months, and for one month in Brazil. A brief description of this Collaboration follows.

4.1 – Researchers

Presently the group is composed by the following researchers working systematically (some are former students, now in a fixed position): J. Mário C. Malbouisson (UFBA), J. David. M. Vianna (UFBA/UnB), Arthur Matos Neto (UFBA), A. E. Santana (UnB), T. Marciano da Rocha Filho (UnB), A. Pedro C. Malbouisson (CBPF), Luciano Mello Abreu (UFRB), Esdras S. Santos (CEFET-BA), F. C. Khanna (UofA), M. de Montigny (UofA), M. Revzen (Technion).

4.2 – Universities and Research Centers

The Institutions involved in the collaboration are: Instituto de Física, Universidade Federal da Bahia (UFBA); Instituto de Física, Universidade de Brasília (UnB); Centro Brasileiro de Pesquisas Físicas (CBPF), Rio de Janeiro; Centro Federal de Educação/BA (CEFET-BA); Universidade Federal do Recôncavo da Bahia (UFRB); Theoretical Physics Institute, Department of Physics, University of Alberta (UofA), and TRIUMF, Canada; Faculte St. John, University of Alberta (UofA); Technion, Haifa, Israel.

Besides that, over the years we established some other collaboration: Dr. M. Kobaiachi (Gifu University, Japan), Dr. S. P. Kim (Kunsan University, Korea), Dr. M. C. B. Fernandes (UnB, Brazil), Dr. J. Cardeal (UEFS, Brazil), Dr. H. X. He (Beijing, China), Dr. M. A. Rakhimov (Tashkent, Uzbekistan), Dr. D. U. Matrasulov (Tashkent, Uzbekistan).

4.3 – Research Areas

The research areas are the following:

4.3.1 – Quantum field theory

Elementary Particles

Condensed Matter physics: Casimir Effect;

Superconductivity

Quantum Optics

4.3.2 – Mathematical Physics

Representations of Group theory

Clifford Algebras

Lie groups applied to field and transport equations

4.4 – Results

The results of this research program are:

4.4.1 – Organization of Conferences

The group has been directed involved with organization of the following conferences: School on Quantum Field Theory and Gravitation (participation in the first, second and third school) (Brazil); Brazilian National Meeting on Theoretical and Computational Physics (permanent) (Brazil); Fundamental Interactions (2004) (International Conference in Uzbekistan).

4.4.2 – Computer Programs

The Brasília group has developed the Package: SADE (Symmetry Analysis of Differential Equations), which has been largely used by our Collaboration to study symmetry properties (and to find solutions) of field equations.

4.4.3 – Publications

We have published papers and chapters of books (see some data base about our publications, or the Lattes CV). Nowadays we are involved with the writing of a Monograph by four of us: F. C. Khanna, A. P. C. Malbouisson, J. M. C. Malbouisson and A. E. Santana, Thermal Quantum Field Theory: Algebraic Aspects and Application; to appear – W. Scientific. In part, the monograph is a synthesis of our work up to now.

4.5 – Students

Over the years, PhD and MSc students and Post Docs have been involved with the research program. The main problem to keep and improve on our collaboration is to find

proper financial support. Our dynamics of work has been to visiting each other at least two times a year. Some support for that we have found in Post-Graduation Programs of the Brazilian Universities, which are supported by Brazilian Agencies, CAPES and CNPq. In Canada we find support from NSERC. In both of the cases, the support is as personal grants, which are used to cover the local expenses with accommodations and meal. Our Universities have provided enough facilities for our work. We do not have money for the group in an institutionalized way. This aspect has been the main difficulty to improve our collaboration, and to involve more students. Maybe we can find some solution to these problems with an agreement among our Universities. This is an aspect that we are dealing with presently.

4.6 – Contacts

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5 – Cooperation in Biology

(by Blandina F. Viana)

In relation to Biological Sciences, we provided information about the collaboration in ecology with researchers of the University of Guelph (UOGUELPH) and Université du Québec à Montréal (UQAM). The collaborative research program between UFBA-UOGUELPH and UFBA-UQAM has started in 2002 and 2003, respectively. The research areas are conservation biology, crop pollination and pollination ecology. Beside UFBA, other universities are involved in this collaboration. More recently, the researchers from the Universidade Federal de Minas Gerais (UFMG) and Universidad de Cordoba, in Argentina, join the team. Every two-year since 2003 a bi-national field course in Pollination Biology is offered in Bahia by UFBA and UOGUELPH. Technicians, Masters and PhDs from various universities as well from other research centers in Brazil and Latin America have attended this course.

5.1 – Researchers

Presently the group is composed by the following researchers (some are former students, now in a fixed position): Blandina Felipe Viana (UFBa), Breno Freitas (UFC), Claudia Jacobi (UFMG), Domingos de Oliveira (UQAM), Edinaldo Luz das Neves (Faculdade Jorge Amado), Fabiana Oliveira da Silva (UNEB/FJA), Favizia Freitas de Oliveira (UEFS), Hisatomo Taki (UOGUELPH), Leonardo Galetto (Universidad de Córdoba, Argentina), Marina Siqueira de Castro (EBDA/UEFS), Nadia Roque (UFBa), Peter Kevan (UOGUELPH), Roy Funch (Fundação Chapada Diamantina), Washington Rocha (UEFS).

5.2 – Universities and Research Centers

The Institutions involved in the collaboration are: Instituto de Biologia, Universidade Federal da Bahia (UFBa);

Departamento de Ciências Biológicas, Universidade Estadual de Feira de Santana (UEFS); Universidade Federal de Minas Gerais (UFMG); Universidade Federal do Ceará (UFC); University of Guelph; Université du Québec à Montréal (UQAM); Faculdade Jorge Amado (FJA); Empresa Baiana de Desenvolvimento Agrícola (EBDA) and Universidade do Estado da Bahia (UNEB).

Besides that, over the years we established some other collaborations: Dr. Leonardo Galetto (Universidad de Córdoba); Dr. Alexandra Maria Klein (University of Gottingen); Dr. Jean Paul Metzger and Dr. Astrid Kleinert (Universidade de São Paulo).

5.3 – Research areas

The research areas are the following:

5.3.1 – Biological conservation

Conservation and management of pollinators
Landscape Ecology

5.3.2 Pollination Ecology and Biology

Crop pollination
Floral Biology
Visitor-flower interaction

5.4 – Results

Since 2002 there here are regular visits between researchers of the Canadian Universities above mentioned and UFBA. The cooperation has included meeting and graduate course organization, students supervising, research project developments and publications.

The results of this research program are:

5.4.1 – Organization of conferences

In Canada and Brazil the group has been directly involved in the organization of the following activities: 150th

Meeting of the Entomological Society of Ontario (Guelph) and Forum Brazil - Sciences and Societies (Montreal).

5.4.2 – Collaborative teaching

Canadian and Brazilian researchers have offered systematically the following graduate and under graduate courses:

In Brazil: 2003, 2005 and 2007: Bi-national Pollination Course (UOGUELPH/UFBA/UEFS); 2005: Pollination in Agroecosystem Course (UQAM/UFBA/EBDA)

In Canada: 2004: Arctic Ecology and Entomology Course (Manitoba); 2004 – Applied Ecology Course (Ontario).

5.4.3 – Publications

The group has published scientific articles and a book (see www.labea.ufba.br, or the Lattes CV). Nowadays we are organizing another book with the contributions of the participants of Pollination course 2007.

5.4.4 – Research partnership

In 2007 and 2008 we elaborated proposal to Request for Funding to *Kinross Canada-Brazil Network for Advanced Education and Research in Land Resource Management* and National Geographic to support collaborative researches projects and the Pollination Biology Course.

5.5 – Students

Even though there is a close collaboration between researchers from Canada and Brazil the Brazilian student's exchanging has been still modest. Over the years, few PhD and MSc students and Post Docs have been involved with the research program. The main problem to involve more students and researchers is to find proper financial support.

Recently UFBA and UQAM have signed bilateral agreements. The mainly objective of the agreement is developing collaboration on Biology, Letters, Communication

and Environmental Sciences. Specifically it will promoting integrative research projects; exchanging professors and expertise for teaching and supervising; exchanging students; strengthening collaboration between scientists. With this institutional collaboration we expected to find financial support from Brazilian and Canadian agencies to keep and improve the students and researchers participation.

5.6 – Contacts

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6 – Cooperation in Engineering

(by Luiz Rogério P. de Andrade Lima)

Regarding Engineering, we present the collaboration between the Department of Materials Science and Engineering of UFBA and the Departments of Chemical Engineering of McGill University (Prof. A. D. Rey) and Mechanical Engineering of the University of British Columbia (Prof. D. Grecov) in the fields of rheology of complex fluids and computational materials science. We also present the collaboration between the Department of Materials Science and Engineering and the Department of Mining, Metallurgy and Materials Engineering of the Laval University (Prof. D. Hodouin) in the fields of extractive metallurgy, mineral processing, and process system engineering. Other collaborative

initiatives, such as, between the Department of Electrical Engineering and the McMaster University and the University of British Columbia in telecommunication and power engineering was presented. Finally, we discuss the current undergraduate exchange experiences between UFBA and Canadian universities, such as McGill and Concordia University, and the recent agreement, led by the Department of Chemical Engineering of UFBA, to host the 2008 Engineering Study Abroad Program of the McMaster University.

7 – Concluding remarks

Finally we were able to exhibit a summary of the cooperation in Biology, Physics, Mathematics and Engineering, between researchers of UFBA and researchers of many Canadian institutions. There is also cooperation in other areas of Natural Sciences, as for instance Chemistry that was not presented here. Although the majority of the presented researches correspond to individual initiatives, mainly started from post-doctoral programs, they are very fruitful resulting in continued collaborations. Our main conclusion is the necessity of improving the financial support mainly for student exchange as well as the relevance of increasing institutional research programs that are very welcome by the Office of International Affairs of UFBA. We are interested in setting up student exchange program as well as providing an institutional character for the actual cooperation. We hope to get some support from the Canadian Embassy as well as from ABECAN.