Recent Advances of the Brazilian Science and Crystallography in Particular

GLAUCIUS OLIVA

2014 international year of crystallography
Historical Notes on S&T in Brazil

- Until World War II Brazil had a very small number of scientists and little institutional base for research
- Industry was incipient, mostly in traditional sectors
- Federal S&T agencies (CNPq, CAPES, FINEP) created in 1951-70
- Graduate programs and full-time faculty positions established only in the 1960s
- In the 1970s CNPq, CAPES and FINEP (FNDCT) strongly supported the institutional base for S&T

Despite the short history, Brazil has already achieved important advances in S&T, with significant impacts in our economy
BUILDING BRICKS
EXPLORING THE GLOBAL RESEARCH AND INNOVATION IMPACT OF BRAZIL, RUSSIA, INDIA, CHINA AND SOUTH KOREA

FEBRUARY 2013

THE BRICK NATIONS REPRESENT THE MOST SIGNIFICANT GROWING INFLUENCE IN THE GLOBAL ECONOMY AND RESEARCH LANDSCAPE.
GROWTH IN THE GROSS DOMESTIC PRODUCT (GDP) OF THE BRICK NATIONS

FIGURE 1

Source: Data from the World Bank expressed as US$ current in the year for which the data are recorded (i.e., 2001 data at 2001 prices). Data not adjusted for purchasing power parity. Some sources query the precise values but not the profile for China.
ANNUAL CHANGE IN GROSS EXPENDITURE ON RESEARCH & DEVELOPMENT (GERD) AS A PERCENTAGE OF NATIONAL GROSS DOMESTIC PRODUCT (GDP)

Figure 2

Source: OECD and Network for Science and Technology Indicators (RICYT); analysis: Thomson Reuters
ANNUAL RESEARCH PUBLICATION OUTPUT OF THE FIVE BRICK COUNTRIES

FIGURE 5

CHINA’S OUTPUT EXCEEDED 150,000 PAPERS IN 2011

Source: Thomson Reuters Web of Knowledge. (See also Figure 7 on trajectories of patent output.)
Source: Thomson Reuters Web of Knowledge. Although the average citation impact of much of the research remains below world average (which is set at 1.00), it is evident that the impact trend is generally consistently upwards for all these countries. Several BRICKs show an impact drop in the last few years, but this is a data artifact associated with atypically early citation of papers published in G7 economies.
Cases of Success in Science & Technology

UFRJ
Universidade Federal do Rio de Janeiro

COPPE
UFRJ

PETROBRAS

CENPES

CIÊNCIA SEM FRONTEIRAS
Ministério da Ciência, Tecnologia e Inovação
GOVERNO FEDERAL
BRASIL
PAÍS RICO É PAÍS SEM POBREZA

CNPq
Conselho Nacional de Desenvolvimento Científico e Tecnológico
Leader in deep sea oil and gas prospection and extraction
Cases of Success in Science & Technology

Prof. Richard H. Smith, Head of Aeronautics Dept. at MIT → Brazil, 1948
3rd largest aerospace company in the world
Centenary Agricultural Schools
Leader in Tropical Agriculture, Food Production and Export

Brazilian agricultural production has been fuelled by S,T&I

<table>
<thead>
<tr>
<th>Product</th>
<th>World production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar, orange juice, coffee</td>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
</tr>
<tr>
<td>Soya, Beef and poultry</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
</tr>
<tr>
<td>Corn, fruits</td>
<td>3&lt;sup&gt;rd&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
Sugarcane Bio-ethanol for Vehicle Fuel

- First experiments date back to 1925
- Proálcool (1975): bioethanol blended in gasoline (25%)
- Flex-fuel engines (gasoline, bioethanol or mix) introduced in 2003
- 90% of the sold cars are flex-fuel
- Total bioethanol today equals the amount of gasoline
Science without borders:
The new Brazilian scientific international mobility program
National Development Strategy

• Invest in people: development of skills and competences needed to the full insertion in the knowledge-based economy

• Focus on the national strategic challenges
  – Engineering and other technological areas
  – Strategic areas

• Promotion of industrial R,D&I
# Landscape of the Brazilian Higher Education System

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institutions (Universities and Colleges)</td>
<td>2,377</td>
</tr>
<tr>
<td>Undergraduate enrolments</td>
<td>7.2 million</td>
</tr>
<tr>
<td>Undergraduate conclusions per year</td>
<td>1.2 million</td>
</tr>
<tr>
<td>Graduate students (MSc+PhD)</td>
<td>200,000</td>
</tr>
<tr>
<td>MSc conclusions per year</td>
<td>43,000</td>
</tr>
<tr>
<td>PhD conclusions per year</td>
<td>13,000</td>
</tr>
</tbody>
</table>
Number of Enrolments in Higher Education
(only undergraduates, includes distance education)
2001-2010

Source: MEC / Inep
Science Without Borders Program

• Boost Brazilian science, technology, innovation and competitiveness through the expansion of international mobility. (100,000 fellowships in 4 years)

• Increase the presence of Brazilian researchers and students of various levels in institutions of excellence overseas; Brazilian institutions will open similar opportunities for foreign scientists and students;

• Increase the innovative expertise of personnel from the technological industries;

• Attract young scientific talents and highly qualified researchers to work in Brazil.
Priority Areas

- Engineering and other technological areas;
- Natural Sciences
- Health and Biomedical Sciences;
- Computing and Information Technology;
- Aerospace;
- Pharmaceuticals;
- Sustainable Agricultural Production;
- Oil and gas;
- Nuclear Energy
- Renewable Energy;
- Minerals;
- Biotechnology;
- Nanotechnology and New Materials;
- Technology for prevention and mitigation of natural disasters;
- Biodiversity and bioprospection;
- Marine Sciences;
- Technologies for the green economy;
- New technologies for constructive engineering;
- Capacity building for technical personnel.
Modalities of Fellowships and Targets 2012-2015

<table>
<thead>
<tr>
<th>Fellowship Type</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Sandwich” - Undergraduate</td>
<td>64,000</td>
</tr>
<tr>
<td>“Sandwich” – PhD</td>
<td>15,000</td>
</tr>
<tr>
<td>Full PhD abroad</td>
<td>4,500</td>
</tr>
<tr>
<td>Post-Doctoral Fellowship abroad</td>
<td>6,440</td>
</tr>
<tr>
<td>Fellowships for industrial scientists and engineers</td>
<td>7,060</td>
</tr>
<tr>
<td>Young talents to Brazil</td>
<td>2,000</td>
</tr>
<tr>
<td>Visiting Leading Scientists to Brazil</td>
<td>2,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>101,000</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government</td>
<td>75,000</td>
</tr>
<tr>
<td>Private sector</td>
<td>26,000</td>
</tr>
</tbody>
</table>

Science without Borders
# Companies supporting the CsF Program

<table>
<thead>
<tr>
<th>Company</th>
<th>Additional Fellowships</th>
</tr>
</thead>
<tbody>
<tr>
<td>Febraban</td>
<td>6.500</td>
</tr>
<tr>
<td>CNI</td>
<td>6.000</td>
</tr>
<tr>
<td>ABDIB</td>
<td>5.000</td>
</tr>
<tr>
<td>Petrobras</td>
<td>5.000</td>
</tr>
<tr>
<td>Eletrobras</td>
<td>2.500</td>
</tr>
<tr>
<td>VALE</td>
<td>1.000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>26.000</strong></td>
</tr>
</tbody>
</table>
Fellowships awarded
(Dec/2013)

<table>
<thead>
<tr>
<th>Fellowship Type</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Sandwich” - Undergraduate</td>
<td>47,713</td>
</tr>
<tr>
<td>“Sandwich” – PhD</td>
<td>5,691</td>
</tr>
<tr>
<td>Full PhD abroad</td>
<td>1,660</td>
</tr>
<tr>
<td>Post-Doctoral Fellowship abroad</td>
<td>3,695</td>
</tr>
<tr>
<td>Young talents to Brazil</td>
<td>338</td>
</tr>
<tr>
<td>Visiting Leading Scientists to Brazil</td>
<td>925</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>60,022</strong></td>
</tr>
</tbody>
</table>
SwB Fellows around the world
SwB Fellows around the world

University of California, Davis

http://ucdavis.edu
Davis, 95616, Estados Unidos

**Bolsistas:**
- Doutorado Sanduíche no Exterior: 21
- Doutorado no Exterior: 4
- Graduação Sanduíche no Exterior: 62
- Pós-Doutorado no Exterior: 16
- **Total:** 103

**Filtros:** Estados Unidos;

Bolsistas Vigentes  Todos os Bolsistas
SwB Fellows around the world

University of California, Davis, Estados Unidos

Mariana Lemos de Moraes
UFRGS - Universidade Federal do Rio Grande do Sul
Porto Alegre - RS
Bolsista de Doutorado Sanduíche no Exterior
Área prioritária: Produção Agrícola Sustentável
Área do conhecimento: Zootecnia
Vigência: 01/09/2012 a 31/05/2013

Jessica dos Anjos Oliveira
UNB - Universidade de Brasília
Brasília - DF
Bolsista de Graduação Sanduíche no Exterior
Área prioritária: Biologia, Ciências Biomédicas e da Saúde
Área do conhecimento: Não informado
Vigência: 01/09/2012 a 31/08/2013
O programa Estágio Ciência Sem Fronteiras é voltado para as empresas, instituições de ciência e tecnologia e bolsistas da Ciência sem Fronteiras interessados em troca de conhecimento profissional. O objetivo desse espaço é unir as empresas interessadas em oferecer vagas de estágio nas áreas de interesse relacionadas, como também ao selho para a edição eletrônica, permanecendo essencialmente inalterado. Se popularizou na década de 60, quando o Letraset lançou decalques contendo passagens de Lorem Ipsum.

Lorem Ipsum é simplesmente uma simulação de texto da indústria tipográfica e de impressos, e vem sendo utilizado desde o século XVI quando um impressor desconhecido pegou uma bateria de tipos e os embaralhou para fazer um livro de modelos de tipos.
Crystallography in Brazil
Past, Present and Future
Crystallography in Brazil - 1952


• 40th Anniversary of the Discovery of X-ray Diffraction

“10 June 1952 at a special meeting promoted by the Brazilian National Committee for Crystallography and held under the sponsorship of the Brazilian Academy of Sciences. Dr. Arthur Moses, President of the Academy, Chair, and after the presentation of a message written for the occasion by Prof. von Laue the following papers were read:"


10 June 1952: at a special meeting promoted by the Brazilian National Committee for Crystallography

• 'History of the Discovery of X-ray Diffraction with an Account of Forty Years Progress in the Crystallographic Field' by E. Tavora, Secretary of the Brazilian National Committee for Crystallography and Professor of Mineralogy at the University of Brazil.

• 'Crystallography and Chemistry' by Admiral Alvaro Alberto, Founding President of the National Research Council (CNPq) and Professor of Chemistry at the Naval Academy of Brazil.

• 'Crystallography and Physics' by Bernard Gross, Head of the Sector of Physical Research of the National Research Council.

• 'Crystallography and Metallurgy' by E. Fonseca Costa, Director of the National Institute of Technology and Professor of Metallurgy at the University of Brazil.

• 'Crystallography and Biology' by Carlos Chagas, Professor of Biophysics at the University of Brazil.

• 'Crystallography and Mineralogy' by E. Tavora.
Prof. Yvonne P. Mascarenhas

Powder Diffraction

Single-crystal chemical crystallography

SAXS

Protein Crystallography

1956 – Physics Department of the University of São Paulo at São Carlos
1975 Acquisition of an automatic single crystal diffractometer for the IFSC Crystallography Laboratory.
PDP 11 – 128k de memória (1976)
Chemical crystallography in Brazil

~3000 structures solved in Brazil

Yvonne P. Mascarenhas

Eduardo E. Cstellano
Protein Crystallography in Brazil

~400 structures solved in Brazil since 1990
SAXS in Brazil
March 1972 Creation of the Brazilian Association of Crystallography with the participation of mineralogists, physicists and chemists.
1975 V Ibero-American Crystallography Congress held in Brazil.

Lima de Faria (Portugal), Galloni (Argentina), Zeferinno Vaz (Reitor) YPM, S. Caticha Ellis, ?, Rilson Rodrigues da Silva (Pernambuco), Zbgniew Baran (Cristalógrafo polonês radicado na Bahia)
1997 – LNLS - a Landmark: The construction and operation of the first Synchrotron Facility in the Southern Hemisphere

2016 – SIRIUS The new Brazilian Synchrotron Source, under construction
XVI Reunião da SBCr

De 16 a 19 de março de 2003
Campus da USP/São Carlos
19ª Reunião da ABCr

9 a 11 de setembro 2009 - Campus Pampulha da UFMG - Belo Horizonte
Brazilian publications in Crystallography

14,400 publications in the period 2000-2013
Lattes Platform: the Brazilian curricula database in S,T&I

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of Curricula</td>
<td>3,284,473</td>
</tr>
<tr>
<td>Curricula with at least one product</td>
<td>1,890,433</td>
</tr>
<tr>
<td>Curricula with at least one published paper</td>
<td>475,383</td>
</tr>
<tr>
<td>Curricula with at least one patent deposit</td>
<td>13,842</td>
</tr>
<tr>
<td>Curricula of Masters or PhDs</td>
<td>535,362</td>
</tr>
<tr>
<td>Daily access to the Platform</td>
<td>100,000</td>
</tr>
<tr>
<td>Daily Curricula updates</td>
<td>15,000</td>
</tr>
<tr>
<td>PhDs in Crystallography</td>
<td>3,097</td>
</tr>
</tbody>
</table>
The creation of LACA
The Latin American Crystallographic Association

To be hosted by Brazil and with provisional Executive Committee with:

President of LACA: President of the Brazilian Crystallographic Association
Vice-Pres. of LACA: President of the Argentinean Crystallographic Association
Secretary of LACA: Member of the Executive Board of the Mexican Crystallographic Association
Brazil & IYCr2014

• As part of IYCr2014, the Latin American summit meeting on "Biological Crystallography and Complementary Methods" will be held at the National Synchrotron Light Laboratory (LNLS) in Campinas, Brazil from the 22nd to the 24th of September 2014.
Thank you!

Dr. Glaucius Oliva
President
Brazilian National Council for Scientific and Technological Development