Annual Report of the National Institute of Science and Technology in Astrophysics (INCTA) - 2009

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What is the INCTA? – An executive summary

Context

Brazilian Astronomy, although young, has already made some important achievements.. The first graduate programs were established in the 1970´s and, since then, the community experimented continuous and vigorous growth. Today nearly 30 institutions support of astronomical research at some level. The first scientific equipment were planned and built in the early 1970´s; an important strategic step was the construction of LNA – the first (and for long time the only one) national laboratory to operate in Brazil. Thanks to this laboratory, Brazilian Astronomy experienced a growth, both in quantity and in quality. This allowed joining the Gemini and SOAR consortia in the 1990´s. These consortia operate world class astronomical instruments.

The situation of optical and infrared astronomy is, thus, quite favorable. The participation in the Gemini and SOAR consortia has put our community in contact with the best practices of science management and, at the same time, integrated networks of specialists. Although the SOAR telescope does not have its full instrumentation operational, we already can state that Brazilian contribution to the publications of both Gemini and SOAR consortia is at the highest ranking. At the same time the perspective of world–class instrumentation has revitalized the various groups and attracted young talented people to the graduate programs.

For the next decade, world astronomy is planning new and significant steps. At all wavelengths, a next generation of telescopes is under construction: optical 20-40m class (GMT, TMT, ELT) telescopes, radio-interferometers (ALMA, SKA), a new generation of space-borne instruments (IXO, Webb) and a large deep optical survey telescope (LSST). Many of these equipments are multinational initiatives, given the high costs involved, some of them, in the range of a billion dollars and will take 10 to 15 years to be built. Direct participation in such projects is beyond our possibilities, but there are niches from which our astronomy may benefit. The form and intensity of these benefits depend on some new investments but mostly on careful and strategic planning. If this is not done, our community will have less and less opportunities in the international scenarios for the coming decades.

In the present INCT, a significant number of researchers from many institutions meet, to plan and implement actions, having in mind the future of Brazilian Astronomy. ***We are researchers from diverse institutions and of distinct specialties, but we all need the same***

scientific infrastructure and above all, similar collective strategies. *These are the characteristics that provide the* ***unity*** *to this initiative. These strategies are more and more necessary, given the high costs of the new research equipment and timescales needed for their construction.*

Our community already has a national laboratory (LNA) that operates the national infrastructure in optical and infrared astronomy. The INCTA aims toward a partnership with LNA and other institutions to mobilize the community in fostering the best insertion of Brazilian Astronomy in the great international projects underway and those that still will be proposed.

Moreover, we want to promote the culture of technological innovation by supporting the development of world class instrumentation aimed at basic research.

If in the recent past Brazilian Astronomy has advanced in a significant way, its future depends on our planning and organization capabilities. New large and expensive projects are under way in the developed countries, many of them in the form of international consortia, given their high costs, which are prohibitive toward our direct participation. However it is possible to create alternative routes, identifying niches that can bring benefits to our science through creative strategies of international cooperation.

Such associations will increase the networking, both institutional and individual, showing us the best international practices of organization, planning and management of science. This effort is of fundamental importance to provide the environment for the next generation of scientist to perform frontier research.

The "Instituto Nacional em Ciência e Tecnologia em Astrofísica – INCTA", in addition to the host institute, has one associated laboratory (LNA), 3 other MCT research institutes, 14 federal universities, 3 state universities and 6 private universities, comprising a total of 32 research groups, 12 being consolidated and 20 emergent ones in 27 different institutions. A total of 144 PhD scientists are joining the institute; 52 of them have CNPq scientific productivity fellowship, 12 being level 1A.

Misssion

The mission of the National Institute of Science and Technology in Astrophysics is to insert Brazilian Astronomy into the future of the World Astronomy.

Strategic Goals

1- Maximizing the return from the Gemini and SOAR telescopes.

a) Scientific return: Brazil already presents the highest productivity index among the Gemini partners (Brazilians have used 2.3% of the time and published 10% of the papers). For the SOAR telescope this statistical comparison is still premature as the telescope was built about 5 years later than Gemini. Surely the numbers that matter are not only the number of papers. Quality is also relevant. As a goal, we propose that Brazil maintains the leadership in scientific productivity for both Gemini and SOAR consortia for the next 5 years.

b) Graduate programs: There are 10 graduate programs that offer Master+PhD programs in Astronomy (USP; UFRGS; UFMG; ON; INPE; UFRN; UFSC; UNIVAP; UFSM; FEG-UNESP). Another 4 offer master degree only (UNICSUL; OV-UFRJ; UESC; UERN). The possibilities opened with the access to the Gemini and SOAR telescopes have attracted many new talented

people to Astronomy. Today we have a good number of promising talented young people in our graduate programs and integrating them in the scientific production with the use of large telescopes and world-class instruments is one of the most effective ways of attracting and educating more talented people. Our goal is to double the number of papers published by Brazilian graduate students with data from the Gemini and SOAR telescopes in the next 3 years (2009-11 compared to 2006-08) with a following growth of 15% per year.

c) Supporting emergent groups: Besides attracting and educating talented people, we also want them to get a job in our country. Our major research institutes seem to be saturated growth wise. At the same time, the vast majority of universities do not have a single astronomy professor. In recent years Brazilian Astronomy has, in fact, experimented a new phenomenon: non-traditional universities, both public and private, have hired a number of young and productive astronomers in their faculty. These new groups, often very small in number, need to be supported, integrated in networks and have access to the best existing equipment. Our goal is to double the number of papers published with authors from emergent groups with data obtained from Gemini, SOAR and alike, for the next 3 years, followed by a growth of 15% per year. Among other incentives, INCTA will provide support to their research, by supplying computer equipment to researchers that obtain observing time with large telescopes provided they are justified within the aims of the Institute. We propose to support the participation of people from emergent groups in scientific meetings when presenting results from large telescopes. These groups will also have access to financial support to foster national and international networking, that is, contact with scientists for seminars, to avoid intellectual isolation, as most of these groups are located far from the main centers.

d) Stimulate the development of instrumentation for the Gemini and SOAR telescopes. The Brazilian participation in the Gemini and SOAR consortia has allowed, for the first time, the effective construction of modern instruments for large telescopes. Currently Brazil is concluding the construction of the SIFS – SOAR Integral Field Spectrograph – with 1300 fibers, capable of operating with adaptive optics. Other two instruments are in distinct phases of construction: the Steles (high resolution spectrograph) and the BTFI (Fabry-Perot large field imaging spectrograph). Our goal: to conclude the construction and commissioning of the three instruments underway and begin a new one in the next three years.

2 – Brazilian Astronomy in the era of the LSST and ELT projects. *The next generation of large telescopes is being planned now. The GMT, TMT and E-ELT are in the process of starting their construction. It is important for Brazilian astronomy to establish a strategy for the era of ELTs, that will be operational by the year 2020. The Large Synoptic Survey Telescope, on the other hand, is a North-American initiative for building and operating a telescope of 6.5 m effective aperture (8.4m nominal) to monitor the sky in 6 filters. This will be a deep survey with an unprecedented approach in the sense that it will revisit the same regions in the sky at about every 4 days, so that it will add a temporal dimension to the data. The magnitude limit for single observations will be r ~24 and it will have a cumulative limit of r~27.5. This project has 4 main broad goals: a) the nature of dark energy and dark matter; b) The transient sky; c) The structure of the Milky Way and d) The structure of the Solar System. This project will make some observations available in real time having profound impact on Brazilian Astronomy.*

3 – Virtual observatories*. Great part of the data from space missions and also from ground based telescopes are available in databases. These datasets contain a wealth of information and mining them may be of enormous benefit to Brazilian Astronomy, without proportional financial investments. Significant effort in software is imperative to make the appropriate and necessary development. Our goal is to have an operational network of virtual observatories in Brazil within the next 3 years.*

4 – New projects of scientific equipment*. A minimum of 3 new projects, to be defined by the Science committee, will be elaborated and proposed: at least one in radio-astronomy, at least one scientific satellite and at least one in optical/infrared astronomy. These projects will be elaborated to the point where they can be presented to the funding agencies or to possible international partners.*

5 ***– Education activities:*** *we propose to organize a distance learning course on astronomy for science teachers.*

The report: 2009

Introduction

This is the first scientific report of the National Institute for Science and Technology in Astrophysics - INCT-A. The activity INCT-A began in May 2009, after the first resources were received. Soon after we had the meeting of the IAU General Assembly in Rio de Janeiro which required the very large concentration of efforts of the main leadership. Therefore the activities started in fact in the second half and will be accelerated in the first half of 2010.

Also in May 2009 the Scientific Committee of INCT-A decided to adopt as a method of planning, the ellaboration of "White Papers" for the different activities. Two months later, the MCT has formed a Special Committee on Astronomy - CEA. This Commission also decided to produce "White Papers" (WP), hence the initiative of the WP/INCT-A merged with those of CEA and a significant number of WP was released. This is the first step of planning INCT-A and WP with strong participation of members of INCT-A are reproduced in the annexes and make up the essence of this report. Both this report as the other documents are available to the public on the website of INCT-A:

www.astro.iag.usp.br / incta

Below we present results, by item, of our five strategic objectives.

1 - Return on investments in the Gemini and SOAR

1a - Scientific Production

In 2009, the 144 researchers of the INCT in Astrophysics published 148 papers (see bellow). Of these, 83% were published in journals classified as Qualis A by CAPES (see Table 1). It is true that significant scientific output would have occurred without the existence of INCT. On the other hand it shows that the group of researchers linked to INCT has a great capacity for scientific work and that a strategic plan for that area makes sense.

Brazil's participation in the Gemini and SOAR has shown significant return. In Gemini, the Brazilian participation in refereed publications is already about 10% and is growing. In 2009, Brazilian authors participated in 13% of the papers and 9% were the first authors. Altogether 69 authors have signed Brazilian papers with data from Gemini to date.

In SOAR, scientific production is still incipient. This telescope began its operation five years after the Gemini. Still, we can say that Brazil accounts for 54% of the papers published to date, having used only 30% of the time. We list the publications of Brazilian authors containing data from the Gemini and SOAR telescopes bellow. Perhaps more important at this time is that the SOAR Telescope has enabled Brazilian Astronomy to establihe a world class instrumentation program (see bellow).

1b / c - Human Resources and Emerging Groups

In terms of human resource training, the INCTA allocated the first postgraduate scholarships for Masters, restricted to emerging groups. In addition, the emerging groups produced a "White Paper" proposing a strategy for action (Appendix 1b). A collection of books Astrophysics in Portuguese, was acquired by INCTA and distributed to all emerging groups.

1d - Instrumentation

The SOAR Telescope has enabled the development of a world-class instrumentation program. In December/2009, SIFS (SOAR Integral Field Spectrograph see Appendix 1d) was sent (with financial support from INCT-A) to Chile. This spectrograph is already installed on the telescope and is in its commissioning phase (see Annex Item 1d). The spectrograph, which costed U.S. $ 1 420 000.00, was funded by FAPESP (79%), LNA (15%) and CNPq / Millennium (6%). The participation of INCTA was small (components and transportation).

Most of the INCT/FAPESP spending in the first year were related to BTFi (Brazilian Tunable Filter Imager). This project, coordinated by Prof. Claudia Mendes de Oliveira, has a budget of one million dollars and is being funded directly by FAPESP (53%), indirectly by FAPESP through INCTA (29%) and by LNA (13%). The instrument is in the final stage of integration in the lab of IAG.

2 - Brazil in the era of LSST and ELTs

The discutions on ELTs (Extremely Large Telescopes) has taken much of the efforts of INCTA. Several contacts and meetings were held between the sub-group with special responsibility and the various projects. Annexes 2a, 2b and 2c describe these activities.

3 - Virtual Observatories

A sub-group was appointed that is responsible for drafting a "White Paper" (see Annex 3a). Three researchers participated in international events in the IVOA-International Virtual Observatory Alliance. Their trip reports can be found on the INCTA site.Trough INCTA, Brazil became a member of the IVOA.

4 - New projects

With respect to this item, a sizable number of white papers were produced (see annexes 4). The INCT along with INESPAÇO hosted a workshop on the prospects of space astronomy in Brazil.

As for projects, they can be classified between instrumental and purely scientific. They map the demand from Brazilian astronomy with detail.

5 - Education

INCTA also formed a group on Education, with the goal of designing a course in astronomy for science teachers of primary and secondary schools throughout Brazil. This group also selected a book to be translated into Portuguese and serve as a reference book for the course: "Voyages trhough the Universe" by Fraknoi, Morrison and Wolff. Contacts were made with the authors, their publishers and potential publishers in Brazil interested in publishing it.
Several study visits were made in order to understand the demand and propose partnerships. Among these visits we visited the Secretariats of Education of the State of São Paulo and Minas Gerais.

Table 1 - Distribution of the papers published by the INCT of Astrofísica researchers in 2009, by journal

Journal	Qualis	Nr of papers	%
A&A	A2	34	23
MNRAS	A2	35	23
ApJ	A1	27	18
PhRvD	A2	10	7
AJ	A2	10	7
PhRvL	A1	1	1
AstL	s/c	1	1
CoPhC	s/c	1	1
JCAP	A1	5	3
PhLB	A2	3	2
Icarus	B1	2	1
GReGr	B2	1	1
AdSpR	s/c	4	3
APh	B3	1	1
P&SS	s/c	1	1
CeMDA	B4	1	1
ApSS	B4	4	3
RMxAA	B1	1	1
New Astron	B2	2	1
IJMPA	B3	3	2
PASJ	B1	1	1
PASA	s/c	2	2
Ast L	s/c	1	1
PhRvL	A1	1	1
CoPhC	s/c	1	1

83% Qualis A
11% Qualis B
6% Others

Articles published by researchers of the INCT of Astrophysics in 2009

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   2009PhLB..673..107A
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   Physical approximations for the nonlinear evolution of perturbations in inhomogeneous dark energy scenarios2009PhRvD..79b3516A
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   The signature of dark energy perturbations in galaxy cluster surveys
   2009JCAP...07..040A
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ANNEXES

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