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## *Chapter 4*

# **BRAZILIAN OLYMPIAD OF ASTRONOMY AND ASTRONAUTICS**

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## **ABSTRACT**

We have been organizing the Brazilian Olympiad of Astronomy and Astronautics since 1998 and in this Chapter we will show the results of the event of 2011. The main goal is the popularization of Astronomy and Astronautics, but also equally important is the capacitation of the teachers of elementary and high school who teach these sciences. We have been successful in our goals because there are over one million students that are taking part in the Olympiad, distributed over all states of Brazil. The number of teachers involved (64,000) in the process is also very important. In fact, it is the most important aspect of all, because we wish to teach them Astronomy and Astronautics. The Olympiad takes place in the middle of May and it lasts one day, but the most important part is everything that those teachers do before that. With our help they teach a little more of Astronomy and Astronautics to their students, who observed the sky and made didactic experiments during the day using, for example, the Sun, or the shadow of a stick. After the Olympiad day we collect all tests and organize the lists of participants. We send certificates to everyone and about 33,000 medals. We invite a few hundred to take part in special events, such as the Space Journey, the Energy Journey, the Brazilian Olympiad of Rockets, the Latin American Olympiad of Astronomy and Astronautics, or in the International Olympiad of Astronomy and Astrophysics.

## **INTRODUCTION**

The Brazilian Olympiad of Astronomy and Astronautics (OBA in Portuguese) began in 1998[1]. Initially the subject was Astronomy only and it was organized by the Brazilian Astronomical Society. In 2005 we included the Astronautics and since then we have been

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working together with the Brazilian Agency of Space. The main point, however, is that since 1998 the main goal of the OBA is not just the competition between students or schools or cities, but the teaching and popularization of Astronomy and Astronautics. How can we do that? We use the natural interest of young people for competitions. Everyone likes competitions, especially when it comes to sports, but young people appreciate competitions of any kind, not just sports. Every human being loves to be the “winner”, the champion. Well, we are using this special interest of young people to attract them to the OBA. If we motivate the students, we can teach them, and more, we can also get their teacher involved, and we can also help them to better understand Astronomy and Astronautics. This is the main point. We teach the teachers so that they can teach their students. Unfortunately, the teachers that teach Astronomy and Astronautics in elementary schools and also in high schools have only a superficial understanding of Astronomy and Astronautics. Therefore we need to help them to better understand these sciences, so that they can better teach their students. We are organizing the OBA, but we have also been organizing many others activities in order to reach our goals.

Besides our main goals with all our activities, which includes OBA, Brazilian Olympiad of Rockets (OBFOG in Portuguese), Workshops, International Olympiads and Regional Meetings on Teaching Astronomy and Astronautics, we also have the following goals: 1) To train and inform the ordinary citizen of the importance of the scientific and technological apparatus existing in the country, 2) To awaken interest in the study of science, 3) To serve as a mobilizing agent community; 4) To emphasize the importance of education for personal development, 5) To motivate teachers to teach astronomy, astronautics, mathematics, physics, science, geography and chemistry as well as promoting the creation of study groups within schools to enable the dissemination of information and knowledge; 6) To establish innovative forms of learning; 7) To discover and encourage new talents towards a career in science in general and in astronomical research or aerospace science, in particular; 8) To allow the development of disseminating agents that often, for lack of support, do not carry out projects of interest to students and their communities; 9) To use the formulations of the questions and their solutions to bring correct and updated knowledge on astronomy and astronautics to students and , indirectly, to their teachers, because they will grade the tests according to a template provided by the National Organizing Committee; 10) To encourage the student population in the study of science using the OBA as a motivator; 11) To reward with medals about 30,000 students who presented the best performances; 12) To issue certificates of participation for all students as well as for their teachers who contributed to the event; 13) To distribute educational material for teachers, who are representatives of OBA; 14) To use their questions and their feedback to change misconceptions about Astronomy traditionally found in textbooks and among teachers; 15) To encourage teachers responsible for teaching the astronomy in elementary and high school to be able to upgrade their knowledge of the content to better meet the needs of their students; 16) To encourage the creation of astronomy clubs or clubs of amateur astronomers; 17) To involve teachers, their pedagogical coordinators and school principals in a nationwide joint effort to support the teaching of Astronomy; 18) To establish closer contacts between Brazil’s professional and amateur astronomers with teachers of elementary and high school, responsible for teaching content of Astronomy; 19) To encourage the participation of those teachers in the Regional Meetings on Teaching of Astronomy and Astronautics and in the National Symposium on Teaching Astronomy; 20) To encourage visitation of the fixed and portable Planetarium; 21) To disseminate and discuss

the reasons why Brazil should possess, maintain and encourage a space program; 22) To present the post-war historical context in which took place the Space Race between the United States and the former Union of Soviet Socialist Republics; 23) Show the benefits of the Space Race, such as remote sensing, weather forecasting, the controlling of deforestation, satellite communications, among others; 24) To promote the development of aerospace activities and emphasize its importance for the Brazilian scientific development; 25) To explain the problem of global warming and the changes that the global population will have to implement in order to reverse the situation.

The Brazilian Olympiad of Astronomy and Astronautics proved to be an excellent tool for the interaction between teachers responsible for teaching this content in elementary and high school levels and the Brazilian astronomers and aerospace engineers. We use this event as a pedagogical vehicle to teach astronomy and the fundamentals of aerospace science to the teachers responsible for those contents. Although the Olympiad involves the students, we are much more concerned in cooperating with the proper training of the teachers, after all they are the ones who have to teach astronomy and basic concepts of aerospace, year after year, class after class. Therefore, our interest lies in the completion of teacher training. In order to achieve this we have sent educational material to schools participating in the OBA. We believe we are the only Olympiad that has this concern and uses most of its resources to print educational material for teachers who are our representatives within their respective schools. In addition, between 2010 and 2011 we distributed, about 16,000 telescopes called Galileoscopes, rotating celestial planispheres for the Southern Hemisphere, books, etc.

Each school that wishes to take part in the OBA has a teacher representative of the School. They receive the OBA regulation with all instructions on how to publicize the event among their students and how to prepare them. They also receive a registration form to register the students who volunteer to participate in the OBA. The teachers teach additional classes of Astronomy and Astronautics, guide the studies, watch the sky and launch homemade rockets and other activities.

All students take the tests on the same day in their own school, which has been previously registered, under the supervision of the teacher representative of the school, because we wish to effectively involve teachers in the whole process. The teachers grade the tests from a template provided by the National Organizing Committee of the OBA and then mail only the top 10 tests of each level, as well as the list of names and grades of all participating students (not only the best of each level) to the National Commission. We type names and grades and ranks in descending order of students within each grade level. The ranking is done on a national level, as opposed to state, city or school.

Overall, during this process we are teaching Astronomy and Astronautics to both students and their teachers, although they have never studied those contents in their regular courses. As the textbooks were not written or reviewed by experts, they still have mistakes[2][3], despite the efforts of the Ministry of Education to improve the quality of those books. In the OBA tests we have the opportunity to provide the correct information. We donated printed materials or DVDs with the contents of Astronomy and Astronautics to all schools that effectively took part in the OBA. Below we are going to show the results and actions of the XIV OBA.

## ANNUAL PARTICIPATION OF STUDENTS IN THE XIV OBA

The enthusiasm of the students participating in the Olympiads is contagious, because the participation rate is rising as we can see in Figure 1. In 2009, the International Year of Astronomy, there was a giant leap in the number of participants: we achieved to 868,171 participating students! Therefore, there was an increase of 95,1% over the previous year! In 2010 we expected a small reduction in the number of participants. In fact 786,000 students participated, distributed over 9,152 schools. But in 2011 the number of participants rose again, as we reached a total of 803,218 students, as show in Figure 1. We also advise teachers not to force their students to participate, because what interests us are the ones who are volunteers to participate. We are not interested in quantity but quality, i.e., in really interested participants.

For the foregoing reasons it is evident that this type of event brings together teachers of elementary and high school and professional astronomers, as well as specialists on Brazilian aerospace. In the following sections we will present the main results of participation of students, schools and teachers, during the XIV OBA.

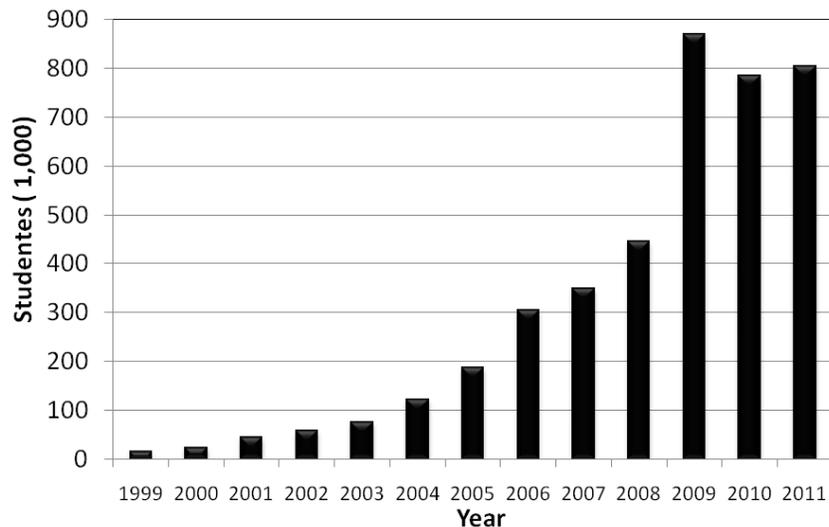


Figure 1. Total number of students participating in the OBA throughout the years.

## STATE DISTRIBUTIONS OF STUDENTS AND SCHOOLS PARTICIPATING IN THE XIV OBA

Our goal is to have participating students in all Brazilian states. We believe that talent can be anywhere in Brazil, in any school. We hope with this Olympiad to discover them and encourage them to continue their studies, to believe in their potential, to have confidence in themselves and show that achieving success is a matter of individual effort, and that there are people and institutions who are willing to help them.

Figure 2 depicts the distribution of students participating in the XIV OBA (2011) by Brazilian states. As we insist to have participants from all Brazilian states our publicity always involves all Municipal Secretaries, State and Regional Education. It can be seen from Figure 2 that the State of Sao Paulo has the largest participation, with 193,000 students, followed by Ceará with almost 94,000 students, and in third place comes Minas Gerais, with approximately 85,000 students. But the most important thing is that we have interested students in all states and in 13 of them we have more than 20,000 students participating. As the Brazilian states have huge differences in size, population and therefore population density, Figure 3 shows a graphic of the percentage rate of schools participating in the OBA.

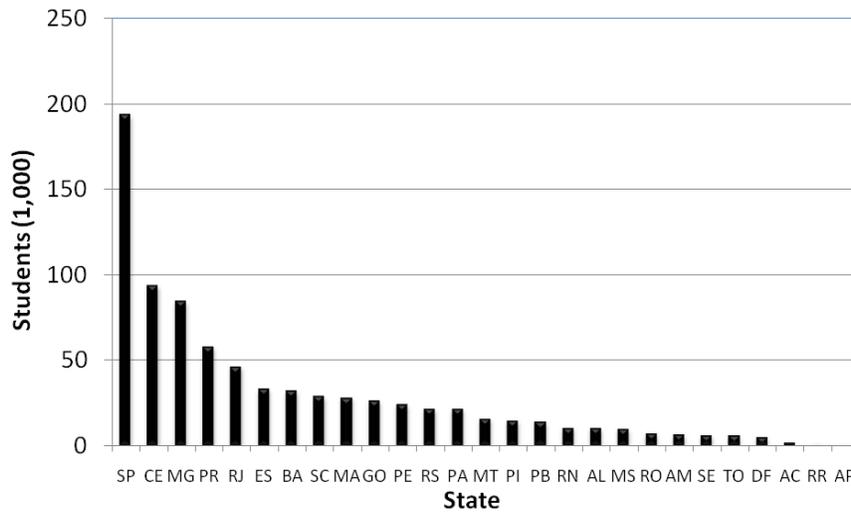


Figure 2. Distribution of students among the Brazilian states that participated in the XIV OBA.

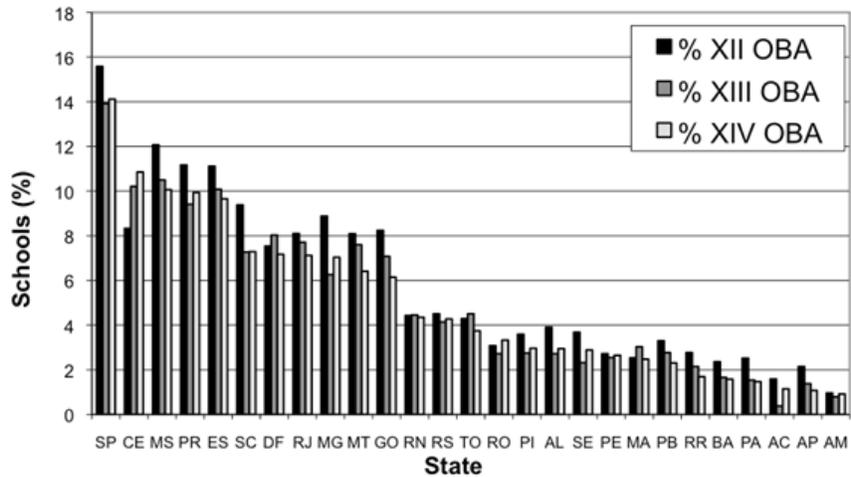


Figure 3. Percentage distribution, per state, of schools that have already participated in the OBA in the years 2011 (XIV OBA), 2010 (XIII OBA) and 2009 (XII OBA) for purposes of comparison.

The graph thereby eliminates the need for the number of schools in each state. Figure 3, also shows the participation rate of schools in the last three years for comparison purposes. It

is very satisfying to see that we have states such as São Paulo, Minas Gerais, Ceará and Paraná with more than 10% of all schools participating in the OBA and several other states already have about 8% of their schools participating in the OBA. With the exception of the Ceará, all the states in the North and Northeast of Brazil have less than 4% of its schools participating in the OBA. In those states we find a high concentration of rural schools, which makes it very difficult to communicate with them.

The Olympiad has also stimulated many schools to organize small groups of astronomy that are the embryos of future astronomy clubs, who organize themselves to study various astronomical topics, ranging from the practice of astronomical observation to the more theoretical issues. Some schools are even committed to buying telescopes for their students, due to the same motivation.

We encourage the realization of practical activities, because every year we send out to every school registered some detailed proposals for low cost experiments concerning astronomy and astronautics, such as educational rocket launching, astronomical observations during daytime or nighttime, construction of solar and lunar clocks, determining the mass of the Earth, comparing the volumes of the planets and the Sun, the correct determination of the cardinal points, observation of the celestial sphere, recognition of stars of different temperatures (colors), etc.

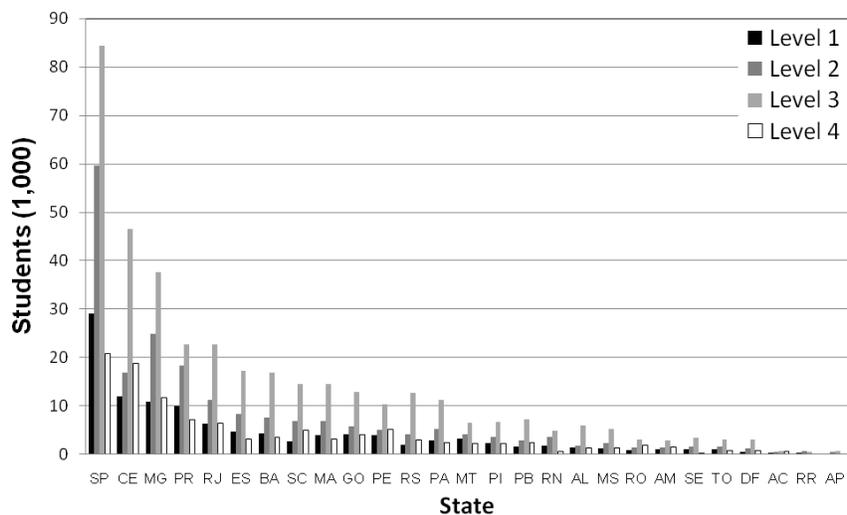


Figure 4. Distribution of students according to level and state.

Thus, there is no doubt that the Olympiad is an extremely efficient vehicle for enhancing student motivation in their studies. And as it is necessary to study physics, mathematics and even geography in order to better understand Astronomy, certainly one who intensifies their studies in astronomy will also be studying several other sciences. And as anyone who studies always improves his/her knowledge, this is an Olympiad in which each attendee is a winner.

Figure 4 shows the number of students participating in the XIV OBA separated by four levels. From Figure 4 we see that we have approximately the same percentage of students at levels 1 and 4. The level 3 has the majority of participants followed by the level 2.

### 1.1 Distribution of Test Scores of Levels 1, 2, 3 and 4

The Olympiad is open to the first year students of elementary school till to the last year of high school but separated in four levels, namely:

Level 1 - for students from 1st to 3rd grade of elementary school,

Level 2 - for students from fourth to fifth year of elementary education;

Level 3 - for students from sixth to ninth years of elementary school and

Level 4 - for high school students.

Figure 5 shows the frequency distribution of grades at level 1. These graphics are important in order to know whether the test will be feasible to be solved by the students.

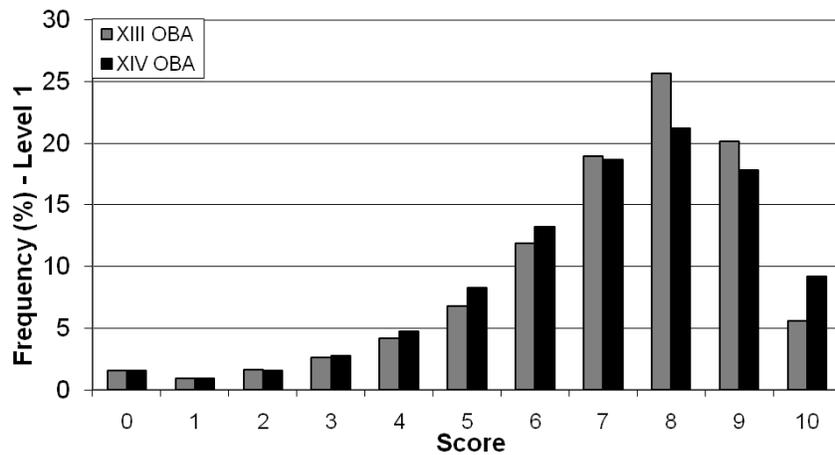


Figure 5. Frequency distribution of test scores of the level 1 of XIII and XIV OBA.

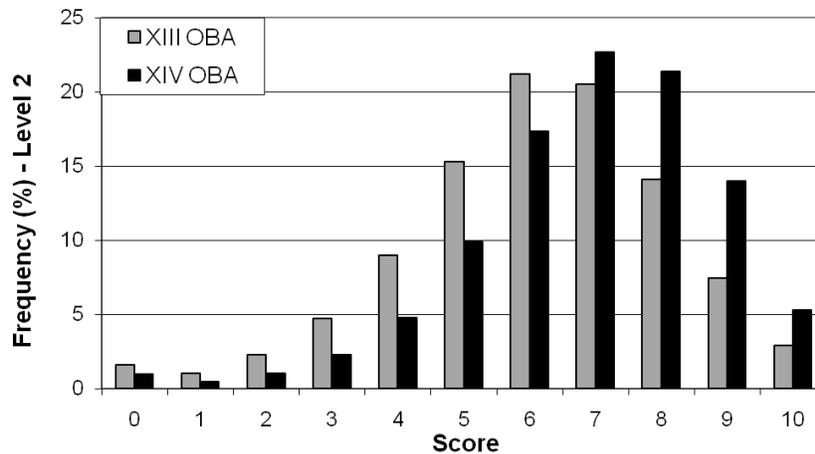


Figure 6. Frequency distribution of test scores of level 2 for XIII and XIV OBA.

Figure 5 compares the frequency distribution of grades, including the distributions of the XIII and XIV OBA to the same level 1. It can be observed that the test of XIV OBA was simpler than the earlier, because much more students got score 10 in XIV OBA than the previous one. However, the two peaks of the distributions are near the score 8. Figure 6 shows the frequency distribution of student scores at level 2 of the XIII and XIV OBA. It can be said that the test of XIV OBA has a score rate much higher than that of the XIII OBA. XIII OBA had scores 6 to 7 at the peak, whereas there was a higher percentage of scores 8, 9 and 10 in the XIV OBA. This tells us that we can ask questions a little more complex for level two than we did in 2011, but not as much as we did in 2010. Similar results were obtained for levels 3 and 4.

## 2.1 Distribution of Medals

The medals are highly motivating elements for the students. Therefore, there is no sense in distributing only a few tens or even hundreds. This would configure a group of highly talented young people extremely focused on the Olympiads who are in general already studying in excellent schools. They will have success independent of our actions. Therefore, we distributed 33,500 medals in XIV OBA, which represented 4.2% of rewarding students. The medal also honors, though indirectly, the teachers of these students and their school as a whole. Many of these students become news in the newspapers of their cities, which in turn highlights the works of his school.

The medals are distributed at intervals of grades. The ranges of notes do not change much from one year to another, except for the lower limit for the bronze level 4, which rose one point in relation to the XIII OBA. This is explained by the change introduced in this competition in 2011.

## EVENTS RESULTING FROM THE XIV OBA

It is undeniable that every year the OBA becomes an increasing event, not only in terms of the number of schools, students and teachers, but also due to events arising from it and involving students and their teachers. In 2011 we organized the following events: 1) VII Space Journey; 2) IV Energy Journey; 3) V Brazilian Rocket Olympiad; 4) III Rocket Journey; 5) Organization and participation in the III Latin American Olympiad of Astronomy and Astronautics and 6) Participation in the International Olympiad of Astronomy and Astrophysics.

### 1) VII Space Journey

We organized the VII Space Journey together with the Brazilian Space Agency, in São José dos Campos, from October 30<sup>th</sup> to November 5<sup>th</sup>, 2011, with students who had excellent answers to the questions of Astronautics in the XIV OBA. Each year we select a group of 60 high school students and their teachers, among those with the best grades in Astronautics and

invite them to participate in the Space Journey. During one week, students and teachers visit the Integration and Testing Laboratory of the National Institute for Space Research and the Brazilian Aerospace Memorial. They take part in workshops, courses and lectures about the space sector. The topics were: climate change, rockets, satellites and space exploration. The Brazilian astronaut, Marcos Pontes, gave a lecture to the participants. In 2011 six of these students received a scholarship, as a reward from Fundação Educar. The scholarship consists of a notebook, an English course and vocational guidance.

## 2) IV Energy Journey

We performed the IV Energy Journey in the cities of Rio de Janeiro and Penedo, from the 19<sup>th</sup> to 21<sup>st</sup> of October, 2011, with students who had excellent answers for the energy questions of the tests of the XIV OBA.



Figure 7. PET bottle rocket being launched.

Each year a select group of 25 students and their 25 teachers are invited to participate in the Energy Journey. On this occasion they visit the Planetarium of Rio de Janeiro, the National Organizer System, the company that controls the generation and transmission of energy throughout Brazil and also visit the hydroelectric power plant in Itatiaia.

## 3) V Brazilian Olympiad of Rockets

We promote annually the realization of the Brazilian Olympiad of Rockets, with students from elementary and high schools. At the elementary school level they are asked to launch a rocket using a simple blowing of soda straw, for example.

At high school level we ask them to launch rockets using, for example, vinegar and baking soda in a PET bottle. The two levels are given some preliminary guidelines and safety rules. It is asked for attendees to discover which improvements are necessary to launch their rockets as far as possible. In 2011 we had the participation of 19,130 students distributed over 640 schools and 2,729 teachers involved. All of them received certificates of participation. In Figure 7 we show a PET bottle rocket being launched.



Figure 8. Picture of participants of the III Rocket Journey in Passa Quatro, MG.

#### **4) III Rocket Journey**

We performed the III Rocket Journey in Passa Quatro, MG, from October 31<sup>st</sup> to November 2<sup>nd</sup>, 2011. One hundred and fifty people attended, divided into 30 teams, one from each school, with five people on each team. Participants were selected because their rockets, which were constructed from PET bottles, reached the longest distances. All attendees that took part in the III Rocket Journey came from high school. During the event they showed their rockets and launched them in front of a jury, and attended lectures by experts in rocketry. The evaluation committee was composed of teachers from all teams and they had to judge the following items for each team: 1) Completion of the rocket; 2) Originality of the rocket; 3) Completion of the base; 4) Originality of the base; 5) Safety (general aspects) and 6) Team presentation. The best six teams in the jury evaluation were rewarded with trophies. The 12 teams who launched their rockets the farthest won trophies. The trophy was a replica of the Satellite Launcher Vehicle. Figure 8 shows the participants in front of the tower of the Pousada do Verde, in Passa Quatro, MG.

#### **5) III Latin American Olympiad of Astronomy and Astronautics (III OLAA)**

The I OLAA took place in Brazil in 2009. The II OLAA took place in Colombia and the III OLAA was set to be in Chile. However, problems caused by the earthquakes in Chile, made it impossible for the III OLAA to be organized there. No other country offered itself to host the III OLAA on such short notice, therefore, we decided to have the III OLAA in Brazil again. It took place in Rio de Janeiro, where occurred the opening ceremony and tests of Planetarium. After that we went to Passa Quatro, in Minas Gerais State, from October 23<sup>rd</sup> to the 30<sup>th</sup>, 2011. The advantage of Passa Quatro was the price of lodging, the unpolluted sky and the proximity to the National Laboratory for Astrophysics, which we were able to visit.

Eight countries took part in the III OLAA, namely, Argentina, Bolivia, Brazil, Chile, Colombia, Mexico, Paraguay and Uruguay. Each country came up with four or five students and one or two teachers. The event was a huge success in the opinion of all present in the event and had great media coverage, including TV and radio. We must emphasize that the focus of this Olympiad is on the integration between participants and countries rather than to stimulate competition.



Figure 9. The picture shows the participants of the III OLAA during their visit to National Laboratory for Astrophysics.

To encourage interaction among them all three tests were done in multinational teams, except for individual tests. Figure 9 shows a photo of the participants on their visit to the National Laboratory for Astrophysics in Brasópolis, MG. The III OLAA assembled 34 high school students from eight countries in Latin America, who achieved the best grades in the Olympiads of Astronomy and Astronautics in their respective countries.

## **6) Participation in the International Olympiad of Astronomy and Astrophysics (IOAA)**

We played an active part in the founding of the IOAA in 2007 and we have been participating in the IOAA on an annual basis with a team of one or two team leaders and four or five students selected after a long process of training a big group of high school students. We coach about two hundred students for a few months after the OBA accomplishment on May. Then, on April of the following year we select two teams. One will represent Brazil in the IOAA e the other in the OLAA. Every year our teams were awarded with medals on both Olympiads.

## REGIONAL MEETINGS FOR TEACHING ASTRONOMY

The Regional Meetings for Teaching Astronomy (EREA in Portuguese) was created in the International Year of Astronomy (IYA), in 2009, as a subprogram of the celebrations of IYA. The EREAs focus is to promote the training of teachers of elementary and high school presenting practical methods for teaching astronomy and also astronautics, giving to the participants educational material for teaching astronomy. We donate telescopes (Galileoscope) to each school that participates in the event. The EREAs have been coordinated by OBA. We organized three of them in 2009, eleven in 2010, twelve in 2011 and eleven in 2012. We intend to continue organizing about a dozen EREAs each year. In each event we have the participation of about 100 teachers and each event takes three or four entire days and sometimes even five days.

## CONCLUSION

The OBA is a great opportunity for professional and amateur astronomers and scientists of aerospace sciences to collaborate with teachers of elementary and high schools that teach Astronomy and Astronautics. During the whole process we have been distributing didactic material, such as telescopes, planispheres, books, DVDs, as well as proposing daytime and nighttime experiments related to Astronomy. In the Astronautic we have been organizing the Brazilian Olympiad of Rockets which is a great success because students have the opportunity to put in practice their knowledge on rocket launching. The students that launch their rockets the farthest are invited to take part in a Journey of Rockets, and we award junior scholarships to the best students of this event.

We send the best students in Astronomy to represent Brazil in the Internationals Olympiads. The teachers have been receiving proper training in the EREAs.

Many more students and teachers have been visiting the Planetariums and Observatories and, most importantly: they are looking a lot more to the sky and having fun.

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We thank all the people that have helped us prepare the tests of the OBA and train the students to take part in the International Olympiads. We also thank the hundreds of astronomers and engineers of aerospace science who have helped us organize the Regional Meetings for Teaching Astronomy.

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