

CHAPTER I

TWENTY SEVENTH GENERAL ASSEMBLY

INAUGURAL CEREMONY

Tuesday 4 August 2009, 14.00 - 16.00

Centro de Convenções SulAmérica, Rio de Janeiro

1. Opening Address by DR CATHERINE CESARSKY, President, International Astronomical Union

Minister of Science and Technology
Governor of the State of Rio de Janeiro
Mayor of the City of Rio de Janeiro
President of the Academy of Sciences of Brazil
Mrs. Patricia Gruber
Ladies and gentlemen, Friends and colleagues

It is wonderful to be here, in Rio de Janeiro, in the company of our distinguished visitors in a country with a very active astronomical community, and it is a great pleasure for the IAU to hold its 27th General Assembly in this spectacular city. We are delighted that you have been able to join us for this Opening Ceremony.

The rise in scientific activity in Brazil is related to the access to independence, in 1822. In particular, the first Emperor, Pedro I, authorized in 1827 the construction of a national observatory. The construction lingered, but finally took place on the hill of Morro del Castello, on the grounds of the Eschole Militar. The place became really active under the second Emperor, Pedro II, who had a keen interest in astronomy and knew how to operate telescopes; - he was an amateur astronomer and had an observatory at the So Cristvo palace. In 1882, he ordered the participation of Brazilians in international scientific expeditions to three different points on the Earth, the aim being to take advantage of a rare transit of Venus in front of the sun to accurately determine the distance between the Earth and the Sun.

As it happens, the Parliament did not authorise the trips. A member of Parliament said: “the people are not concerned about finding out what is going on in the stars that is a luxury.” But promptly private money was found, two rich farmers funded the trip, and Brazil indeed took part in the expedition on three outposts.

Despite these early beginnings, modern astronomy really started in Brazil in the sixties, again through international connections, as gifted Brazilian students went to obtain degrees abroad. There are now 300 PhD and 500 astronomers, involved among others in prestigious international projects such as the GEMINI and SOAR telescopes, building frontline instrumentation and involved in the most up to date research topics. Future steps towards the enhancement of our discipline in Brazil, such as the potential construction of a VLBI addition to the millimetre and submillimeter world project ALMA, or a participation to the E-ELT project, are being studied in the framework of the Commission on projects for the future set up by the Ministry of Science

and Technology. It is thus highly appropriate, in addition to being extremely pleasant, that we, astronomers from all corners of the world, find ourselves in beautiful Rio de Janeiro for our 2009 General Assembly.

But let us come back to the debate about the use of basic science in general, and of astronomy in particular. Today, in the era of earth observing satellites, interplanetary missions and GPS systems, we know the practical value of accurate measurements of quantities such as the distance between the Earth and the Sun. In the twentieth century, many discoveries about our universe ended up having a strong impact on our daily life. One of the most illustrious examples is the understanding by Hans Bethe of the source of energy which allows stars to shine over long periods: nuclear energy, promptly domesticated for our daily usage. In the 21st century, the incredible progress of astronomy and of our understanding of the universe derives directly from the excellent use astronomy makes of the latest developments in high tech technology. But astronomy not only profits from these advances, it fosters and even enhances them, with two effects. One is that empowers industry by helping it to succeed in realizing ultimate developments, raising its capabilities and skills. The other is that almost invariably the high tech developments fostered by astronomy in ground or in space, or even by theory and numerical modelling, end up having unexpected applications in our daily lives. Here the most obvious examples are the very numerous applications to medicine of imaging techniques, in both hardware and software.

But of course the indirect bonuses of astronomical research are not its main driving force. Astronomy is a natural human response to deep yearnings, the wish to know about our collective origin and our fate, to be part of the universe. As anybody who attempts to popularize our science and make it accessible to the public intuitively knows, all men and women are born astronomers. Some of us have the immense luck to have transformed this inner impulse to search into a profession, that eats our lives but also makes them exciting and fulfilling. We owe it to the public in general, from the taxpayers around us who pay for our research to the underprivileged all over the world to share our knowledge and our wonder.

This is the motivation of the International Year of Astronomy 2009, a global celebration of astronomy and its contribution to scientific development and cultural enrichment. This follows an original idea by former IAU President Franco Pacini, to coincide with the 400th anniversary of Galileo Galilei's first observations through the telescope he had just built. In the IAU GA of 2003 the General Assembly emitted a resolution in favour of IYA. In December 2007 the United Nations proclaimed 2009 as the International Year of Astronomy,

“The General Assembly

*Convinced that the Year could play a crucial role, inter alia, in raising public awareness of the importance of astronomy and basic sciences for sustainable development, promoting access to the universal knowledge of fundamental science through the excitement generated by the subject of astronomy, supporting formal and informal science education in schools as well as through science centres and museums and other relevant means, stimulating a long-term increase in student enrolment in the fields of science and technology, and supporting scientific literacy
Decides to declare 2009 the International Year of Astronomy”*

The IYA2009 activities take place at the global and regional levels, and especially at the national and local levels. National Nodes in each country have been formed to prepare activities for 2009, with global coordination by the IAU through its IYA Secretariat set at ESO Headquarters.

Now, we have passed the middle of IYA, and the results so far surpass all our expectations: 145 countries have set up IYA nodes, compared to the 63 national members of IAU. At least 2 million people have participated in the activities offered. Quoting Lars Lindberg Christensen and Pedro Russo, IYA coordinators: “Never before has such a network of scientists, amateur astronomers, educators, journalists and scientific institutions come together. IYA2009 is truly the largest network in astronomy”, and, I shall add, in science. At this GA, a Special session is devoted to IYA, posters will be visible all along, and dedicated movies will be projected. I recall

here the goals we set ourselves, years ago, for this very particular year:

- Increase scientific awareness.
- Promote widespread access to new knowledge and observing experiences.
- Empower astronomical communities in developing countries.
- Support and improve formal and informal science education.
- Provide a modern image of science and scientists.

Many of the IYA goals and objectives are related to education at all ages, and to the global development of astronomy. As we are discussing the IYA 2009 legacy, we see clearly that in it a prominent role should be played by educational programmes. Thus, this is an opportune time to review the long-term strategy of the IAU in development and education. The IAU Executive Committee regards has always given importance to stimulating astronomy education and development throughout the world, and Commission 46 has achieved impressive results, despite the scarcity of resources. Now, under the leadership of one of the vice-presidents, George Miley, a strategic plan for IAU involvement in development and education during the next decade has been emitted. This plan addresses the rationale for astronomy development, education at the primary, secondary and tertiary levels, public outreach and the development of an infrastructure for research. The plan will be presented in several occasions during the GA, and everybody is invited to discuss it at a Town meeting Friday at lunch time. This discussion is important since the Executive Committee has submitted two resolutions about this plan which will be voted at the end of the meeting.

400 Years after Galileo's first glimpse of the sky through a telescope, astronomy is in its golden age. To put things in perspective: 400 years after the discovery by Galileo of Jupiter satellites, space agencies all over the world, NASA, ESA, JAXA, and the Russian agency, are joining forces to send a probe which will visit two of these satellites, Europa and Ganymede.

The pace of discovery is so fast that even astronomers have difficulties in following; IAU General Assemblies give us all a chance to catch up on the news in the various fields every three years, especially with the new feature we have introduced here of having an up to date plenary review for each of the Symposia. An additional opportunity to hear first hand of new discoveries is through the IAU regional meetings. The ones from Latin America, LARIM, and from Asia Pacific, APRIM, already are fully established, and keep growing in quality, number of attendees, and in interest. This triennium we have inaugurated with success, in April last year in Cairo, a third type of regional meetings, Middle East and Africa: MEARIM.

This month, the IAU is celebrating its 90th birthday. The IAU was in fact born at the same time as the International Research Council, which later became ICSU. Born in difficult historic times, IAU at first comprised only countries that had been allies of the winning side of the First World War. With time, IAU has succeeded in federating a large number of countries, united by a common interest in astronomy, Astronomy - and all of Science - has changed enormously over those dramatic 90 years, and we can see in this General Assembly that the IAU has followed and reflects these changes. The International Year gives us the opportunity to celebrate and share in this progress.

So once again, welcome to the IAU General Assembly 2009. The Universe is yours to discover!

2. Performance of the Brazilian National Anthem

The Brazilian National Anthem was performed by *Atràs da Nota Choir (Rio de Janeiro City Hall)* and *Choir Association CPRM, (Geological Survey of Brazil)*, conducted by Mario Assef and assisted by Silvia Sobreira.

3. Address by JACOB PALIS JUNIOR, Presidente da Academia Brasileira de Ciências

President of the Brazilian Academy of Science

Authorities of the Federal Government, of my state and of my city, colleagues, ladies and gentlemen:

It is very gratifying to welcome all of you to this beautiful city and beautiful state at the moment when Brazilian science is at its highest level of performance. This has to do with the persons present here today, and the President of the Republic who has been supporting science in a very special way which I would say is unique in our history.

Soon, we hope to have the same support from the city of Rio de Janeiro and I must say that the Mayor and its Secretary of Science and Technology are looking forward to joining forces with the state agency that is now spending 2% of its budget on science and technology in the state, which is unique in Brazil.

On behalf of the Brazilian Academy of Science and the Brazilian Astronomical Society I extend to you a very warm welcome and I wish you success in your work in what is probably the most charming science of all, and in celebrating Galileo, whom I think is the father of modern science.

Thank you!

4. Address by EDUARDO PAES, Prefeito da Cidade do Rio de Janeiro

Mayor of the City of Rio de Janeiro

Dear friend Governor Sergio Cabral,
 Madame President of the International Astronomical Union, Dr. Catherine Cesarsky,
 Mr. Jacob Palis, President of the Brazilian Academy of Science,
 Mr. Sergio Resende, Minister of Science and Technology, Mr. Alexandre Cardoso, Secretary of Science and Technology of the State of Rio de Janeiro,
 Mr. Rubens Andrade, Secretary of Science and Technology of the City of Rio de Janeiro,
 Mrs. Jandira Feghali, Secretary of Culture of the City of Rio de Janeiro,
 Mr. Paulo Jobim, Secretary of Administration of the City of Rio de Janeiro,
 Mr. Kepler Oliveira, researcher on astronomy and member of the National Organizing Committee,
 Mr. Clive Ruggles, chair of the commission of the IAU and the UNESCO World Heritage working group on astronomy and world heritage,
 ladies and gentleman, dear friends who have come to our beautiful city of Rio de Janeiro:

First, I would like to say that with Mr. Palis, who spoke just before me, I have already lost a lot of money in this first introduction. He wants me, as he said, to join efforts with the federal government of Mr. Lula, President of the Republic, which since it came into power in 2003, has much invested in the area. A great effort has also been made by the State in the past two and half years, since Mr. Cabral came into power. So after 6 -7 months of government, he is still expecting us to put a lot of money into science and technology. And that will happen anyway, so, first thing, it is a great pleasure to be here and I do not mind losing the money, but I need to get my budget into a better situation.

I was listening to Dr. Cesarsky's speech and I think there is a complete connectivity between the City of Rio and this event. First, because the city of Rio is the city in Brazil where most of the research institutes, as well as federal, state and private universities, are located. Rio is a huge research center, that is one of our main goals for the city, that is one of our natural capabilities, a

natural way for the city to be developed. So that to host events like this one, concerning science and technology, Rio is a great place. And the other way that this event has connection with the city is in research, or trying to understand things that are not simple to regular people, like us. Rio is a city that inspires higher dreams, is a city that instigates the desire of the people to know more about where they came from and what is happening all around the Universe. The only thing Rio is missing in these days is what we call “astro rei”, I do not know how to say it in English, “astro-king”, which is our Sun. For sure your presence here it will make the Sun come out and illuminate this great event.

Thanks for coming to Rio. Enjoy the city! Welcome to our marvelous city. Thank you very much.

5. Address by **SERGIO MACHADO RESENDE**, *Ministro de Ciência e Tecnologia do Brasil*

Minister of Science and Technology of Brazil

Good afternoon to everyone. I would like to welcome Dr. Catherine Cesarsky and on your behalf all foreign participants. Let me greet the Governor of the State of Rio de Janeiro, Sergio Cabral, the Mayor, Eduardo Paes, the President of the Brazilian Academy of Science, Jacob Palis, the Secretaries Alexandre Cardoso, Rubens Andrade and Jandira Feghali. Let me also greet Beatriz Barbuy, and on your behalf greet all Brazilian participants.

I was very happy to hear the Mayor of Rio de Janeiro speaking about engaging the city in the effort of science and technology. This comes together with a plan that has been under development for the last few years, to put Brazilian science and technology on a higher level. In fact, Professor Jacob Palis had very favourable words about President Lulas government on this respect. But one thing that we are trying to do is to get the federal government, the state governors and the municipalities engaged in this effort because it is very clear, not to many people, but to most of the governors and some of the mayors, that this is the way to change the course of Brazilian development.

As you all know, and as the foreign participants also know, Brazil was a late comer in science. Although we had the National Observatory created almost 200 years ago, we had a very, very slow development in professional astronomy. In fact, perhaps you, our visitors, do not know that Brazil started giving doctors and masters degrees only 40 years ago. Before that we had an amateur system of science and technology. However, in the last forty years big progress has been made in many areas, for instance in astronomy. In 1975 we had something like 15 astronomers. Today we have about 250 astronomers with PhDs. Moreover, we now have 12 institutions educating people to Master and PhD degrees and the activity in all areas, including astronomy, is increasing very fast.

Brazil has 5 institutes under federal governorship that have astronomy and astrophysics as one of their research areas. In Rio de Janeiro we have three of them: the Brazilian Center for Physics Research (CBPF), the National Observatory (ON) and National Museum of Astronomy (MAST). We also have one institute in So Jos dos Campos, the National Space Center (INPE) and one in Minas Gerais, the National Astrophysics Laboratory (LNA), which provides most of the connection to some of the international projects like the Gemini, in which Brazil is an active participant, and also the SOAR.

Since we are concerned with the current development in this area, we have just created a few weeks ago a national committee to propose a plan for the next steps in the development of Brazilian astronomy. The committee is formed by people from our institutes but also from researchers from universities and other centres. In a few months we will have a plan to propose to the government and we know that among the proposals is joining the new big Astronomical Observatory ALMA, in Chile. I am sure that the Government will support the proposals, so that we can change, not only keep up the developing pace of the work in astronomy, but we are actually at a point where we have to change the level of the development of astronomy in Brazil.

On behalf of the Brazilian Government and specifically President Lula, who could not be here today, I would like to welcome all the foreign participants and wish you all a very good week of work in this XXVIIth General Assembly of the IAU. Thank you very much.

6. Address by SRGIO CABRAL, Governador do Estado do Rio de Janeiro

Governor of the State of Rio de Janeiro

Madame Catherine Cesarsky, President of the International Astronomical Union, Mr. Paes, Mr. Resende, Mr. Palis, ladies and gentlemen:

First, I would like to welcome all the participants of the General Assembly of the International Astronomical Union and to give my compliments to the organization for taking the right decision in choosing Rio de Janeiro to host such wonderful event. As I recall, for the first time in Brazil.

It is indeed an honour to receive the worlds most important event in the field of astronomy. In fact, the connections between astronomy and Rio de Janeiro can be traced back to 1827, as Catherine Cesarsky said, when the Imperial Observatory of Rio de Janeiro, today the National Observatory, was officially inaugurated introducing the scientific study of the stars and other celestial bodies in Brazil. Going back in time even further, we must recognize the vital importance of the study of astronomy for the very discovery of Brazil. The Portuguese were only able to reach our territory, in the year of 1500, thanks to the development of the technology inherited from the Arabians, for a long time very influential in the Iberian Peninsula, and which permitted the localization of warriors in the desert using the position of the stars. It was, I might say, the grand-grandfather of our modern hand-held GPS. Later on, the advent of the compass and of the astrolabe guaranteed the success of the great voyage.

Talking about history, I am convinced that this General Assembly will be a very important part of it, and I believe that the Union will have a difficult mission trying to find a city as beautiful as Rio to host the event in the future. The “cariocas”, natives of Rio de Janeiro, have the unique ability to combine hard work and healthy leisure. This is one of the features that make our people so well known all over the world and our city such a joyful place to live, to work and, of course, to watch the stars. I am certain that the beauties of the marvellous city will conquer the hearts and minds of those dedicated to conquering space.

Finally, I would like to ask you to ask the stars during the meeting about a very important challenge for us: in Copenhagen, on October 2nd, we are in the running to host the 2016 Olympic Games, along with Madrid, Tokyo and Chicago. If we win, it will be the first time in South America. Please, ask the stars to support us!

Thank you very much.

7. Presentation of Sponsors

The National Organizing Committee is pleased to acknowledge the support of the following institutions and sponsors:

- Astronomy and Astrophysics - Sponsor of Poster
- CAPES-MEC - Participant Support
- CNPq-MCT - Participant Support
- CNRS - Participant Support
- EMBRATUR - Sponsor for Promotion
- European Southern Observatory - Participant Support
- European Space Agency - Participant Support

- FEPEMIG - Participant Support
- FAPERJ - Organization Support
- FAPESP - Participant Support
- Gruber Foundation - Inaugural Ceremony Support
- IUPAP - Participant Support
- Laboratório Nacional de Astrofísica - Organization Support
- L'Oréal Corporation Foundation - Sponsor of Lounge
- Ministry of Science and Technology - Organization Support
- Norwegian Academy of Science and Letters - Sponsor of Education Luncheon
- Observatório Nacional - Organization Support
- Prefeitura do Rio de Janeiro - Organization Support
- Rede Nacional de Ensino e Pesquisa - Sponsor of Media Streaming
- US National Science Foundation - Sponsor of YA and WiA Luncheon

8. Brazilian Celebration, Yes!

Performed by *Companhia Folclórica do Rio-UFRJ (The Rio-UFRJ Folkloric Company)* of the School of Physical Education at the Federal University of Rio de Janeiro (UFRJ) under the General Director, Eleonora Gabriel, Musical Director, Ronaldo Alves and Production Director, Katia Iunes

9. Peter and Patricia Gruber Foundation - Presentation of Cosmology Prize 2009 and Foundation Fellowship

Catherine Cesarsky

As President of the IAU, I would like to welcome The Peter and Patricia Gruber Foundation to the Inaugural Ceremony of our 27th General Assembly. We are very pleased that they again form part of our program, and we continue to appreciate the fruitful collaboration between our organizations, which dates back a decade. It is now my pleasure to present Patricia Murphy Gruber, president of the Gruber Foundation.

Patricia Gruber

Welcome to the presentation of the 10th annual Cosmology Prize, honoring a leading cosmologist, astronomer, astrophysicist or scientific philosopher for theoretical, analytical, or conceptual discoveries leading to fundamental advances in our understanding of the universe. On behalf of my husband, Peter Gruber, myself, and all of us at the Foundation, we are pleased to be here in Rio de Janeiro to present this Prize at the 27th General Assembly of the International Astronomical Union. Thank you, Catherine Cesarsky, for your warm welcome.

The Cosmology Prize was established in 2000 as the first Gruber international prize, and I would like to gratefully acknowledge the vision and leadership of Peter Gruber in establishing this and the other prizes. The Cosmology Prize is presented in conjunction with the International Astronomical Union. It is my pleasure to introduce Dr. Karel van der Hucht, Secretary General of the IAU, who will say a few words about this fruitful collaboration.

Karel van der Hucht

The IAU is pleased to collaborate with the Gruber Foundation on the Cosmology Prize. The primary goal of the IAU is the development of astronomy world-wide.

The collaboration between the PPGF and the IAU consists not only of the Cosmology Prize, but also an annual Fellowship established in the Gruber Foundation name. The annual fellowship is selected by the IAU and awarded competitively to a postdoctoral researcher. The stipend is to be used to further his or her research.

The Gruber Foundation contributes 50,000 US dollars annually to this fellowship program, which is administered by the IAU. Awards are presented to promising young scientists of any nationality to pursue education and research at a center of excellence in their field; the IAU selects recipients from applications received from around the world. The fellowship has been awarded to scientists from Poland, India, Spain, Greece, the Russian Federation, Mexico, and the United States.

The 2009 Gruber Fellow is Thijs Kouwenhoven, from the Department of Physics and Astronomy at the University of Sheffield in the United Kingdom. His work focuses on the stability and dynamical evolution of newly formed planetary systems in young, gas-rich star clusters. I am happy to introduce him on this occasion and invite him to say a few words.

Thijs Kouwenhoven

First of all my thanks to the Peter and Patricia Gruber Foundation for the award of this Fellowship, which I will use to go to the newly established Kavli Institute for Astronomy and Astrophysics in Beijing, China. I am aware that it is still uncommon for western astronomers to go to China, but the world is changing and China is becoming more important in all fields, including astronomy, astrophysics, and space science. The majority of the the staff of this new Kavli Institute are from outside China, mainly from Western Europe and North America, and I am proud to be joining this community. Thank you.

Patricia Gruber

Thank you Thijs.

We are here to honor the achievements of Wendy Freedman, Robert Kennicutt, and Jeremy Mould, leaders of the Hubble Space Telescope Key Project on the Extragalactic Distance Scale. But first let me tell you a little about the company they are keeping.

The Foundation's prize program, established in 2000, now presents five annual 500,000 US dollar prizes in the fields of Cosmology; Genetics; Neuroscience; Justice; and Women's Rights. Each prize recognizes achievements and discoveries that produce fundamental shifts in human knowledge and culture.

On September 24th, the Justice Prize will be presented to the European Roma Rights Centre and Bryan Stevenson, at the Cumberland School of Law in Birmingham, Alabama.

On October 18th, at the annual meeting of the Society for Neuroscience, the Neuroscience Prize will be presented to Jeffrey Hall, Michael Rosbash, and Michael Young.

The Genetics Prize will be presented at the annual meeting of the American Society of Human Genetics on October 23rd, to Janet Rowley.

And on the 29th of October, in St. Thomas, United States Virgin Islands - where the Foundation is headquartered - Leymah Gbowee and the Women's Legal Centre will receive the Women's Rights Prize.

Returning to Cosmology, the 2009 Prize recipients were selected by a distinguished Cosmology Prize advisory board:

- Jacqueline Bergeron
- Ronald Ekers
- Peter Galison
- Andrei Linde
- Julio Navarro

- James Peebles
- Roger Penrose

Owen Gingerich and Virginia Trimble also serve as special cosmology advisors to the Foundation. Peter and I deeply appreciate the knowledge, commitment, and enthusiasm that the advisors bring to the judging process. Let me now invite the advisory board Chair, James Peebles, to say a few words about the history of the Gruber Cosmology Prize on its tenth anniversary.

James Peebles

The first Gruber Cosmology Prizes were presented in the year 2000. In my estimation this is when cosmology was completing its transition to a predictive theory.

Cosmology was a real physical science well before that, and it was predictive, in part, but largely adaptive. We saw the need for dark matter, so we added it. We saw the need for a cosmological constant, so we added it too. But in about the year 2000 the growing evidence had greatly restricted our freedom to adapt and shown that the relativistic hot big bang cosmology had become a predictive theory. The Gruber Cosmology Prizes have recognized many of the steps that made this so.

The first two Prizes were awarded to Alan Sandage and me. Here's a measure of Alan's insight. A half century ago, in his paper *The Ability of the 200-Inch Telescope to Discriminate Between Selected World Models*, he placed particular emphasis on the redshift-magnitude test and the expansion time test. Both matured four decades later, at the time of the first Gruber Cosmology Prizes.

There were many challenges to putting together the pieces of a theory of the universe. The third Prize went to Martin Rees, who had the deep physical insight to do this, time and again.

I remember being delighted by Vera Rubin's vivid demonstrations of the flat rotation curves of isolated spiral galaxies, an indication of dark matter. The citation for the fourth Prize mentions one aspect of a full and productive life in astronomy, beginning in 1951 with a pioneering discussion of what she termed the local ellipsoidal agglomeration of galaxies, and Gerard de Vaucouleurs renamed the Local Supercluster. She's still publishing.

Another edifying life in astronomy is recognized by the 2003 award for a particular advance, Rashid Sunyaev's analysis with Yakov Zel'dovich of the effect of hot plasma in clusters of galaxies on the sea of thermal radiation that fills space. The effect has become a valuable tool in the exploration of the large-scale structure of the universe.

When I was a postdoc there were dark corners of cosmology we usually discussed only in private. What was the universe doing before the big bang, assuming there was one? Why do well-separated regions that in theory have not been in causal contact since the big bang look so similar? Alan Guth and Andrei Linde were honored in 2004 for their parts in creating the promising and influential answer, inflation.

When I was a postdoc the Palomar Sky Survey photographs of the sky were a valuable tool for astronomy. In 2005 Jim Gunn was honored for his vision, and his technical skills and leadership, that gave us a vastly improved tool, the Sloan Digital Sky Survey. It is fueling research on topics from the smallest stars to the most distant quasars.

The 2006 Prize recognized the demonstration that the sea of thermal radiation that fills space has the critical signature of a fossil from the early universe. The Prize named the COBE satellite Science Working Group, with John Mather as Project Scientist. Organizers of major prizes must learn how to recognize fundamental advances that increasingly depend on essential contributions by many. Maybe this is a step in the learning curve.

The redshift-magnitude relation is discussed in Richard Tolman's book on cosmology published in 1934. The test matured seven decades later, again at the time of the first Gruber Cosmology Prizes. The 2007 Prize recognizes the teams in the final push, and their leaders, Saul Perlmutter and Brian Schmidt.

Precision measurements show that the distribution of the sea of thermal radiation left from the hot big bang has properties that require a cosmological constant, consistent with the redshift-magnitude and expansion time tests. They also require a baryon mass density consistent with what is inferred from light element production in a hot big bang, and dark matter, consistent with what we had supposed when cosmology was a looser art. Learning how to make these measurements was part of the growth of cosmology into a mature big science, and it was the work of many. Dick Bond, who was awarded the Gruber Prize in 2008, stands out for his many years of leadership in emphasizing the importance of these measurements and how to interpret them.

Patricia Gruber

I'd now like to introduce Ronald Ekers, who will present the official citation and introduce the scientific accomplishments of our Cosmology Prize recipients. Dr. Ekers is a Federation Fellow of the Australia Telescope National Facility and also an advisor to the Cosmology Prize.

Ronald Ekers

The official citation reads:

The Peter and Patricia Gruber Foundation proudly presents the 2009 Cosmology Prize to Wendy Freedman, Robert Kennicutt and Jeremy Mould for the definitive measurement of the rate of expansion of the universe, Hubble's Constant. This parameter effectively determines the age of the universe at the current time and underpins every other basic cosmological measurement.

An accurate measurement of the expansion rate was one of three major goals of the Hubble Space Telescope when it was launched in 1990. From meticulous measurements of a particular kind of variable star, the Cepheids, Freedman, Kennicutt and Mould met this goal, resolving one of the longest-standing debates in the history of modern cosmology. Let me add an additional comment. It is so very appropriate in this, the International Year of Astronomy, when we are also celebrating the achievement of Galileo, that we are awarding this prize to Freedman, Kennicutt, and Mould. Galileo used the first telescope to establish the place of the Earth in the Universe, today's Gruber Prize recipients used the first telescope in space to answer humankind's quest to know how big and how old is our Universe. I invite the recipients to come forward.

Wendy Freedman

Thank you very much, and deep thanks to the Peter and Patricia Gruber Foundation, and to Peter and Pat personally, for this award. All three of us were surprised to be selected for this profound honour. I would like to recognise the contribution and support of the Carnegie Institute of Science which, through its observatories, has supported the work of people such as Hubble, Sandage, Rubin, and many other distinguished astronomers for more than a century. I would also like to pay tribute to Henrietta Swan Leavitt, who discovered the relationship between the period and luminosity of Cepheid variables which radically changed the theory of modern astronomy and underpins all work on the distance scale of the Universe since the time of Hubble. She could not obtain a Ph.D. in those days, and I am grateful that we now live at a time when women can rise to the levels of Directors or Presidents. I would also like to recognise the work of the engineers and technicians whose work made the project possible. We all work in large teams nowadays, and we benefited from a talented and dedicated team working together for over a decade. We should also pay tribute to Marc Aaronson who lead this project at the start but who died tragically in an accident in 1987, and of course to my two co-recipients. Finally, I would like to give special thanks to a colleague, Barry Madore, with whom I have worked for more than 25 years, and who was also a member of our team.

Robert Kennicutt

After you spend more than 10 years and over 100 telecons working together, you start thinking alike, so I will not repeat much of what Wendy has just said. We are very flattered, honoured

and yet humbled by this award. We appreciate that we are only three out of many people who have worked on the problem of the distance scale and the Hubble constant, and we recognise their contribution. I would like to thank the Peter and Patricia Gruber Foundation for their generous support of astronomy and for sharing our passion for cosmology - thank you - *obrigado*.

Jeremy Mould

It is a particular pleasure to thank the Peter and Patricia Gruber Foundation for the award of this prize. Cosmology is a fascinating subject, dealing as it does with the largest questions of the Universe, and we are lucky that the Gruber Foundation has chosen it as one of its prize topics. I would like to thank all my colleagues on the H0 team - one couldn't ask for a better team of people, on whose shoulders we stood. I would, of course, like to thank my family who allowed me the time to work of this challenging project. Research can seem a thankless task, but when a prize like this comes along it makes it all seem worthwhile. Peter and Patricia, thank you again.

Patricia Gruber

Please note that these three recipients will give a public lecture entitled "Measuring the Hubble Constant with the Hubble Space Telescope" at 12:45 pm tomorrow in this room. Thank you for attending the 2009 Cosmology Prize ceremony. This concludes our presentation.