

CHAPTER I

TWENTY SIXTH GENERAL ASSEMBLY INAUGURAL CEREMONY

15 August 2006, 14:00 hr
Kongresové centrum Praha, Congress Hall

Master of Ceremonies:
Jan Palouš, chairman of the National Organizing Committee

Opening address by Dr. Ronald D. Ekers, President, International Astronomical Union

Mr. Ladislav Mrgavec, from the office of the President of the Czech Republic, Mr. Miloš Gregar, from the Lord Major's department, Professor Václav Pačes, President of the Academy of Sciences, national representatives, our hosts, IAU members and invited participants:

We have come to meet here in Prague and for some of you, you have come again to meet here in Prague. We re-unite again, of course to meet old friends, but also here in Prague to make connections with this wonderful city and its rich astronomical heritage. This meeting is about new and exciting developments and discoveries in our Universe. It is about an IAU which is very actively creating for itself a future relevant for the 21-st century.

But here in Prague, one is inevitably drawn into the history, as well as looking to the future. So I cannot resist drawing a little from the history of Prague, by using it, I think also as an inspiration for the future. 400 years ago, just before Galileo had sighted the moons of Jupiter, when astronomers had perhaps one of the most interesting and serious debates ever in the history of astronomy, on the Copernican system, whether the Earth was the center or not. You may think the questions you ask now are big questions, but just think of what it was like here in Prague 400 years ago and the questions they were addressing. In looking at what was happening 400 years ago and especially with Tycho Brahe and Johannes Kepler here in the city of Prague, the analogies flow so smoothly, that I thought I would just run with this story for a bit in my talk.

Tycho had the fabulous Uraniborg Observatory in Denmark, a well funded fabulous observatory, comparable in terms of fraction of GNP to any of the great modern observatories. However, there were changes. His funding agency was his patron, who had become Emperor Rudolf II. They had different ideas on what should be funded. I would say Tycho perhaps failed almost completely to adapt to the changes that the funding agency was looking for and his funds were withdrawn. He had no more money to stay in Denmark and he abandoned the observatory and came here to the scientific sanctuary

in Prague. Now Tycho had truly realized that, and I'll quote his words, "*an Astronomer must be cosmopolitan, because ignorant statesmen cannot be expected to value their services*". Not bad for 400 years ago. And so what he had done, was make sure that his instruments and his equipment were designed to be transportable, so he was able to move them here to Prague and set them up in this city.

At almost the same time Johannes Kepler faced very different problems. In his hometown of Graz he was a Lutheran in a Catholic area of Austria, and because of religious persecution he also moved to Prague. Which, again, afforded him scientific sanctuary. Now the moral of this story is not that everybody who feels pressured by their government or persecuted for their beliefs should move to Prague. I think even that might test the enormous skills of our host organizers.

But there is a serious message here, that I want you to remember. That is: our community of science and astronomers is an international community. We can move with enormous freedom around the world and work in different countries, and the national barriers are not strong limitations to what we do. This is a wonderful privilege that we have in this time and in our area of research.

Now to continue the story, Tycho and Kepler made a perfect team. Tycho had accumulated some of the best collections of observations in the history of astronomy, and it would prove that Kepler would be an excellent interpreter of these observations. But either alone could not have made happen what happened. Tycho did not have the vision or the theoretical background, and of course Kepler didn't have the data. But how these two teamed up is in itself one of the great stories in the history of astronomy in Prague. For Tycho carefully guarded his notebooks, he didn't share his observations. There was the dream of whatever 400 years ago was the equivalent of the Nobel Prize masterpiece. That was his focus. Tycho was a Danish aristocrat and Kepler was a mere peasant from Germany. These were barriers which were too strong to form a collaboration in the way we might form it today.

What happened, as you may know the story, was bizarre. Tycho was attending a dinner, hosted by Petr Vok Ursinus Baron Rozmberk here in Prague. Tycho, as was normal I gather, drank to his usual excess but, in the presence of Baron Rozmberk, was too polite to leave the table to relieve himself when he should have done so. As a result, he got a bladder infection and died shortly afterwards. Kepler then took over the observational data base and made the interpretations. So for you observers, if you are being wined and dined by theoreticians here in Prague, be careful.

So that was 400 years ago. Let's take a shorter period of time, a tenth of that. Thirty-nine years ago we had a General Assembly here in Prague, a small fraction of the history of Prague, but in fact about half of the lifetime of the IAU. I thought it might be interesting in fact to have a very quick show of hands for those of you here in the audience and I know that how many are, many were here in Prague in 1967. Where are you? ... Look at that, isn't that amazing.

Just briefly, looking at what happened in that General Assembly, 39 years ago, there are some incredible things and no details. You know many of the details, QSOs had been discovered a few years before. There were workshops, meetings and obviously enormous activity, just as there are today. That problem has remained exciting throughout the last 40 years. Two years before the meeting, Arno Penzias and Robert Woodrow Wilson discovered the microwave background, one of the greatest discoveries and later to receive a Nobel Prize, just before that meeting in Prague. Probably it was too hot a topic, because I don't see much indication that it was discussed in Prague, but of course in this meeting in Prague, in the next ceremony, we will be awarding the Gruber Prize in

Cosmology to somebody whose work happened as a consequence of the discovery of the microwave background.

Perhaps – and I didn't realize it until I was looking at my history carefully – to me the most remarkable thing that was happening during the General Assembly in Prague, in 1967, was that the astronomers in Cambridge had observed pulsars two weeks before the General Assembly and were deciding what to do with this incredible discovery. Jocelyn Bell Burnell is here and I hope people will talk to her afterwards about what was going on at that time. But to the best of my knowledge, at that time they were thought to be little green men and the issue was what would you tell the government and how would you do it. That was while the discussions were happening in Prague. We have of course major, major pulsar discussions at this meeting.

Just one or two things, before I close, about the IAU. The IAU really works in the background, to provide the lubrication for the wheels of the international machinery of astronomy and international science. When I accepted the position as IAU President, I knew relatively little about what the organization does and I imagine it is much the same for most of you here. But this is the way it should be. The IAU needs to facilitate astronomy and can do it in the background. But there is a huge team of Commissions and a network of Working Groups that are all busy behind the scenes. And the results of some of these activities are revealed and come out during these meetings and result in sometimes complex resolutions, but also sometimes other resolutions. More of that in a moment. This is also a meeting the shape of which is set very much by the Division Presidents. The Division Presidents represent the areas of astronomy in the Union, and we now have a new structure in which they are directly involved in the Union activities. I also found it of incredible interest that the first proposal for this kind of structure in detail came from Luboš Perek at the Prague 1967 General Assembly when he took over as General Secretary and he will be speaking to you shortly. It took the 40 years, or a good fraction of them, before such a change was in fact acceptable to the community, but now we have implemented it, primarily since the Kyoto 1997 General Assembly, and it is an important part of the Union.

Now I mentioned some things that happen in the background and result in resolutions. There are events which will be unfolding at this General Assembly, which will be unexpected and are certainly not the usual way things happen. I wanted to say a word or two about what will happen in the next week-and-a-half, and some of you may not be aware of what is going on. Because of international treaties, because of the IAU's mandate to get agreement on nomenclature, it is part of our job to make sure that we can communicate by having well-defined terms.

The definition of a planet has been sadly left not well-defined for hundreds of years. However, in order to proceed with IAU resolutions relating to the definition of a planet we have had to be very circumspect and to operate almost *in camera*. Because of the intense public interest in this topic and the intense pressure from the press, we have set up some groups representing not just astronomers, but historians and people from outreach, science writers and educators, to discuss this issue. Tomorrow, in the GA newspaper you will read about the results of these discussions. Everything is being embargoed until tomorrow. This is certainly not the way the IAU normally works, but I hope you will accept that in this case, with the enormous outside pressure, we felt it was the best course of action. So, by tomorrow everybody will be fully informed, and you have to be fully informed. Because in this next week-and-a-half, you will have an opportunity to debate what is being proposed, to give your input, to think about it. It is a complex issue, think carefully. And in the Second Session of this IAU General Assembly we will be making a vote on an IAU resolution related to the planets.

So my final comment is: after this IAU XXVIth General Assembly in Prague I think it would be wonderful if, instead of the Prague Spring, it could be remembered as the Prague Planet Protocol.

I now open this XXVIth General Assembly of the International Astronomical Union.

Address by Dr. Miloš Gregar, Councilor, City of Prague

Mr. President, ladies and gentlemen:

I am delighted and honored to be able to welcome your congress in our City of Prague, the heart of Europe. Especially, I welcome the representatives of the International Astronomical Union. The city of Prague is proud that Prague is hosting your meeting already for the second time. The last General Assembly in Prague took place 39 years ago. Therefore, Prague has become the third city, along with Sydney and Rome, where this congress comes for the second time.

Ladies and gentlemen, Prague has many attributes: Golden Prague, Prague – Mother of Cities, Prague – Heart of Europe, Prague – Rome of the North, Prague – Hundred Towers. None of the attributes belongs to Prague so indubitably as the one of “Prague Astronomical”. In this respect, Prague’s *genius loci* could hardly find a rival in the world.

Prague is literally an “astronomical” city. Its original, up to this day preserved town-planning disposition, which the emperor Charles IV gave to the city almost seven centuries ago, was drawn up according to the strict astronomical rules. Even the most unique UNESCO-protected architectural landmarks, as the Charles Bridge, the Old Town Bridge Tower and others are for experts something like small astronomy textbooks. One of the most unique technical sights in the world, the 600 years old Prague Astronomical Clock, has been indicating about twenty astronomical entries with remarkable precision up to the present day. We could hardly find any city in the world connected as much to the history of astronomy as Prague. At every corner you can find places remaining almost untouched by the flow of time, you can stand in the niches where Giordano Bruno, Tycho Brahe, Johannes Kepler, Tadeáš Hájek of Hájek, Joost Bürgi, David Gans, Jehuda Löw, Christian Doppler, Ernst Mach or Albert Einstein used to live and work on their inventions. Their legacy has been connected to Prague forever.

Prague not only protects, but also tries to further develop their legacy. The remembrance of these titans is essential for today’s astronomy. We can say that we are probably successful in our efforts, since the modern Prague Observatory belongs among the most visited educational institutions in our country. Your congress is a great example of Prague’s astronomical reputation.

Ladies and gentlemen, I believe that despite of your challenging program you will be able to visit the places where your predecessors used to reside with us, and that you will find the time for both relaxation and entertainment.

I wish your IAU General Assembly every success. Thank you for your attention.

Address by Prof. Václav Pačes, President, Academy of Sciences of the Czech Republic

Ladies and gentlemen:

It is a pleasure and honor for me to address you on behalf of the Academy of Sciences of the Czech Republic. The Academy of Sciences in this country is a system of

research institutes ranging from mathematics up to humanities and social sciences, with the emphasis on natural sciences.

I am proud that the Institute of Astronomy of the Academy undertook the task to co-organize this IAU XXVI General Assembly. The Institute of Astronomy is a medium sized institute that is devoted to solar physics and stellar astrophysics, to black holes, to galaxies, to astrometry and to the small bodies of the solar system.

It operates the 2-m telescope that was put in operation 39 years ago at the occasion of your IAU XIII General Assembly, which, as it was already mentioned, was held in Prague. Prague is, I think, a very good place for your Assembly because it always was a city of science and especially, as mentioned here, it is a city where, for instance, Johannes Kepler and Tycho Brahe lived and worked.

It was in the time of Emperor Rudolf II, who reigned over the whole Habsburg empire from the Prague castle. Rudolf II was a collector of arts and he was supporter of art and science. Of course at that time, the 17th century, science was different from today's science. Chemistry was mixed with alchemy, astronomy was mixed with astrology.

It was the time when the Prague Rabbi Loew created the artificial servant with the name Golem. There is a nice old Czech movie on these times. Rudolf II in this movie, invited Tycho Brahe to the Prague Castle to let him explain how the planets move and he did so in the company of the famous alchemist, Magister Kelly, and several of the noblemen at the Prague Castle. But these people – in the movie – wanted to get the Golem, and they couldn't do it without removing Rudolf II, so they decided to poison him. They put poison in his glass of wine at the very moment when Tycho Brahe started to show them how the planets moved, and I thought that you might be interested in seeing how your predecessor Tycho Brahe was explaining the movement of planets in the solar system, and so I took a piece of this movie and would like to project it to you, so please ... [*showing an excerpt from the movie "The Emperor and the Golem", 1951*].

Thank you for your attention.

**Address by Prof. Jana Musilová,
Vice-Rector for Research, Masaryk University, Brno**

Dear participants of this so highly anticipated event – astronomers from all over the world, dear distinguished guests, ladies and gentlemen:

I am very glad and honoured by the opportunity of addressing you on behalf of the Rector of Masaryk University, Professor Petr Fiala.

Astronomy and astrophysics have significantly contributed to our understanding of the picture of the world. This is in fact not different from other fields of physics. However, as the Sun, the Moon, the stars in the sky, and outer space altogether have always fascinated everybody – adults or children, scientists or poets – astronomy has in its hands a rare chance to get as many people as possible acquainted with physics cognition, to support the general knowledge of its importance. We are very aware of it at Masaryk University.

No famous astronomer has worked in Brno, neither in past nor in presence – neglecting for a while that a number of them, such as Josef Mohr, Luboš Perek, Jirí Grygar or Luboš Kohoutek, who became famous in Prague or abroad, had started their careers in Brno. The university observatory owns only a 60-cm telescope. Nevertheless, some world astronomer personalities maybe appear there, because of the enormous interest of students in astrophysics fields of study at Masaryk University.

Therefore, I wish your discussions in your sessions be successful, strengthen the already existing scientific contacts and establish new ones. Thank you for your attention.

**Address by Prof. Jan Bednář,
Vice-Rector, Charles University, Prague**

Dear President of the International Astronomical Union, dear participants of the General Assembly, distinguished guests, ladies and gentlemen:

Astronomy and astrophysics belong to the deepest and most common roots of natural sciences, as one of the main sources of human civilization, development and advance. They study not only planetary and stellar systems, interstellar matter and similar physical problems, but they offer essential and fruitful contributions to the understanding of the whole Universe, including deep and sophisticated philosophical interpretations.

Astronomy has provided during its history a great number of initialization and interpretations for mathematics, mechanics, classical relativistics and quantum physics.

We can all say that astronomy has deeply contributed to the human community progress during long history of our human world. It is surely pleasant and inspirational for the organizers of this General Assembly and also for me, representing Charles University in Prague, that astronomical studies have had a long and fruitful tradition, also in the local territory of the Czech Republic, especially in Prague in the field of the Charles University. I hope that this will be presented in detail in the lectures during other ceremonies.

I would like to wish to the General Assembly great scientific success, presentations of new substantial scientific results, new hypotheses and theories and generally many inspirational ideas. I also wish you a very pleasant stay in Prague.

Thank you very much for your attention.

**Address by Prof. Václav Havlíček,
Rector, Czech Technical University, Prague**

Mr. President, ladies and gentlemen, dear colleagues and friends:

It is a great honour for me to greet the participants of the XXVIth General Assembly of the International Astronomical Union on behalf of the Czech Technical University, the oldest university of technology in Central Europe.

The Engineering School of the Czech Estates was founded on the basis of an edict, issued by the holy Roman Emperor Joseph I in 1707, and classes began in 1780. The studies were at first directed toward military engineering, but the orientation soon moved toward engineering for civilian purposes. In the early 19th century the studies were thoroughly re-organized by Frank-Joseph Gerstner and the modern Prague Polytechnic opened in 1806.

Engineering education at the University has always been based on mathematics and physics and there have been strong connections with astronomy. Many of our professors of mathematics or physics have done research in astronomy too. I would like to mention especially Professor Christian Doppler, who taught mathematics at Prague Polytechnic from 1835 to 1847. In 1842 he published the paper “Über das farbige Licht der Doppelsterne”, writing about the shift of the light spectrum of double stars. In this paper he first formulated Doppler’s principle, which is still being used in astronomy and other technical applications today.

The Czech Technical University nowadays consists of seven faculties. One of them is the Faculty of Nuclear Science and Physical Engineering. Research in nuclear physics,

closely connected with astronomy, provides answers to basic questions of the existence of the Universe and is an important practical application of astronomical research results.

Last but not least, I wish you interesting papers, good discussions, important results and a pleasant stay in Prague. Thank you for your attention.

Address by Emeritus Professor Luboš Perek, Astronomical Institute of the Academy of Sciences of the Czech Republic, Prague; chairman NOC of the XIIIth IAU General Assembly in Prague, 1967; General Secretary of the International Astronomical Union 1967-1970

Ladies and Gentlemen, welcome again after 39 years:

At the XIIIth General Assembly of the IAU, held thirty-nine years ago, I had the privilege to invite the audience to meet again soon in Prague. Thirty-nine years is a short time in astronomy, but in human life it means two generations.

Many things have changed in that time. All branches of astronomy made substantial advances, thanks to space research, to computer technology, and, in the first place, thanks to a larger number of human brains working in the field. It is impossible to give an account of all new discoveries and of new understanding of old problems. Please be referred to 200 volumes of IAU Colloquium proceedings and 200 volumes of IAU Symposium proceedings, which appeared in those 39 years.

There are things, however, which have not changed. Among them is the individual membership in the IAU, an important support of personal contacts across space and time. As regards space, we greet astronomers from 67 countries and expect participants from eight additional countries to join us today or tomorrow.

As regards time, connecting past with the present, we have in Prague four former Presidents of the IAU. The youngest, in terms of service, is Franco Pacini, whose name is closely connected with rotating neutron stars. He was preceded by Lodewijk Woltjer, a supporter of the Very Large Telescope at Mount Paranal. Yoshihide Kozai stands for lunisolar perturbations of satellite orbits. The oldest in service is Adriaan Blaauw. He put all runaway stars into their place in an improved cosmic distance scale. More than half a century ago, I had the honor and pleasure to share an office with Adriaan at the Leiden Observatory, where the atmosphere consisted not of air or oxygen, but of pure astronomy.

Seven former General Secretaries, who devoted part of their lives to the IAU, are among us, starting with my predecessor, Jean-Claude Pecker, my life-long friend, who attended more IAU congresses than anybody else, or almost anybody else. My successor, Kees de Jager, made the Sun his permanent residence. Further, Jean-Pierre Swings, supporter of Mars exploration, Derek McNally, fighter against adverse environmental impacts, Johannes Andersen, director of the Nordic Optical Telescope, and Hans Rickman, observer of the comet impact on Jupiter. These seven musketeers have been recently joined by Jacqueline Bergeron. Therefore, the total count is now eight former General Secretaries.

Names of all former presidents of commissions, professors, and colleagues who connect the past with the present are too many to be listed here and now. They are all welcome, as well as all those who will become friends and colleagues at this General Assembly.

Ladies and gentlemen, next time, please, do not wait thirty-nine years. You are welcome any time. Thank you.

Presentation of the Peter Gruber Foundation Cosmology Prize Award 2006 and the Peter Gruber Foundation Fellowships 2006

Introduction by Patricia Murphy Gruber

Welcome to the Peter Gruber Foundation Cosmology Prize Ceremony presentation. We are happy to present this award in partnership with the IAU.

With the vision of my husband, Peter Gruber, we established this Prize in the year 2000 and it was the first of our international Prizes. We have established five Prizes: in Cosmology, Justice, Genetics, Neuro-science and Women's Rights. Each award recognizes discoveries and achievements that produce fundamental expansion of human knowledge.

I would like to acknowledge the vision and leadership of my husband Peter Gruber. It has been his ideas and the income from his successful career that entirely funds the work of the Peter Gruber Foundation.

Introduction by Peter Gruber

First of all, I just want to welcome all of you to this wonderful event. I am bedazzled by the spectacle of being here in Prague and seeing this wonderful city and its unfolding. I want to make this a very brief speech, if I can. There is an old expression that says "I throw my glass so that others will throw their jade".

Many years ago, and then I will stop, many years ago, when I was a little boy about eleven years old, I was in boarding school, and Brother Darcy, who was one of the teachers, loved two things. He loved astronomy and he loved his garden. And those people who helped him in his garden, got up at night to go to see the stars.

And that is how I became involved and very much interested in this, in the whole issue of astronomy. I just wanted to share that with you and tell you that it has been a wonderful trip, and I am enjoying it enormously. I just want to thank you so much for being here. Thank you.

Introduction by Patricia Murphy Gruber, continued

So Cosmology was our very first Prize and as Peter said, originated from when he was eleven years old being able to look through a telescope.

We award this Cosmology Prize annually, recognizing ground-breaking theoretical, analytical or conceptual discoveries. Past recipients are Allan Sandage and Jim Peebles (2000), who is here with us today; British Astronomer Royal, Martin Rees (2001); Rashid Sunyaev (2003), who is also here with us today; Alan Guth and Andrei Linde (2004); and, last year, James Gunn (2005).

Before announcing the 2006 laureate, I would like first to present our Fellowships for young astronomers. These fellowships were established with the IAU, with the aim of encouraging promising young investigators in cosmology. They are selected by the IAU from numerous applications. The 2006 Fellows are two: Inma Martinez-Valpuesta and Hum Chand.

Inma cannot be with us today. She was born in Spain and she is currently studying at the Centre for Astrophysics Research at the University of Hertfordshire. She is investigating the evolution of stellar bars in disk galaxies.

Hum is from India and is studying at the inter-university Centre for Astronomy and Astrophysics at Pune. He and his colleagues have found that the fine structure constant is not increasing with time, it really is constant. This is a good thing for the world of physics. I am told it means you do not have to rewrite your theories.

And now for the 2006 Cosmology Prize of the Foundation. This Prize carries a gold medal and an unrestricted cash prize of 250,000 US dollars. A distinguished

international board of advisers has guided our selection of the 2006 laureate. These advisers are nominated by the IAU and other scientific unions to ensure the scientific integrity of the Prize. The members, this year, are James Peebles, Ron Ekers, Jocelyn Bell Burnell, Roger Penrose, Peter Galison, Simon White, and Jacqueline Bergeron. Owen Gingerich and Virginia Trimble advise the Foundation on cosmology matters. It is gratifying to acknowledge the serious dedication, the knowledge and the enthusiasm that the advisers bring to the judging process.

Now it is time to announce the Prize. The 2006 Gruber Prize for Cosmology is awarded for ground-breaking studies, looking back over 13 billion years to the early Universe and confirming that our Universe was born in a hot Big Bang.

The 2006 Prize is awarded to Dr. John C. Mather and the *COBE* team. The Prize is shared by Dr. John Mather and the *COBE* science working group, representing the hundreds of people who contributed to *COBE*.

Before asking John Mather to accept the award, I'd like to ask two of the advisers to speak briefly about the achievements of Dr. Mather and the *COBE* team. Firstly, Prof. Virginia Trimble from the University of California at Irvine and Las Cumbres Observatory, she will outline John Mather's personal achievements.

Laudation by Virginia L. Trimble

Dr. John Cromwell Mather is, in a sense, a typical American, in another sense not. He just celebrated a significant birthday, and so is on the absolute cutting edge of the baby boom and the generation whose lives were transformed by Sputnik and its successors.

On the other hand, in a country of transients, he lives now only one state line away from where he was born, in Roanoke, Virginia. John grew up on a farm, in Sussex County, New Jersey, where his father was working in a dairy cattle experimental station of Rutgers. His mother was an elementary schoolteacher, and it is clear they taught him a good deal more science than was available in the local school, visited every other week by a Bookmobile. My school had lots of books, we were visited once a year by a cow, so that we could see what it looked like.

Sputnik went up when John was eleven, and by high school he was an enthusiastic consumer of summer school college classes in mathematics and physics. He was also even then persistent in the face of experimental failures. His first home-built short wave radio receiver didn't work, so he got some more parts and built another one.

When the discovery of the CMB was announced in 1965, Mather was a freshman majoring in physics at Swarthmore. Having read books by George Gamow, he was not surprised, though the discoverers were. In 1968, bachelor's degree in hand, John was awarded both NSF and Woodrow Wilson Fellowships. He accepted the NSF Fellowship that was worth about US\$ 400 more per year (a lot of money in those days), and went off to the University of California, Berkeley.

And we now discover that John Mather is very far on the hedgehog end of the fox-hedgehog spectrum of scientists, for, when he settled down to a thesis project in 1970, it was to work with Paul Richards on CMB measurements. (Rocket data had shortly before apparently suggested a large excess of short wavelength emission, no!) They, together with David Woody and Michael Werner (with some encouragement from Charles Townes) built a suitable widget and hauled it up 12,000 feet, almost to the top of White Mountain. John is the first author on the 1971 ApJ Letter that reports that they saw no spectral features or excesses.

Next came a balloon experiment. Incidentally, physicists say 'experiment' where astronomers would say 'observation'. Mather and Woody drove that one in a University truck from Berkeley to Palestine, Texas, where the flight was a success but the

instrument failed. Back to Berkeley, where Woody rebuilt the instrument. Later flights worked as planned and still saw no excess or feature emission.

Meanwhile, Mather wrote up a thesis and headed off to New York to be a ‘proper’ radio astronomer, working with Pat Thaddeus on observations of interstellar molecules. But the CMB was calling, and two years later, he was at Goddard Space Flight Center, on track to become the lead scientist on what we now call *COBE*.

Let us fast-forward to a Saturday afternoon at the January 1990 meeting of the American Astronomical Society, a session called Cosmic Background Radiation. The *COBE* authors had been very brave, because the abstracts had been submitted before the 18 November launch date. Nancy Boggess, who is also here, introduced the session and the satellite. We heard from Mike Hauser and from George Smoot and then from John Mather. He actually said rather little, and put up the measured spectrum, a more perfect black body than the calibrating sources, and remarked that it represented only a tiny fraction of the data. The audience spontaneously rose and broke into applause. The session chair growled into the microphone: . . . *What are you clapping for? The Universe?*

And I will hand over the microphone to Jim Peebles, to make just a little more clear what we were clapping for!

Laudation by P. James E. Peebles

Mr. President, friends and colleagues:

It is a distinct pleasure to join you in celebrating a deep advance in physical science.

I remind you that in the early 1970s we knew space is filled with microwave radiation. We had the idea that this radiation is a remnant from the Early Universe. But we felt reasonably sure that if this were so, then the radiation would have the distinctive thermal blackbody spectrum. We knew that the long-wavelength part of the spectrum is indeed close to blackbody. We had indications that there is an excess over blackbody near the peak. That apparent anomaly persisted for some 20 years, during which time we theorists were forced to consider the possibility that our universe is a good deal more complicated than we would have liked to have imagined.

We rose to the occasion and we discussed perturbations to the radiation spectrum by decaying dark matter or magnetized superconducting annihilating cosmic strings, for example. This is beautiful physics, and it still may be part of our physical world, but we know that it is not dominant in the energy inventory. The *COBE-FIRAS* experiment, with principal investigator John Mather, showed that our Universe on this scale of things is wonderfully simple, and furthermore that the microwave background is almost uniquely interpretable as a fossil from a time when our Universe was very different from now. What a wonderful advance.

The second experiment on *COBE*, DMR, with George Smoot as PI, aimed to detect the disturbance from an exactly homogeneous distribution of this radiation that must be present, given that our Universe is not exactly homogeneous. When *COBE* was planned, in 1974, we knew the physics of this disturbance; in fact we had too many theories of what might have happened to drive the formation of galaxies and concentrations of galaxies in the expanding Universe, in the process disturbing the spatial distribution of the thermal radiation. The deep contribution by DMR was to show the community the direction that it has taken since then to get now a wonderfully tested cosmology that describes the expansion of the Universe and the evolution of structure within it. This theory rests on the general relativity Einstein introduced nearly a century ago. General relativity has stood the test of time, and an enormous extrapolation from the Solar System, where it

was first tested, to the Universe. This is a wonderful result, and another great contribution from *COBE*.

The third experiment on *COBE*, DERBY, with Michael Hauser as PI, addressed another question with a long history. From the time people seriously considered the possibility that the Universe is homogeneous in the large scale average, a fascinating issue has been what has become of the starlight from the generations of stars. One of the goals for the DERBY experiment was to address an aspect of that question that Mike Hauser and I had been debating in the 1970s: what is the present energy density of this accumulated radiation, and what is its distribution in wavelength? DERBY set us on the right track: we have now a more or less a consistent story relating what is observed to what has been happening in galaxies and their AGNs. This is another important advance.

I asked John yesterday: "Weren't you a little nervous putting three eggs – the three experiments on *COBE* – in one basket?" He was young, a post-doc, when he set out in 1974 to become project-scientist for a mission of considerable size and importance. It was a brave adventure and a marvelous success.

A final word. The awarding of major prizes is a wonderful thing, not so much for the individual, although that is fun, but to the community to show our respect, and to the broader community to show that people are doing things in this field that are worth respecting. But during the many years of the tradition of major prizes in science, the way science is done has evolved: great advances depend on crucial contributions from increasingly large numbers of people. I don't think we have broken any very unique ground in the way this award has been arranged, but it does at least take a step toward recognition of how science has evolved. It is a pleasure to consider that this award to the *COBE* mission team struck a good and proper balance.

Thank you.

Words of thanks by John C. Mather

I would like very much to thank the Gruber Foundation for recognizing the work of our team, from the bottom of my heart and on behalf of the whole *COBE* team.

You said out loud that great discoveries come from teams and not just from one or two or three people. I have just heard my talents described in a delightfully embarrassing way, but I have to tell you I didn't do this project myself at all. I think, as individuals we all know our history, we know how we came together to do something beautiful. But I don't know if we really appreciate the flow of history and faith, the forces that come together for a moment to do something magnificent. Standing here in Prague, a beautiful city, maybe a thousand years old, with a very exciting and interesting and difficult history, one can really feel that and sense it.

We astronomers have been blessed by these forces. How could Hans Lipperhey have known 400 years ago, what he would do to astronomy? Or how could Thomas Jefferson and Benjamin Franklin, two of the first scientists in the New World, have guessed that their future tax payers would support fundamental science for the good of all mankind, or that the benefits would be so immense? Or that the discipline that it takes to put spaceships on the moon, using sliderules to design them, would lead so far.

Now to be more specific, I would like to thank some people, especially my family who gave me great opportunity and showed me about science. My father was a scientist, my mother's father was a scientist. I thank my dear wife Jane, who encouraged me when the going was tough, which it was often, and understood what it meant that I was terrified that I might make a big mistake while helping to lead a team of a total of 1500 people.

I thank my thesis-adviser Paul Richards, who is here today. He had actually designed the prototype instrument. The prototype spectrometer should measure the cosmic

background radiation spectrum, while I was his graduate student. I thank my fellow student David Woody, who actually made the apparatus work, after I left Berkeley and proved that it could be done. I thank my post-doctoral adviser Pat Thaddeus, who saw that this idea actually could fly in space and helped me organize the team that we grew to write a proposal to NASA, back in 1974.

Then NASA Headquarters, in the person of Nancy Boggess, saw that this proposal was good and chose six people: four from our team and two from two competing teams and said that we should define a new *COBE* mission. Nancy had leadership in this new field of infrared astronomy for NASA Headquarters. She actually backed four major observatories that are coming along. The first was the *InfraRed Astronomical Satellite*, then there was the *COBE*. Now the *Spitzer Space Telescope* which is flying now, and what is coming next is the Stratospheric Observatory for Infrared Astronomy, the *SOFIA*. It is almost done. So, she did that even though the technology was very hard to develop. I am sure that without Nancy's leadership our project would never have got started.

On our science team we had an outstanding chairman, Rainer Weiss, who actually spent some of his childhood right here in Prague. My fellow principal investigators and our deputies, George Smoot and his deputy Chuck Bennett, Mike Houser and his deputy Tom Castle, my deputy Rick Shaver, they were brilliant to work with.

But beyond all of these individual outstanding people, I have to express the appreciation of the science team for the professional engineers, who actually took these challenges and made the *COBE* work. The expert engineers worked side by side with the scientists. Reaching the limits and finding ways around them and they worked like crazy. There are many stories of the ways that the *COBE* almost failed, but was saved because somebody was working late at night or in weekends and noticed something was not quite right. If you really want to know what happened, you have to read the book.

So, on behalf of all of us on the *COBE* team: our grateful thanks and appreciation to the Gruber Foundation. We have a glorious future ahead of us.

Thank you.

Dr. Alena Hadravová

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Cultural performances during the Inaugural Ceremony were presented by:

The Lesser Town Singers

The Children Traditional Ensemble Rosénka

The Brass Ensemble of the Prague Castle Guard Orchestra