

An *Unforgettable* Year!



The VATICAN OBSERVATORY
2009 *Annual Report*



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Vatican Observatory Publications

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Cover: Pope Benedict XVI, looking at a meteorite from Mars,
Specola Vaticana, 16 September 2009

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1. From the Director

An Unforgettable Year

This past year, the International Year of Astronomy, has given us many unforgettable moments, but for the director and staff of the Specola Vaticana one stands above all others: September 16, 2009; the day Pope Benedict XVI came to bless and inaugurate the new facilities of the Vatican Observatory.

In an interview with Vatican Radio I described it as a “family” visit, the visit of a father to his astronomer children. Even now, months later as I write this piece, memories of that day are still very much alive. However, two moments seem to me of particular significance. On his arrival, the Holy Father was greeted by Cardinal Lajolo with the words: “Your Holiness, welcome to your Observatory!” This greeting summarizes the mission of the Specola Vaticana: we are here to serve the Pope, and in doing so, serve people by carrying out astronomical research.

The second moment was before the Holy Father left the Specola, when he sat at my desk and signed a parchment as a souvenir of his visit. There is another parchment at the Specola, a testament to the visits of past Popes, which bears the signatures of Pius XI, Pius XII, John XXIII, Paul VI and John Paul II. But there was no more room for another Pope’s signature, so Father Maffeo had become the custodian of a brand new one, which was simply waiting for the right moment to receive the signature of such an illustrious visitor. That day finally came and, after a tour of the new facilities, our distinguished guest became the first to add his signature to it. It was a truly unforgettable moment to have the Pope sitting at my desk. I explained to the Holy Father that in signing this new parchment he was beginning a new chapter in the history of the Vatican Observatory. You see, that day, September 16th 2009, marked exactly 75 years to the day since Pius XI had initiated the older parchment and with it the presence of the Vatican Observatory in the Papal Palace of Castel Gandolfo.

Thanks to the generosity of the Holy See and the efforts of the Governatorate of the Vatican City State, the Vatican Observatory has new and comfortable facilities for its precious collection of meteorites, antique books, astrolabes and telescopes, as well as an area reserved for the Summer School, for conferences and visiting scholars.

Our new premises, a renovated monastery in the southern end of the Pontifical Villas of Castel Gandolfo, are almost a metaphor of the observatory’s mission: though within the Church, close to the Pope, we are on the border with the wider world and therefore open to dialogue with everyone, with those who believe and those who do not.

Another memorable moment of this year was our audience with the Holy Father in Vatican City in celebration of the International Year of Astronomy. The highlight of the day was a private audience with Pope Benedict XVI who addressed an international group of renowned astronomers. A group of friends and benefactors of the Vatican Observatory Foundation also participated in the papal audience.

This was just one of the many events we held here at the Vatican for the International Year of Astronomy. Others are outlined in a special section, of this Annual Report, dedicated to our activities related to this important celebration of Astronomy.

In short, 2009 was a very busy and intense year for us all here at the Vatican Observatory. Besides the organization of conferences and exhibitions, this year we also moved the Observatory's library, offices, the meteorite and photographic plate collection and the Jesuit Residence.

None of this could have happened without the support of many colleagues, benefactors and friends, especially H.E. Cardinal Giovanni Lajolo, President of the Governatorate of Vatican City State; H.E. Mons. Gianfranco Ravasi, President of the Pontifical Council for Culture; H.E. Mons. Sánchez Sorondo, Chancellor of the Pontifical Academy of Sciences, and Father Federico Lombardi, S.J., Press Secretary of the Holy See. To all of them and many more, goes our deepest gratitude.

Looking back on 2009 we have many reasons to be grateful to the Lord.



José G. Funes, S.J. Director





2. The International Year of Astronomy

"This celebration, marking the 400th anniversary of Galileo's first celestial observations, compels us to consider the immense progress in scientific knowledge in the modern era and, particularly, to turn our gaze towards the sky with wonder, contemplation and commitment in the search for truth, wherever it is to be found."

Pope Benedict XVI'

The Vatican Observatory has long been at the forefront of efforts to bridge the gap between faith and science. With this in mind during 2009, we invited scientists from across the world, believers and non believers, to participate in initiatives held at the Vatican to mark the International Year of Astronomy. Some of these events, such as an exhibition in collaboration with the INAF (Italian National Institute for Astrophysics) and Vatican Museums, traced how far we have come since Galileo's first telescopic observations 400 years ago. Others, such as the conference on Astrobiology held in conjunction with the Pontifical Academy of Sciences, or the Vatican Observatory Super Summer School, looked at the scientific puzzles still waiting to be solved. Below we publish a brief overview of the main events of 2009, the International Year for Astronomy, at the Vatican.

Astronomers received by the Pope

"On the threshold of yet greater scientific discoveries"

Pope Benedict XVI'

On October 30th and 31st the Specola Vaticana hosted a symposium at the Vatican to celebrate the International Year of Astronomy. The symposium was introduced by Prof. Pierre Léna on behalf of the Pontifical Academy of Sciences, and included an address by Prof. John Huchra of Harvard-Smithsonian Centre for Astrophysics and President of the American Astronomical Society with the title "From Galileo to Hubble: Astronomy in the 21st Century." The programme also included a tour of the Tower of the Winds, a visit to the Vatican Secret Archives, the Sistine Chapel, and the exhibition ASTRUM 2009 at the Vatican Museums. The event culminated in a audience with Pope





Benedict XVI. A group of friends and benefactors of the Vatican Observatory Foundation, which generously supports the work of the Observatory in the United States, was also present at the Papal audience.

During his speech, the Pope reminded his audience that the Year of Astronomy primarily aims “to recreate in today’s world the sense of wonder that characterised the great era of scientific discoveries of the seventeenth century”. According to Benedict XVI, our era “positioned on the threshold of yet greater scientific discoveries,” can derive benefit from the “same sense of wonder” and the “desire to attain a truly humanistic synthesis of knowledge” which were characteristics of the fathers of modern science such as Galileo. “Who can deny,” the Pope repeated, “that the responsibility for the future of humanity and also the respect for nature and the world around us, demands, now more than ever, the careful observation, the critical judgement, the patience and the discipline that are essential to the modern scientific method?”



Pag. 8
Pope Benedict XVI
addresses participants
at the colloquium in the
Clementine Hall

Pag. 9
Pope Benedict XVI;
Cardinal Giovanni
Lajolo, President of
Governorate of Vati-
can City State (left);
Fr. José Funes S.J.,
Director Vatican
Observatory (right) with
Friends and Benefactors
of Vatican Observatory,

Pope Benedict XVI
greet participants
at the colloquium in the
Clementine Hall

¹ Pope Benedict XVI to participants in the colloquium sponsored by the Vatican Observatory on the occasion of the International Year of Astronomy, Clementine Hall, Friday, 30 October 2009

² Pope Benedict XVI to participants in the colloquium sponsored by the Vatican Observatory on the occasion of the International Year of Astronomy, Clementine Hall, Friday, 30 October 2009

Pag. 11
H.E. Cardinal Tarcisio
Bertone, Vatican
Secretary of State,
visiting ASTRUM 2009
with Ileana Chinnici
as his guide.

Astrobiology Conference

"Both science and religion posit life as a special outcome of a vast and mostly inhospitable universe. There is a rich middle ground for dialogue between the practitioners of astrobiology and those who seek to understand the meaning of our existence in a biological universe"

Professor Chris Impey

Following on from the colloquium for the International Year of Astronomy, a five-day conference gathered astronomers, physicists, biologists and other experts to the Casina Pio IV in Vatican City from 6 to 10 November to discuss the budding field of astrobiology. Thirty scientists, including non-Catholics, from the U.S., France, Britain, Switzerland, Italy and Chile explored the study of the origin of life and its existence elsewhere in the cosmos. Among those who participated in this conference, organised in conjunction with the Pontifical Academy of Sciences, were Jonathan Lunine, chair of the Scientific Organizing Committee, professor at the department of physics in Rome's Tor Vergata University; Chris Impey, professor at the department of astronomy in the University of Arizona and the Steward Observatory, Tucson, USA., and Athena Coustenis, professor at the Observatoire de Paris-Meudon, LESIA/CNRS, France. The conference provided a special opportunity for scientists from different basic disciplines to spend an intensive week understanding how the work in their particular speciality might have an impact on, or be impacted by, that in other areas.

Going back - ASTRUM 2009, 400 Years of Astronomy and its Instruments

"All of us astronomers somehow are children of Italian astronomy".

- Fr. José Funes

On 16 October Vatican celebrations for the International Year of Astronomy and the 4th Centenary of the introduction of astronomical observations were launched by the inauguration of an exhibition organized by the Italian National Institute of Astrophysics (INAF), the Vatican Observatory and the Vatican Museums. The exhibition concluded in conjunction with the closing of the year dedicated to astronomy on 16 January and fell under the patronage of Vatican City State, the President of the Italian Republic and the following institutions: Pontifical Council for Culture, Pontifical Academy of Sciences and the Italian Ministry for Universities and for Research.

Due to its scientific and historical approach, the exhibition focused on the historical evolution of the different technical instruments created by people down through the centuries to enhance and perfect the observation of the sky, location of stars and celestial bodies.

An important selection of the most precious and rarest instruments for astronomical observation, lent by many Italian observatories, was on show. The display included some 130 objects, such as instruments, maps, manuscripts of Galileo Galilei, models of the Ptolemaic and Copernican systems, paintings, photographs, codexes and books. Visitors were able to admire items created between the 11th and 20th century, heretofore unseen by the general



public, generously lent by INAF, the Vatican State (on loan from the Vatican Observatory and the Vatican Apostolic Library) or belonging to private Italian collectors.

One of the most valuable objects in the exhibition was a 16th century astrolabe – an instrument used to determine the altitude and position of the stars in the heavens – given to Pope Leo XVIII for his priestly jubilee. The re-foundation of the Vatican Observatory in 1891 is closely connected to this artefact.

Only two exhibitions of this type have been held previously: one in 1929 and another in 1958.

Going forward – Super VOSS '09

The Vatican Observatory may be one of the oldest astronomical institutions of the world, but without doubt, beyond its dedication to scientific research, education is one of its primary missions, education directed especially at young astronomers of developing countries. This mission gave birth to the Vatican Observatory Summer School, or VOSS in 1986. Over the past two decades, VOSS has helped to create a worldwide community of young scholars in Astronomy and Astrophysics. The summer schools take 25 students (out of some 200 applicants) from all over the world to spend four weeks of intensive study in some aspect of astrophysics. Two thirds of our students come from the developing world, and about half have been women. The topic varies from school to school.

Super VOSS is the irregularly-scheduled reunion of students from the Vatican Observatory Summer School (VOSS). In 1998 and 2002 the Vatican Observatory organized two International symposia with the participation of alumni and faculty of VOSS. There are nearly 300 alumni now, and about 60 attended the Super VOSS '09 dedicated to the International Year of Astronomy. Students from 20 years ago are now themselves professors at leading research institutes in Astrophysics. In fact, this Super VOSS was organized entirely by alumni from the school.

“We all belong to the same Universe, we all see the same sky”.





Held at the "Istituto il Carmelo" in Sassone, Rome 21-26 June, this Super VOSS focused on how we can also use astronomy as another important common ground to open dialogue over different important issues. The meeting combined presentations of scientific research results and discussions on public outreach in Astronomy. There were reviews of topics from galaxy evolution, to the nature of dark matter and dark energy and meteor streams.

In the words of one of the organizers, Bro. Guy Consolmagno; "Listening to their reviews made me realize how wonderful it is when you see someone who you knew as an eager undergraduate, who you can now appreciate as an expert going well beyond where you once were... this education thing, it works!"

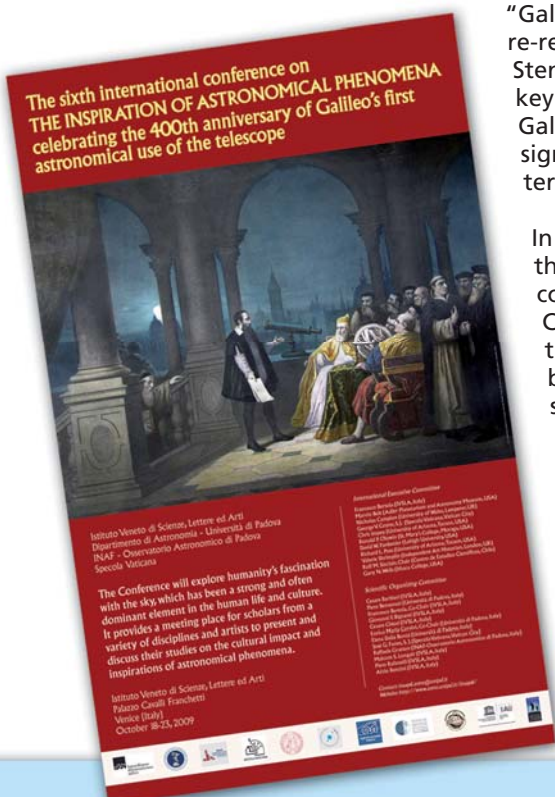
With the occasion of Super Voss 09, on 24 June the Vatican Observatory and the Pontifical Council for Culture also organized a seminar for the general public. There were three presentations. Monsignor Gianfranco Ravasi, president of the Pontifical Council for Culture, spoke on "In the beginning God created heaven and earth. Biblical Cosmology"; Prof. Marco Bersanelli of the University of Milan spoke on "Beauty and the vastness of the cosmos"; Fr. George Coyne, director emeritus of the Vatican Observatory, spoke finally of "Life in the universe: what wonder and how many questions".

Galileo, 400 years later

The Vatican Observatory was also involved in the scientific organization of two other meetings.

"Galileo 2009," a historical, philosophical, and theological re-reading of the Galileo Case, was organized by the Istituto Stensen in Florence, 26-30 May. Fr. George Coyne, one of the keynote speakers, discussed the meaning of discovery which Galileo must have sensed as he, for the first time, realized the significance of "listening" to the universe rather than pre-determining it.

In Venice, 18-23 October, the Department of Astronomy of the University of Padua organized the sixth international conference on The Inspiration of Astronomical Phenomena. Cardinal Angelo Scola, Patriarch of Venice, greeted the participants and was the bearer of a Pontifical Message signed by Cardinal Tarcisio Bertone, Secretary of State. The message said that the Pope was "pleased that the Conference would treat the relationship of astronomy to art, culture, history, literature, music, religion and inspiration."



Cosmology

There is a long standing controversy regarding the foundations of general relativity: does mass-energy generate space-time (an idea known as Machs principle, after the 19th century physicist and philosopher of science) or does space-time generate mass-energy? The resolution of this issue touches on both relativity theory, the basis of our understanding of space-time, and quantum theory, the basis of our understanding of mass-energy. In a paper this past year, Michael HELLER and colleagues have proposed a model unifying general relativity and quantum mechanics by demonstrating that there is a sense in which mass-energy can be regarded as emerging from "noncommutative pregeometry." One could say that, in this case, mass-energy is produced out of pure (noncommutative) geometry.

An interesting property of the proposed model concerns the status of the initial and final singularities – the beginning and the end of the universe. Owing to random properties of the model, on the fundamental level (in its "pregeometry phase") both singularities are irrelevant: they have no effect on a noncommutative dynamics. If, however, one goes to the classical limiting case, the random properties of the model are averaged out, and the standard idea for the evolution of the universe emerges with its initial Big Bang and its final Big Crunch singularities.

This work was published in the paper: M. Heller, L. Pysiak, W. Sasin, Z. Golda, Noncommutative Closed Friedman Universe, General Relativity and Gravitation 41, 2009, 1625-1637.

In the past year, Ellis and STOEGER have continued their collaboration in critiquing and expanding on current advances in cosmology.


One of the key ideas in our present understanding of how the universe formed is the concept of "inflation" – the extremely rapid (much faster than the speed of light) expansion of space-time for a very short period in the earliest moments after the Big Bang. It has been suggested that inflation may occur outside the limits of our observable universe to produce many other universe domains. In some well-known scenarios of open-universe eternal inflation, a large number of universes nucleate and thermalize within the eternally inflating mega-universe.

According to this idea, each universe nucleates at a point, and therefore the boundary of the nucleated universe is a space-like surface nearly coincident with the future light cone (i.e. that part of space-time that lies in the future in every frame of reference) emanating from the point of nucleation, all points of which have the same proper time. This leads those authors to conclude that at the proper time at which any such nucleation occurs, an infinite open universe comes into existence.

However, Ellis and STOEGER point out that this is due entirely to the supposition of the nucleation occurring at a single point. They note that, in light of quantum cosmology, this seems difficult, if not impossible, to support. Even an infinitesimal space-like length at the moment of nucleation gives a rather different result – the boundary of the nucleating universe evolves in proper time and becomes infinite only in an infinite time. Thus they conclude that the alleged infinity is never attained in any finite time.



3. Research Highlights



This work was reported in George F. R. Ellis and William R. Stoeger, "A Note on Infinities in Eternal Inflation," General Relativity and Gravitation 41, 2009, 1475-1484.

Common sense says that an effect must happen after the event that causes it; and cosmology agrees. But because Relativity has shown that what we think of as "time" can be shifted by our frame of reference, one must be careful in determining that a proposed "cause" occurs in a place and time that is in the past in all possible frames of reference (commonly called the "past light-cone") and likewise that only events in the "future lightcone" can be affected by events occurring now. The actual path/history of any given object is generally referred to as its "worldline" within the light cone.

The limit of causality usually considered in cosmology is the particle horizon, which is defined as the set of world lines which intersect our past light cone at the Big Bang surface. It delimits the possibilities of causal connection in the expanding universe. Any event outside that horizon is too far away to affect us; it could only affect the present moment by making itself known – sending information about itself – with a signal faster than the speed of light. Since that's impossible, we can conclude that nothing outside that horizon can be the cause of anything occurring here.

However, the particle horizon is not a realistic indicator of the limits of important interactions in space-time, since most "causes" make themselves known by interactions that travel at speeds much slower than the speed of light. In a recent paper, Ellis and STOEGER consider the matter horizon for the Solar System, that is, the co-moving region that has contributed matter to our local physical environment. This lies inside the effective domain of dependence, which consists of those regions that have had a significant physical influence on this environment through effects such as matter accretion and acoustic waves. This is determined not by the velocity of light, but by the flow of matter perturbations along their world lines. This means, they emphasize, that the region of the perturbations that became our Galaxy occupied a relatively small amount of space, relative to the observable universe – even relative to the smallest-scale perturbations detectable in the cosmic microwave background radiation.

Such relatively very small fluctuations are just beginning to be discernable with advanced detection systems, but the size of those fluctuations is smaller than the thickness of the last-scattering surface itself. Thus, the microwave signal from the Milky Way-size clumps at that time (almost 13.7 billion years ago) will be swamped by the statistical fluctuations in the last-scattering surface itself.

Looking to the future of our local cosmic domain, Ellis and Stoeger suggest simple dynamical criteria for determining the present domain of influence and the future "matter horizon." The former is the radial distance at which our local region is just now separating from the cosmic expansion. The latter represents the limits of growth of the matter horizon in the far future, the boundary between regions which will eventually cease expanding and collapse into our region, and the region outside which we expand forever.

This work was presented in G. F. R. Ellis and W. R. Stoeger, "The Evolution of Our Local Cosmic Domain: Effective Causal Limits," Mon. Not. R.A.S. 398, 2009, 1527-1536.

Stellar Astronomy

Stars come in a variety of brightnesses and a variety of colors, but these differences among the stars can be caused by both the intrinsic nature of the stars -- larger stars can be brighter than smaller stars -- or by their relative position from our telescopes -- closer stars are brighter than fainter stars. Likewise, even their colors can be affected by the passage of their starlight through clouds of gas and dust which are distributed throughout the galaxy. When we see a star of a given brightness or a given color, how do we sort out these different effects?

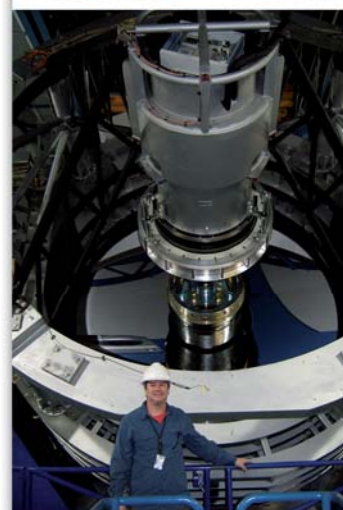
Clusters of stars, stars formed together and still travelling together through the galaxy, can provide one answer. In a cluster one may find stars with many different kinds of spectra, but since they are all located near each other in the same part of space, their light has all travelled the same distance, through the same pathways, to reach our telescopes. Thus any differences in the light we measure from star to star within a cluster can indicate the intrinsic differences due to the stars themselves. In this way, one can more reliably connect the spectral type of a star with its intrinsic luminosity, in a pattern usually described in the so-called Hertzsprung-Russell diagram. From such diagrams, the characterization of stars in what is called the "main sequence" stage in their evolution has been derived.

But just because a number of stars appear to be next to each other, can we be sure that they really are members of the same cluster? Certainly, some fraction of those stars must just, by chance, lie in the same line of sight as the cluster, but closer or farther away than the cluster stars. It's by observing carefully the amount that their spectra have been changed by travelling through the dust clouds of the galaxy that we can sort out those stars whose light has seen a common amount of alteration, versus those that are less altered (and thus nearer to us). In the process, this kind of analysis helps us work out the distribution of such dust clouds in the galaxy itself.

But these differences can be subtle. The first step is to devise a system to get as accurate as possible a measurement of the colors of the star clusters. A. G. D. Philip (Union College) and BOYLE have been taking CCD images through a variety of useful color filters of open and globular clusters at the Vatican Advanced Technology Telescope with the goal of obtaining accurate measurements of each star's brightness in each filter that are good to a very high precision, if possible better than 0.01 magnitude. Measurements of this quality can later be analyzed to yield estimates of temperature, luminosity and metallicity i.e., element abundance of the stars in the cluster. This allows one to estimate the age and history of the cluster, and eventually compare clusters from different parts of the galaxy

However, even the best CCD chips do not yield photometry of this quality without further corrections. How can they determine how much correction is needed, and where that correction needs to be applied? To solve this issue, they looked at data from one of the most well-observed clusters of stars in the sky, the open cluster M 67. This is a cluster that has been well characterized by many observers using many different systems, and one for which a number of images taken with the Vatican CCD camera were already available. They took the best published values for the brightness of various stars

Dante Minniti, during visit to European Southern Observatory Very Large Telescopes (VLTs), at Paranal Observatory, Cerro Paranal, Chile.





in the field, which served as their standard stars. Then they could calculate the differences between these standards and the results derived from the VATT camera images, as a function of position on the chip. These corrections were then applied to all the CCD frames; with this procedure they were able to obtain a precision of 0.01 magnitudes in all the fields that they observed.

With this improved photometric precision, over the past year, BOYLE and Philip and their colleagues Vrba (from the Naval Observatory in Flagstaff), Janusz from Poland, and Straizys, Bartašit, Deveikis, K. Zdanaviius and J. Zdanaviius from Lithuania have obtained CCD observations of the open clusters NGC 752, in the constellation of Andromeda; IC 361, located in the constellation of Camelopardalis; and stars near a dark dust cloud near the North American Nebula known as the "Gulf of Mexico."

For NGC 752, they used eight intermediate-band filters of the Stromvil (Ström-gren + Vilnius) system. Four fields of 12 arcminutes in width and height were observed, covering the central part of the cluster. The good-quality multicolor data made it possible to obtain precise estimates of distances, metallicity and foreground reddening for individual stars down to the limiting magnitude, $V = 17.5$, enabling the identification of faint stars that are probably members of the cluster. The new observations provide an extension of the lower main sequence to three magnitudes fainter than the previous limit, based on data taken years ago with photographic plates. The relatively small number of photometric members identified at fainter magnitudes seems to indicate the actual limit to the number of low mass stars in the cluster.

For IC 361, they used the eight-color Vilnius + I system. Based on this multicolor data, they were also able to estimate distances, foreground reddening and metallicity for individual stars measured in the field of the cluster. This allowed the authors to identify and eliminate most of the field stars from the image, and to identify the probable cluster members. From this, they could then derive the true distance and metallicity of the cluster. The interstellar extinction caused by intervening clouds of gas and dust was found to be non-uniform across the field, with values ranging from 1.9 to 2.6 mag. They conclude that IC 361 appears to be a mildly metal-deficient cluster of intermediate age, located as far as, or just beyond, the Perseus spiral arm of our galaxy.

Finally, within the program of photometric and spectral investigation of stars in the vicinity of the North America and Pelican nebulae, BOYLE and his collaborators have determined the photometric spectral types of 40 faint stars (down to $V = 18$ mag) in an area of the dense dust cloud known as Gulf of Mexico (a part of the larger cloud L935) in the North America nebula. Most of the stars are K and M dwarfs located either in front of or inside the dark cloud at a distance of about 1800 lightyears from our sun.

This work was reported in Philip, A. G. D., Boyle, R. P., and Janusz, R., 2009. A photometric observing program at the VATT: Setting up a calibration field. Bull. A. A. S. 41, 703; Bartašit, S., Janusz, R., Boyle, R. P., Philip, A. G. D. and Deveikis, V., 2009. Multicolor CCD photometry of the open cluster NGC 752. Proc. IAU Symposium No. 266, eds. R. de Grijs and J. R. D. Lepine, 361; Zdanaviius, J., Boyle, R. P., Vrba, F. J., Zdanaviius K., and Bartašit, S., 2009. IC 361, a distant intermediate-age cluster in Camelopardalis. Proceedings IAU Symposium No.

266, eds. R. de Grijs and J. R. D. Lepine, 557; and Boyle, R. P., Janusz, R. and Straizys, V., 2009. Deep photometry and classification of stars in the Gulf of Mexico. *Bull. A. A. S.* 41, abstract #2353.

Galactic Astronomy

Like all spiral galaxies, at the center of the Milky Way is a large “bulge” of stars. But characterizing that bulge is a challenge because we can only observe it from our vantage point within the galaxy itself, and the path of light from the center of the galaxy to our telescopes goes past thick clouds of gas and dust. In other galaxies, we can see that some bulges look like small elliptical galaxies (“classic” bulges) while others look like disk galaxies (“pseudobulges”). One active debate is over whether the Milky Way bulge has the characteristics of a classical bulge or that of a pseudobulge. MINNITI and collaborators have published several papers this past year exploring this issue.

Detailed abundance studies of bulge stars is a key to investigate the origin, history, and classification of the bulge. One way to obtain the sorts of stellar parameters that can help solve this issue is to study detailed abundances of different elements as determined from near-infrared spectra for bulge giants already investigated with optical spectra. In particular, the abundances of the important elements carbon, nitrogen, and oxygen (CNO) are better determined in the near-infrared. In one project, they recorded high-resolution, near-infrared spectra in the H band using the Very Large Telescope (VLT) in Chile; the CNO abundances were determined from the numerous molecular lines in the wavelength range observed.

The results suggest that the Milky Way bulge experienced a rapid and early star-formation history like that of a classical bulge; however, a similarity between the bulge trend and the trend of the local thick disk seems present. Such a similarity could suggest that the bulge has a pseudobulge origin.

The bulge metal-poor clusters may be important tracers of the early chemical enrichment of the Galaxy. In another project, MINNITI worked with collaborators studying the globular cluster NGC 6522, which lies in the bulge and which is notable for being unusually low in metals; indeed, it was the first metal-poor globular cluster identified in the bulge by W. Baade. Despite its importance, very few high resolution abundance analyses of stars in this cluster are available in the literature.

The main purpose of this study was to determine the metallicity and elemental ratios in individual stars of NGC 6522. High resolution spectra of 8 giants of the bulge globular cluster NGC 6522 were obtained at the eight-meter VLT UT2-Kueyen telescope. Multiband photometry was used to derive effective temperatures as reference values. The moderate metallicity points to a population of very old globular clusters in the Galactic bulge. The ultimate conclusion is that the bulge is old, and went through an early prompt chemical enrichment.

Studies of the Galactic Bulge will be further advanced by the Wide Field Camera 3 (WFC3), which was installed on the Hubble Space Telescope (HST) during the first spacewalk of Space Shuttle mission STS-125 on May 14, 2009. With this new camera, the astronomical community will have access to powerful new capabilities for investigating resolved stellar populations.



MINITTI served as one of the astronomers detailing the tools available for astronomers to use these data. The WFC3 Galactic Bulge Treasury program will obtain deep imaging in five photometric bands on four low-extinction fields. These data will have no proprietary period, and will enable a variety of science investigations not possible with previous data sets. The bulge data will shed light on the bulge formation history, and will also serve as empirical population templates for other studies.

*This work has been presented in Ryde, N., Gustafsson, B., Edvardsson, B., Melendez, J., Alves-Brito, A., Asplund, M., Barbuy, B., Hill, V., Kaufl, H. U., Minniti, D., Ortolani, S., Renzini, A., and Zoccali, M., 2009. Chemical abundances for 11 bulge stars from high-resolution, near-IR spectra. *Astron. Astrophys.*, in press (arXiv:0910. 0448); Barbuy, B., Zoccali, M., Ortolani, S., Hill, V., Minniti, D., Bica, E., Renzini, A. Gúmez, A., 2009. VLT-FLAMES analysis of 8 giants in the bulge metal-poor globular cluster NGC 6522: oldest cluster in the galaxy? *Astron. Astrophys.*, in press (arXiv:0908. 3603); and Brown, T. M., Sahu, K., S., Zoccali, M., Renzini, A., Ferguson, H. C., Anderson, J., Smith, E., Bond, H. E., Minniti, D., Valenti, J. A., Casertano, S., Livio, M., Panagia, N., Vanden Berg, D. A., Valenti, E., 2009. The WFC3 galactic bulge treasury program: a first look at resolved stellar population tools. *Astronom. J.* 137, 3172-3180.*

Planetary Science

Meteor saturation: To record the flight of meteors, Fr. Jean-Baptiste KIKWAYA S.J. and his collaborators at the University of Western Ontario, under the direction of Professor Peter Brown, take long exposure images of the night sky with very sensitive video cameras. The high sensitivity allows them to follow meteors that would be too faint to be seen with the naked eye. But this sensitivity also means that when a brighter meteor zooms across the field of view, the image of its trail can be over-exposed. When the detector becomes “saturated” in this way, you can’t measure the actual brightness of the meteor from the images; all you can tell is that it was brighter than the camera could record. This is a problem, since the brightness of the meteor is an important clue to its size and density.

However, it has long been known that no camera gives perfectly sharp images; even a point source, like a star, produces a spot that is brightest at its center, then fainter as one moves away from the center in fashion that is a well-understood mathematically, usually a variant on the well-known “bell-shaped curve” called a point-spread function. Could it be possible to recover the actual brightness of an overexposed meteor by modeling the “point-spread function” based on parameters such as the less-exposed outer edges of the meteor trail? Kikwaya and his colleagues have developed just such a model. But how can they test its accuracy?

Kikwaya and colleagues pointed two image-intensified video cameras the same direction to capture meteors seen in the skies over Ontario during three nights (October 31, November 2, and November 6, 2008). While the aperture of one camera was set at f/0.85, the other camera had its aperture turned two stops down to f/2, reducing its sensitivity. With these conditions, some meteors saturated the first camera but not the second (group I); some saturated both cameras (group II); and some did not saturate either (group III). They collected 516 meteors, including 30 of group I and 7 of group II.

In the case of group I meteors, they compared the meteor brightness from the second camera to their correction of the saturated part of the same meteor brightness extracted from the first camera. In the case of group II meteors, a modeled saturated correction was applied on the observed saturated brightness from both cameras; then they compared the two modeled results.

For meteors of group I, an average residual of less than 0.4 magnitude was found between the observed brightness and modeled corrected brightness. For meteors of group II, the average residual between the two corrected brightnesses ranged about 0.3 magnitude. Based on the agreement between observed brightness and modeled one, they are now confident of the model's accuracy. In the future, this method can be used to extract information, such as its mass and density, of any meteor that would otherwise be hidden in its saturated state.

This work is described in Kikwaya, J.-B., Weryk, R. J., Campbell-Brown, M., Brown, P. G., and Hawkes R. L., "Saturation correction for meteoric photometry" accepted for publication by the journal Astronomy and Astrophysics.

Enstatite Meteorites: enstatite chondrites are meteorites marked by an abundance of enstatite (hence their name), a mineral made of magnesium and silicon oxides, and a depletion or absence of the mineral olivine, which in other meteorites can be thought of as resulting from the reaction of iron oxide with enstatite. The abundance of iron in the enstatite chondrites is not all that different from the ordinary chondrites; but instead of being present as iron oxide in the minerals, it is present as metal.

Due to their relative rarity compared to other chondrites, enstatite chondrites are poorly understood as a group. Of the many attempts to sort these meteorites on the basis of petrography or trace elements, the most widely used system divides the enstatite chondrites into two groups, EH and EL, based on the metallic iron content (High and Low). These groups also are reported to show systematic differences in the abundances of trace elements and silicon dissolved in the metal.

But do the two groups really differ in iron content? In many cases, the bulk compositions reported in the literature, which were the basis for dividing the meteorites into two classes, were determined from samples significantly smaller than 10 grams. But enstatite chondrites can be heterogeneous at this scale; even with the unaided eye one can see abundant large clasts of atypical material mixed into the fabric of the meteorite.

Measuring the grain density and magnetic susceptibility of larger samples can resolve this issue, as they provide a quick and non-destructive measure of average whole-rock iron content. Samples with higher iron contents should have higher densities and higher magnetic susceptibility measurements; and rather than measuring the content of a thin slice taken from a small sample of the meteorite, the whole rock can be measured by these techniques.

In previous work, Bro. Guy CONSOLMAGNO and his collaborators Dan Britt and Bro. Bob Macke S.J. (University of Central Florida) had reported grain density and porosity for nine separate enstatite chondrites including both fresh meteorites seen to fall, and possibly weathered samples found in locales such as dry deserts. They found a slightly higher average grain density



for EH compared with EL samples, but the difference was not as large as one might have expected from the original classification scheme, and indeed there was considerable overlap between the two groups. It was unclear at that time whether the difference was real or only the result of measuring an insufficient number of samples.

Thus, as part of a larger survey of meteorite physical properties, in the past year this group have reported measurements of the density, porosity and magnetic susceptibility for 26 samples of 16 different enstatite chondrites. These included 7 EH (4 falls, 3 finds) and 9 EL (5 falls, 4 finds). They utilized the well-established, non-destructive and non-contaminating methods for measurements of the meteorite samples reported in previous Annual Reports. Grain densities were determined via helium ideal-gas pycnometry using a commercially-available instrument, the Quantachrome Ultrapycometer 1000; bulk densities were determined using the Archimedeian glass bead method, with small corrections made for systematic error; and magnetic susceptibility was measured using a hand-held device, the ZH-Instruments SM-30 magnetic susceptibility meter. Porosity was calculated from the bulk and grain densities.

The results are startling: EH and EL chondrites are indistinguishable in all of the physical properties tested: density, porosity, and magnetic susceptibility. The grain densities for all the samples fell between 3.45 and 3.75 g/cm³, with a few outliers at slightly lower density and one (Khairpur [EL]) with a density of 4.17 g/cm³. The average grain density for EH samples was 3.61±0.14 g/cm³, while that for the EL samples actually slightly higher, at 3.65±0.24 g/cm³. Statistically the two groups are indistinguishable. Among only the fresh falls, both EH and EL have the same average grain density of 3.64 g/cm³. Porosities from all but one sample were between 0 and 6.4%.

Most samples had a magnetic susceptibility between a log of 5.35 and 5.64, with three having much lower susceptibilities. Average log for EH is 5.21±0.46 and for EL is 5.38±0.30. Eliminating outliers, average log's for EH and EL agree at 5.45.

This considerable overlap between EH and EL chondrites in all of the physical properties tested – on average both groups have the same densities, magnetic susceptibilities and porosities – indicates that there is no apparent difference in iron content between EH and EL chondrites. In fact, the highest-density, highest-magnetic-susceptibility meteorite in this survey (Khairpur) is an EL chondrite, and among the lowest-density, lowest-susceptibility samples is an EH (Bethune). Density and magnetic susceptibility therefore cannot be used to distinguish EH and EL chondrites. They conclude that there is no systematic difference in iron content between EH and EL chondrites.

Still, individual enstatite chondrites show clear mineralogical differences that cannot be explained by metamorphism; indeed there may be multiple enstatite chondrite parent bodies. A re-examination of these important meteorites with modern analytical tools, cognizant of their large heterogeneities, should allow a better understanding of trace element trends and their origins. Continuing this study on further enstatite chondrites may also help determine how consistent the grouping is, and whether the “outliers” themselves represent significant groups of enstatites.

This work was reported at the Lunar and Planetary Science Conference and the Meteoritical Society annual meetings; see Macke R. J., Britt D. T., and Consolmagno G. J., 2009. Enstatite chondrite physical properties: density, porosity and magnetic susceptibility. Lunar Planet. Sci. XL, abstract #1598 and Macke R. J., Hutson M. L., Britt D. T., and Consolmagno G. J., 2009. EH and EL enstatite chondrite physical properties: no difference in iron content. Meteorit. Planet. Sci. 44, abstract #5047.

Exoplanets: Following up on the discovery of two exoplanets reported in last year's Annual Report, Dante MINNITI and collaborators have reported the discovery of low-mass companions orbiting five solar-type stars. These discoveries were found with the Magellan precision Doppler velocity survey, with minimum masses ranging from 1.2 to 25 times the mass of Jupiter. These nearby target stars range from mildly metal-poor to metal-rich, and appear to have low chromospheric activity. The companions to the brightest two of these stars have previously been reported from the CORALIE survey. Four of these companions (HD 48265-b, HD 143361-b, HD 28185-b, and HD 111232-b) are low-mass Jupiter-like planets in eccentric intermediate- and long-period orbits. On the other hand, the companion to HD 43848 appears to be a long-period brown dwarf in a very eccentric orbit.

This work was reported in Minniti, D., Butler, R. P., Lopez-Morales, M., Shectman, S. A., Adams, F. C., Arriagada, P., Boss, A. P., Chambers, J. E., 2009. Low-mass companions for five solar-type stars from the Magellan planet search program. Ap. J. 693, 1424-1430.

History of Astronomy

During 2009, International Year of Astronomy, the National Institute for Astrophysics (INAF), the Vatican Observatory and the Vatican Museums organized an exhibition on the Italian astronomical heritage, under the title of Astrum 2009. The exhibition, held at the Vatican Museums from 16 October 2009 to 16 January 2010, is divided into nine sections illustrating the development of the astronomical instrumentation by displaying the historical materials kept in the Italian Observatories. For the first time, a unique heritage consisting of instruments, books, archival documents, such as Galileo's manuscript of the Sidereus Nuncius (1610) and other material coming from prestigious libraries and museums, has been collected and rendered accessible to the public. The exhibition with its catalogue is the result of a collective effort of the three promoting institutions. The curators of the different sections of Astrum 2009 members have served as the Scientific Organizing Committee, contributing actively to the essays in the catalogue and the explanatory displays of the exhibition. Ileana CHINNICI, with the assistance of Sabino MAFFEO and José FUNES, were responsible for the Vatican Observatory's contribution in this effort.



4. Instrumentation and Technical Services

Vatican Advanced Technology Telescope (VATT)

The technical work at the Vatican Advanced Technology Telescope continued in 2009 with the same excellent personnel. Working with Bob Peterson as Steward Observatory's mountain operations manager and Ken Duffek as the VATT manager, Christopher Corbally, S.J., remains director for the VATT, while Richard Boyle, S.J., is the telescope scientist and scheduler. Ned Franz, Dave Harvey, Chris Johnson, and Gary Gray comprise the rest of the VATT's regular engineering team.

Telescope Upgrades

Duffek, Harvey, and Johnson performed another network upgrade in the summer. The important highlights of this upgrade include:

- A fiber isolated main feed from the microwave tower was installed this year to eliminate the last hardwire copper connection to the Observatory equipment. All fiber network feeds are working flawlessly.

- All IP addresses have been changed to a 10.0.0.0 scheme to form a private network. This change was done to improve network security as well as to save on network charges. A total savings on network charges should be on the order of \$3,000/yr.

- Johnson purchased, and installed a flashed based network firewall and VPN to enhance network security and create a secure connection between sites. This task was accomplished to pave the way towards remote observing in the future.

- Johnson renamed all computers in the host table to better identify computers throughout the Observatory as part of the private network setup. This task corrects past deficiencies in machine names that were confusing and non-descriptive (i.e., the computer that ran the VATT 4K CCD camera used to be called VATT pcx; it now is VATT 4kccd). The naming process chosen was to better identify each machine by function and location.

- Franz built the new VATT 4Kccd vacuum pump station. This new pump allows for better portability and better cold temperature operation. A new pump down procedure was also implemented and documented.

- Harvey, Johnson, and Boyle have been instrumental in continued observer training and support during the observing season.

Power Audit

During the 2008 summer shutdown the VATT manager coordinated a power audit for the observatory site. This audit was ordered to determine phase balancing of the Observatory electrical power distribution system and proper grounding of the VATT building ground grid to the microwave communications tower. A few electrical code violations were identified as

well as excessive UPS ground currents; Franz and Gray corrected all code violations and rectified all UPS ground problems over the course of this year.

Microwave Grounding

Since the repair of the microwave tower grounding system, MGIO and Duffek have implemented a yearly check of the ground impedance. The specification it needs to meet is 25 ohms or less. Currently we are seeing after a year of service a total of 1 ohm which is only a .5 ohm increase since the fix. This is well within the Motorola standard.

Safety Program

Our safety program continues with great success. With the Steward Observatory safety manager, Dale Web, and mountain operations manager, Bob Peterson, walk-throughs continue on a six month interval to identify any potential safety issues. Currently this year none have been identified.

This year Gray extended the deck around the Telescope to facilitate a safe access for pumping down the VATT 4kccd camera. In the past, personnel had to remove the camera from the Telescope and take it to the instrument room, where a fixed vacuum pump was employed to pump the system down. This method exposed the camera to hazards such as dropping the instrument or electrical static discharge. The deck extension located on the Northeast side of the Telescope, accommodating our new portable vacuum station, now allows personnel to service the VATT 4kccd in situ and eliminates the above mentioned hazards.

The engineering team are continuing to work towards a safer work environment.



Gary Gray standing on the scissors elevator and besides the new extended decking around VATT. The Camera GUF1 hangs from the telescope. David Harvey photography



Telescope Maintenance

The Telescope primary mirror had a hard wash this year by Gray. This was his first solo on the task and the mirror looks great. Gray has now become a licensed protector and keeper of the mirror.

The Dome pulley system for opening and closing the Dome shutter was overhauled. All new pulleys have been installed and the cable system re-tensioned for proper operation. During the pulley work Gray and Franz inspected the shutter rain seal. No damage or replacement was needed.

The Azimuth hydrostatic bearing pump number one had a new pump head installed this year. Towards the end of winter observing pump number one was exhibiting a cavitation problem and so we switched over to pump number two to finish out the season. Pump one has now been put back in to service with no more issues reported. At the same time a complete overhaul of the Azimuth oil bearing return lines was accomplished. It was noted that the original return system began leaking and fracturing this year. Franz specked out and redesigned the oil return system to be more efficient on the delivery of oil and to open up access to the Telescope pier.

*New oil return lines from the VATT azimuth bearing, from a view immediately below the telescope.
David Harvey
Photography*

Instrumentation

Camera GUF1

The Vatican Observatory Research Group and the Centre for Astronomy, National University of Ireland Galway (NUI Galway), agreed upon a memo of understanding whereby the Galway Ultra Fast Imager (GUF1) would be located at VATT for a year starting on June 1st, 2009, with provision for renewing the agreement. This L3CCD instrument, based on a DV887 iXon Camera, has practically zero deadtime between exposures and so is particularly suited to monitoring or obtaining the period of rapidly varying objects.

*Assembly of the Camera GUF1 by Leon Harding and Ned Franz.
Richard Boyle
photography*



The advantages of placing this state-of-the-art instrument on a reliable telescope in a high quality observing site led to the agreement. The research collaborator of the NUI Galway group at the Vatican Observatory is Boyle, and the instrument is available to all VATT users.

Aaron Golden, Gregg Hallinan, Leon Harding, and Ray Butler (NUI Galway) were guided by Franz in the rebuilding of GUF1 to match the extremely fine imaging tolerances of VATT and in the placement of the instrument and its dedicated computer. The success of this collaboration was evident in the very smooth commissioning phase of GUF1 at VATT, well in time to take part in a multi-telescope observing campaign later in June. All VATT's engineering team was involved in the installation, and Harvey joined Boyle in becoming an approved supporter of other GUF1 observers.

VattSpec

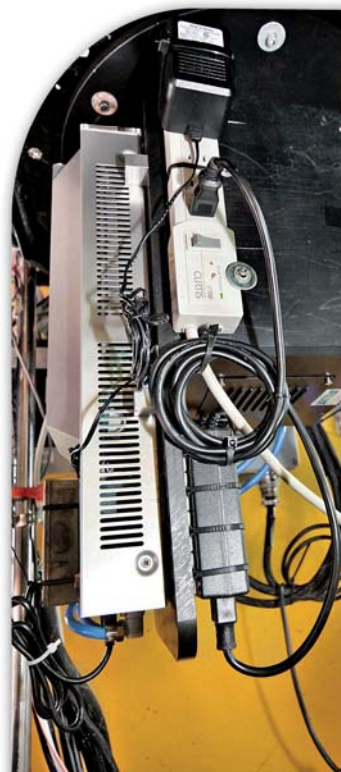
When not on the mountain, the VATT engineering team has been working on the new optical spectrograph, "VattSpec." They have optically aligned the instrument and tested the new electronics for axis control. Harvey and Johnson are writing the low level control code and GUI respectively. Completion of the software is scheduled for late 2009, and testing of the complete software and mechanics will begin soon thereafter.

Vatican Observatory Website

The Vatican Observatory website has been redesigned using the content management system (CMS) Joomla. Its webmaster, Ayvur Peletier, took the opportunity of the Super VOSS III to give tutorials on editing in Joomla to Christopher Corbally, S.J., overall website manager, and to Alessandro Omizzolo and Francesco Rossi, who manage the "Specola Vaticana" section, which includes the Vatican Observatory Summer School website. This Italian section, along with the Vatican Observatory Foundation section, managed by Colleen de Keratry of Petrus Development, were the first to be posted on the internet and provide attractive browsing to the website visitors. The "Vatican Observatory" (English) section has many subsections, which include those for the VATT, and so took longer to finalize but it appeared in time to show Christmas and New Year's greetings. All sections can be reached via <http://vaticanobservatory.org>

Digitization of Schmidt Camera Plates

After 6 years of work the digitization of the Schmidt plates of the Vatican Observatory, which involved scanning a total of about 4000 plates each covering a field in the sky of 4.5x4.5 degrees, is now complete. These glass photographic plates had been exposed with the Specola's Schmidt camera telescope in the gardens of Castel Gandolfo from the early 1960s until 1980 and represent an enormous trove of data on the sky. However, to access the data on these photographic plates required the use of elaborate mechanical measuring machines used in those years and now long out of function. Now the digital version of these images, prepared by Alessandro Omizzolo, can be accessed by anyone and measured with modern computer software.



Camera GUF1
installed on VATT.
David Harvey
photography

To test the quality of the data, Omizzolo derived the variability curve of the quasar 3C345 and compared the photometric data obtained from the scanned images with those published some years ago and derived from the same plates through visual estimation of the magnitude: the two sets of data are in very good agreement.

Every image is stored in a FITS file, with a header containing the relevant data about every image: telescope, instrument, exposure time, the filter used, coordinates of the center of the image, and coordinates of the observatory where the image was taken. The next step was to apply astrometry to every image, i.e. to associate to every star in the image the corresponding coordinates in the sky. This has been done by Richard D'Souza using dedicated software, and so now one can know the correct coordinate of every object in every image.

But how to provide access to this huge amount of data to the international scientific community? We have established a website (<http://saccheri.as.arizona.edu/>) through which it is possible to browse the database of the plates and to see a preview of every image, and also ask a CD-copy of the original image for scientific purposes.

The work now continues with the digitization of the plates of the Vatican section of the Carte Du Ciel. This promises to provide a very interesting data mine, as these plates date as far back as 1891; once obtained, these star positions and brightnesses from more than 100 years ago can be compared with modern data obtained by satellites.

*Pag. 27
Bro. Consolmagno
in front of CERN's
Large Hadron Collider
particle accelerator*

Events for the International Year of Astronomy were at the forefront of the Vatican Observatory activities in 2009, often burrowing into time staff would normally, and happily, spend engaged in research initiatives. Nonetheless, in 2009, Vatican Observatory scientists and adjunct scholars were the recipients of awards, received prestigious appointments, travelled the world as guest speakers at conferences and conventions and continued in the time honoured tradition of patient exploration of the universe.

But, perhaps, the most important aspect of this International Year of Astronomy was that it served as a vehicle to re-engage the general public in the field of Astronomy. Taking advantage of this unique opportunity, in 2009, the Specola Vaticana and its staff dedicated a lot of its time to education and public outreach.

CERN Visit

2-4 June, Cardinal Lajolo, accompanied by Fr. José Funes, and Bro. Guy Coslomagno of the Vatican Observatory, visited CERN (The European Organization for Nuclear Research) in Geneva, on the invitation of Prof. Ugo Amaldi.

The visit to CERN lasted a full day. Cardinal Lajolo was able to admire the gigantic Large Hadron Collider particle accelerator. Prof. Rolf Heur, Director General of CERN hosted a breakfast in honour of the Cardinal. In the afternoon, Professor Amaldi presented the research activities of the Tera foundation which has as its primary aim the development, in Italy and abroad, of radiation therapy techniques based on the use of hadronic particles and, more generally, on the applications of physics and computer science in medicine and biology.

The visit concluded with a workshop in which scientists at CERN and the Observatory presented the research taking place in both institutions.



5. Observatory and Staff Activities

APPOINTMENTS AND AWARDS

A change in staff members at the Specola Vaticana

Father Paul Mueller, S.J., of the Jesuit Province of Chicago, has been appointed Superior of the Jesuit Community at the Specola Vaticana. On 15 January 2010 Father Paul Mueller also joined the staff of the Observatory. In 1996 Father Mueller graduated with a Master of Science in Physics from the University of Chicago. He completed his doctorate in Conceptual and Historical Studies of Science at the University of Chicago in 2006. During his theological studies at the Jesuit School of Theology in Berkeley, he developed his interest in religion-science issues and earned a Master of Sacred Theology in 1993. He was ordained to the priesthood in 1993. From 2006 through 2009 he was Assistant Professor of Philosophy, Academic Dean of the Jesuit First Studies Program and Academic Dean of the St. Joseph College Seminary at Loyola University.

Father Mueller replaces **Father Giuseppe Koch, S.J.**, who after serving 7 years as superior of the community and 6 years as Vice Director for Administration, received a new destination from his superiors. We owe our deepest gratitude to Father Koch for his service at the Vatican Observatory.

On September 5 Cardinal Lajolo, president of the Governatorate of Vatican City State, approved the appointment of **Father Jozef M. Maj S.J.** as Vice Director for Administration. Father Maj belongs to the Jesuit Province of Southern Poland and was ordained a priest in 1982. In 1990 he earned his doctorate at the Pontifical Oriental Institute in Rome. He is Adjunct Professor of Byzantine Liturgy at the Pontifical Oriental Institute. From 1992 until 2006 he worked at the oriental section of the Pontifical Council for Promoting Christian Unity, responsible for relations with the Orthodox Churches of Eastern Europe and secretary of the Catholic Committee for Cultural Collaboration

On 1 September **Brother Jonathan Stott S.J.** joined the Observatory's staff in Tucson. Brother Stott is a member of the New England Jesuit Province. He obtained a doctorate in Physics at the Case Western Reserve University in Cleveland. From 2001 through 2004, he was research fellow at the Massachusetts General Hospital, Department of Radiology in Boston, researching topics in biomedical optics. He joined the Society of Jesus in 2004. In 2008 he spent the summer at the Vatican Observatory in Castel Gandolfo working with Father Boyle processing data from the VATT 4K CCD camera.

And finally, after 33 years of commendable service at the Vatican Observatory **Father Juan Casanovas S.J.** returned to the Jesuit Province of Tarragon. Fr. Casanovas is very knowledgeable in the History of Astronomy, especially in the Gregorian Reform of the Calendar. We are also grateful to him for his service as librarian.

Other appointments in Brief

Bro. Guy Consolmagno S.J. was elected to the organizing committee of Division III (Planetary Systems) and continued to serve on the Working Group for Planetary System Nomenclature of the International Astronomical Union for the term 2009-2012. He also became chair of the European Jesuits in Science for the term 2009-2011, and was elected to the Education Board of the American Astronomical Society.

Fr. Christopher Corbally S.J. was appointed President for Division IV (Stars) of the International Astronomical Union for the term 2009-2012. He also chaired the Awards Committee of the Institute on Religion in an Age of Science.

Adjunct Scholar **Fr. Michael Heller** was appointed director of the newly founded Copernicus Center for Interdisciplinary Studies in Krakow. The Copernicus Center, established in 2008 through the initiative of Heller, is a joint-venture of the Jagiellonian University and the John Paul II Pontifical University in Kraków (former Pontifical Academy of Theology in Kraków). The Center's activities are focused on multidisciplinary research, which engages specialists from various fields of knowledge (physics, chemistry, biology, neuroscience, philosophy, theology, law). During the first year of its operations the Center established 11 research teams consisting of scholars from several Polish universities. It has launched a book series in Polish, *Monografie Centrum Kopernika* (Copernicus Center Monographs) within which one monograph has been published and several others are in print. Within the coming year two further publication projects are expected to be launched: a series of monographs in English, Copernicus Center Library, and a periodical Copernicus Center Reports. And the Center has organized seminars and special lectures, including the Cracow Methodological Conference held in May 2009, with the participation of Professor Francisco Ayala. More information can be found in: www.copernicuscenter.edu.pl.

Awards

The George Van Biesbroeck Prize for 2009 was awarded to **Fr. George Coyne** by the American Astronomical Society "in recognition of the diversity and scientific richness he has brought to the astronomical community through his visionary leadership of the Vatican Observatory Summer School and its long-term mentoring program, and for the unique role he has played at the juncture of science and religion". He also received a doctorate *Honoris Causa* from Le Moyne College, Syracuse, New York, USA and from the College of the Holy Cross, Worcester, Massachusetts, USA.

Fr. Michael Heller was awarded the distinction *Polonia Restituta* by the President of Polish Republic and received an *Honoris Causa* doctorate, University of Cardinal Stefan Wyszyński, Warsaw, Poland

And finally, as shown in the photograph, on November 16th **Fr. Juan Casanovas** received the Holy Cross Pro Ecclesia et Pontifice from Cardinal Lajolo in recognition of his laudable 33 years of service at the Vatican Observatory.



Staff Presentations, Academic Activities and Conference Participation.

Boyle presented a paper at the 213th Meeting of the American Astronomical Society, 4-8 January, Long Beach, California • participated in the Super VOSS 2009 on the theme "Astronomy: A Common Ground for Sharing Humanity's Concerns" from 21-26 June, Sassone, Rome • participated in the International Astronomical Union XXVII General Assembly, 3-14 August: Rio de Janeiro, Brazil.

Carreira gave a series of lectures on the occasion of the International Astronomical Year at the universities of Colombia (Bogota, Cali and Medellin), in Spain (Almeria, Barcelona, Madrid, Palencia and Ciudad Real), in Rome (Ateneo Pontificio Regina Apostolorum) and in Havana Cuba • opened a Congress on "Evolution and Theology" with several extra lectures to different audiences of a university level.

Caruana delivered a paper on "The Evolution of Belief" at the Philosophy Department Research Seminar, Heythrop College, University of London 14 January • on "Darwin and Theology" to the Faculty of Theology, University of Malta 15 February • and on "Darwin and the basis of morality" at the 9th international symposium Echoes of Darwin, Institute of Humanities, Unisinos, São Leopoldo, Brazil, 9 – 12 September.

Consolmagno attended the Opening ceremony of the International Year of Astronomy held at UNESCO headquarters in Paris, January 15-16 • visited the University of Aix-en-Provence, the University of Marseilles, and the Observatoire Côte d'Azur where he gave several talks, 19 – 21 January • was a visiting scholar at Hans Bethe House, Cornell University, 9-11 March • spoke on the Stratigraphy of the Solar System at the Dublin Institute for Advanced Studies on 31 March, at Washington University, St. Louis, on 16 April, and at the Institute for Human and Machine Cognition, Pensacola, Florida on 30 September • participated in a panel on Science, Faith, and Religion at the World Science Festival, June 10 -13, New York City • organized and participated in the biennial meeting of the European Jesuits in Science, 9-13 September, Braga, Portugal • paid a working visit to the physics department of Boston College as the guest of Prof. Cy Opeil S.J. in May, and team taught (with Fr. Jan Lambrecht S.J.) a course on Dynamic Evolution at LeMoyne College, Syracuse NY, from October to December.

Corbally led a workshop session on "Intermediate Mass Stars & Massive Stars", 9-11 February, Strasbourg France • delivered an invited talk entitled "An Astronomer's Faith within an Evolutionary Cosmos" and joined a panel discussion during a student organized conference at Notre Dame University, IN, held from 3-4 April on "Evolution of Age: Multidisciplinary Reflections on Darwin" • participated in the Super VOSS 2009 on the theme "Astronomy: A Common Ground for Sharing Humanity's Concerns" from 21-26 June, Sassone, Rome • was invited to participate in the International Society for Science and Religion Conference 2009, 3-5 July, Cambridge, England • described "A Stellar Spectral Classification Encoding Scheme" at the Commission 45 meeting during the IAU XXVII General Assembly held in Rio de Janeiro from 3-14 August • after the IAU-GA gave a colloquium on "The

Puzzling λ Boötis Stars" at the Brazil's Laboratório Nacional de Astrofísica, located in Itajuba, and visited the nearby Pico dos Dias Observatory • on 21 September gave an invited talk on "Activity in a Sample of Nearby Solar Analogs" during the Solar Analogs II Workshop held at Lowell Observatory, Flagstaff • participated in the Annual General Meeting of the International Dark-Sky Association, 13-15 November, Phoenix, Arizona.

Coyne gave a talk on "The Evolutionary Universe" at the retreat organized by St. Paul's Institute of London, 12-15 January, on the theme of God Through the Looking Glass at Hemingford Grey, UK. • presented the Farstrup-Mortensen Lecture on "Science and Religion" at the Bethania Lutheran Church, Solvang, California on 21 February • gave a paper on "Galileo Judged: Urban VIII to John Paul II" at the International Conference on the Historical, Philosophical and Theological Reappraisal of the Galileo Affair held at the Stensen Institute in Florence, Italy, 26-30 May • to celebrate the International Year of Astronomy 2009 in Turin, Italy, 3-5 June, gave three seminars: on "The Laws of Nature and Finality in the Universe" at the Foundation Luigi Firpo; on "The Measurements of the Age of the Universe" at Thales Alenia Space; on "The Dance of the Fertile Universe" at the Turin Academy of Sciences • was a keynote speaker at the Joint Meeting of the North and South Italy Groups on Science and Faith, 12-14 June, Frascati, Italy with a paper on "Measuring the Age of the Universe and its Significance" • was on the organizing committee of the Super VOSS 2009 on the theme "Astronomy: A Common Ground for Sharing Humanity's Concerns" from 21-26 June, Sassone, Rome • attended the annual meeting of the Society for Developmental Biology, 23-27 July, San Francisco, California, USA gave a keynote paper on "Talking About and Teaching Evolution" • at the International Congress on Darwin's Impact on Science at the Catholic University of Portugal, Braga, 10-12 September, presented a paper on "Evolution and Intelligent Design. What is Science and What is Not" • to celebrate Galileo and Darwin lectured on "The New Cosmos of Galileo" on 6 October at the Center for Astrobiology and Early Evolution at the University of Washington, Seattle, Washington, USA • gave a lecture on "Galileo and Bellarmine" at the Sixth Conference on the Inspiration of Astronomical Phenomena, 18-23 October, Venice, Italy • on 19 November gave a talk on "The New Cosmos of Galileo" at the symposium "Changing the Paradigm: The Challenge of Galileo" at the Keck Institute for Space Studies, California Institute of Technology, Pasadena California, USA • gave an invited address at the congress, Dio Oggi, of the Progetto Culturale of the Italian National Bishops' Conference, 10-12 December, Rome, Italy.

Funes attended the Opening ceremony of the International Year of Astronomy held at UNESCO headquarters in Paris, January 15-16 • presented a paper at the IAU-UNESCO Symposium 260 "The Role of Astronomy in Society and Culture, 19-23 January, in Paris • presented a paper at the Zeldovich Meeting, 20-23 April, Minsk • participated in "Galaxies Properties Across Cosmic Ages", 28-29 April, Rome • participated in the "Galileo 2009", 26-30 May, Florence • participated in the "Filling the Cosmos with Stars", 6-10 July, Spineto Italy • participated in the Study Week on Astrobiology, 6-10 November, Vatican City • gave a lecture in the Master program on Science and Faith at the Pontifical Atheneum Regina Apostolorum.

Heller attended a seminar of the Institute of Theoretical Physics: "A Noncommutative Friedman-Lemaître Cosmological Model", Warsaw University February 21 • participated in the Jagiellonian University, Noncommutative Picnic "Aspects of Noncommutative Symmetries", Krakow, May 8-9 • was invited to participate in the Big Public Lecture "Spying the Sky", May 11 • took part in a public discussion at the XIII Cracow Methodological Conference on the "Evolution of the Universe - Evolution of Life", together with Francisco J. Ayala and delivered a paper on "Catholic Church and the Theory of Evolution. Vatican and Philosophy" May 18-19 • gave a public lecture at the Greenwich Observatory and Maritime Museum, London on the "The Origin of the Universe in Science and Cosmology", May 27 • attended the University of Bristol, Department of Philosophy, seminar "Noncommutative Friedman World Model", May 29 • was part of a panel discussion at the World Science Festival, New York, on "Time since Einstein", June 13 • delivered a paper at the Grassmannian Conference in Fundamental Cosmology, University of Szczecin, paper on "A noncommutative Friedman World Model", September 16-19 • gave a public lecture on the "Big Bang and the Creation of the Universe", September 17 • took part in the Meeting with Polish intellectuals and a talk on "Human Time and Cosmic Time". September 24, Chicago, Polish Consulate • attended a public talk on "Creation of the Universe. God and Contemporary Cosmology", September 19, Illinois Institute of Technology • delivered a public talk on "Creation of the Universe. God and Contemporary Cosmology", September 20, Polish Consulate, New York • November 29, Institute of John Paul II, Washington D.C., delivered a public talk: "The Origin of the Universe in Science and Philosophy" • November 30, Columbia University, gave a public talk on "The Origin of the Universe in Science and Philosophy".

Maffeo was involved in the organization of the exhibition "Astrum" in the Vatican Museums, ancient astronomical instruments, commissioned by the Italian National Institute for Astrophysics (INAF).

Stoeger participated in the Workshop, "Astrobiology and Societal Issues," at the SETI Institute, Mountainview, CA February 9-11; this workshop provided input for the new "Roadmap on Astrobiology and Societal Issues." • was an invited participant and speaker at the III STOQ International Conference, "Biological Evolution – Facts and Theories: A Critical Appraisal 150 Years After The Origin of Species," at the Pontifical Gregorian University, Rome, Italy, March 3-7. Stoeger's invited talk was entitled, "Directionality and Finality in an Evolutionary Universe" • was the featured speaker and discussant at the "10th Study Day of Fundamental Theology" entitled "Methodology and competencies in the field of natural sciences and in the field of theology" at Pontifical Gregorian University, Rome, Italy, March 10 • attended the Catholic Theological Society of America annual convention in Halifax, Nova Scotia June 4-7 – participated in several theology and natural sciences related parallel sessions • gave an invited talk on "The Quest for Understanding and Meaning: From Process and Complexity to Meaning and the Transcendent" at the annual Metanexus Conference, "Cosmos, Nature and Culture: A Transdisciplinary Conference," July 18-21 in Phoenix, Arizona • participated in and gave an invited talk at, the "Astronomy and Civilization" conference in Budapest, Hungary, sponsored by

the Hungarian Academy of Sciences in honour of the International Year of Astronomy. Stoeger's presentation was entitled "Rationality and Wonder: From Scientific Cosmology to Philosophy and Theology" • September 9-16 Stoeger participated in two conferences at the Jesuit University UNISINOS in São Leopoldo, Rio Grande do Sul, Brazil, and gave an invited talk at each: **1)** at the 9th International Symposium of the Instituto Humanitas Unisinos, "Echoes of Darwin," on "From Cosmic Evolution to Biological Evolution: Emergence, Relationality and Finality"; **2)** at the 10th International Symposium of the Instituto Humanitas Unisinos, "Narrating God in a Post-Metaphysical Society," on "Does God Have Something to Do Today?: Speaking of God from a Cosmological Perspective." • participated in a workshop, "Philosophy of Cosmology," in honour of George Ellis's 70th birthday at St. Anne's College, Oxford University, U. K., September 19-23. Stoeger spoke at an invited panel on "Cosmology as a Science."

Whitman attended the 47th annual summer meeting of the Clavius Group of Mathematicians, held at Notre Dame University from June 27 - July 25.

Conference Participation

19-23 January: Paris. IAU-UNESCO Symposium 260 "The Role of Astronomy in Society and Culture." JOSÉ FUNES, S.J., presented a paper.

9-11 February: Strasbourg, France. Intermediate Mass Stars & Massive Stars. CHRISTOPHER CORBALLY, S.J., led a workshop session.

21 February: Warsaw University, Seminar of the Institute of Theoretical Physics: "A Noncommutative Friedmann-Lemaître Cosmological Model" MICHAEL HELLER S.J., participated.

3-4 April: Notre Dame, Indiana. Conference on Evolution of Age: Multidisciplinary Reflections on Darwin. CHRISTOPHER CORBALLY, S.J., gave an invited paper and was on a discussion panel.

20-23 April: Minsk. Zeldovich Meeting, JOSÉ FUNES, S.J., presented a paper.

28-29 April: Rome. "Galaxies Properties Across Cosmic Ages." JOSÉ FUNES, S.J., participated.

11-15 May: Prague. "International Meeting on Bolides and Meteor Falls." GUY CONSOLMAGNO S.J., gave an invited paper.

18-19 May: XIII Cracow Methodological Conference "Evolution of the Universe - Evolution of Life." Public discussion by Francisco J. Ayala and MICHAEL HELLER S.J., paper on "Catholic Church and the Theory of Evolution. Vatican and Philosophy".

26-30 May: Florence. "Galileo 2009." JOSÉ FUNES, S.J., participated.

27 May: Greenwich Observatory and Maritime Museum, London, public lecture: "The Origin of the Universe in Science and Cosmology." MICHAEL HELLER S.J. participated.

21-26 June: Sassone, Rome. Super VOSS 2009, Astronomy: A Common Ground for Sharing Humanity's Concerns. JOSÉ FUNES, S.J. and GEORGE COYNE, S.J., were on the organizing committee, GUY CONSOLMAGNO, S.J., gave a paper, and RICHARD BOYLE, S.J., DAVID BROWN, S.J., CHRISTOPHER CORBALLY, S.J., and ALESSANDRO OMIZZOLO participated.

3-5 July: Cambridge, England. International Society for Science and Religion Conference 2009. CHRISTOPHER CORBALLY, S.J., participated.

6-10 July: Spineto. "Filling the Cosmos with Stars." JOSÉ FUNES, S.J. participated.

13-17 July: Nancy. Meteoritical Society Annual Meeting. GUY CONSOLMAGNO, S.J., coauthored two papers.

3-14 August: Rio de Janeiro, Brazil. International Astronomical Union XXVII General Assembly. RICHARD BOYLE, S.J., presented two poster papers, CHRISTOPHER CORBALLY, S.J., gave an oral paper, GUY CONSOLMAGNO, S.J., participated.

16-19 September: Grassmannian Conference in Fundamental Cosmology, University of Szczecin, paper: "A noncommutative Friedman World Model" MICHAEL HELLER S.J. participated.

20-23 September: Flagstaff, Arizona. Lowell Observatory workshop on Solar Analogs II. CHRISTOPHER CORBALLY, S.J., gave an invited paper.

5-8 October: Puerto Rico. American Astronomical Society Division for Planetary Sciences annual meeting, GUY CONSOLMAGNO, S.J., presented a paper.

6-10 November: Vatican City, Study Week on Astrobiology. JOSÉ FUNES, S.J. participated.

13-15 November: Phoenix, Arizona. Annual General Meeting of the International Dark-Sky Association. CHRISTOPHER CORBALLY, S.J., participated.

Public Outreach, Education and Media Coverage

Consolmagno gave more than fifty public talks and seminars on the Vatican and astronomy, science and religion, and his research on meteorites and asteroids. Among the most notable venues included presenting the Cardinal Beauford Lecture at Winchester College, England, 13 January • presenting the Gonzaga Lecture, St. Aloysius College, Glasgow, Scotland, 24 March • a lecture at the Castle Observatory, Cork, Ireland, 30 March • a talk at the annual conference of the Anglican Diocese of Ely, England, 23 September.

Corbally introduced a premier showing of the PBS documentary "Four Hundred Years of the Telescope: A Journey through Science, Technology & Thought" at the Elks Opera House, Prescott, Arizona, on 8 March • spoke on the Vatican Observatory in Arizona to the Kitt Peak Docents during their monthly meeting, 16 March, NOAO headquarters, Tucson • helped train the Discovery Park Docents, 16 May, by leading them through the Vatican Observatory Advanced Technology Telescope and describing its features and current research • 17 September, led a discussion on "Does an Evolving Cosmos Belittle the Creator?" in the Third-Thurs-day Star Talks series, Prescott Public Library, Arizona.

Coyne gave a talk on "The Dance of the Fertile Universe" to the Desert Foothills Astronomy Club, Anthem, Arizona, USA • spoke to the Briarwood Country Club, Sun City West, Arizona on "Evolution and Intelligent Design" • spoke on "The God of the Evolutionary Universe" at St. Clement's Church, Sun City, Arizona • addressed the USA National Academy of Sciences Symposium on "Science, Evolution and Creationism" on the attempts to introduce religious concepts into science courses • gave the keynote talk to the Friends of the Adler Planetarium, Chicago, Illinois, USA on "The Meaning of Discovery in the Life of Galileo" • spoke on "The World Evolving" upon acceptance of the Sacred Universe Award at the spiritual center, The Well, La Grange Park, Illinois.

Maffeo delivered a lecture on "Science and Faith in Father Angelo Secchi, S.J.", in Rome, at the Library Casanatense, and Grottaferrata (Rome), at the Abbey of St. Nilus • gave a lecture on the history of the Vatican Observatory as part of the Master program "Science and Faith" at the Ateneo Romano "Regina Apostolorum Legionaries of Christ" • gave a lecture on the history of the Vatican Observatory in Somma Vesuviana (Naples) • accompanied groups, Italians and foreign, on tours of the Vatican Observatory.

Funes gave public lectures at Osservatorio Astronomico di Capodimonte, Naples • Casa Madonna dell'Uliveto, Reggio Emilia • Federazione Italiana Donne Arti Professioni Affari, Lecce • Centro Ecnemico, Zuglio • Aloisianum, Padua • Piove di Sacco • Liceo Morin, Mestre • Centro Interculturale "Tau Onlus", Salerno • Club UNESCO, Teramo • Presented the book "L'Infinitamente Grande: L'Astronomia e il Vaticano, (Infinitely Great, Astronomy and the Vatican)" Pordenone book fair • gave a lecture on "The Heavens Proclaim" as part of the master program on Science and Faith at the Pontifical Athenaeum Regina Apostolorum, Rome.

News Media Coverage

Consolmagno was interviewed by BBC Radio York 3 March • was featured in an article in the Irish Times 31 March • was profiled in the magazines The Walrus Toronto and Technology Review Cambridge, MA • was interviewed on the Canadian Broadcasting Company radio program "Looking Up," broadcast 19 October • appeared on the popular American cable television show "The Colbert Report" 1 December.

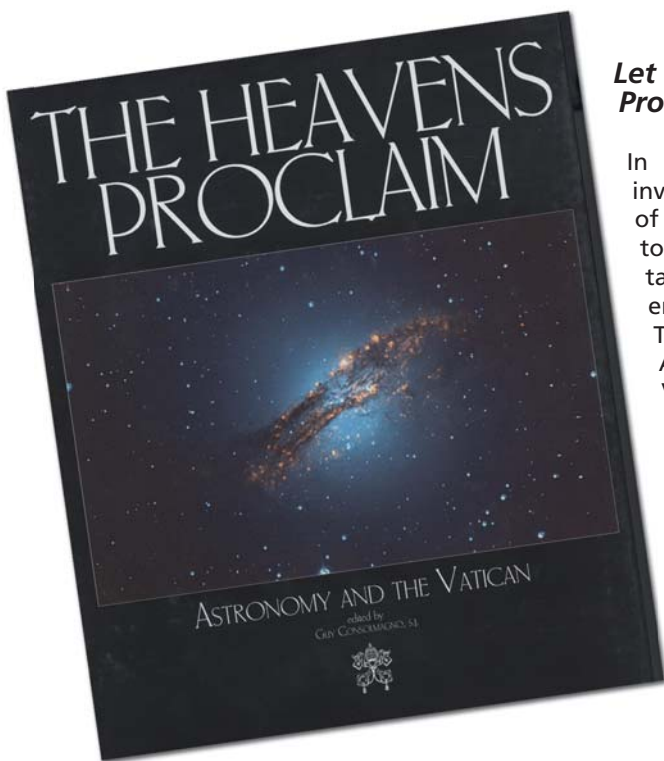
Corbally was interviewed 19 December 2008 by Jeff Gardiner for Inside the Vatican on "Copernicus and the Vatican Observatory in IYA2009"

- 29 January Stijn Fens of RKK Television for Inside the Vatican, "The Pope and Science", interviewed COYNE in Tucson and CORBALLY at VATT • gave an interview 18 February for the Drew Mariani Show on Relevant Radio on the topic, "The Galaxy has billions of Earths" and on 22 December for the same Show on "The Star of Bethlehem." • was interviewed 2 March by Rikki Mitchell for the Arizona Daily Wildcat story entitled, "UA astronomy department draws Vatican visitor" • 20 March, with Aileen O'Donoghue, hosted George Johnson at VATT for a story, "Vatican's Celestial Eye, Seeking Not Angels but Data" that was printed in the 23 June issue of the New York Times Science Section • gave an exploratory interview 5 May to Bill Goody for a "Spirit of Space" documentary • 26 May, was interviewed by Neil deGrasse Tyson for the StarTalk Radio Show on "Galileo, the Church, and IYA2009" • 25 August, gave a joint interview with Kris Koenig for the John Hall & Kathy Emmons Afternoon Show, aired on Word-FM Pittsburg, about Galileo and 400 Years of the Telescope • answered questions to Katerina Rovva for an article on the Vatican Observatory that appeared in ΕΘΝΟΣ (Ethnos) newspaper on 23 May • 12 November, interviewed by Robin Lustig, BBC Radio 4, for The World Tonight on "Would ET be a problem for the Catholic Church?" • 13 November, interviewed by Mark Whittaker, BBC World Service, for The World Today, on "The Vatican and ET" • both Corbally and Stoeger were interviewed on 8 December by Dave Carr, Prometheus Pictures, for a History Channel series on Ancient Aliens.

Funes participated in three press conferences at the Vatican Press Office • gave interviews to L'Osservatore Romano, Centro Televisivo Vaticano, Vatican Radio, Avvenire, Italy; CNN Español; NBC USA; TG5 Italy; Radio 24 Italy; Il Foglio Italy; Washington Post USA; Notimex Mexico.

Maffeo has given several interviews to journalists and TV media, some of which were subsequently published in newspapers and magazines.

Despite the pressing demands of the International Year of Astronomy, this year no less than four new books were published by Specola authors. They discuss the classification of stars, the origin of the universe, and the history of the Vatican's involvement in astronomy.



Let the Heavens Proclaim

In 2007 Cardinal Lajolo, invited the staff members of the Vatican Observatory to produce a book targeted to the general public. The result is *The Heavens Proclaim, Astronomy and the Vatican*, published in English by Our Sunday Visitor Press. (An Italian translation, *L'Infinitamente Grande*, has been issued by the Vatican press Libreria Editrice Vaticana, and DeAgostini.)

The cardinal's invitation was perfectly in line with the two-fold statement mission of the Specola. We have to do good science; but we must also be seen doing so – we must let the world see that the Church is supporting us as we're doing our science. This book addresses the second part of our mission.

The book covers the main fields of astrophysics where the Specola is active: from our backyard, the solar system, to distant galaxies and the universe itself. In addition, as the subtitle implies by making the connection between Astronomy and the Vatican, the will of the modern Popes to have a research institute in Astronomy is seen in a chapter showing how they have addressed topics related to the study of astronomy since Leo XIII. In addition, a section is dedicated to other historical topics, from the reform of the Calendar, to Galileo, to the history of the Specola Vaticana. In all, twelve Specola astronomers contributed chapters, along with a number of wonderful photographs provided by our friends and collaborators. Bro. Guy Consolmagno assembled the material, while the Vatican Press did the final design and layout of the book.



6. Publications

This book was published in 2009, the International Year of Astronomy, when we celebrate the 400th anniversary of the first use of an astronomical telescope by Galileo Galilei. As Fr. Funes writes in his preface, "This ordinary-extraordinary event in human history indeed opened a new window to the exploration of the universe for everyone. Astronomy has had a huge impact on our culture. Astronomy helps us to see the beauty of the universe and to appreciate the fragility of our existence. For people of faith, it opens minds and hearts to the Creator. The Church has always understood the importance of astronomy in human culture, and has embraced, encouraged, and promoted it. The Specola today is a concrete sign of that commitment."

Classifying Spectra

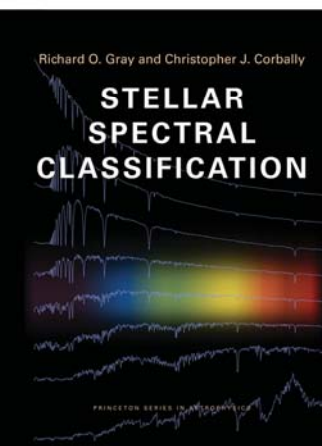
Richard Gray (professor of astronomy at Appalachian State University) and Christopher Corbally, S.J., wrote *Stellar Spectral Classification* (published by Princeton University Press, 2009) to discuss and present the foundations and most up-to-date techniques for classifying stars by their spectra, in which field they are described as two of the leading experts.

The authors started their book-writing project in 2004 at the prompting of a colleague in Vienna, Ernst Paunzen. While the techniques and framework for modern classification of stars by their spectra was established in 1943 by William W. Morgan and Philip C. Keenan (and so known as the MK System), over the 20 years prior to Paunzen's suggestion much progress in their application had happened, thanks to digital detectors and space-based observatories. So the spectra in the book are not only illustrated in the traditional blue-green region, but they also cover the ultraviolet, the far red, and the infrared regions.

Advances in the field also include the addition of the L and T spectral classes for the objects which are so low in mass that they do not even merit to be called stars, but brown dwarfs. To write about these coolest of objects, as well as to cover developments in classifying the hottest stars (the OB types), the authors enlisted the help of four colleagues who are acknowledged experts in these types of stars: Adam Burgasser, Margaret Hanson, J. Davy Kirkpatrick, and Nolan Walborn.

Since the book is aimed not just at seasoned researchers who want a handy reference, but also at students learning the art and usefulness of spectral classification, the authors included historical foundations of the field (which go back to Father Angelo Secchi, S.J., whose 19th century work in astronomy was a forerunner of the Specola Vaticana), philosophical underpinnings of the technique, physical basis for why variations are seen in the spectra of stars, a glossary of special terms and concepts, and of course comprehensive indices of topics and stellar objects.

In the preface the authors state that they hope their readers will learn even a fraction of what they did in writing the book. They also express gratitude to Professor Robert Garrison who introduced both of them as graduate students at the University of Toronto to the beauty of stellar spectra and to the power in these for astrophysical discoveries.



By kindness of the organizers of the Canadian Astronomical Society meeting in Toronto, the authors presented a copy of the book to Professor Garrison during a plenary session of CASCA on 28 May, 2009.

Explaining the Universe

Discussing his new book *Ultimate Explanations of the Universe* (Springer, 2009), Specola affiliate and Templeton Prize Winner Fr. Michael Heller has said, "I consider the book as my most important contribution in this year. It contains a sort of 'my philosophy'."

We humans are collectively driven by a powerful - yet not fully explained - instinct to understand. We would like to see everything established, proven, laid bare. The more important an issue, the more we desire to see it clarified, stripped of all secrets, all shades of gray. What could be more important than to understand the Universe and ourselves as a part of it? To find a window onto our origin and our destiny? This book examines how far our modern cosmological theories - with their sometimes audacious models, such as inflation, cyclic histories, quantum creation, parallel universes - can take us towards answering these questions. Can such theories lead us to ultimate truths, leaving nothing unexplained? Last, but not least, Heller addresses the thorny problem of why and whether we should expect to find theories with all-encompassing explicative power.

More information about this book can be found by logging on to: <http://www.springer.com/astronomy/practical+astronomy/book/978-3-642-02102-2>

ASTRUM 2009:

Astronomy and Instruments, Italian Heritage Four Hundred Years After Galileo is the book edited by Ileana Chinnici and published by Edizioni Musei Vaticani e Sillabe that contains the catalogue of ASTRUM 2009. José Funes, S.J. and Sabino Maffeo S.J. contributed with essays to this work.

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MAFFEO, S., *The Carte du Ciel and the Founding of the Vatican Observatory*, ASTRUM 2009, p. 62, 192.

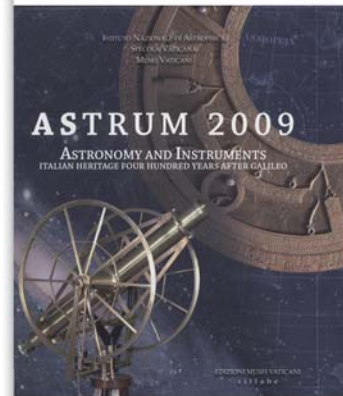
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Also in 2009, Fr. Maffeo supervised the preparation of proofs for the third Italian edition of the Volume by Annibale Fantoli "Galileo - Per il Copernicesimo e per la Chiesa"

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7. Visitors to the Vatican Observatory



Specola on the move

As mentioned at the beginning of the report, this year saw the re-location of the Vatican Observatory from the Papal Palace in Castel Gandolfo to new premises within the grounds of the Pontifical Villa. The move occupied much of the energies of the resident staff and as a result visits were at a minimum. However, without doubt, the visit of the Holy Father Pope Benedict XVI for the inauguration of the new premises was the highlight of the year for all of the staff at the Specola.

He was accompanied by Cardinal Lajolo, and the Superior General of the Society of Jesus, Fr. Adolfo Nicolás.





This edifice built originally in the 17th Century which has reverberated with the constant prayers of consecrated virgins Pope Benedict XVI having realized the resources necessary to restore it to its original decorum so as to dedicate it to the service of the Vatican Observatory on 16 September 2009 in the fifth year of his pontificate honored it with his apostolic presence and like his predecessors a strong supporter of the sciences he inaugurated it

Cardinal Lajolo in Tucson Arizona

Cardinal Lajolo, to whom the Vatican Observatory reports, visited the Vatican Observatory in Tucson, Arizona, USA to participate in the Foundation Board Meeting and the events surrounding it from 26 through 28 February. A highlight of his visit was a tour of the Vatican Advanced Technology Telescope at the Mt. Graham International Observatory in Arizona. On the evening of March 2 His Excellency Pietro Sambi, Papal Nuncio to the United States, hosted a reception on behalf of the Vatican Observatory Foundation at the Papal Nunciature in Washington, D.C. Unfortunately, air travel problems at the last moment prevented Cardinal Lajolo from attending.

In 2009 the following paid working visits to the Vatican Observatory Research Group in Tucson Arizona

AILEEN O'DONOGHUE, St. Lawrence University, Canton, New York, USA



VATICAN OBSERVATORY STAFF

The following are permanent staff members of the Specola Vaticana, (Vatican Observatory), Ville Pontificie Castelgandolfo Italy, and the Vatican Observatory Research Group (VORG) Tucson, Arizona, USA:

- JOSÉ G. FUNES, S.J., Director, Vatican Observatory
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National Committee to International Astronomical Union
- JÓZEF M. MAJ, S.J., Vice Director for Administration
- RICHARD P. BOYLE, S.J.
- DAVID A. BROWN, S.J.
- GUY J. CONSOLMAGNO, S.J., Coordinator for Public Relations
Curator of the Vatican Meteorite Collection
- GEORGE V. COYNE, S.J., President, Vatican Observatory Foundation
- JOHN B. HOLLYWOOD, S.J., Assistant to the President,
Vatican Observatory Foundation; Assistant to the Vice Director, VORG
- JEAN-BAPTISTE KIKWAYA, S.J.
- SABINO MAFFEO, S.J., Special Assistant to the Director
- PAUL R. MUELLER, S.J., Philosopher of Science
- ALESSANDRO OMIZZOLO
- WILLIAM R. STOEGER, S.J., Coordinator for Science and Theology Programs
- JONATHAN J. STOTT, S.J.
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