

# THE VATICAN OBSERVATORY

2007 ANNUAL REPORT



2009



THE INTERNATIONAL YEAR OF  
**ASTRONOMY**

# VATICAN OBSERVATORY ANNUAL REPORT 2007



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**Vatican Observatory Publications**

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**Cover:** Moonglow reflects off the dome of the Vatican Observatory's 40 cm (16 inch) visual refractor at Castel Gandolfo, Italy.

(Photo by: Ron Dantowitz, Clay Center Observatory, Brookline, MA)

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## FROM THE DIRECTOR

*In this annual report you will find a detailed description of the many accomplishments of the Vatican Observatory's staff during the past year. But to me, the most exciting news is what is to come in Castel Gandolfo in the near future—the transfer of the Observatory's headquarters from the papal summer palace to new, expanded quarters in the papal gardens that adjoin the palace. Planning for the transfer has taken up much of my time this past year. With luck, the new quarters will be ready for us by the end of 2008, just in time for the start of a busy year in 2009 when the Observatory will participate in the International Year of Astronomy.*

### NEW VATICAN OBSERVATORY HEADQUARTERS

The Observatory's beginnings can be traced to Pope Gregory XIII's reform of the calendar in 1582. But it was Pope Leo XIII who formally restructured the Vatican Observatory (*Specola Vaticana* in Italian) in 1891. In doing so, he issued a personal decree in support of the Observatory's work so

...that everyone might see clearly that the Church and her Pastors are not opposed to true and solid science, whether human or divine, but that they embrace it, encourage it, and promote it with the fullest possible dedication.  
(*Motu Proprio Ut Mysticam*, 14 March 1891)

At that time, the Observatory's telescopes were located on the walls of the Vatican itself in Rome, with its headquarters in the famous Tower of the Winds. But in 1935, Pope Pius XI moved the Observatory to the summer palace of the popes in Castel Gandolfo, 25 km outside of Rome. From that time on, the Observatory has been staffed by a small Jesuit community of astronomers. In the 1980s, increased light pollution from Rome led to the founding of a second Observatory location in Tucson, Arizona, and the eventual construction of the Vatican Advanced Technology Telescope (VATT) on Mt. Graham. The papal palace in Castel Gandolfo continued to serve as the Observatory's headquarters and to host numerous international meetings and the Observatory's famous biennial summer schools.

But this is about to change again to accommodate competing needs for space. On one hand, an upsurge in scientific work at the headquarters, and the likely addition of a number of young Jesuits to the staff in the next few years, has made it clear that our old facilities would need significant upgrading. At the same time, the papal palace continues to serve large crowds that gather for audiences and to host numerous dignitaries who visit the Pope during the summer. These needs are not easily combined with a residence for Jesuits engaged in study, teaching, and research. For example, the Observatory's summer

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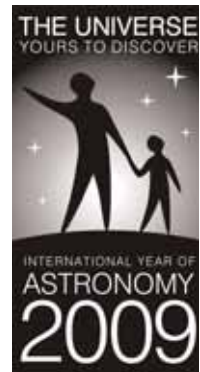
schools and the international congresses regularly held at the papal palace use facilities that are quite close to the Pope's personal quarters. For security reasons and to assure privacy for the Popes who come to the palace to rest, a different arrangement was sought.

For several years Vatican officials considered this situation and came to offer the Observatory a former monastery that is located within the papal gardens adjacent to the summer palace. This monastery will be completely renovated and expanded to conform to the needs of the Observatory and its Jesuit community. The telescopes will remain on the roof of the papal palace and will continue to be at the disposal of the Jesuits for their research.

Adaptation of the former monastery that will receive us, and the transfer of the offices, will take some time. But we hope that the new Observatory headquarters will be ready by the end of 2008, so that the move can be completed by the summer of 2009. The significant effort and expense that the Vatican is investing in this new headquarters is a confirmation of the importance attributed by the Holy Father to the work being carried out both at Castel Gandolfo and in Tucson.

## INTERNATIONAL YEAR OF ASTRONOMY 2009

In 2009 the Vatican Observatory will take part in a global celebration of astronomy and its contributions to society and culture. Called the International Year of Astronomy, or IYA2009, this celebration is an initiative by the International Astronomical Union and UNESCO that will be highlighted by the 400th anniversary of the first use of an astronomical telescope by Galileo Galilei. Italy, Galileo's home country, submitted the IYA2009 resolution to the United Nations, which approved it on 20 December at its 62nd General Assembly.



Galileo made his first telescopic astronomical observations in 1609 and a year later published *Sidereus Nuncius*, or "Starry Messenger," to communicate the observations he made of the Moon and, in particular, his discovery of four satellites around Jupiter. The first page of *Starry Messenger* announces that the book will reveal "...great, unusual, and remarkable spectacles, opening these to the consideration of every man, and especially of philosophers and astronomers; as observed by Galileo Galilei."

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

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existence. For people of faith, it opens minds and hearts to the Creator. The Catholic Church has always understood the importance of astronomy in human culture, and has embraced, encouraged, and promoted it – notwithstanding its sometimes contentious relationship with Galileo himself! The Vatican Observatory today is a concrete sign of that commitment.

I would like to share with you some activities we are preparing to celebrate the IYA2009.



The Vatican Observatory is lending this astrolabe, an observing instrument from the 1600s, to the IYA2009 exhibit at the Vatican Museums.

PHOTO: CHRISTOPHER CORBALLY, S.J.

### Telescope Exhibit at the Vatican Museums

Telescopes are essential tools for astronomers, serving as extensions of our eyes. In collaboration with Italy's National Institute for Astrophysics and the Vatican Museums, the Vatican Observatory is sponsoring an exhibit on the history of telescopes to be displayed at the Vatican Museums. The exhibit will feature antique instruments from Galileo's time up to models of the largest telescopes that are used today for astronomical research. The exhibit is scheduled to open in Fall 2009.

### SuperVOSS 2009

As part of the celebration of the IYA2009, the Vatican Observatory is organizing an international symposium to be held in June 2009 that will be by invitation only to alumni and faculty from all of the previous Vatican Observatory Summer Schools (VOSS). This is the third such symposium, known as a SuperVOSS; others were held in 1998 and 2002. SuperVOSS 2009 will stress the role of astronomers and astronomy in 21st century society. Like previous SuperVOSS, the morning sessions will be devoted to research talks covering the full spectrum of modern astrophysics, and the afternoon sessions will focus on issues of science education and the dialogue between science and religion. Through its Summer Schools, the Vatican Observatory continues its commitment to offering educational opportunities to the next generation of astronomers from all over the world. Eleven VOSS have been held so far, producing approximately 275 alumni and faculty members.

### Study Week on Astrobiology at the Pontifical Academy of Sciences

The Vatican Observatory is participating in the organization of a Study Week on Astrobiology at the Pontifical Academy of Sciences in November 2009. Astrobiology—the



science concerned with understanding life in the universe and with the search for extra-terrestrial life—is one of the most exciting and promising fields in astronomy. Since it combines research in many disciplines, principally, astronomy, cosmology, biology, chemistry, geology, and physics, astrobiology is an appropriate topic for the Academy, which has a multi-disciplinary membership.

### **“400 Years of the Telescope”—A Public Outreach Project**

The Vatican Observatory is on the Advisory Board for the *400 Years of the Telescope* project ([www.fourhundredyears.com](http://www.fourhundredyears.com)), a state-of-the-art series of visual and educational experiences for the American public being developed by Interstellar Studios of Chico, California. This yearlong effort in support of IYA2009 will feature a PBS TV broadcast, a companion full-dome digital and traditional planetarium program, interactive web activities, communications for mobile devices, as well as activities at local science centers, and community events.

### **PERSONNEL NEWS**

On 1 March **Federico Balzoni** joined the staff of the Vatican Observatory at Castel Gandolfo. He helps with the library and the organization of conferences.

On 30 November **Luigi Lori** retired from working at the Vatican Observatory in Castel Gandolfo. We are very grateful to Luigi for his 36 years of exemplary service. We wish our very best to him. Besides being a very talented carpenter, he is a wonderful person.

On 1 December **Romano Reggio** joined the staff of the Vatican Observatory at Castel Gandolfo, replacing Luigi Lori.

On 30 December, after 31 years as cook for the Jesuit Community of the Vatican Observatory at Castel Gandolfo, **Maria Piazza (Lilla) Scordo** retired. Her devoted service will not be forgotten.

**Brother John B. Hollywood, S.J.** has joined the staff of the Observatory as Assistant to the President of the Vatican Observatory Foundation and Assistant to the Vice Director of the Vatican Observatory Research Group in Tucson, Arizona.

**Michael Heller** was awarded the Golden Cross of Merit from the President of the Polish Republic.

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**George Coyne, S.J.** was awarded an honorary Doctorate in Science by Boston College at the commencement on 21 May. He also received a Marcel Grossman Award at the July Grossman Meeting in Berlin sponsored by the International Center for Relativistic Astrophysics. St. Joseph's University, Philadelphia, awarded Coyne its Clavius Award at the Sigma Xi Meeting held there on 20 April, and his alma mater, Loyola High School in Baltimore, awarded him the Rev. Joseph M. Kelley, S.J. Medal on 19 April.

**Kenneth R. Kilroy** was elected to the Board of Directors of the Vatican Observatory Foundation at the Board's annual meeting held 23 February.

### IN MEMORIAM

We were very saddened by the death on 21 December in Oslo, Norway, of **Gustav Teres, S.J.**, a longtime Adjunct Scholar of the Observatory. While ministering to Hungarian peoples living in Norway, he also spent long working visits at Castel Gandolfo and was responsible for a major reorganization of the library there.


We mourn the passing of **Cardinal Rosalio José Castillo Lara**, President Emeritus of the Pontifical Commission for Vatican City State, who in that office diligently worked for the welfare of the Observatory especially in his support for the Vatican Observatory Research Group in Tucson, Arizona.

We were also saddened by the death of **Archbishop Gianni Danzi** who had served as Secretary to the President of the same Pontifical Commission.

We also mourn the passing of **Enrico Di Rovasenda, O.P.** who served as Chancellor of the Pontifical Academy of Sciences.

We remain deeply saddened at the death on 28 February 2006 of **Romeo Piermattei (Piero)**. He was a devoted member of the staff of the Observatory at Castel Gandolfo for more than 35 years.

We also mourn the loss of **Fiorinda Rossi**, mother of Observatory staff member Francesco Rossi.

  
**José Funes, S.J., Director**

## I. RESEARCH HIGHLIGHTS

During 2007, Vatican Observatory astronomers reported on studies covering a broad range of topics, from an examination of the tiniest specks of interplanetary dust to analyses of the nature of not only our universe but of possible parallel universes, or “multiverses.” Below we offer popular descriptions of some of this work.

### PLANETARY SCIENCES

#### **Unlocking the secrets of miniscule meteors**

Space dust in the form of microscopic meteors rains on Earth constantly. Most of this dust comes from comets and asteroids, material left over from the formation of our solar system. Like the larger meteors, which often leave dramatic light displays in the night sky, micrometeors are also free samples of the “bricks” out of which our solar system was built, and they hold tantalizing clues about that early construction phase *if* they can be studied. The problem is that most of this space dust burns up during its passage through the planet’s upper atmosphere. Even so, Jean-Baptiste Kikwaya, S.J., is still able to probe their secrets by studying the ultra-faint streaks of light they leave in the sky as they burn up.



Jean-Baptiste  
Kikwaya, S.J.

Kikwaya, who is obtaining his doctorate from the University of Western Ontario, Canada, has been measuring how high in the atmosphere the dust particles begin to glow; how brightly they glow; how quickly they are slowed down in the atmosphere; and how deeply they penetrate into the lower atmosphere before they are completely consumed. Heavier particles carry more energy and thus shine brighter; fluffy particles are more easily slowed by the thin air of the upper atmosphere; and larger particles glow for a longer period of time. This information can be used to calculate the mass and density of the dust, and to determine which micrometeors came from comets (orbiting bodies of packed ice and dust originating in the far reaches of the solar system) and which from asteroids (rocky bodies in the asteroid belt between Mars and Jupiter).

Actually detecting these unpredictable particles is a challenge in itself, since often their light paths are too faint to be seen by the naked eye. During May 2004 in Ontario, Kikwaya and collaborators set up a network of special video cameras with wide-angle lenses sensitive to low levels of light, gathering a dozen images of micrometeors. The system’s improved image intensifiers, resolution, and field of view allowed more-precise measurements of deceleration for very faint micrometeors than ever had been attained previously.

As a part of his doctoral thesis work, Kikwaya has been developing detailed computer models to interpret these observations in terms of the actual values of mass and density of the dust particles. By measuring the precise brightness of the imaged micrometeoroids, he calculated that their masses range from 4.2 milligrams to 0.35 milligrams. Then, tracking how each micrometeoroid's light varied over time, he used his computer models to calculate the bulk density of each, revealing what they are made of—metal or stone—and how tightly packed they are.



Camera set-up to record micrometeoroids.

Interestingly, Kikwaya found that a large proportion of the faint micrometeoroids he and his colleagues had imaged vaporized at lower altitudes in the atmosphere than previously expected. The fact that they were able to penetrate so deeply into our atmosphere suggests, according to Kikwaya's computer models, that these particles have high densities. Indeed, the data suggest that some of the dust particles are as dense as iron.

When Kikwaya further examined the data of these low-altitude particles, he found a mystery. Their orbits suggest that they came from the asteroid belt and not from comets. But many of these apparently asteroidal dust grains have features reminiscent of comets—they've undergone extensive fragmentation, implying that they

were originally stuck together in "fluffy" aggregations, much as would be expected if they came from comets.

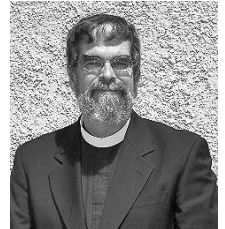
Although more remains to be done to refine the results, the apparently high percentage of these putative asteroidal objects at such small sizes is quite surprising, since earlier findings by other astronomers had suggested that only about 10% of micrometeoroids at the masses Kikwaya calculated should be asteroidal in origin.

*About this study:* Kikwaya reported the results of the micrometeoroid computer modeling at the Annual Meeting of the Division for Planetary Sciences of the American Astronomical Society, 7-12 October, in Orlando, Florida.

### Digging for data in a museum meteorite collection

Pieces of space material larger than dust-size particles can survive passage through the Earth's atmosphere to hit the ground. These are the familiar meteorites that are housed in collections around the world. Guy Consolmagno, S.J. has done an extensive survey of the density and porosity of meteorites in one such collection that belongs to the

Vatican and is housed at the Vatican Observatory in Castel Gandolfo. Measuring meteorite density and porosity (how much of the meteorite's volume is taken up by cracks and voids) provides clues about how the primordial dust out of which the early solar system formed got packed into the coherent rocks we see today, and what physical processes since then have controlled the fabric of the rocks.

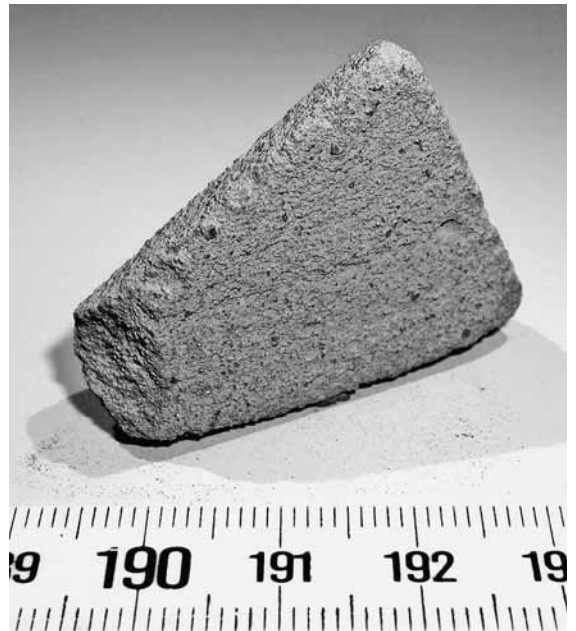


Guy Consolmagno, S.J.

During his 2006 sabbatical at Fordham University in New York City, Consolmagno and colleagues began a similar survey of the meteorite collection at the American Museum of Natural History. This collection includes many rare types of meteorites previously unmeasured anywhere in the world. They initially expected that their examination would turn up significant differences among the meteorite types, but instead they discovered a remarkable uniformity from sample to sample and from type to type. They found that the Allende meteorite is remarkably homogeneous (having measured nearly 50 samples of this large fall found in Mexico in 1969); that the primitive achondrite class is identical in density and porosity to the ordinary chondrites (the most common meteorites found); and that the CK carbonaceous chondrites are likewise indistinguishable from the CV carbonaceous chondrites. On the other hand, most of the carbonaceous chondrites studied at the AMNH were more than twice as porous as the other types of meteorites.

These findings suggest that most meteorites got their porous nature relatively recently, probably by shock waves following collisions in the asteroid belt, long after the differences in meteorite chemistry were set. But the carbonaceous meteorites, with their much higher porosities, must have experienced a very different collision and shock history, suggesting that they come from a very different part of the asteroid belt than the other meteorites. Carbonaceous chondrites, which are rare, contain elemental carbon, a basic building block of life.

*About this study:* Consolmagno's colleagues included Fordham University undergraduate student Doug Wignarajah,



This carbonaceous chondrite known as Ornavas fell in Doubs, France, in 1868. The sample is from the Vatican's meteorite collection housed at the Vatican Observatory.

PHOTO: GUY CONSOLMAGNO, S.J.

Dan Britt of the University of Central Florida, and Bob Macke, S.J., who is pursuing a doctoral dissertation at the University of Central Florida. The survey results were presented at two annual meetings: the Meteoritical Society, 13-17 August, in Tucson, Arizona, and the Division for Planetary Sciences of the American Astronomical Society, 7-12 October, in Orlando, Florida.

### Getting a clearer picture of dwarf worlds

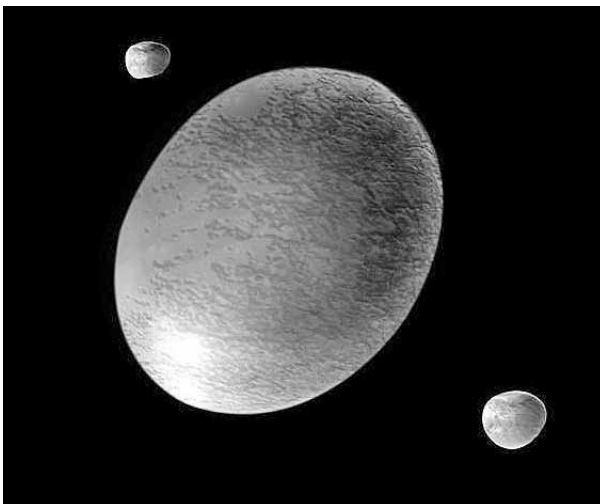
In 2006, Pluto was demoted from its place as the solar system's ninth planet and put into a new class of objects known as dwarf planets, which include several asteroids. Astronomers predict that the family of dwarf planets will continue to grow, and several newly discovered ones were scrutinized in 2007 with the Vatican Advanced Technology Telescope as well as at another Arizona facility, the MMT Observatory.

Guy Consolmagno, S.J. was part of the team that made precise measurements of the spectra of these dwarf planets. A detailed analysis showed that one of them, the still-unnamed asteroid 136472 (2005 FY9), appears to have small amounts of frozen nitrogen mixed into its surface layer of methane ice. By contrast, the cigar-shaped dwarf planet known as 136108 (2003 EL61) appears to have no methane ice present.

These findings reinforce a long-standing mystery about these bodies: some are methane rich, and others are essentially free of methane. The most striking example of this puzzle are Pluto and its moon Charon: Pluto is methane rich, like 2005 FY9, while its moon is methane free, like 2003 EL61. Pluto and the other dwarf planets are classified as Trans-Neptunian Objects, which include any object in the solar system whose orbit

around the sun is farther out than the orbit of Neptune. The smaller Trans-Neptunian Objects, too faint for spectra to be detected, are known to be split generally into "red" and "neutral" colors. Perhaps they are smaller versions of the two dwarf planet populations: those that are methane rich and those methane free.

*About this study:* Consolmagno's colleagues were Steve Tegler of Northern Arizona University; Bill Romanishin of the University of Oklahoma; and Faith



Artist rendition of dwarf planet 2003 EL61 and its two moons.

CREDIT: NASA, ESA, AND A. FEILD (STSCI)

Vilas, who is the MMT Observatory director and a member of the Vatican Observatory Foundation board. Karen Mogren and Dave Cornelison at Northern Arizona University and Will Grundy at the Lowell Observatory in Flagstaff assisted in interpreting the data. The first results of this study were published in the *Astronomical Journal*. A more-detailed report is in press at *Icarus*.

## STELLAR ASTRONOMY

### Double sunsets like Luke Skywalker might see

In March, NASA announced that astronomers using the Spitzer Infrared Space Telescope found evidence for dusty disks of debris circling twin star (binary) systems. The debris disks most likely harbor young planets, and the obscuring debris is presumably material left over from the planet forming process. What's exciting about this discovery is that the systems seen by the Spitzer telescope had only been imagined in the realm of science fiction. In the film *Star Wars*, Luke Skywalker watched as double suns set on the horizon of his home planet Tatooin.

Working behind the scenes to make this discovery possible were Vatican Observatory astronomer Christopher Corbally, S.J. and his colleague Richard Gray of Appalachian State University in North Carolina. They helped determine the infrared signatures of what the binary systems ought to look like if they did, or did not, have disks. Corbally and Gray provided data for 62 of the 69 systems observed in the Spitzer survey. The data came from their ongoing study, the NStars project, which is surveying the 3,600 stars that are the nearest neighbors to the Sun.



Christopher Corbally, S.J.

Planets orbiting double stars have been detected before, but those binary stars were widely separated from each other, and the planets merely orbited one star or the other. In contrast, the Spitzer study was able to find disks in systems where the two stars are close together—closer than Jupiter is to the Sun—and the planet-harboring disks encircle both stars at the same time.

Some theorists had suggested that planets could not form in such close binary systems because the gravitational pull of the twin stars—each exerting a slightly different pull—would disrupt the encircling disk material, preventing planet formation.

But the naysayers were wrong.

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Artist conception of planet-forming debris disk found around a close binary star system by the Spitzer Infrared Space Telescope. The inner gap is swept clear by one or more planets.

CREDIT: NASA/JPL-CALTECH/T. PYLE (SSC)

Of the 69 binary systems surveyed, the Spitzer telescope found that about 40% have debris disks; more surprisingly, 60% of the closest binary systems have disks. These findings suggest that planets orbiting twin stars should be at least as common as around single stars, like our sun.

*About this study:* Corbally and Gray were co-authors of the paper about this discovery published in the *Astrophysical Journal*. The lead author of the report was David Trilling of the University of Arizona; others participating in this work were John Stansberry, George Rieke and Kate Su of the University of Arizona; Geoff

Bryden, Andy Boden and Charles Beichman of the Jet Propulsion Laboratory, Pasadena; and Christine Chen of the National Optical Astronomical Observatory, Tucson.

### Removing the “noise” from star images



Richard Boyle, S.J.

By analyzing light from stars that are gravitationally bound into clusters, Vatican Observatory astronomer Richard Boyle, S.J. and a Jesuit colleague, Robert Janusz, S.J., are trying to get a better idea of how matter is distributed in our galaxy.

Boyle and Janusz have a highly sensitive light-detecting system at their disposal, the new 4K x 4K CCD installed on the Vatican Advanced Technology Telescope (VATT), but like astronomers elsewhere, they are hampered by a lot of “noise” in their images.

CCDs, or charge-coupled devices, are electronic cameras that are similar to but far more sensitive than the digital cameras popular today with amateur photographers. CCDs used on modern telescopes can record images of objects that are 1,000 million times fainter than the eye can see.



Unfortunately, astronomical CCD cameras are sensitive to more than just the light from the celestial objects of interest. They also pick up stray light from the background sky, light from bright stars (or the moon) reflected within the telescope, stray cosmic rays, and the shadows of any bits of dust that might lie on the camera's surface or on the filters used to divide the light into colors. A CCD even picks up faint electronic noise within the camera itself.

Astronomers use a special technique to subtract some of this noise from the digital image data—a process called “reducing the data.” To do this, they use the same camera and filter to image regions of the sky without bright stars (or the inside of the telescope dome), where only the dust and reflected light show up. These regions are called flatfields. Computer programs then subtract the flatfield image data from the original data, leaving behind a less-noisy image.

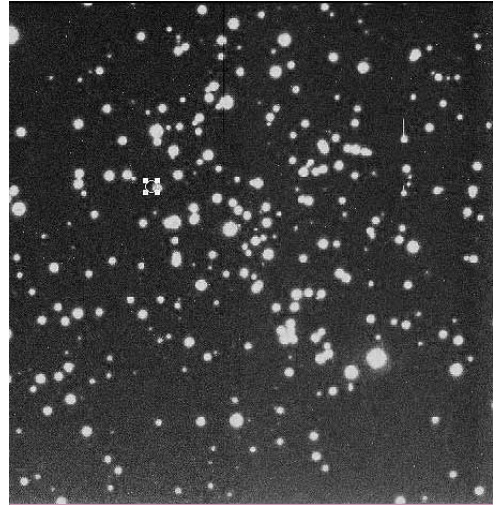


Image of star cluster M 67 taken at the VATT to correct flatfielding exposures.

There's a problem though: for most telescopes, flatfields are not optimum, and that compromises the quality of the final image. Boyle and Janusz have developed a method to correct the initial flatfields for their study of star clusters by detecting and correcting for how the magnitudes (brightnesses) of the stars appear to depend on their location in the CCD frames.

With the new cleaning method, the astronomers are seeing a significant improvement in their measurements of the magnitudes (brightnesses) of the stars. Without the corrected flatfielding, the star magnitudes for each color filter would have an uncertainty of several percent. But with the corrected flatfielding, that uncertainty is decreased to one percent, and this yields good photometric quality. Boyle and Janusz are using this method to accurately determine the brightness and spectral types of the different stars in a cluster, information that indicates how long the cluster has evolved since the stars were formed. And subtle differences from cluster to cluster can reveal new insight into the distribution of matter within the galaxy.

Since the clean-up system is automated, it could eventually lead to a drastic reduction in the time necessary to classify whole clusters of stars. The research goal of Boyle and Janusz is to have a computer system capable of examining images of the same star field taken through a number of colored filters, identify the same star from image to image,

note the relative brightness of each star in each color, and thus make a preliminary assignment of spectral type for each star.

*About this study:* Boyle and Janusz described their work in *The Future of Photometric, Spectrophotometric and Polarimetric Standardization*, a conference volume published by the Astronomical Society of the Pacific. More details about the new CCD are found in section II: Instrumentation and Technical Services.

## EXTRAGALACTIC ASTRONOMY

### What determines how quickly new stars are born?



José Funes, S.J.

Giant clouds of gas and dust scattered among the billions of stars in a galaxy are where new stars are born. The rate at which the clouds collapse and form new stars, however, is swayed by physical aspects of the galaxy itself.

A team of astronomers, including José Funes, S.J., Director of the Vatican Observatory, are trying to understand the connections between the current activity of star formation in nearby galaxies and the characteristics of those galaxies themselves, including how bright the galaxies are, how massive they are, and how they are shaped.

Their study is part of the “11 Megaparsec H-alpha and Ultraviolet Galaxy Survey” (11HUGS). By looking at the specific light emitted by hydrogen atoms known as H-alpha, which is especially emitted by the hydrogen-rich gas clouds where stars are formed, the

team has been able to trace the connection between star formation rate and galaxy characteristics. Their results provide clues for identifying the large scale physical processes that drive and regulate star formation, especially in the relatively low-mass galaxies that made up the bulk of those surveyed.

*About this study:* A report of this work has been accepted for publication in the *Astrophysical Journal Letters*. The lead author is Janice Lee of the Carnegie Observatory in Pasadena, California. In addition to Funes, other collaborators include Robert Kennicutt



Galaxy NGC628, shown here in an R-band (red) image taken at the VATT, was one of the galaxies studied by Funes and his colleagues.

PHOTO: JOSÉ FUNES, S.J.

of Cambridge University, Shoko Sakai of the University of California Los Angeles, and Sanae Akiyama of the University of Arizona.

### **A multinational survey of galaxy clusters**

Galaxies are not isolated islands of stars. Gravity pulls dozens even thousands of them into clusters.

Father Alessandro Omizzolo continues his work with the Wide Field Galaxy Cluster Survey (WINGS) to examine the properties of 77 relatively nearby galaxy clusters. This program involves collaborators from the United States, Italy, France, Spain, and Australia. Omizzolo and his colleagues have completed the analysis of galaxy cluster images they obtained in 2006 at the prime focus of the University of Arizona's 90" Bok Telescope on Kitt Peak, Arizona. In November, they used the B&C spectrograph at the Bok Telescope to obtain spectra of the main galaxies in their surveyed clusters.

This survey is providing new insight into Ultra-Compact Dwarf Galaxies, which are a particular class of dwarf galaxies that are important for understanding the evolution of galaxies and the role of dark matter in their formation and in the dynamics of clusters.



Father  
Alessandro  
Omizzolo

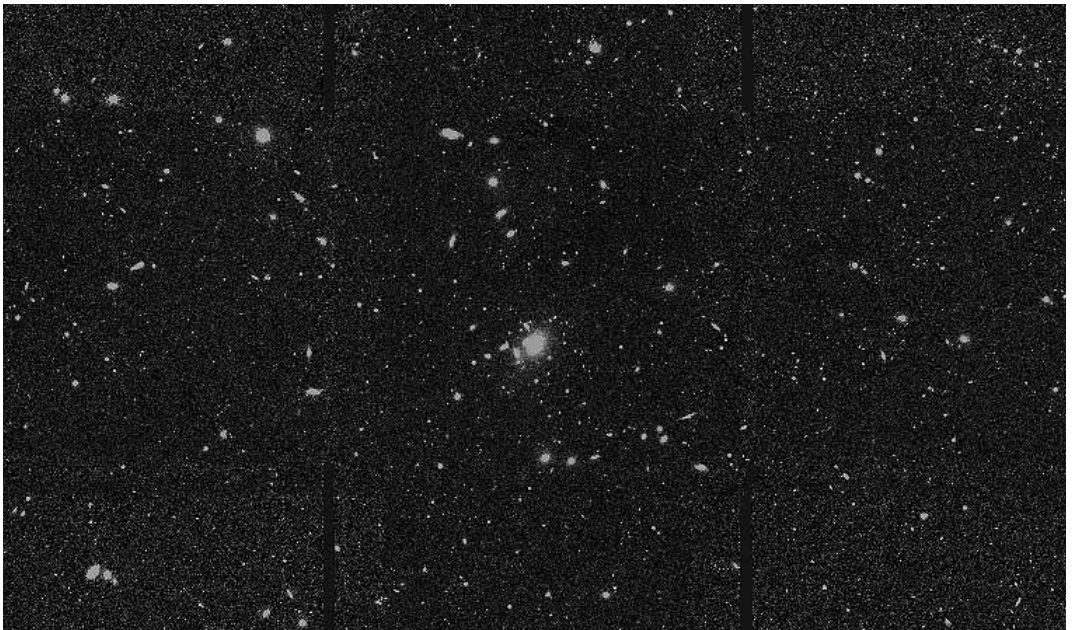


Image of galaxy cluster Abell 2124 taken through an ultraviolet filter with the Large Binocular Telescope on Mt. Graham, Arizona. Captured by an array of large CCD chips, this image covers nearly a full degree of the sky. The original file contains more than half a gigabyte of information.

*About this study:* Data from this work were an essential contribution to two papers, one submitted to *Astronomy and Astrophysics* and the other to the *Astrophysical Journal*.

## COSMOLOGY AND PHILOSOPHY



Father Michael Heller

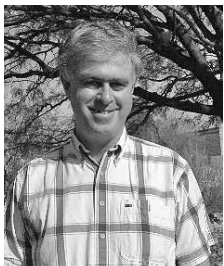
### The mathematics of multiple universes and the Big Bang

While most astronomers study celestial objects that can be observed, theoretical cosmologists analyze concepts only imagined in science fiction novels.

Father Michael Heller, a theoretical cosmologist with the Vatican Observatory, has been building the mathematical framework needed to analyze cosmological models aimed at providing an “ultimate explanation of the universe.” Part of this effort is trying to determine if our universe is the only one around, or if it is one of many within what is referred to as a *multiverse*. Arriving at an answer requires uniting quantum theory (which explains how matter and energy behave on atomic scales) with the broader picture of Einstein’s theory of relativity (which explains how matter and energy behave on large scales).

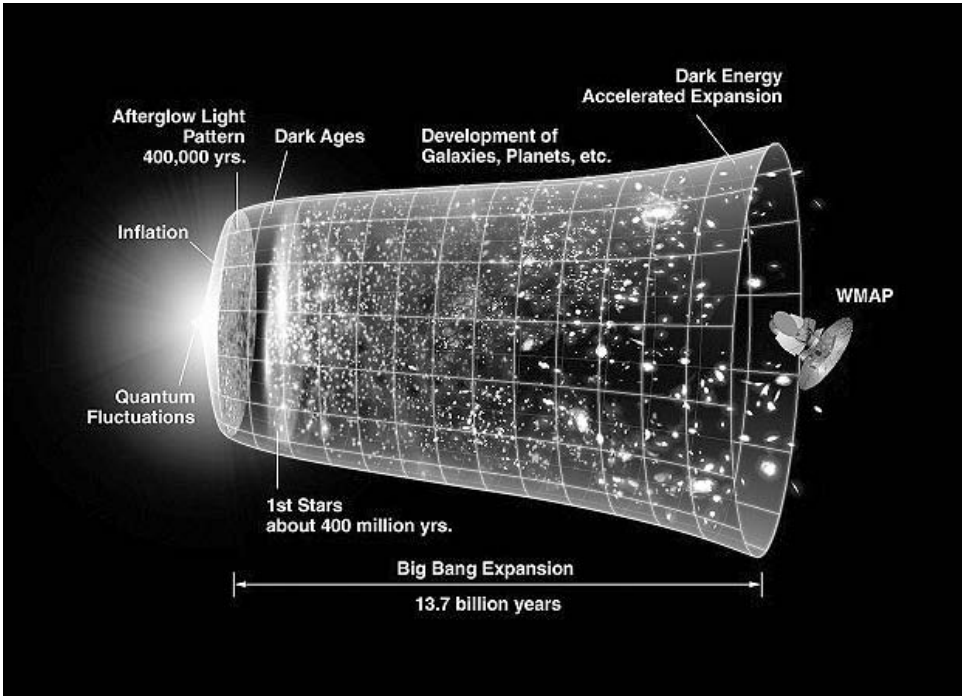
In collaboration with the group of mathematicians at Warsaw Technical University in Poland, Heller has been applying noncommutative geometry to analyze different cosmological models proposed to explain the shape of the universe. Noncommutative geometry describes space at the quantum level where matter behaves quite differently from matter on the large scale of the everyday world.

Heller and his group are also applying a mathematical framework—differential space theory and noncommutative geometry—to analyze the structure of the primordial state of matter believed to have expanded into our universe after the Big Bang. Whatever state of matter existed at that instant is called a “singularity,” infinitely small and infinitely dense and where the force of gravity was infinitely large—conditions whose analysis is clearly beyond the scope of everyday mathematics.



William Stoeger, S.J.

Vatican Observatory astronomer William Stoeger, S.J. is also working on specific aspects of understanding the mathematical nature of cosmology. He and his colleagues have taken a technique commonly used in electrodynamics, where highly complex equations are assumed to be approximately linear (and thus simple to understand), with small perturbations added to account for their non-linear nature. They have applied this sort



Graphic representation of the Big Bang expansion.

CREDIT: WILKINSON MICROWAVE ANISOTROPY PROBE (WMAP) SCIENCE TEAM, NASA

of averaging procedure to the fundamental equations of cosmology and found that it can be used to describe a universe that is homogeneous and isotropic, or nearly so: that is, a universe that is essentially the same everywhere and in every direction. The concept of such a universe is based on the work of Friedmann, Lemaître, Robertson, and Walker, and is commonly known as the “FLRW spacetime metric.”

Models of such a universe can actually be compared against observations of the universe as seen today. Stoeger and colleagues have done so by comparing the way that mass is observed to be distributed in our universe with that predicted by the standard FLRW models. Their results show that the distribution of distant galaxies observed by the second Canadian Network for Observational Cosmology follows a pattern that, relative to luminosity and red shift distances, could be evidence for “self-similar fractal structure.” In other words, the way that galaxies are distributed in space repeats itself over both relatively short distances and extremely long distances. Thus they warn that using different cosmological distance measures to analyze the statistics of how galaxies are distributed can lead to ambiguous answers.

*About these studies:* Heller is preparing a manuscript that provides a critical mathematical analysis of cosmological models that aim to provide an “ultimate explanation of the universe,” including cyclic models, models with closed time, quantum creation models, and the concept of multiverses. In an extensive review paper in the *International Journal of Theoretical Physics*, Heller discusses the cosmological model developed by him and his colleagues, which unifies general relativity and quantum mechanics.

The linearized approach to cosmology was published in the *International Journal of Modern Physics* by Stoeger and his colleagues Amina Helmi of the University of Groningen, the Netherlands, and Diego Torres from the Universitat Autònoma de Barcelona. The comparison of models against observations appeared in a pair of papers prepared by Stoeger and colleagues at the Federal University of Rio de Janeiro, Brazil. Work with M. E. Araújo examined how locating and measuring the angular-diameter-distance maximum and its redshift can be used to determine both the matter and the dark-energy densities of our universe. This result has been submitted for publication. And the differential density statistics of galaxy distributions and the luminosity function appeared in a paper in the *Astrophysical Journal* coauthored with V. V. L. Albani, A. S. Iribarrem, and M. B. Ribeiro.

### **Anthropic arguments, multiverses, and “natural evil”**

Cosmology is of interest not only because it describes the shape of the universe in which all our astronomical observations are made, but also because it can provoke interesting philosophical arguments about the nature of the universe itself.

One intriguing set of arguments notes that the universe we live in has laws of physics that appear to be “fine tuned” to make intelligent life possible. Is the universe specifically made for intelligent creatures like us — an “anthropic” universe — or are we merely living in one of a large set of possible universes? In the book *Universe or Multiverse?* edited by Bernard Carr at Queen Mary College, the University of London, Stoeger addresses the question of whether anthropic arguments that have suggested the possibility of parallel “multiverses” are legitimate, testable scientific theories. He describes what is needed for such theories to be adequately defined and tested, and then goes on to describe the purely scientific application of anthropic arguments. Throughout he focuses on the legitimacy of anthropic arguments, both those directed at answering purely scientific questions and those that push beyond cosmology to philosophical considerations.

Another such discussion centers on *natural evils*—how philosophers refer to the causes of human pain, suffering, and death. Natural evils, it is argued, have their roots in

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the underlying characteristics of the universe and of nature, particularly, in the nature of matter and its interactions, including gravity, and in the increase of entropy, or disorder, in the universe according to the Second Law of Thermodynamics, which is always in force.

Stoeger has been lending a cosmologist's point of view to this discussion through his participation in a research collaboration between the Vatican Observatory and the Center for Theology and the Natural Sciences (Berkeley, CA) to explore the scientific perspective of natural evil.

Stoeger notes that the interplay of various physical interactions via the exchange of matter and gravitational entropy is crucial for the emergence and development of structure and complexity throughout the universe. Thus transience, dissolution, and death are the price that entropy demands for the exploration of new possibilities, the generation of novelty, and the support of highly organized systems in our evolving universe.

*About this study:* Stoeger wrote about natural evil in *Physics and Cosmology: Scientific Perspectives on the Problem of Natural Evil* (Libreria Editrice Vaticana, 2008).

## II. INSTRUMENTATION AND TECHNICAL SERVICES

### **Vatican Advanced Technology Telescope (VATT)**

In the spring, the VATT's operations manager, Dan McKenna, left to manage operations at the world-famous Mount Palomar Observatory. Replacing Dan is Ken Duffek, an electrical engineer who had first worked on the VATT during its commissioning phase some fifteen years ago. The new staff technician is Gary Gray. He had been a general maintenance mechanic with the Mount Graham International Observatory and is thus also already familiar with the VATT. Christopher Corbally, S.J. remains the VATT's Director, while Richard Boyle, S.J. is the telescope scientist and scheduler.

This change in staffing offered the opportunity to reassess the overall management of the VATT. The Vatican Observatory astronomers consulted with members of the University of Arizona's Steward Observatory management team, including Jeff Kingsley, associate director, and Bob Peterson, operations manager. This resulted in bringing the VATT into Steward's Mountain Operations, which is responsible for running the University of Arizona's medium-sized telescopes.

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Ned Franz and Chris Johnson guide the VATT's primary mirror back into its cell after it was successfully re-aluminized during the summer maintenance shutdown.

PHOTO: DAVID HARVEY PHOTOGRAPHY

This change allows the VATT to take advantage of the large pool of technical expertise already assembled at Steward Observatory. We continue to have the good services of Ned Franz as chief mechanical engineer who took on added responsibilities in the transition between operations managers; and we have integrated Chris Tardif into our operations as electrical engineer, Chris Johnson as software engineer, and Dave Harvey as both software engineer and observer support. Gary Rosenbaum and

Joe Hoscheidt, from Mountain Operations, provided additional expertise during the project to re-aluminize the VATT primary mirror during the summer shutdown period. This "A-team" swiftly brought the telescope back into operation after the shutdown, despite all the potential difficulties of re-connecting everything and finely aligning the optics. The telescope has been yielding good science to observers since September.

Most notable among the VATT improvements has been an upgrade by the Steward Observatory Imaging Technology Lab to the telescope's science camera. The new camera, the VATT 4K Imager, was prepared by Mike Lesser at the Imaging Technology Lab and was based on a CCD chip designed by Richard Bredthauer of Semiconductor Technology Associates, Inc. Not only does the new camera have four times as many pixels (covering four times the area of the sky) as the previous CCD camera used at the VATT, it also features improved sensitivity and quality. It uses the latest camera control software, AZCam, developed at the University of Arizona.

Further upgrades are being implemented, including the installation of \$100,000 worth of new networking and computing equipment donated by Hewlett-Packard (HP) to aid a collaboration between the Vatican Observatory and HP Labs. This generous gift was facilitated by Vatican Observatory Foundation Board member Richard Friedrich.



## **Vatican Observatory at Castel Gandolfo**

Although the majority of the Vatican Observatory's observational work takes place in Arizona with the VATT, the Observatory still has two active telescopes on the roof of the Papal summer palace in Castel Gandolfo. The increase in the sky brightness near Rome has limited their efficiency, and has also led to the mothballing of two other telescopes located in the Papal gardens next to the palace.

The past science done by those telescopes, however, lives on in the photographic glass plates taken with them over the last century and which are stored in the plate vault at Castel Gandolfo. For several years now, Father Alessandro Omizzolo has undertaken the delicate project of making digital scans of these plates. By the end of 2007, the first stage of this project was nearly complete: more than 2000 of the 2400 plates of the Schmidt archive have been digitized. Now that these images are available in computer form, they can be analyzed using modern image processing techniques, and—perhaps more importantly—the digital images can be copied and shared with other researchers, rather than actually loaning out the fragile glass plates themselves.

In August, Ronald F. Dantowitz, Director of the Clay Center Observatory in Boston and a noted astrophotographer, visited the Observatory in Castel Gandolfo for two weeks to explore the qualities of the site for high-resolution astrophotography. He brought with him large telescopes provided by the Meade Telescope company and also special cameras that were affixed to the Observatory's Double Astrograph and Visual telescopes. His project concentrated primarily on imaging the Sun in the morning hours, when the air over Lake Albano is especially still, but it also included observing the rare event when one of Uranus' moons passed in front of another, which happens only every 42 years.

## **Meteorite Collection at Castel Gandolfo**

The meteorite collection at the Observatory's headquarters in Castel Gandolfo has been moved to a new location, a room adjacent to the museum area where they were formerly kept. This new location has been outfitted as a small laboratory. Now samples to be studied are conveniently housed, in a new cabinet built by Luigi Lori, next to the microscopes and measuring instrumentation. The lab containing the collection is climate controlled with both air conditioning and a powerful dehumidifier to retard degradation of these valuable samples.

Two new meteorites were added to the collection in 2007: the mesosiderite Mount Padbury, found in the desert in western Australia, and the pallasite Fukang, which comes

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VOSS 07 students, faculty, and staff at a private audience with Pope Benedict XVI.

from China. Both are examples of the rare stony-iron class, believed to be fragments of a small differentiated planetoid broken apart during the formation of the solar system 4.5 billion years ago.

### III. OBSERVATORY AND STAFF ACTIVITIES

#### **Presentations and Academic Activities**

The Eleventh Vatican Observatory Summer School (VOSS) in Astrophysics on the topic of “Extrasolar Planets and Brown Dwarfs” was held at the Observatory at Castel Gandolfo from 9 June to 6 July with the participation of 26 students from 22 countries. The students and faculty were received in a private audience by Pope Benedict XVI on 11 June.

From 1 to 5 October nearly 200 astrophysicists met at the Matteo Ricci Center at the Pontifical Gregorian University for an international conference titled Formation and Evolution of Galaxy Disks. Conference chairman was Vatican Observatory director José Funes, S.J. Sponsors were INAF, ICRANET, Camozzi Holding.

On 25 October the St. Thomas More Catholic Center at Yale University, New Haven, Connecticut, sponsored a public seminar by Vatican Astronomers at the Thomas E. Golden, Jr. Center. On the following day, the Vatican Observatory Foundation held its semi-annual Board Meeting at the same center.

The St. Albert the Great Forum on Theology and Science continues under the leadership of William Stoeger, S.J. as chairman of the Board. Christopher Corbally, S.J. is a member.

Giuseppe Koch, S.J. and Sabino Maffeo, S.J. represented the Vatican Observatory at the inauguration of the new meridian, Targa I, in the Vatican.



Participants review research posters at the international conference Formation and Evolution of Galaxy Disks, sponsored by the Vatican Observatory.

PHOTO: CHRISTOPHER CORBALLY, S.J.

CARUANA • Presented the standard courses on Metaphysics, Philosophy of Science, and Belief and Unbelief at Heythrop College, London University • Delivered a paper on "Jesuit Styles of Scientific Thinking," as one of the guest speakers at the International Symposium on Jesuits and Modern Science: Past Heritage, Present Status and Future Prospects, 1-5 January, organized by the Jesuit University Jnana-Deepa Vidyapeeth, Pune, India. The same paper with further modifications was presented and discussed at a conference in Worcester, Massachusetts, on "Jesuit Heritage," 23-28 September, organized by the College of the Holy Cross. • Delivered a paper at the All Saints Pastoral Centre, Hertfordshire, UK, on 24 March, entitled "Darwin, Evolution and Religion," as one of the guest speakers at the Heythrop Philosophy of Religion Annual Conference organized by the Department of Philosophy of Heythrop College, London University. The same paper with further modifications was presented on 27 September at the Biology Department of the College of the Holy Cross. • Delivered a paper on 14 November entitled "Is Social Darwinism Based on a Mistake?" at the Heythrop Philosophy Department Research Seminar.

CONSOLMAGNO • January-May 2007, held the Loyola Chair at Fordham University, Bronx, NY, teaching astronomy and physics and conducting research with undergraduates. During that time he was appointed a Research Associate at the American Museum

of Natural History, where he conducted measurements of meteorite density and porosity. • Gave presentations on his research at the Adler Planetarium, Chicago, February 7; Cornell University Department of Space Sciences, April 26; Franklin Institute of Philadelphia, May 9; Museum of Natural History (London), October 3; Michigan Technical University Department of Physics, October 16; Yale University Department of Astronomy, October 26; California Academy of Sciences, November 26. • In September, was elected to the European Jesuits in Astronomy Steering Committee for a six-year term. • Served as chair of the Division for Planetary Sciences of the American Astronomical Society (AAS) until the end of his term in October. In that capacity he made several trips to Washington, DC, meeting with AAS officials, congressional staffers, and NASA officials. From October, he moved to the position of Past Chair, continuing to serve on the Board of the DPS/AAS. • Continued to serve as Past President of Commission 16 and Secretary of Division III of the International Astronomical Union. • Elected a delegate to the Provincial Congregation of the Maryland Province of the Society of Jesus, held in January in preparation for the Society's General Congregation in 2008.

CORBALLY • Made visits to Appalachian State University in April and in August to work on finishing the book *Stellar Spectral Classification* with his co-author Richard Gray. The 668-page manuscript was submitted to Princeton University Press on 1 October. • On 18 October gave the inaugural talk in the Astronomy Lecture Series at Embry-Riddle Aeronautical University, Prescott Campus, Arizona, speaking on "M's the Word: Secrets of Cool Stars."

COYNE • Gave a colloquium on 12 March to the Physics Department of North Carolina State University on "The Age of the Universe." He gave the same talk to the meeting of Sigma Xi at St. Joseph's University, Philadelphia on 20 April and to the Physics and Astronomy Department of the University of New Mexico, Albuquerque, on 16 November. • Gave a keynote address on "Cosmic and Human Evolution" to the meeting of the American Association of Physics Teachers at Greensboro, North Carolina, on 1 August. • As a member of the Advisory Committee of the Peter and Patricia Gruber Foundation, participated in a meeting 12 November in New York to discuss the Foundation's strategic plans for the future.

FUNES • Taught the General Astronomy course during the spring semester in the Department of Astronomy, University of Arizona. • From 15 to 19 October in Guatemala City, at the invitation of *Ciencia sin Fronteras*, made academic presentations at the Universidad del Valle, Universidad San Carlos, and Universidad Rafael Landivar.

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HELLER • On 15 March at the Department of Physics, Australian National University, Canberra, gave a paper entitled "A noncommutative model unifying general relativity and quantum mechanics."

MAFFEO • Gave a lecture on science and faith to the Ateneo Regina Apostolorum in Rome on 3 March. • Spoke on the history of the Vatican Observatory to the following groups: on 17 April, to the Astronomical Society G. V. Schiaparelli; on 18 April, to the Catholic University of Friburg, Switzerland; on 19 April, to the Pleiades Association of Mugano, Lugano, Switzerland; on 28 September, at Frascati, Italy on the occasion of the celebration of the Notte Europea della Ricerca 2007; on 13 November, at the Ateneo Regina Apostolorum. • Gave a talk about Angelo Secchi, S.J. to the Hipparchos Association in Rome. • On 23 April gave a talk at the Salesianum, Rome on the history of the relations between J. G. Hagen, S.J. and Blessed E. Hesselblad.

STOEGER • Spent 28-31 March at Loyola University of Chicago. While there he gave a Physics Colloquium on "Cosmology and the Mysteries of Dark Matter and Dark Energy," and a university public lecture on "Science and Worship: Cosmology, Time and the Vatican Observatory." • On April 4 at the University of Arizona gave an invited lecture for the Templeton Foundation Program on Astrobiology and the Sacred entitled "The Quest for Understanding and Meaning: From Cosmic Process and Complexity to Unity, and Beyond."

WHITMAN • From June 30 to July 28 at Boston College participated in the 45th Summer Meeting of the Clavius Group of Mathematicians. He was one of the organizers of a seminar on topics in differential geometry, which tried to bridge the gap between the language of physicists and that of mathematicians. He also gave seven lectures on the intricacies and details of three fundamental theorems in the Theory of Lie Algebras. • Continued his project of exposing the intricate details of moving from the classification of complex Lie algebras to the classification of the real forms of these algebras.

### **Public and Educational Outreach**

CARREIRA • Lectured at various universities in Europe and in South America. • Gave a ten day course on science and faith at the Catholic University of Colombia in Bogota. • In Lima, Peru, lectured at four universities and two diocesan seminaries. • In Spain, lectured at universities in Madrid, Barcelona, Valladolid, Toledo, and Salamanca. • Gave talks at the *Athenaeum Regina Apostolorum* in Rome.

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CONSOLMAGNO • Spoke on “What Happened to Pluto” in Detroit, on January 20; at the Rutgers University Geology Museum, New Jersey, January 27; in Chicago, February 10; to the Vatican Observatory Foundation, Tucson, February 23; as the speaker for the Fordham Sigma Xi Annual Banquet, May 15 • Delivered the Loyola Lecture on “Truth, Beauty, and Planetary Science” at Fordham University, New York • Spoke on Science and Religion at Old St Joseph’s Church, Philadelphia, February 1 • Served as the Special Science Guest at the Boskone Convention, Boston, February 15-18, Boston • Spoke on “God, Astronomy, Elegance,” in New Hampshire March 2, and at the Franklin Institute, Philadelphia, May 9 • Spoke on “God’s Mechanics” at St. Ignatius Church, New York City, March 29; at Michigan Technical University, October 15; at the New York City Library of Science Industry and Business, November 6; at the University of Colorado, November 29; and at Sacred Heart University, Connecticut, December 4 • Spoke in a program organized by the University of Wisconsin bringing together scientists and Native American Elders, April 12-14 • Spoke on his book *Turn Left at Orion* at the Northeast Astronomy Forum, April 28; to the Princeton (New Jersey) Amateur Astronomers, May 8; and to the Long Island Amateur Astronomers, November 7.

CORBALLY • On 18 October presented “The Vatican and Astronomy” in the Star Talks series at the Prescott Public Library, Arizona. • 15 November, gave a talk to the Sun City Astronomy Club, Arizona, entitled “M’s the Word”.

COYNE • Spoke on the “Dance of the Fertile Universe” at the Newman Center of the University of North Carolina, Chapel Hill, on 30 January; at Rockhurst College, Kansas City, on 6 March; at Duke Divinity School, Durham, on 20 March; at St. Therese Catholic Church, Mooresville, North Carolina, on 24 April; at the Hudson Memorial Presbyterian Church, Raleigh, on 17 May; to the Catholic Youth Convention, Diocese of Raleigh at Greenville, North Carolina, on 19 May; at the North Carolina Museum of Science, Raleigh, on 25 May; and at Temple Beth Or, Raleigh, on 23 June. • Opened the lecture series, Ignatian Mission, at Loyola High School, Baltimore, with the talk “Can God and Science Really Co-Exist,” on 24 October. • On 19 October gave the Magisterial Lecture for the opening of the academic year at the Interamerican University of Puerto Rico, San Juan.

HELLER • Between 10 and 13 March gave a series of lectures in Sydney, Australia. • 19 March at the Cardinal Knox Center, Melbourne, gave a paper entitled “Science and Theology in the Cosmological Context.” • 20 March at Aquinas College gave a paper on “Man in the Cosmos.”

STOEGER • On 14 November gave a lecture to the Legatus Chapter (Catholic Business People) of Pasadena, California, entitled: "The Vatican Observatory and the Church's Stand on the Relationship Between Theology and Science."

### News Media Coverage

CONSOLMAGNO • Was interviewed on New Hampshire Public Radio and in the Concord (NH) Monitor, March 2 • Was interviewed on Centenary College Cable TV, March 30 • Wrote and recorded a 15 minute episode about Galileo for the BBC Radio 3 Program *Strange Encounters*, broadcast April 19 • Was interviewed by the German travel magazine *Merian* for the December 2008 issue on travel to the Vatican • Appeared on the nationally syndicated US radio show *Coast to Coast*, November 14.

CORBALLY • Was interviewed and answered questions from the public for two episodes of the Drew Mariani Show on Relevant Radio. On 21 December 2006 the topic was "The Christmas Star," and on 5 January it was "Aliens and UFOs: The Catholic Position." • Was interviewed on 5 April by Tracey McClure for the English Service of Vatican Radio concerning the Spitzer and N Stars data on planetary material around twin stars. • Was interviewed, together with Simon Mitton, on 5 May by Philip Dodd for the BBC Radio 3 program *Night Waves* on "The Vatican and Astronomy." • In January became an advisor to the project *400 Years of the Telescope*. This project is a coordinated effort by Interstellar Studies in partnership with the Astronomical Society of the Pacific, Carnegie Science Center, and the Imiloa Science Center to create a video production and a set of related experiences and events around the International Year of Astronomy 2009. • In July gave a video interview at the VATT to project producer Kris Koenig, and in November helped the video crew obtain footage from Mount Graham for this production.

COYNE • Granted an interview to *Economist Magazine* on 22 March. • On 2 April was interviewed by Tom Fox of the *National Catholic Reporter*. • On 17 April at the Wilma Theatre, Philadelphia, participated in a dialogue on the production of Brecht's *Life of Galileo*. • Interviewed on 9 October by Lars Becker-Larson of the Danish Television Network. • From 3 to 6 November was interviewed along with Arno Penzias by Riccardo Chiaberge of *Il Sole 24 Ore*, a newspaper of Milan, Italy, to discuss a book Coyne is preparing on science and religion. • On 11 November was interviewed with Richard Dawkins of Oxford University, UK, at Most Holy Trinity Church, Brooklyn, for the three-part series "Origin of Species" being produced by the British Channel 4. • Was interviewed by Liz Kay

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of the *Baltimore Sun* on the Church's view of evolution. • Was interviewed by James McDermott, S.J. of *America Magazine* where the interview was published in the 23 October edition.

HELLER • Gave several interviews in various Polish media (newspapers, journals, radio) on science, philosophy, and science and theology. • Gave three interviews to the Australian Radio Network. • Gave several public lectures on cosmology, science, and theology in Sydney, Canberra, and Melbourne, Australia.

KOCH • Gave interviews to Franca Giansoldati of the *Messaggero* (Rome, Italy), published 19 July; to Isabelle de Gaulmyn of *La Croix* (Paris, France), published 27 September; and to Philippe Demenet of the *Pèlerin* (Paris, France), on 17 December.

MAFFEO • Was interviewed by the international Catholic news agency ZENIT. • Gave interviews to the Japanese television agency Eizokan, Inc.

### **Conference Participation**

5-8 January: Phoenix, Arizona. Joint Winter Meetings of the American Mathematical Society and the Mathematical Association of America. A. WHITMAN, S.J. participated.

5-10 January: Seattle, Washington. The 209th Meeting of the American Astronomical Society. RICHARD P. BOYLE, S.J. and CHRISTOPHER CORBALLY, S.J., presented papers.

31 January: Lublin, Poland. Mathematics in Action. M. HELLER gave a paper.

5-6 March: Tucson, Arizona. Annual General Meeting of the International Dark-Sky Association. CHRISTOPHER CORBALLY, S.J., participated.

8 March: Sydney, Australia. Human Time and the Time of the Universe. M. HELLER gave a paper.

12-14 April: Boston, Massachusetts. The Future of Space Exploration. W.R. STOEGER, S.J. gave an invited paper.

17-18 May: Cracow, Poland. Polish Academy of Science and Art, 11th Cracow Methodological Conference. M. HELLER served on the Organizing Committee and gave a paper.

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21-25 May: Moletai, Lithuania. Photometry School. R.P. BOYLE, S.J. and R. JANUSZ, S.J. participated and gave papers.

7-10 June: Los Angeles, California. Annual Convention of the Catholic Theological Society of America. W.R. STOEGER, S.J. gave a paper and was convener of the Theology and the Natural Sciences Continuing Group.

25-29 June: Alicante, Spain. Catastrophic Disruptions Workshop. GUY CONSOLMAGNO, S.J. presented an invited review talk.

3-30 July: Boston, Massachusetts. 45th Annual Summer Meeting of the Clavius Group of Mathematicians. ANDREW WHITMAN, S.J. organized and lectured.

15-20 July: San Juan, Puerto Rico. BioAstronomy. GUY CONSOLMAGNO, S.J. participated in and served on a special discussion panel for the tenth anniversary of the film *Contact*.

13-17 August: Tucson, Arizona. Meteoritical Society Annual Meeting. GUY CONSOLMAGNO, S.J. presented two papers.

5-8 September: Madrid, Spain. Sophia-Iberia Academic Conference on Human Evolution. W. R. STOEGER, S.J. gave a paper.

7-9 September: Madrid, Spain. European Jesuits in Astronomy Meeting. CONSOLMAGNO, KOCH, and STOEGER participated.

21-23 September: St. Louis, Missouri. ITEST Workshop on Astronomy/Cosmology Breakthroughs and the God Question. GUY CONSOLMAGNO, S.J. presented an invited paper.

1-5 October: Rome, Italy. Conference on the Formation and Evolution of Galaxy Disks, JOSÉ FUNES, S.J. chaired the Scientific Organizing Committee.

7-12 October: Orlando, Florida. Annual Meeting of the Division for Planetary Sciences of the American Astronomical Society. GUY CONSOLMAGNO, S.J. and JEAN BAPTISTE KIKWAYA, S.J. presented papers.

18-20 October: Flagstaff, Arizona. American Physical Society Four Corners Regional Meeting. W.R. STOEGER, S.J. gave a paper.

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- DE ARAÚJO, M. E., and STOEGER, W. R. The Angular-Diameter-Distance Maximum and Its Redshift As Constraints on  $\Lambda$ CDM FLRW Models, submitted for publication (available at arxiv: astro-ph/0705.1846).
- BERDYUGINA, S., BERDYUGIN, A., PIROLA, V. 2007, Molecular Magnetic Dichroism in Spectra of White Dwarfs, *Phys. Rev. Lett.*, 99 (9).
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## V. OBSERVATORY VISITORS

The Vatican Observatory was honored to receive the visit of His Eminence Cardinal William Joseph Levada, Prefect of the Congregation for the Doctrine of the Faith and his collaborators.

Friends of the Vatican Observatory Foundation under the friendly care of Paula D'Angelo, member of the Foundation Board, visited Castel Gandolfo and the Observatory, 3-5 October.

The participants at the meeting sponsored by the Templeton Foundation and held at the Hotel Castelvechio at Castel Gandolfo from 21 to 25 July visited the Observatory.

Sabino Maffeo, S. J. received more than thirty group visits to the Observatory at Castel Gandolfo, including the staff of the Vatican Library and those of the European Space Agency's laboratory at Frascati, Italy.

The following paid working visits to the Vatican Observatory, Castel Gandolfo:

LEOPOLDO INFANTE, Department of Astronomy, Pontificia Universidad Catolica de Chile, Santiago, Chile

A. G. DAVIS PHILIP, Union College and Institute for Space Observations, Schenectady, New York, USA

FILIPPO SMRIGLIO, Department of Physics, University of Rome "La Sapienza", Rome, Italy

The following paid working visits to the Vatican Observatory Research Group, Tucson, Arizona:

GEORGE ELLIS, Department of Mathematics, University of Cape Town, South Africa

DENIS EDWARDS, Flinders University, Adelaide, Australia

ARNO PENZIAS, New Enterprise Associates, Menlo Park, California, USA

A. G. DAVIS PHILIP, Union College and Institute for Space Observations, Schenectady, New York, USA

FRANK YOUNGER, Dominion Astrophysical Observatory, Victoria, British Columbia, Canada





