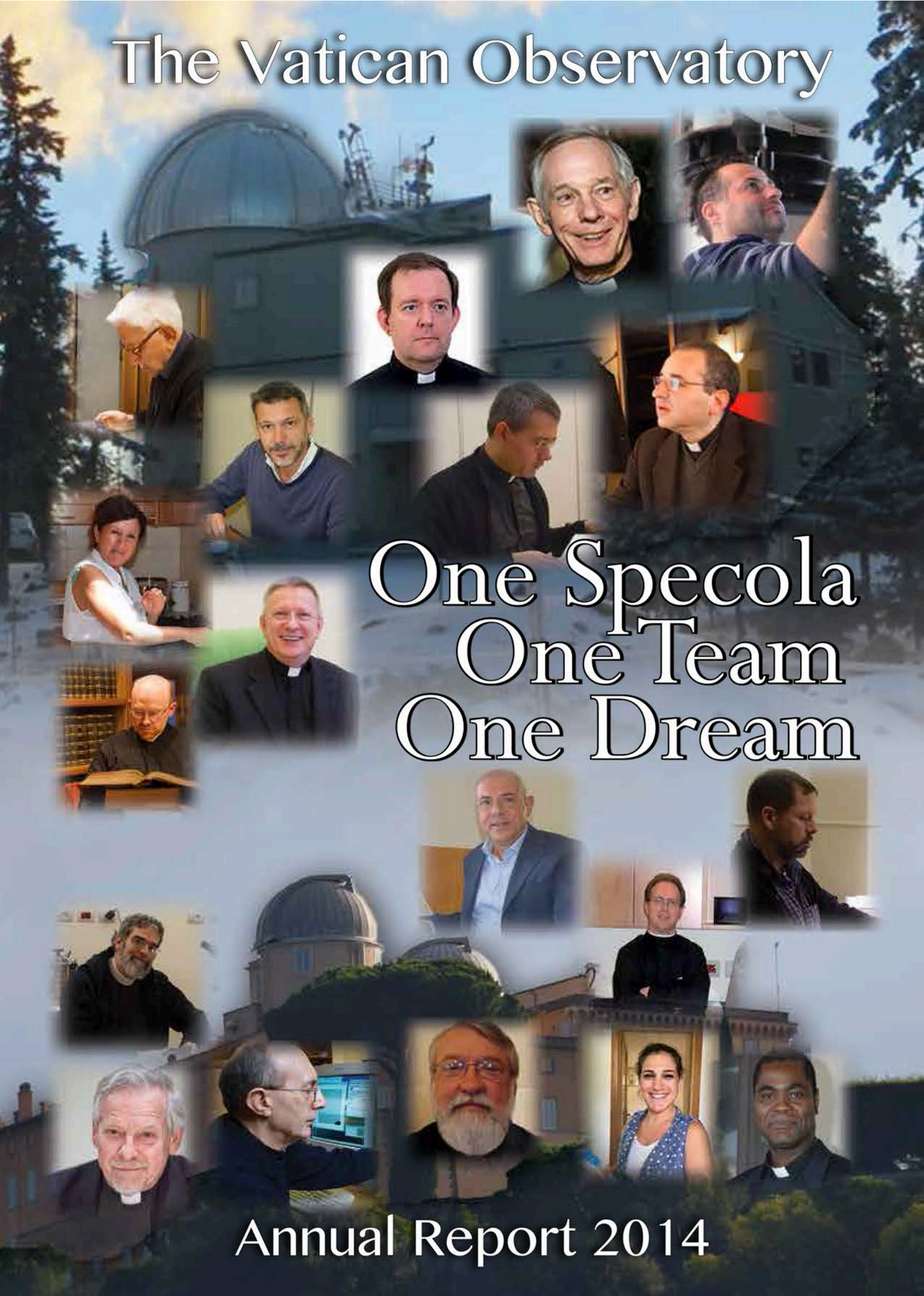
The Vatican Observatory



One Specola
One Team
One Dream

Annual Report 2014

ANNUAL REPORT 2014

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Vatican Observatory Publications

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Cover: *In this year's annual report we meet members of the Vatican Observatory team who work at the headquarters in Castel Gandolfo and VATT in Tucson Arizona alongside our scientists.*

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From the Director

ONE SPECOLA

The Vatican Observatory, known in Italian as the Specola Vaticana, carries out a unique mission in service to the Holy See. Like any other observatory in the world, the history of the Vatican Observatory is determined by the search for dark skies away from the threat of light pollution.

Thus in the 1930s with the support of Pius XI the Observatory moved from Vatican City to the Papal Palace in Castel Gandolfo. Under the auspice of Pius XII a Schmidt wide-angle telescope was inaugurated in 1957 in the Papal Gardens of Villa Barberini.

With the continuously increasing population of Rome the skies above the Observatory again became too bright. For this reason in 1981, the Vatican Observatory opened a research group at the University of Arizona. This affiliation with Steward Observatory gave Vatican astronomers access to many large telescopes in Southern Arizona, and the collaboration blossomed in 1993 with the dedication of the Vatican Advanced Technology Telescope (VATT). The construction of the telescope and related astrophysical facilities on Mount Graham was made possible through the support of donors and friends of the Vatican Observatory Foundation and especially through the generosity of Mr. Fred A. Lennon and Mr. Thomas J. Bannan. The VATT has pioneered the new technology of creating large, lightweight, stable mirrors in a rotating furnace at the Steward Observatory Mirror Lab.

Thus from its two centers, located at Castel Gandolfo and at Tucson, the Observatory is continuing research programs and international collaboration. It is a real challenge to keep these two centers running that is possible thanks to the support of the Governatorate of Vatican City State and to the Superiors of the Society of Jesus who are providing qualified men for this work in service to the Holy See. We are also very grateful to our benefactors who are helping us to carry out different projects.

This time I would like to mention two projects that are important and perfectly respond to the two-fold mission of the Vatican Observatory: to do good science and to be witnesses of the Church's commitment to dialogue with the sciences.

VATT robotization. On March 8, 2014, the Vatican Observatory received a very generous gift from the Papal Foundation for the technological update of the VATT. With this grant we have started the process of "robotizing" the VATT in collaboration with the Steward Observatory of the University of Arizona. In this report we outline the work that has been completed and future milestones for this project.

The robotization of the VATT is part of a larger plan for developing a network of advanced telescopes in Arizona, the Arizona Robotic Telescope Network (ARTN). Many new possibilities will open up for competitive science at VATT both as a stand-alone telescope and as a part of a new cutting-edge facility. The complexity of working in this context is one of the parameters of the project which may be challenging. Furthermore, VATT continues to operate at this time with no disruptions to the observers while undergoing major upgrades.

Renovation of the domes. Due to the increasing number of visitors and our re-evaluation of the Observatory's historical heritage, we have started restoration work on the domes in the Pontifical Gardens of Castel Gandolfo. In the report we will also outline the progress that has been made on this project.

The domes house two telescopes, the Carte du Ciel (1891) and the Schmidt (1957), which were advanced technology telescopes at the time of their construction. The domes are ideally situated to showcase the Holy See's commitment to contributing to the progress of scientific knowledge. The projected Visitor Center will offer the younger generations a different perspective from the one they get from the media. The historical testimony of the Vatican astronomers tells more than words ever can that science and faith can complement each other.

This project is being carried out thanks to the generous contribution of Mr. Roberto and Mrs. Maria Buffetti.

Father Jozef M. MAJ S.J., vice director for administration and I had the great opportunity to brief the Holy Father on these and other projects when we were received in private audience on January 25.

Fr. Funes and Fr. Maj are received in private audience by Pope Francis

On that occasion I also gave to Pope Francis a report produced by the Vatican Observatory Advisory Committee (VOAC). In 2013 I appointed an advisory committee of outside experts in astronomy to help us evaluate the work of the Observatory. Members of this international committee, representing a wide range of astronomical disciplines, were asked to evaluate the various activities of the Observatory, looking at developments over the past seven years and anticipating future needs for the next seven years. I am deeply grateful to the committee members for their generosity in dedicating their time and professionalism to produce an extremely helpful report. The VOAC was formed by Dr. Fernando Comerón (European Southern Observatory), Prof. Christopher Impey

(University of Arizona), Prof. Jonathan Lunine (Cornell University), Prof. Dante Minniti, Pontificia Universidad Católica de Chile.

ONE TEAM

The unique mission of the Vatican Observatory is carried out by one team based in two locations. In this report I wanted to highlight the work of members of the Vatican Observatory team and not just that of the Vatican scientists. I hope you enjoy meeting them as much as we enjoy being part of one family.

I would like to say that with this team it is easy to be their leader. I am proud of them and to them goes my deep gratitude.

This year our team suffered a huge loss. It saddens me deeply to report the death of Father William STOEGER, S.J. on March 24. He was called home to the Lord at the Sacred Heart Jesuit Center in Los Gatos, California, where he was being treated for an aggressive form of cancer. The Jesuit Community of the Vatican Observatory has lost a brother, a friend, and an outstanding scientist. We miss Fr. Bill very much.

ONE DREAM

The Vatican Observatory has been trusted to the Jesuits by the Holy See. The Jesuit dream can be expressed by the following Spanish words "en todo amar y servir" (in all things, to love and to serve).

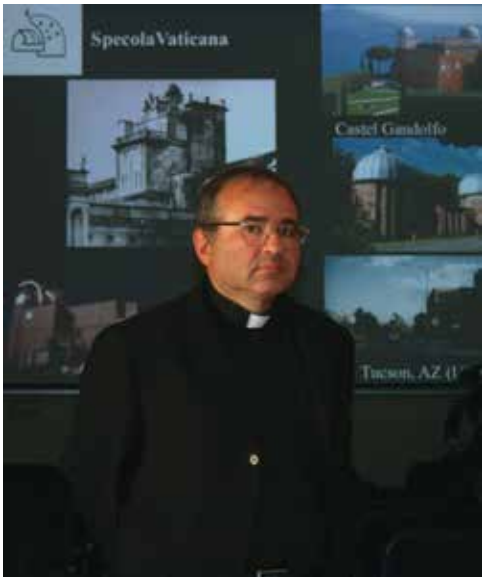
At the Observatory we love our mission, we love to explore the Universe sharing this passion with our colleagues. Astrophysics is a wonderful science and still a very exciting frontier to be at. With our research we hope to serve humanity in asking the deepest human questions about the origin of the Universe and its philosophical and theological implications.

Finally I would like to mention one dream that comes true every two years, the Vatican Observatory Summer Schools. I am especially grateful to those benefactors who, with their generous gifts, have provided scholarships to financially support the participation of our students.

In June we hosted the 14th Summer School on Galaxies: Near and Far, Young and Old. It was another successful and joyful experience thanks to the great dedication of the faculty and the generous participation of the students. I am very grateful to Prof. John Stocke (Chair), University of Colorado, Boulder, CO, USA, and to the faculty: Dr. Michele Trenti, University of Cambridge, UK; Dr. Christopher Carilli, Very Large Array, Socorro, New Mexico, USA, and Prof. Jacqueline van Gorkom, Columbia University, New York, USA, for organizing an excellent academic program. I am also grateful to Brother Guy CONSOLMAGNO, S.J. for serving as dean of the school.

In 1986, the Vatican Observatory organized the first Summer School in Astronomy and Astrophysics, which has become more and more a valuable part of our activities. Since then, this international endeavor has come to number 362 alumni hailing from 64 countries. This Observatory initiative is like the mustard seed from the Gospel parables that grows from something small (Cfr. Mk 4, 27.31). We give thanks to God for the growth which has exceeded our best expectations and to the Holy See for its support throughout these years.

José G. Funes, S.J.
Director



Fr. Josè G. Funes, S.J. Director of Vatican Observatory

One Specola, One Team

ONE SPECOLA
Each year the Vatican Observatory Annual Report sets out to track the work and advances made by its team of scientists in the field of Astronomy and Astrophysics. However, their work would not be possible without the help and support of management and staff who ensure the smooth running and maintenance of the Vatican Observatory (VO) and its facilities at the headquarters in Castelgandolfo and the Vatican Advanced Technology Telescope (VATT) in Tucson, Arizona. Together with the scientists they are an integral part of the Vatican Observatory, its current efforts and future dreams.

THE HEADQUARTERS
Polish native **Fr. MAJ** was appointed to the post of vice-director for administration at the Vatican Observatory in September 2009. When he arrived the headquarters had recently been relocated from the papal palace to its current site in the former Basilian monastery buildings within the pontifical gardens. As vice-director for administration Fr. MAJ began over-seeing the restructuring work at the Specola, which he describes as 'a work in progress'.

Fr. Józef M. Maj, S.J. Vice-Director for Administration

Under his administrative management the new headquarters has been transformed and now has up-to date working areas for the staff, most notably the new Meteorite Laboratory and Library facilities. Other innovations include the extension of spaces to host the Vatican Observatory Summer School (VOSS), such as the conference hall, guest rooms and terraced courtyard which serves as a dinning space for students. A new 'refectory', or dining hall, is planned for 2016. This has meant that VOSS now takes place at the heart of the Vatican Observatory where students have a chance to meet and see the VO scientists at work. "This Vatican Observatory has two realities", says Fr. MAJ. "The institutional aspect and the community aspect. The institution depends on the people who work here and competences vary, but good rest, a comfortable environment helps people to work well and efficiently". He adds that much work has been done on the monastery to meet the operational needs of the Observatory. However, much still needed to be done. As the vice-director for administration MAJ is also tasked with managing the administrative needs of the Vatican Observatory Research Group in Tucson, Arizona. Currently, MAJ is laying the ground work for the VO's next ambitious project: the transformation of the two domes in the papal gardens into a Science Gallery and Visitors Center - more of which you can read about below. The scientific and administrative work at the Specola benefits greatly from the competence and dedication of three staff members: Federico Balzoni, Antonio Coretti, and Romano Reggio.

Romano Reggio is a local of Marino another hill top town close to Castel Gandolfo and works in maintenance and technical services. Under the direction of Fr. MAJ, Romano is tasked with the upkeep of the electrical, plumbing, carpentry and gardening requirements at the Specola. He describes his work at the Specola as something which gives him a "deep sense of satisfaction and contentment".

Mr. Romano Reggio

Roman native **Federico Balzoni** joined the Specola in 2007 and his day to day job is office management. This also includes the organization of VO Conferences at the Specola and the biannual Summer School, as well as liaising with the media on behalf of the VO. Together with astronomer **Fr. David BROWN S.J.**, Federico has also been instrumental in the creation and expansion of the Specola Library searcheable database. Working diligently day after day, he has helped to catalogue and to enter into the database thousands of books.

Mr. Federico Balzoni

He says "working at the Specola is really a special way to serve the Holy Father and in a sense help in the mission that is particular to the Observatory, as a world suspended between science and faith".

Antonio Coretti is from the Southern Italian city of Matera and has been part of the Specola team since 2011. A graduate in Information Technology he deals with everything related to IT, such as developing software, providing technological solutions and improving the Specola's operational capabilities. Since coming on board Antonio has given new life to the Specola's visual presence in the digital world through his talents in graphic design and through his contribution to the design and layout of the Annual Report. Most recently, Antonio

has undertaken to build a new up-to-date user friendly VO website from scratch. He sees his work at the Specola as a "double responsibility", not only in maintaining high professional standards but also in the constant awareness that he is at the service of the Holy See: "This implies a greater spirit of sacrifice, as far as I'm concerned, it implies responsibility and seriousness but above all it's a real pleasure".

Mr. Antonio Coretti

The facilities of the VO are a pleasant enviornment in which to live and work thanks to the dedication of **Assunta Rodia** who is in charge of cleaning. She also works part-time for the Jesuit Community. Assunta keeps the chapel, hallways, and common rooms neat and clean, and she sees to the Community's laundry. She does all of this with great flexibility and with unfailing good cheer. Assunta is also the substitute cook for the Jesuit Community. Together with the full-time cook **Gina Savinetti**, Assunta rises to the occasion when needed, giving a lot of extra service and care when the Observatory or the Jesuit Community has a special event or a special guest.

Ms. Assunta Rodia

As superior of the Jesuit Community of the Vatican Observatory, **Fr. Paul MUELLER S.J.** oversees the "home life" of the Jesuits who live and work at the Observatory.

Gina Savinetti prepares meals for the Community, six days per week. Usually she cooks for a group of 7 or 8 Jesuits. But in the summer, when Jesuits from Tucson and various visitors are in residence at Castel Gandolfo, sometimes she finds herself cooking for 10 or 12 or more. Gina is a whiz when it comes to accommodating the diverse palates and dietary needs of the Jesuits of the Observatory, who come from seven countries on four continents, and who range in age from 40 to 92. When Pope Francis came for lunch, in summer 2013,

Ms. Gina Savinetti

Gina also prepared the meal, complete with Argentinian empanadas.

THE VATT

Keeping the VATT in Tucson at the forefront of observation and research would not be possible without the dedication and professionalism of a gifted team of engineers and technicians.

Robert L. Peterson is Assistant Director of Operations at the Steward Observatory in Tucson. In his capacity as head of Mountain Operations, he currently manages research telescopes on Mt. Graham, Kitt Peak, Mt. Lemmon and the mirror coating facility at the Sunnyside Vacuum Lab. He has assisted with site selection of the Vatican telescope on Mt. Graham and assisted with the construction of the telescope dome on Mt. Graham. He has been actively involved with the VATT safety program for the past eight years and he personally oversees the aluminum coating process for VATT's mirrors. "Having graduated from a Jesuit University, I appreciate the science and education mission that the Vatican Observatory Research Group brings to Tucson.

Mr. Robert L. Peterson

It has been a great pleasure working with this renowned group of Astronomers over the past several years".

Kenneth Duffek is a graduate in Mechanical and Electrical Engineering. His first project at the Observatory was to design and build the VATT drive systems. He was later transferred to the Mirror Lab. After 20 years of work at the Steward Observatory Mirror Lab Ken had the opportunity to work for the VATT again as the Operations Manager. Ken's duties include the day to day operations of the Telescope facility as well as acting head electrical engineer for upgrades and new projects for the Telescope and instruments. Because of Ken's leadership abilities he has been asked to

Mr. Kenneth Duffek

sit on committees and consult on other telescope projects. He also diagnosed

and fixed a data collection problem for the national program, The Night Sky Monitor. Under Ken's direction, the world saw a probe smash into the moon to collect water data, because the VATT was one of only two scopes that captured the images. Ken says that working at the VATT has allowed him to expand his knowledge of what astronomers need while at the same time tailoring devices to enable better science.

Michael Franz started his career at Steward Observatory January, 1996, when he took a job on the mirror casting crew as a technician. He returned to work at VATT in 2004, assisting with such fascinating endeavors as SCIDAR (Scintillation Detection and Ranging), and sky brightness meters. After Dan McKenna left and VATT entered the umbrella of Bob Peterson's Mountain Operations in 2007, Michael directed the removal and re-installation of the VATT primary mirror for aluminization. Michael sees the commissioning of VATTSpec as the "high point" of his engineering career. In 2011, Michael retired to move to Northern California, but was talked out of retirement to become the site presence for remote observing at VATT, in September 2012. Currently Michael is working on a new guide camera for VATTSpec

Mr. Michael Franz

and the Large Binocular Telescope (LBT) instrument, PEPSI. "Altogether a thoroughly challenging and rewarding career", concludes Michael, "I wouldn't have it any other way".

Gary Gray worked for 33 years at the mine in Safford where he was on the safety committee, developing an eye for potential hazards. He joined Mount Graham International Observatory (MGIO) in 2006, and the VATT team in 2007. His responsibilities at VATT include building and facilities management and maintenance. Gary's skills as a fabricator have been a great asset. His projects span a wide range, from furniture (storage shelves) to the "flats" screen in the dome. Many of them focus on safety of people and equipment. His duties include liquid nitrogen manage-

Mr. Gary Gray

ment and the operation of the vacuum pumps for the cameras. In the past couple of years Gary routinely performs instrument changes at VATT. He also maintains and cleans the primary mirror. Gary finds working at VATT very satisfying. The work is varied and interesting, and he says that, "all of the people" are "easygoing" and "like a family".

Chris Johnson is the lead programmer on VATT and Mountain Operations. Chris was raised in Wilmington, Delaware and began his bachelors in the fall of 1993 at California University of Pennsylvania. While studying, Chris had had a summer job on the assembly floor of a TV transmitter factory, and spent a yearlong internship in a small company that manufactured digital measuring instruments. Chris graduated with a degree in Electrical Engineering in 1998 and worked briefly in the financial transaction processing industry before taking an embedded programming job in the Defense industry in the spring of 1999. In 2002 Chris came to Steward Observatory. Since coming to Steward, Chris has spent most of his time working on embedded systems and motion control, and has been been part of many projects including the LBT. Starting in 2005, Chris became a member of the Mountain Operations team, and in 2006 also became member of the VATT team. Since 2012, Chris has also been leader of the IT group at Steward Observatory.

Mr. Chris Johnson

Scott Swindell graduated in 2007 with a bachelor's degree in physics and astronomy in North Carolina. During his college years, he had two internships at the NASA Goddard Space Flight Center, experiences that underscored for him the importance of software development in the sciences. After graduating, he served as a Peace Corps Volunteer in Kenya and South Africa. There, he was able to draw on his skills and passion by teaching science and technology to children and adults. Scott joined the VATT team in August 2012. As a software engineer, he was tasked with the continued development of our new telescope control system and maintaining our current control system. His responsibilities were later expanded to include developing software for robotic control of the VATT. As an engineer, and science enthusiast, Scott says he really enjoys working with the priests and scientists of VATT, helping them to get the best possible data from all its instruments.

ONE DREAM

When he re-established the Vatican Observatory in 1891, Pope Leo XIII had a very specific dream: "that everyone might see clearly that the Church and her Pastors are not opposed to true and

solid science ... but that they embrace it, encourage it, and promote it".
For nearly 125 years the Observatory has embraced good science which has been encouraged by the generous support of the Governorate of Vatican City State, the Vatican Observatory Foundation and benefactors. Moreover, the VOSS and educational outreach programs to students and amateur astronomers at VATT go a long way to promoting the good work of the Vatican Astronomers. But more needs to be done to show that science to the general public. This is why the Observatory has decided to open a Science Gallery in the heart of the Pontifical Villas.
In 1942 a building was erected in the papal gardens to house the Observatory's historic ***Carte du Ciel*** telescope with a second dome added in 1957 for the ***Schmidt*** telescope.

The ***Carte du Ciel*** was brought to Castelgandolfo from the Tower of the Winds in Vatican City State, the Observatory's original headquarters before it moved to Castelgandolfo in the 1930s fleeing Rome's city lights. As its name suggests this telescope was used in the Observatory's participation in the Carte du Ciel photographic map of the sky. Made by Gilon in Paris in 1891, it consists of two optical systems in a single tube: a photographic camera with a 33 cm aperture lens and 3.43 m focal length, and a guider telescope of 20 cm aperture and 3.6 m focal length. The field of view of the camera is 2° onto 13 cm×13 cm plates, for an image scale of 1 arcminute per mm.
The ***Schmidt*** has a 98 cm spherical mirror with a 2.4 m focal length taking light from a 65 cm correcting lens; it has a 5° field of view onto 20 cm×20 cm plates, for an image scale of 1.26 arcminutes per mm.
Neither telescope is operational at the moment, and the domes and building had until recently, fallen into disuse. Today, however, providence has come to the rescue. In fact, thanks to the generous donation made by Maria and Roberto Buffetti, and tenacity of Fr. MAJ, restoration work has begun on the Carte du Ciel starting from the installation of a new dome. Once completed work will continue on the ***Schmidt*** dome.
The building and its domes are the ideal location for the Science Gallery. The dream is to create a space that not only chronicles the Observatory's rich scientific heritage but which also allows the general public to experience science firsthand.
"The idea behind the Science Gallery is not just to reflect the history of the Vatican Observatory", says Fr. MAJ. "But to also reflect the Observatory's unique position as a bridge between science and faith and to also offer an educational aspect in the use of the telescopes".
The Gallery will include a photographic archive of the evolution in research since the Observatory's foundation, and historic documents and instruments that date back to the origins of astronomical research.
But it will also have a space for exhibitions of current research conducted by the Vatican Astronomers, such as their advances in remote observations at VATT and above all it will give the general public the 'first hand' experience of what an observatory looks and feels like. "It won't be just another museum" concludes Fr. MAJ, adding "we want to give people direct contact with astronomy, with the stars. We want the Science Gallery to be a witness to the Church's commitment to scientific research, just as Pope Leo XIII dreamed".

These images capture the removal and restoration of the Carte du Ciel dome in the pontifical gardens, Castel Gandolfo

VOSS 2014

In June last year, the Vatican Observatory hosted 25 students for the 14th Biennial Vatican Observatory Summer School (VOSS). They were drawn from 22 nations to further their knowledge in Observational Astronomy and Astrophysics, focusing on the theme of "Galaxies: Near and Far, Young and Old".

These schools are held every two years at our headquarters in the Papal Summer Gardens of Castel Gandolfo, outside Rome. The school began on June first, lasted four weeks and ended with a Papal audience.

The university and post-graduate students were chosen from one hundred and forty applicants as those most likely to pursue an active career in astronomy. The only other criterion other than academic promise was that no nation would have more than two representatives. The final enrollment included participants from every continent (including two from Africa, six from South America, and eight from Asia), and an almost even split of 13 men, 12 women.

Brother Guy CONSOLMAGNO S.J. served as the Dean and the faculty was led by Dr. John Stocke, of the Center for Astrophysics and Space Astronomy at the University of Colorado. He was joined by Christopher Carilli, of the Very Large Array in Socorro, New Mexico; Michele Trenti, of the University of Cambridge, UK; and Jacqueline van Gorkom, of Columbia University, New York.

The topic of galaxies is timely for many reasons. "Galaxy formation and evolution is at the forefront of modern astronomy research," noted Fr. FUNES, who is an expert in galaxy observations. "Galaxies are the fundamental building blocks of the universe. And new space and radio telescopes, and sophisticated numerical modeling, are challenging our views of galaxies, young and old." Looking out from the local group of galaxies, including our own Milky Way and its near neighbor Andromeda, we can now see galaxies which were formed within the first billion years after the Big Bang. By studying distant galaxies, whose light began its journey to our telescopes more than ten billion years ago, we can look back in time to the conditions that existed when the first stars were formed.

Students are welcomed at the opening session of VOSS 2014 by dean Br. Guy Consolmagno

Guest speakers addressing the students included Miguel San Martin, the designer of the landing system for NASA's Curiosity Rover currently active on Mars; and Dr. Filippo Mannucci, the director of the Astrophysical Observatory of Arcetri outside Florence. In addition to lecturing on the metallicity of galaxies, Dr. Mannucci also hosted the students on a tour of the observatory in Arcetri, including a visit to Galileo's villa.

Field trips are also an important part of the VOSS experience. Here the students pose for a group photo in Siena, Italy

The Galileo visit, including a trip to the Galileo museum in Florence, highlights a theme that ran through this school. The mixture of old and new, near and far, can be applied not only to the history of the universe revealed in the galaxies the students have been studying, but also the history of astronomy revealed in their visits around Italy.

"The Galileo house was amazing," remarked Jaco Mentz, a student from South Africa. "Just to think that he lived here at the end of his life, in such different times."

"I had the same feeling when we visited the church where St. Francis was, in Assisi," commented Juan Garavito, from Colombia. "And the history you can see in the city of Rome is amazing."

A moment of recreation between lessons in the courtyard of the VO Headquarters

For many students, visiting Rome was notable not only for its famous historical sites, but simply by contrast to their home countries. One student admitted that, before this trip, he had never seen the ocean before. And David Chun Wai Lau remarked, "I can't get used to the traffic! In Hong Kong, the traffic follows the traffic lights!"

Titania Virginflosia, from Indonesia, described how she felt to be welcomed so far from home. "I was worried when I came here, because not only do we have

to be expert in astronomy, but also in English, and my English was not strong. I was worried about giving the presentation on my research in English. But Fr. FUNES reassured us that coming from Argentina himself, he understood that we would need time. The faculty are very understanding. And by the second week I was used to the English." Her talk, on the interaction of binary stars with massive black holes at the center of our galaxy, was the first time she had presented her work in English.

Still, the most important lessons from the school may be in the personal interactions among the students. As Jaco put it, "What has most amazed me has been to be able to meet so many people from different cultures, to make friends and possibly colleagues of all these different people."

And Juan agreed. "Science and friends can go together. In my home university there is basically only me and one other student working on these topics. It has been wonderful to find so many new friends here."

David added, "As the youngest, I have had to work very hard to keep up with the content of the lectures. But it has just made me even more enthusiastic about being an astronomer."

The faculty agree. "The Vatican Summer School has been an amazing opportunity to make an impact on tomorrow's leaders in astronomy by mentoring the next generation of thinkers," Dr. Trenti said. "I knew there would be a global and diverse atmosphere as the school, with participants representing different world cultures and backgrounds. But what has surprised me was not just to teach these students, but to live in such close contact with them, and pick up on how passionate they are about astronomy."

Since the first summer school was held in 1986, more than 350 students have taken part in this program. More than 85% continue today as professional astronomers, including some of the most notable figures in contemporary astronomy.

VOSS student Titania Virginiflosia greets His Holiness Pope Francis during a private papal audience with students, June 2014

His Holiness Pope Francis together with participants in VOSS 2014 in private audience in the Apostolic Palace at the Vatican June 2014

THE MCCARTHY-STOEGER SCHOLARSHIP

The Jesuit Community of the Vatican Observatory generously supports young astronomers through the McCarthy-Stoeger scholarship that covers the first 2 years of the PhD program at the University of Arizona.

The scholarship is named after Father Martin McCarthy S.J. and Father William Stoeger S.J., both outstanding members of our staff.Fr. McCarthy had a brillant idea of organizing the Summer Schools. This year the scholarship has been awarded to Juan Nicolás Garavito Camargo from Colombia, VOSS 2014 student, who will start the graduate program in Tucson in August 2015.

PLANETARY SCIENCES

Vesta is not an intact protoplanet: Nearly forty years ago, when CONSOLMAGNO was a young graduate student at the University of Arizona's Department of Planetary Sciences, his work with the late Michael Drake first proposed that asteroid Vesta was the parent body of the Howardite-Eucrite-Diogenite (HED) clan of basaltic meteorites. Now he is part of a team organized by Diego Turrini (INAF, Rome) through the International Space Science Institute of Bern, Switzerland, that has shown that while most HED meteorites probably were chipped off Vesta's surface, Vesta as we see it today could not have been the place where those meteorites were originally melted and crystallized.

All proposed models for the generation of the HEDs, starting with the CONSOLMAGNO and Drake work of 1977, show that these meteorites could only represent about ten percent of the bulk of their parent body, making a crust no more than 25 kilometers thick. However, Dawn revealed two overlapping deep impact craters on Vesta's south pole; current models calculate that these impacts must have excavated material from a depth of at least eighty kilometers, without exposing the bottom of that crust.

Furthermore, CONSOLMAGNO and his co-authors compared what Dawn revealed about Vesta's density and the large iron core against the known densities of HED meteorites and possible olivine-rich mantles (as measured in the Specola meteorite lab in Castel Gandolfo). These calculations also show that Vesta must have a thick HED crust; such a crust, with the large metal core seen by Dawn, leaves no room left inside Vesta for the amount of olivine needed to make the HED meteorites. It is impossible to reconcile a Vesta containing cosmic proportions of the major elements with anything even remotely approaching a mantle composition actually capable of making the HEDs.

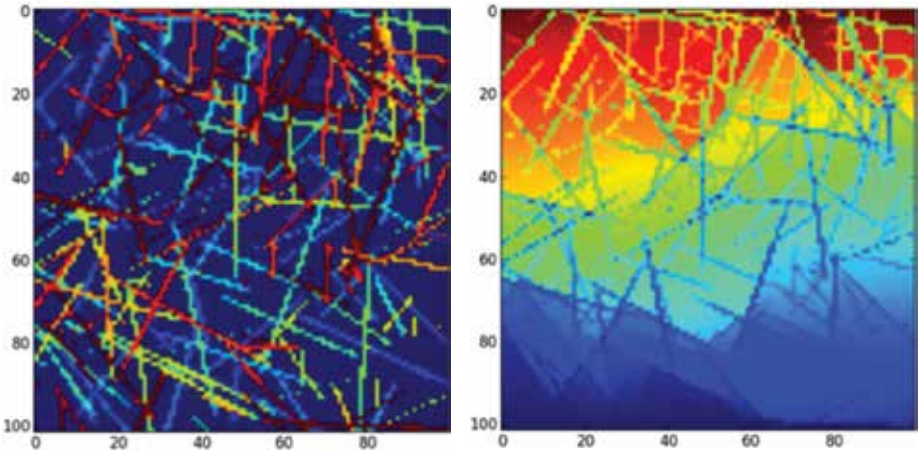
Thus they face a basic conundrum. Vesta is certainly covered with a great thickness of HED meteorite material. But the Vesta that Dawn saw could not have produced those HEDs. How is that possible? The Vesta we see today, CONSOLMAGNO and his colleagues argue, must be a reaccretion of material from now-destroyed protoplanetary parent bodies. The very early formation of the HED meteorites, concurrent with the formation and migration of Jupiter, means that the environment where they were forming would have been one of frequent and intense collisions among protoplanets.

Thus, while Vesta is not the intact protoplanet that the Dawn team hoped to explore, it nonetheless does provide the new and strong evidence that the Dawn team were looking for concerning the violent nature of the solar system at the time when the planets were first being formed.

Brother Robert J. MACKE S.J. and CONSOLMAGNO are continuing their study of meteorite physical properties using the Vatican meteorite collection in our facility at Castel Gandolfo. These properties include density, porosity, and heat capacity (Cp).

Heat capacity measurements of 12 HED meteorites (thought to be from Vesta, see above) predict the that the heat capacity of material on the surface of Vesta should be 500-520 J kg^{-1} K^{-1} at 175K. This value can be tested against infrared measurements of the heat radiated from Vesta's surface, thus putting limits on the structure of the surface material.
This research was presented at the 45th Lunar and Planetary Science Conference.

Furthermore, their study of heat capacity for more than 50 ordinary chondrites has revealed a correlation between heat capacity in the sample and quantity of the mineral olivine within these meteorites. Since olivine is a major element whose abundance is an indicator of meteorite type, these results suggest that their heat capacity measurement technique can be used to help classify bulk meteorites without relying on destructive chemical tests.



An example of one of the thermal conductivity simulations. At left is a map of the cracks in a 100^3-voxel cube of material. (Colors represent depth; red is closer to the viewer and blue is farther away) At right is the thermal profile of the material after coming to equilibrium. (Red is hotter and blue is cooler.) The top and bottom rows are held constant, with the top row one degree K higher than the bottom row. The presence and geometry of cracks clearly affects how heat flows through the material.

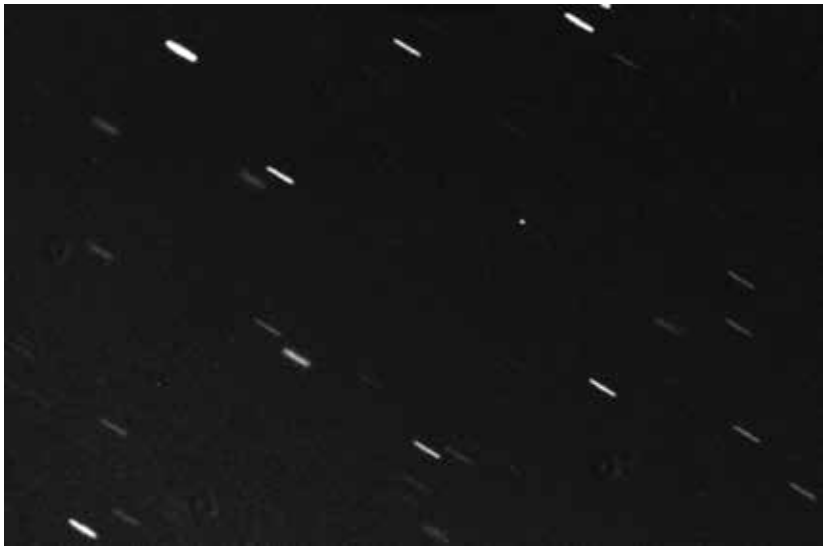
MACKE continues to study the density of lunar materials, including Apollo moon rocks, to better interpret lunar surface gravity data. He spent two weeks at NASA Johnson Space Center in October measuring more than 20 samples of moon rocks returned by the Apollo astronauts more than forty years ago

Given these measurements of thermal properties and physical porosity, can one begin to understand how the physical state of the meteorite predicts its thermal state? In order to address this question, MACKE has begun computer simulations of thermal conductivities (**K**) in porous materials. His work so far demonstrates how the geometry of pore space plays a significant role in controlling **K** and that a simple measurement of porosity alone may be insufficient for determining this factor.

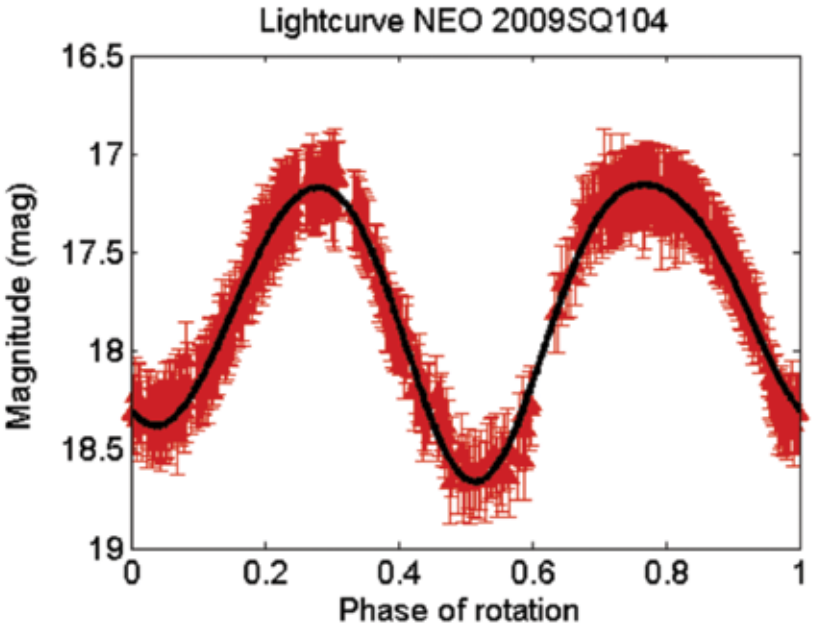
This research was presented at the 77th Annual Meteoritical Society Meeting.

Observing Near Earth Objects: NEOs can be studied not only dynamically, to learn about their impact hazard, but also physically, to establish various properties important both to better address their potential hazard and also to understand what they can tell us about the origin of the solar system and its ongoing processes.

Taking advantage of the two-meter-class telescopes around Tucson, Father John-Baptiste KIKWAYA S.J. and his team plan to observe NEOs synoptically using telescopes at three different locations: VATT (Vatican Advanced Technology Telescope) at Mount Graham (longitude: -109.8719, latitude: 32.7016, elevation: 10469 feet), Bok 2.3 m at Kitt Peak (longitude: -111.6004, latitude: 31.9629, elevation: 6795 feet) and Kuiper 1.5-m at Mount Bigelow (longitude: -110.7345, latitude: 32.4165, elevation: 8235 feet). All three telescopes will aim simultaneously at the same object, each with a different instrument.



NEO 2011SQ104 observed with VATT on April 17, 2013 at 07:02:05.935 UTC. The telescope is tracking the NEO and so nearby stars appear as streaks.

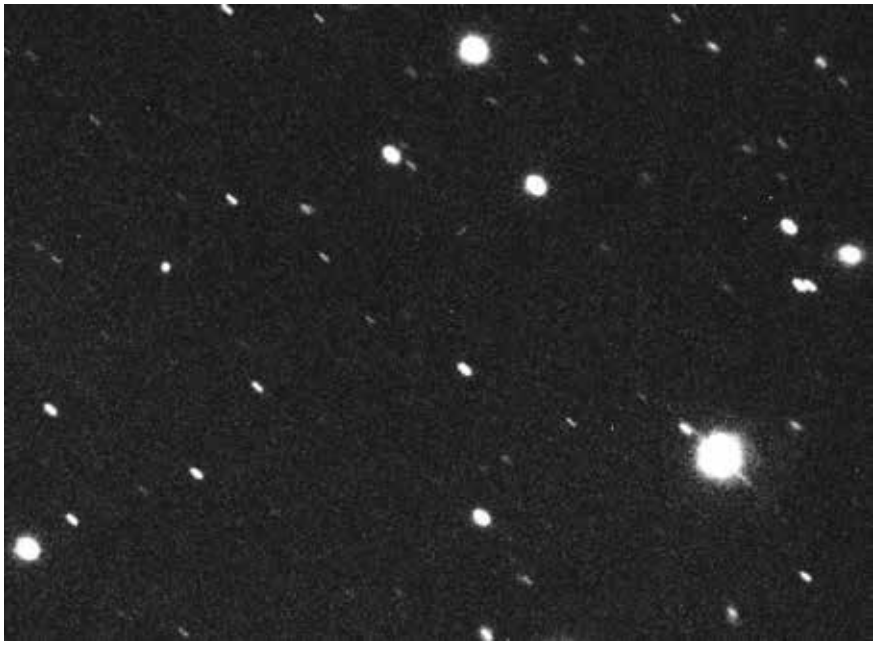


Lightcurve of NEO 2011SQ104 showing a spinning rate of 6.85+/- 0.03 h and an amplitude of about 1.5 mag. Data was collected from April 17, 2013 to April 21, 2013

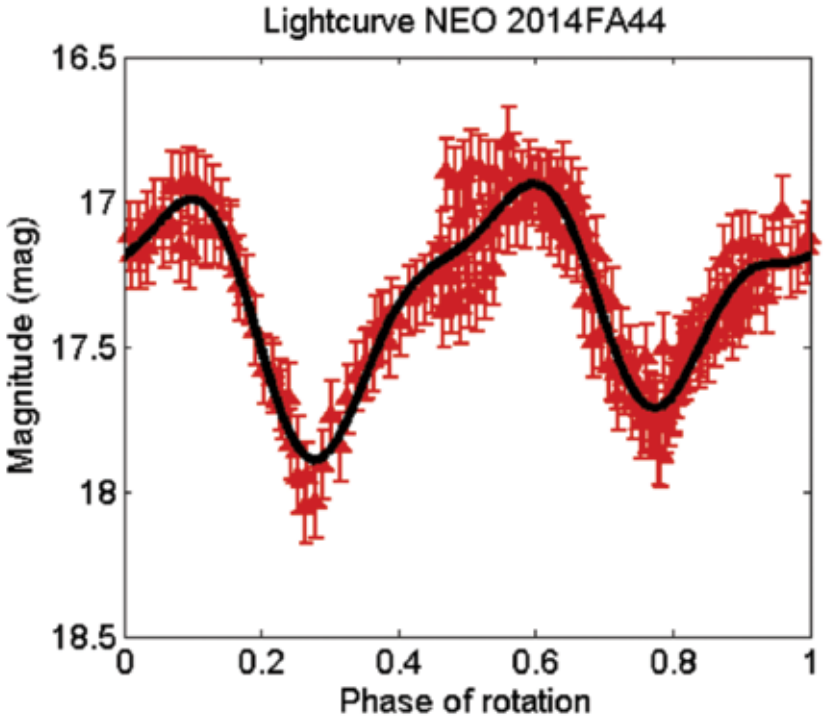
The three telescopes will be part of the Arizona Robotic Telescope (ART) network, a University of Arizona initiative to provide near real-time observations of Target of Opportunity objects across the visible and near-infrared wavelenghts. The VATT-4K optical imager mounted on the VATT has alread been used for photometry. In the future we plan to utilize the BCSpec (Boller & Chivens Spectrograph) for visible spectroscopy on the Bok 2.3 meter and a near-infrared instrument on the Kuiper 1.5 meter.

Using photometry with images recorded with VATT-4K, KIKWAYA and team have already determined the rotation rates and colors of several NEOs. 2009 SQ104 has a rotation rate of 6.85+/- 0.03 h (amplitude of 1.5 mag), 2014 AY28 has a rotation rate of 0.91 +/- 0.02 h (amplitude of 0.4 mag), 2014 EC of 0.54 +/-0.04 h 9 (amplitude of 0.5 mag), 2014 FA44 of 3.45 +/- 0.05 h (amplitude of 0.9 magnitude), 2014 KS40 of 1.11 +/- 0.06 h (amplitude of 1.3 magnitude), and 2014 SB145 of 0.77 +/- 0.03 h (amplitude of 0.3 magnitude).

These results were presented in November at the annual meeting of the Division for Planetary Sciences of the American Astronomical Society, in Tucson.



NEO 2014FA44 observed with VATT on May 2, 2014 at 04:46:34.773 UTC



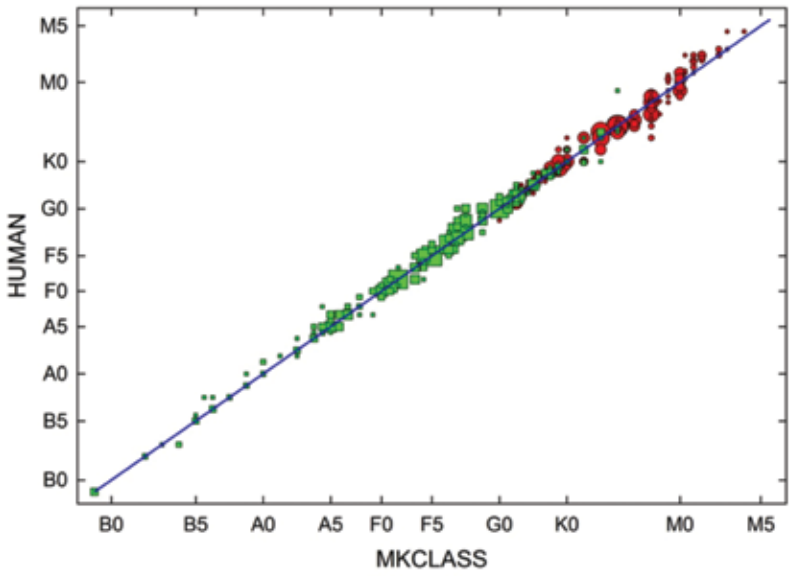
Lightcurve of NEO 2014FA44 showing a spinning rate of 3.45+/- 0.05 h and an amplitude of about 0.9 mag. Data was collected from May 2, 2014 to May 5, 2014

STELLAR ASTRONOMY

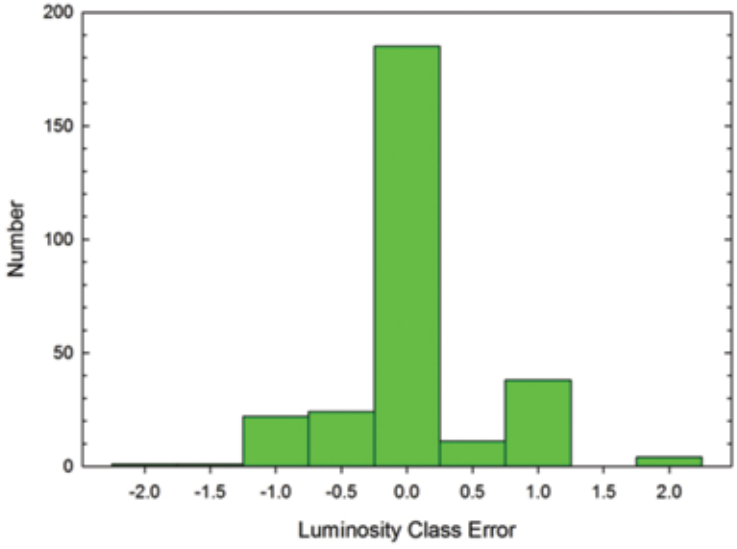
Ever since the 19th century, when Fr. Secchi first classified stars by their spectra from the roof of St. Ignatius Church in Rome, the spectral types of stars have played a critical role in many fields of astrophysics. They are useful in determining stars' physical parameters, ages, distances, and reddenings (i.e., the obscuration of the star by interstellar dust). Equally important, by giving descriptions of the stars in relation to each other, the spectral types identify peculiar and astrophysically interesting stars.

The traditional way of classifying spectra by the human eye has been challenged by the enormous number of spectra that modern telescopes and spectrographs can produce. To cope with all these data Richard Gray and Father Christopher CORBALLY S.J. have designed an expert computer program, MKCLASS. Its accuracy is similar to that when two expert human classifiers are compared, and it does even better for low signal-to-noise spectra. The secret of its success, demonstrated by the plots, is that it classifies spectra of stars on the "MK System" in a way similar to humans.

Gray, R.O., and CORBALLY, C.J. 2014, An Expert Computer Program for Classifying Stars on the MK Spectral Classification System, Astron.J., 147, 80-86.



MKCLASS temperature types plotted against those for the same set of stars classified by Gray et al. The surface temperatures of the stars range from the hottest on the left to the coolest on the right. The size of a given symbol is proportional to the number of spectral types represented by that symbol. The symbols closely follow the 1:1 ratio given by the line.



Histogram showing the difference between MKCLASS luminosity classes and those of Gray et al. A difference of 1 corresponds to that between, for instance, a dwarf star luminosity class and one of a subgiant.

Stellar Observations: Over a period of several months Father Robert JANUSZ S.J. assisted by Dr. Jolanta Koszteyn has analyzed all the known Stromvil filter images of stars and star clusters to create a unique database that can serve as a reference for analyzing these objects. Complicating this effort was the fact that the data attached to many of the images were not always complete enough to determine immediately the location and scale of the image. We have put this repository online, so that it is now very easy to locate the huge set of observed areas of the sky to find standard stars and apply extended observation techniques to these regions.

JANUSZ is also rewriting programs for an updated approach to observations made with the Stromvil data system. Currently we usually mix data from various runs to achieve a common set of data for calibration. To do this more efficiently, a new system is under construction, the "VOPR" (Vatican Observatory Photometry Runner). This system is already able to perform complex operations, such as frame preparation, plate solution, photometry (aperture and PSF) with flat-field correction learned from known objects M67/M29/etc., calibration, and star classification. It can run on any given set of classical 7-filter data or its extensions. It is also possible to use the VOPR for a tie-in method based on a reference object and applying a known color transformation for other, near-by objects. With the VOPR we now have methods to correct the zero-points of color transformation, so it is possible to make a better fit to the Vilnius spectral types stars. Beyond further corrections and developments to the program, future work is planned to port the program, which currently works with the Linux 32-bit system, to make it compatibile with Macs.

During a workshop in Castel Gandolfo in August, Father Richard BOYLE S.J. prepared and afterwards extended a test for the zero-point 'Chupina' experiment with the more traditional tie-in method. The result has been an improved understanding of this method of observing. For example, we learned that through zero-point correction some systematic errors in the classical form of tie-in data reduction can be corrected by having good Vilnius-type stars in a field.

Using a new approach, JANUSZ extended and finished the classical elaboration of Auriga sets. This preliminary data is currently being analyzed.

Subdwarf Stars: David BROWN has continued his research into "extreme horizontal branch stars."

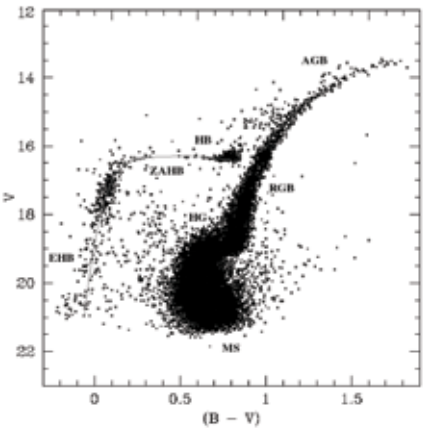
Stars like the Sun in our solar system will burn hydrogen fuel in their centers for about 10 billion years before swelling in size to become red giant stars. After a few million years, such stars will ignite the helium that accumulated from the previous hydrogen burning/fusion reactions. At that point, such stars will shrink in size and will continue to burn helium (He) for the next 10-20 million years as horizontal branch (HB) stars.

Occasionally, these HB stars will be stripped of their outer envelopes, leaving just the He core and a thin envelope of hydrogen surrounding the core. A star like this will have a mass of about half that of the Sun. Because of its location at the extreme end (blue, hot) of the Horizontal Branch sequence in a CMD diagram (see figure to the right), which details the temperatures and luminosities of stars in a given stellar grouping, such a star is called an extreme horizontal branch (EHB) star.

The EHB, or sdB, stars will have temperatures of about 25000 K, typically five times the surface temperature of the Sun. How such sdB stars lose most of their outer envelopes remains unknown, and this forms the type of research that BROWN is doing.

It is widely suspected that the outer envelopes of sdB/EHB stars are stripped off when two stars in a binary system (a double star system) interact, whereby one star transfers part of its mass (in what is called Roche Lobe Overflow) to the other at a point in its evolution when it is nearing the end of its red giant star stage of life and on the verge of becoming a horizontal branch star, just being able to ignite its helium core (center) after mass transfer.

In another binary scenario, two helium white dwarf stars in a binary could also spiral in toward one another and merge to become one star, which if it manages to ignite its He core, it then can become a sdB/EHB star. Exploration by BROWN of the formation of such sdB stars via binary mechanisms for different metallicities Z has sought to build on the momentous and important work of Han et al. (2002, 2003) done for solar metallicity Z=0.02.



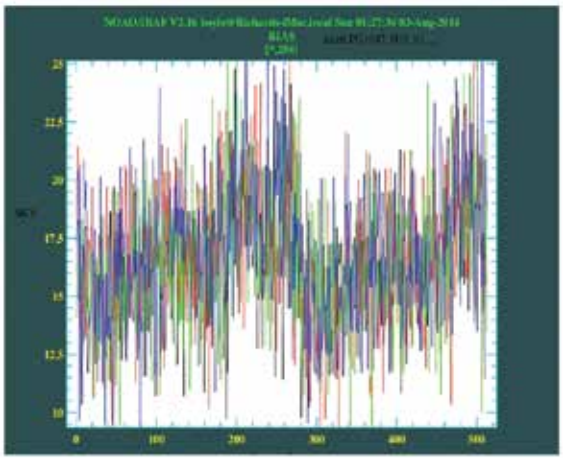
The CMD diagram of the globular cluster NGC 2808 shows the different stars of which the cluster is composed. Such a diagram provides a glimpse of the evolutionary stages of the stars in a cluster, including sdB/EHB stars at the end of the horizontal branch. Figure from Sosin et al. (1997).

There are three aspects in the above theoretical research in which BROWN is currently engaged. First of all, the computer program that has been used for the past few years, STAR95, continues to yield many results, but a new computer code, called MESA, which is also gaining currency in research astronomy, will allow continued research in this field of stellar evolution with different capacities. Such a code, like STAR95, is able to evolve single and binary star systems, yielding details of a star's properties (luminosity, temperature, gravity, etc.) throughout the course of stellar evolution.

Second, this year has seen the beginning of new research with regard to such sdB stars from the point of view of asteroseismology, a technique that is able to investigate stars that pulsate (change their luminosity periodically). To use a rough analogy, just as the study of different types of waves in earthquakes can yield much information in the field of seismology, so too can the study of a star's pulsations (vibrations) yield much information on the structure and properties of a star, including the stellar mass, which is needed to verify empirically the validity of theoretical predictions of the production of sdB stars via binary interactions, including their masses.

To this end, in February 2014, Richard BOYLE and BROWN conducted a 9-day observing run at the VATT 1.8-m f/1.0 reflecting telescope on Mt. Graham in order to study the pulsating sdB star PG 1047+003. They used the GUFI (Galway Ultra Fast Imager) CCD camera, which gives a readout time of only 2ms, to obtain extremely high time resolution images of the star. Since then, image data reduction has been taking place using Leon Harding's GUFI pipeline software.

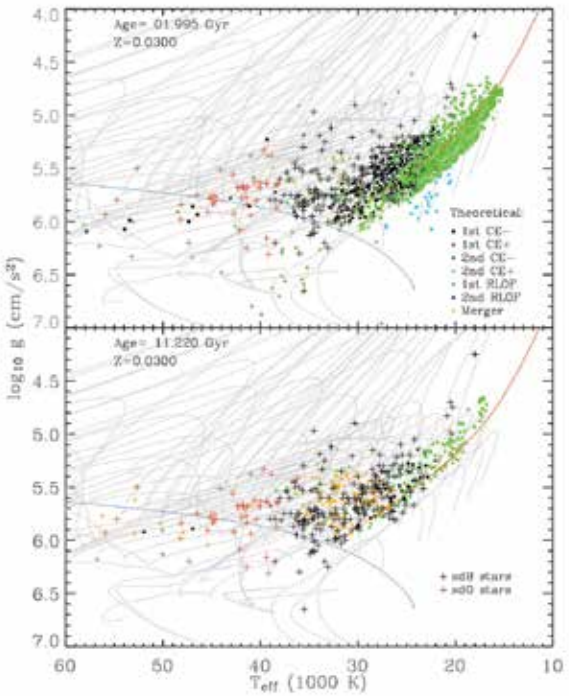
Much still needs to be done, but a preliminary light-curve showing how the luminosity of the star varies can be seen in the figure. Third, theoretical studies by BROWN (2014) using binary population synthesis techniques have provided clues as to how some sdB stars appear in parts of the $Log_{10}g$ vs. log_{10}Teff diagram (see figure below) below the ZAHeMS (the blue line) at temperatures 30000-40000 K, for which canonical theories cannot account. BROWN's simulations for high metallicity Z=0.03 indicate that such stars are produced via binary interactions yielding sdB stellar masses of 0.30-0.40 M, stars whose progenitors are thought to be intermediate-mass stars of about mass 2.0 My.



A very preliminary light curve of the pulsations of the sdB star PG1047+003

This work appeared in proceedings of the 6th ASPC Conference on Hot Subdwarf Stars and Related Objects.

This seems to be a confirmation of the work of Hu et al. (2008), who through their asteroseismological studies of the pulsation modes of sdB stars are able to discern either low-mass or intermediate mass progenitors.



$log_{10}g$ vs. log_{10}Teff diagram which shows the location of sdB stars below the ZAHeMS (the blue line) in the range of 30000–40000K, as given by the Brown simulations

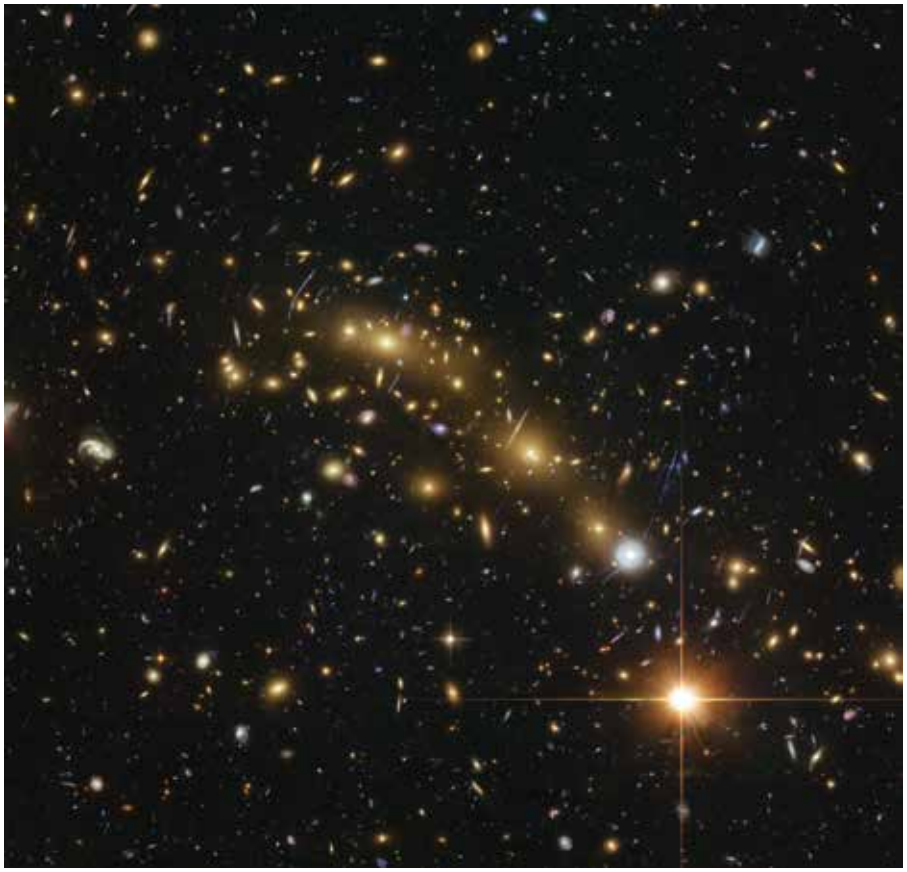
Some galaxies while moving through the galaxy cluster to which they belong, lose a fraction of their components, especially gas and dust. So they appear as "jellyfish" and that is why they are called "jellyfish galaxies" (up NGC4522 galaxy, down ESO 137-01 galaxy).

GALAXIES

Father Alessandro OMIZZOLO is working with a research group on the nearby clusters of galaxies. The team are further analyzing their sample of 76 X-ray selected clusters. After the publication of the catalogs of the galaxies of every cluster, OMIZZOLO and his team are now studying the properties of the galaxies and of the cluster, with particular focus on the star formation rate, the interaction of the galaxies within the cluster, the surface photometry of the galaxies, the spectral properties and
evolution of the galaxies in the clusters. To accomplish this goal OMIZZOLO and his team have also developed a specially dedicated sotware, GASPHOT, which is able to provide, in a single shot, the relevant photometric (total magnitude and effective surface brightness) and structural (effective radius, Sersic index, ellipticity) parameters for the several hundred galaxies typically involved in our wide field cluster images. They have also begun to study a particular class of galaxies, the so called Jellyfish galaxies (fig. 1). These are galaxies that are undergoing changes due to various phenomena in their gaseous interstellar regions, and as a result of their losing a number of their stars. Members of the team are investigating this kind of galaxy and will producing a catalogue of these galaxies in the clusters of their sample (WINGS and Omega-Wings).

COSMOLOGY

T-Duality invariance: Father Gabriele GIONTI S.J. continues his research in Quantum Gravity. Quantum Gravity is a branch of Cosmology which aims to study the behavior of the gravitational force in the very early moments of the beginning of our Universe (below the Planck time ~10^{-44}s). There exist two main approaches to Quantum Gravity, which are Loop Quantum Gravity and String Theory. Loop Quantum Gravity is based on the assumption that the quantum mechanical (=the physics at



The study of the formation and evolution of the universe is both theoretical and observational, the observations being useful to verify the theoretical hypothesis done by the cosmologists. Of particular utility is to observe the galaxy clusters where the effects of the "dark matter" are clearly visible in the form of gravitational lenses (Cluster MCS J0416.1-2403)

atomic and subatomic scales) behavior of the gravitational force can be achieved studying gravity as separate from the other fundamental interactions. String Theory presupposes that the quantum behavior of the gravitational field achieves the unification of all the fundamental forces. This is achieved by introducing a fundamental object, the String, whose quantum mechanical vibrations produces the fundamental particles known in nature.

In the String Theory context, GIONTI and his team have studied the problem of finding a theory which exhibits a T-Duality invariance. This symmetry, which was already known at the level of solutions, says the "compactified" (closed) string with a radius "R" is dual (meaning that another string also exists as solution) to that of the radius "1/R". After three long years of research with his team (De Angelis, Phys. Dep. Naples Univ.; Marotta and Pezzella INFN Naples section), GIONTI succeeded in finding a theory of strings, which is manifestly T-Dual invariant. This was achieved by doubling the number of variables, obtaining a Double String Theory. This, in turn, could shed light on the puzzling question of Dark Matter.

INTER DISCIPLINARY STUDIES

Concepts of the Infinite: in collaboration with Alfredo Sgroi, GIONTI worked on a paper published in the Italian Jesuit magazine Civiltà Cattolica on the historical development of the concept of the infinite. In this paper, they determined that the infinite had a negative connotation in the Greek world and that it was only during the Christian Era that the word began to have a positive significance. In particular Niccolò Cusano was the first scholar to think that the Universe could be Infinite. Later the concept of infinite in Kant is discussed, highlighting that Kant had shown that this concept may cause contradictions in the way it has been usually thought. The final part of the paper compares and contrasts the concept of infinite in Kant and in the 19th century German mathematician Georg Cantor, the inventor of set theory whose work laid the foundation for modern chaos theory.

A Cosmic End: Attracted by curiosity about the end of the universe, FUNES presented a paper on "A Cosmic End: from the Earth to the Universe" to this year's Plenary Session of the Pontifical Academy. In the paper he argued that while the scientific method is not the only approach to answering the age-old questions of existence, it certainly is an important one. Quoting T.S. Elliot's "In my beginning is my end", he argued that the end of the Universe is somehow written in its initial conditions.

We can only think of the past and the future of the Universe based on its present and from the data we have collected and interpreted. We have quite a good picture of the early universe. Though there are many unknowns we still have a very good comprehension of the formation and evolution of galaxies, stars and planets. It is a bit uncertain to scientifically predict the future. Our predictions will depend on the different time and space scales that we consider. Thus we can consider the end of Earth, of the Sun, of our Galaxy and of the whole Universe.
In the very distant future the universe

eventually will be shredded. The universe is going toward a final state of cold and darkness, thermal death, which says that the universe will go toward a state of maximum entropy. This long-term scenario is obviously hostile to life.
This perspective poses many questions. If our location in the universe is crucial for life, will all life end with Earth? Is life a common phenomenon? What will happen with life in trillions and trillions of years when the universe fades? If there are other universes will life survive in those places?
What is the Christian perspective on the end of the Universe? What can we say about the *Last Day*. As Joseph Ratzinger says in *Introduction to Christianity*, "Christian realism goes beyond the physical, as realism of the Holy Spirit".

HISTORY and PHILOSOPHY

Emotional Brains: As an extension of The Human Sentience Project (*http://thehumansentienceproject.org*), Margaret Boone Rappaport and CORBALLY have been investigating what they call "The Emotional Brain Hypothesis", or how emotional, social, and religious vetting have evolved to be important in rational decision making and scientific modeling.
They returned to the theme of the emergence of sentience among early members of the genus Homo, as a way to evaluate Big History Threshold 6 – the rise of Homo sapiens and "collective learning." They focused on *Homo sapiens idaltu*, who lived some 160,000 years ago in East Africa, and tried to pinpoint – as closely as the latest archaeological evidence allows – when and where the development of "collective learning" took place on Earth. They also revisited their theme of the origins of religious thought as an aspect of the development of sentience. Far more people than they expected are interested in religion's place in Big History, a view of history that incorporates astronomy, bioastronomy, anthropology, and many other disciplines.

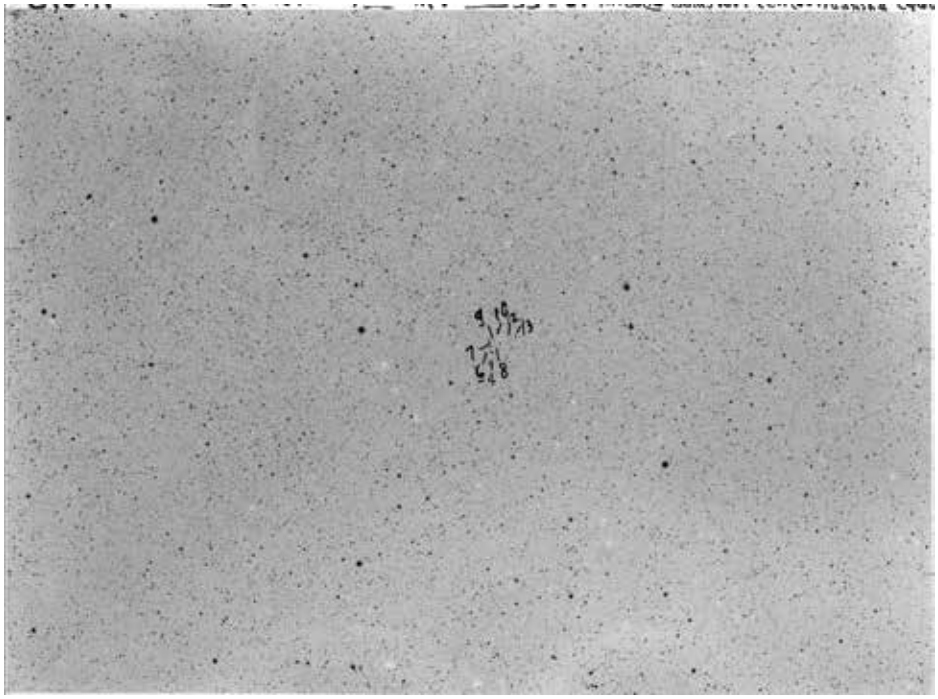
Chris Corbally and Margaret Boone Rappaport, in Costume for "The Appearance of a Guest Star in A.D. 1054" a Skit on the Sighting of the Supernova Creating the Crab Nebula.

Cross-talk: Fr. MUELLER is continuing his research in the area of history and philosophy of science, especially the history and philosophy of physics in the early modern period. Recently he is grappling with work done by other scholars concerning previously unsuspected "cross-talk", at the level of methodology, between Renaissance philology and early modern science. Fr. MUELLER hopes to elucidate some philosophical consequences of that "cross-talk", concerning the interplay of the universal and the particular in both science and theology. From this he hopes to tease out some interesting implications for the faith-science dialogue.

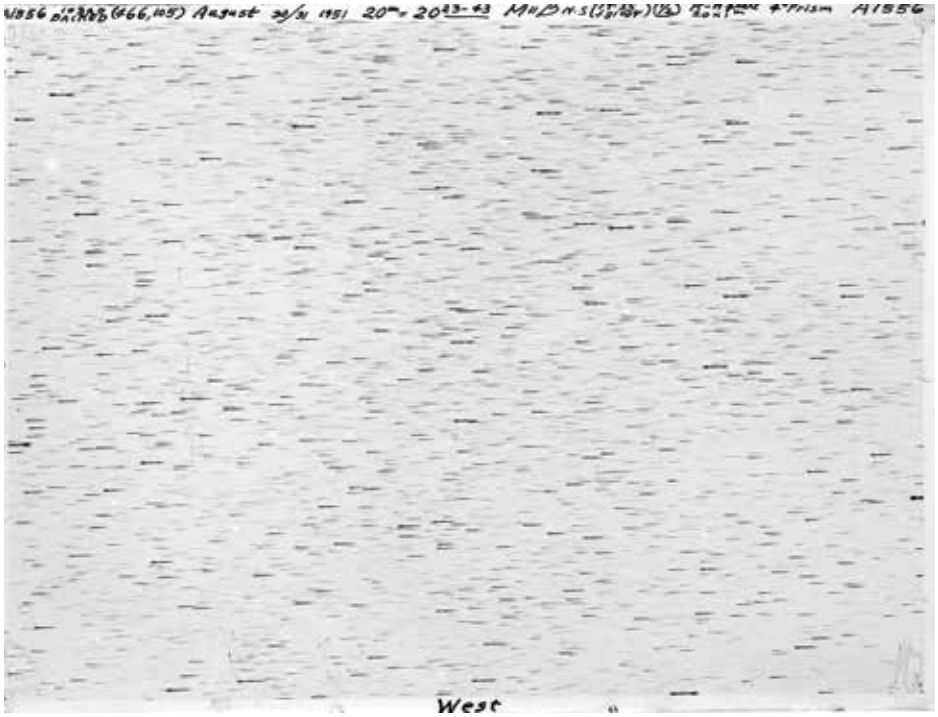
Secchi and his instruments: In the field of History of Astronomy, CHINNICI's main research topic has been the figure of the Jesuit astronomer Angelo Secchi (1818-1878) and his contribution to the development of astrophysics. After the publication of his correspondence with the astronomer Pietro Tacchini (1838-1905) Ileana CHINNICI is pursuing further investigations on his archival fund kept at the Gregorian University and which are largely unexplored. She is particularly focusing on Secchi's spectroscopic instruments and his interactions with instrument-makers of his time. CHINNICI has also signed a contract with Brill to publish a scientific biography of Angelo Secchi S.J. in the series "Jesuit Studies".

The Double Astrograph Telescope, at Castel Gandolfo

The digitization of the plates of VO archive: This long term work is on-going. Now that the plates of the Carte du Ciel have been scanned successfully, OMIZZOLO is digitizing those of the Double Astrograph). Over a period of 40 years, from the 1930's through the 1970's, this telescope was used not only for astrophotography but also for spectroscopy of all the objects in the instrument's field (similar to a Schmidt Telescope); thus one often can get a photographic image (see right, above) and spectra (see right, below) of all the objects in the same field. Obviously the spectra are not high



An example of a photographic plate taken by the Double Astrograph



An example of a spectra taken by the Double Astrograph

resolution spectra, but they are useful for a first study of the objects in the photographic plate.

Keeping track of it all: Father Sabino MAFFEO S.J. has been pushing ahead with the painstaking task of updating and indexing the Vatican Observatory Archives. These include: An archive of correspondence, newspaper articles and documents relating to the VO from 1864 to date; an archive of correspondence relating to the VO's participation in the Carte du Ciel and Astrographic Catalogue between 1887 and 2012; an archive of the work and correspondence of former VO director Father Patrick Treanor and the young Jesuit Christopher Corbally; an archive specially dedicated to documents by or relating to Father Secchi; an archive dedicated to the theme of Science and Faith, with reference to the work of Jesuits in this field. Finally MAFFEO has also set up a photo archive that visually documents the changing faces and instruments of the VO down through the centuries and has plans to catalogue and archive the priceless and antique astronomical instruments currently in the VO's possession.

F. Sabino Maffeo, S.J.

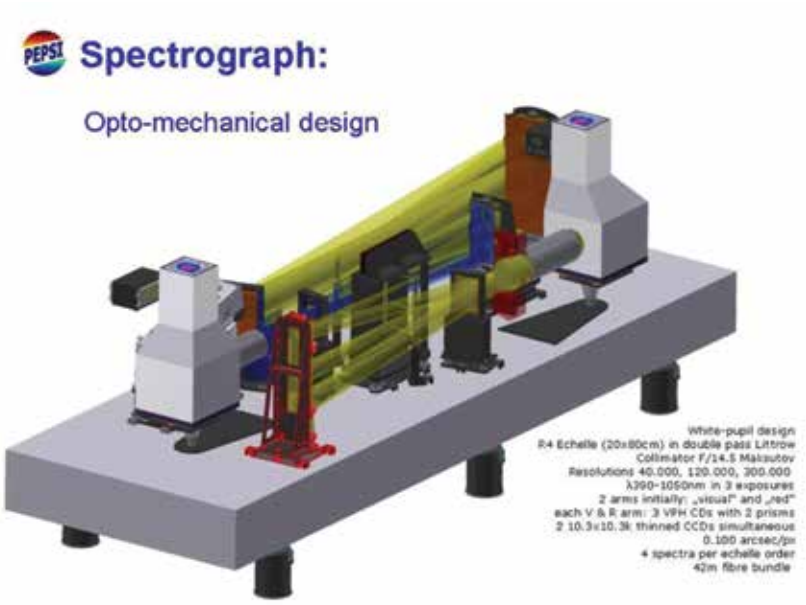
Instrumentation & Technical Services

PERSONNEL
As of July 1, thanks to an "Agreement concerning the Radial Velocity Project with PEPSI and VATT" with the *Leibniz-Institut fuer Astrophysik* Potsdam, Germany, we were able to welcome Michael Franz on a full-time basis as a mechanical engineer. Michael also continues to support remote observing runs.

MAINTENANCE
A major corrective maintenance operation was the replacement of the uMAC temperature-sensor controller. It was originally envisaged in the context of VATT's automation and scheduled for 2015. The failure of the old system advanced our plans. More details below.

On September 25, GRAY cleaned VATT's primary mirror.

INSTRUMENTATION AND NEW EQUIPMENT
In collaboration with Ed Tedesco, Planetary Science Institute, four new ECAS filters (v, w, x, and p) are available at VATT. Filter holders were made, the filters were fitted and tested.



PEPSI
In collaboration with the Astrophysics Institute in Potsdam (see above), three 405-meter long optical fibers connect VATT to the PEPSI chamber in the LBT building. A dedicated *Fiber Injection Unit* was tested at VATT, allowing light to flow from VATT to the *Potsdam Echelle Polarimetric and Spectroscopic Instrument* (PEPSI). The first tests, performed during the assembly of PEPSI in September, were very successful, with a spectral resolution of 190,000.

The PEPSI spectrograph being reassembled in its enclosure where it will be kept in a stable atmosphere at a constant temperature with variations less than one thousandth of a degree (Credit: M. Steinmetz).

VATT Upgrades
On March 8 in answer to a proposal prepared with Steward Observatory, and submitted in August 2013, the Vatican Observatory received a very generous gift from the Papal Foundation for an overhaul of VATT. This major operation is part of a larger plan for developing a network of advanced telescopes in Arizona, the Arizona Robotic Telescope Network (ARTN). Many new possibilities will open for competitive science at VATT both as a stand-alone telescope and as part of ARTN. The whole ARTN project is carried out by the University of Arizona Steward Observatory's Mountain Operations group.

VATT's robotization employs the distributed processing approach, where each subsystem will be run by its own *Local Control Unit* (LCU), granting it a level of autonomy, and making the system as a whole more robust. The LCUs are single-board microcontrollers based on the Arduino concept. Two prototypes of the LCU were built and underwent laboratory testing. One was subsequently im-

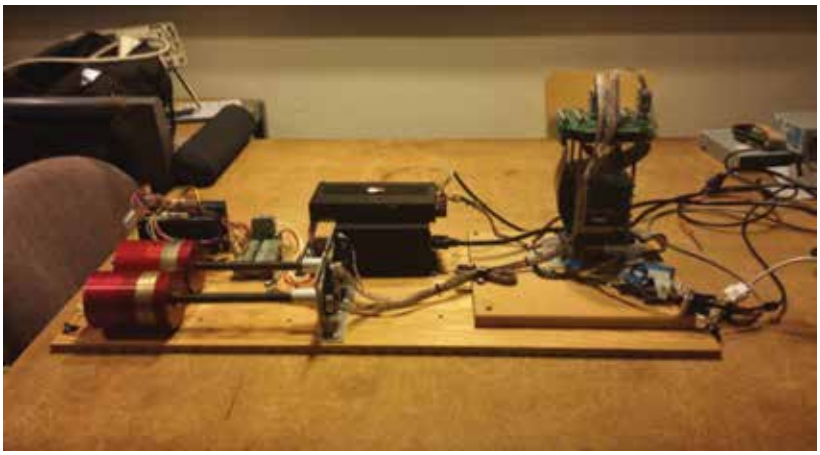
plemented at VATT where it successfully controls the thermal system. The other is a swappable spare. Satisfactory operation parameters were achieved (controlling primary mirror temperature to a level smaller than 0.1 K).

Fiber Injection Unit for supplying PEPSI at VATT

The motion of the telescope in the altitude, azimuthal and field derotator axes is ensured by applying appropriate current to the motors at appropriate times. VATT's robotic upgrade does not concern the existing motors. The drive amplifiers, however, will be replaced. The specifications of the required drive amplifiers, i.e., units generating the current, were calculated and commercially available units were identified. A power supply for the drive amplifiers was designed.

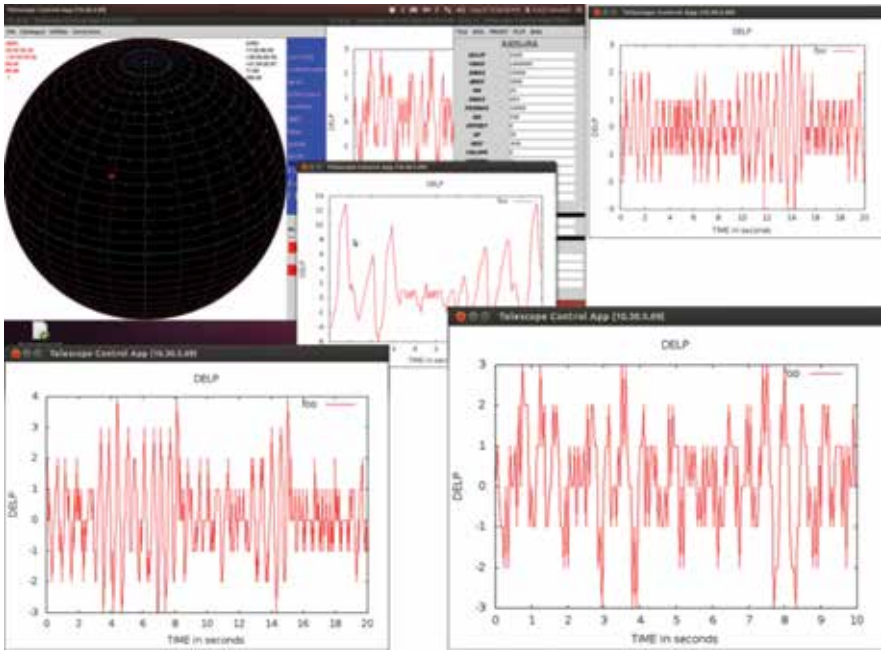
The Next Generation Telescope Control System (NGTCS) is a software, developed at Steward Observatory, allowing telescope pointing and tracking, essentially translating the assignment to observe a given object into instructions to the telescope hardware (drive amplifiers and motors running the three telescope axes), as well as many other features. The Steward Observatory is gradually implementing the NGTCS on all of its telescopes (with the exception of the largest ones).
The routines for Direct Current drivers were written and tested, including laboratory tests on a pre-existing breadboard, and subsequent on-sky tests on the 61" Kuiper Telescope on Mt Bigelow. The NGTCS software will run on a dedicated computer unit, including the drives. A laboratory setup (breadboard) comprising the NGTCS computer unit and appropriate drives, was built and tested. Furthermore, the two-tier servomechanical system between the NGTCS and drive amplifiers was tuned in the laboratory. The system was used to run the declination axis of the Kuiper 61-inch Telescope on Mt Bigelow. Satisfactory operation parameters were achieved, with a tracking error of 0.27 arcsec peak-to-peak at sidereal tracking rate.
The position of the telescope's altitude and azimuthal axes is identified using absolute encoders. Required specifications were established and commercially available units were procured.

The overall goal of autonomous telescope operation requires software to perform dynamical observation scheduling as well as conduct the actual observations, data acquisition and initial processing. Two levels of software will be developed, implemented and commissioned: (1) The lower-level software which will interface with the telescope and facility subsystems, as well as with the filter wheel, the guider and science cameras, etc., and (2) the high-level software which will run



NGTCS Unit breadboard

the telescope network. The former (1) will be RTS2 and the latter (2) requires further research, with RTS2 being a possibility. The RTS2 (www.rts2.org) is an open source software package. Some development is required and some drivers will be written as a prerequisite of its implementation at VATT and ARTN. Further, research will be conducted into the choice of the high-level software (2). Consequently, this software will be tailored to the science cases selected for ARTN. It will be implemented and commissioned.
A version of RTS2 lower-level and high-level software (device drivers and scheduler) was implemented at the Steward Observatory's 21-inch Raymond E. White Telescope on the University of Arizona campus. As a part of the testing process, several nights' observing was conducted by the telescope fully autonomously.



NGTCS drive unit was used to run the declination axis of the Kuiper 61-inch Telescope on Mt Bigelow

Three Antique Clocks
On November 20, 2013, Thomas Rébenyi, the Master watchmaker at the Deutsches Museum Watch Restoration Laboratory and Prof. Frank Wernel, came to the VO Headquarters to dismantle and three antique clocks that had fallen into disuse. They transported the precious artifacts to Munich's Deutsches Museum. Two of these clocks were made by the Carl Theodor Wagner workshop in Wiesbaden. The third – which bears the production number 539 – was made by Clemens Riefler in Nesselwang und Munchen. In July 2014, having completed the restoration of the clocks, Mr. Thomas Rébenyi and Prof. Frank Wernel, returned them to the VO headquarters in Castel Gandolfo where they have been relocated in perfect working condition.

Thomas Rébenyi, Master watchmaker at the Deutsches Museum Watch Restoration Laboratory and Prof. Frank Wernel with the three antique clocks they restored for the VO.

VATT's Dome in motion

Observatory and staff activities

Appointments
Since September 1, Brother Guy CONSOLMAGNO is the new President of the Vatican Observatory Foundation (VOF). He was elected to the office on February 21 by the board of directors. Br. CONSOLMAGNO will continue with his research and outreach activities.

After three years in the office of President of the Vatican Observatory Foundation, Father Albert DIULIO S.J. has received a new mission from his Jesuit Superior of the Wisconsin Province (USA). We are very grateful to Fr. DIULIO for his professional contribution to the VOF and through it to the Observatory. We wish him well in his new mission.

Fr. Albert Diulio, S.J.

Brother Thomas WILLIAMS S.J., from the Jesuit Province of Maryland (USA), has been assigned to the VORG in Tucson. He is assistant to the President of the VOF and in charge of the daily management of the Observatory residence in Tucson.

Father Richard D'SOUZA S.J., from the Jesuit province of Goa (India), has been assigned to the Jesuit community of the Vatican Observatory. He is completing his doctorate in Astrophysics at the Max Planck Institute for Astrophysics in Garching, Germany.

As of August 1, MACKE is the curator of the meteorite collection in Castel Gandolfo.

GIONTI has been appointed Associated Research Member of the National Laboratories of Frascati, Theory Division, of the Italian National Institute for Nuclear Physics.

Awards
This year CONSOLMAGNO was honored with the Carl Sagan Medal for Public Outreach in Planetary Sciences by the American Astronomical Society Division for Planetary Sciences at their annual meeting. He is the first religious in the history of the award to receive the honor. AAS chose Br. CONSOLMAGNO because he "occupies a unique position within our profession as a credible spokesperson for scientific honesty within the context of religious belief." The award is named after the late astronomer Carl Sagan, who was a popular author and writer of the 1980 television series "Cosmos."

On October 22, GRAY was awarded the Safety Star Performer award by Steward Observatory for his outstanding commitment and contribution to the safety of persons and equipment. This achievement is all the more significant because GRAY is the very first recipient of the newly created distinction.

Father Michael HELLER received a series of awards and distinctions for his contribution to science this year. On January 28, the Catholic University of Lublin awarded HELLER with the Gratae Memoriae Distinction. On May 3, he was awarded the Order of the White Eagle. On June 8, he was presented with the Ecce Homo Order and finally on June 17, he was honoured with a Doctorate Honoris Causa, by the University of Life Sciences in Lublin.

Asteroid 23443 KIKWAYA
Asteroid (23443) KIKWAYA = 1986 TG1 discovered 1986 Oct. 4 by E. Bowell at the Anderson Mesa Station of the Lowell Observatory has been named after Father Jean-Baptiste KIKWAYA, a native of the Democratic Republic of Congo. Using optical meteor measurements, he estimates the bulk densities of smaller meteoroids through numerical ablation models.

Fr. Jean-Baptiste Kikwaya, S.J.

In Memoriam
We are deeply saddened to report the death of Father William R. STOEGER, S.J.. He was called home to the Lord on March 24 at the Sacred Heart Jesuit Center in Los Gatos, California, where he was being treated for an aggressive form of cancer.

Fr. STOEGER was a staff scientist for the Vatican Observatory Research Group in Tucson, specializing in theoretical cosmology, high-energy astrophysics, and interdisciplinary studies relating to science, philosophy and theology. He was born in 1943 in Torrance, California and grew up in Redondo Beach, California. He entered the Society of Jesus in September 1961, and in 1967 completed his bachelor's degree with honors in philosophy from Spring Hill College,

Fr. William Stoeger, S.J.

Mobile, Alabama. In 1969 he was awarded an M.S. in physics from UCLA. After lecturing briefly in the physics department at the University of San Francisco, he began theological studies at the Jesuit School of Theology in Berkeley, California where he finished an S.T.M. and was ordained to the priesthood in 1972. Afterwards he pursued doctoral studies in astrophysics at Cambridge University, U.K., and completed his PhD in 1976. From 1976 - 1979 he was a research associate with the theoretical gravitational physics group at the University of Maryland, College Park, Maryland. He joined the staff of the Vatican Observatory in September 1979. Fr. STOEGER's research has dealt with various problems connected with the physics of accretion onto black holes, and mathematical and physical issues connected with torsion and bi-metric theories of gravity, as well as the harmonic map structures contained in gravitational theories, including general relativity. More recently, he had concentrated on observationally oriented projects in theoretical cosmology, attempting to build more adequate bridges between theory and cosmologically relevant astronomical observations. He also continued to pursue some research on the physics of the central engine in active galactic nuclei and quasars. Besides his research and writing in cosmology and astrophysics, Bill was very active in lecturing and teaching at the University of Arizona, at the University of San Francisco, and at Vatican Observatory Summer Schools. He was a member of the American Physical Society, the American Astronomical Society, and the Society for General Relativity and Gravitation. He was on the Board of the Center for Theology and the Natural Sciences (CTNS), Secretary of the Vatican Observatory Foundation, and co-editor of the series "Philosophy in Science." He also was an active participant in the Vatican/CTNS workshops on "God's Action in the World: Scientific Perspectives on Divine Action" and in the Science-Theology Consultation of the Center of Theological Inquiry, Princeton.

Fr. STOEGER also exercised his priestly ministry in the Diocese of Tucson helping out in parishes. He was a very fine spiritual director and gave retreats around the US.

We have received many condolence messages from his colleagues and friends that show how much he was appreciated for his deep spirituality and profound knowledge.

VO Conferences

The Vatican Observatory and the University of Arizona co-hosted a conference on "The Search for Life beyond the Solar System. Exoplanets, Biosignatures & Instruments" from March 16-21 in Tucson, Arizona. The conference was the result of the continued and fruitful collaboration between the University of Arizona and the VO, and was arguably the major event of the year in the field. Over 200 scientists attended sharing their research and expertise on exoplanet observations, early and extreme life on Earth, atmospheric biosignatures, and planet-finding telescopes.

As noted in an article published June 13, 2014 in L'Osservatore Romano on the conference : "One of the main debates in astrobiology is the sequence of steps which would allow us to learn more about life beyond the Solar System… The conference served the crucial purpose of bringing people together to discuss how best to proceed. And thanks to the conference, a consensus is closer now than it was before".

While the conference was not open

Participants at the VO/UA conference "The Search for Life beyond the Solar System. Exoplanets, Biosignatures & Instruments", held in March in Tucson, Arizona.

to the public, NASA's Astrobiology Institute broadcast a live feed of the entire conference, which remains available online at the following address: *https://astrobiology.nasa.gov/seminars/featured-seminar-channels/conferences-and-workshops/2014/3/16/search-for-life-beyond-the-solar-system-conference/*

On March 31, the Vatican Observatory and the Pontifical Gregorian University organized the second part of the seminar on the beginning and end of the universe from the point of view of science, philosophy and theology. Since the question of the end of the cosmos does not exclude, but rather, encourages us to move beyond the horizons of science, it was an good initiative for the educational community of the Gregorian University and the general public to discuss and reflect upon these issues.

Organized by CONSOLMAGNO the Observatory hosted a meeting of IAU Working Group on Planetary Surface Nomenclature, April 7-9.

Staff Presentations, Academic Activities, and Conference Participation
BOYLE was first author on one and co-author on a second poster paper at the 223rd Meeting of the American Astronomical Society, Washington, DC, January 5-9

BROWN attended the Library and Information Services in Astronomy (LISA VII), held at INAF - Astronomical Observatory of Capodimonte, June 17-20, 2014, Naples, Italy • the European Week of Astronomy and Space Science (EWASS 2014) June 30–July 4, 2014, Geneva, Switzerland

CARUANA gave a postgraduate lecture and seminar on 'The Scientific Mentality and Public Health Ethics' at Heythrop College, University of London, February 12 • gave a lecture on 'The End and Aim of the Universe' at the Gregorian University, Rome, March, 31 • gave a response to Guy CONSOLMAGNO's lecture on 'Jesuits and Science', at Senate House, University of London on the occasion of the 400th anniversary of Heythrop College, University of London June 19.

CHINNICI gave an invited talk on "History of Astronomy in Sicily" at the XIX Seminario di Gnomonica Cefalù, Palermo, April 4-6 • gave an invited talk on the relationship between Pietro Tacchini and Giuseppe Lorenzoni, Meeting for the commemoration of the centenary of the death of the astronomer Giuseppe Lorenzoni, Padova, July 7-8 • together with author Paolo Brenni (CNR & Fondazione Scienza e Tecnica, Firenze) gave a talk on the Palermo & Rome Merz telescopes at the Scientific Instrument Symposium 2014, Tartu (Estonia), August 20-25 • gave an invited talk on the material heritage of Palermo Observatory at a Conference on "Le collezioni scientifiche nell'area palermitana" Palermo, October 23-24.

Dr. Ileana Chinnici

CONSOLMAGNO presented the Bannan Lecture at the Bannan Institute of the Ignatian Center for Jesuit Education, Santa Clara University, titled "Why Science Needs God" February 11 • delivered the Commencement Address for the Georgetown University College of Arts and Sciences May 17 • presented a paper on "Jesuits and Science" at a two day colloquium held in honor of the 400th anniversary of Heythrop College, London, June 19 • presented a luncheon talk to The Assembly of Catholic Professionals, Brisbane Australia October 16 • presented the lecture "Astronomical Ideas That Were Almost Correct" the American Astronomical Society Division for Planetary Sciences at their annual meeting at Centennial Hall, University of Arizona • presented two papers in Helsinki, Finland: Asteroids Comets Meteors June 30 - July 4 • presented a paper Tucson, Arizona: DPS Annual Meeting, November 9 – 14.

CORBALLY co-authored a paper with Margaret Boone Rappaport at the 15th European Conference on Science and Theology, in Assisi, Italy, April 30 - May 4 • was first author on one poster paper and co-authored two others at the18th Cambridge Workshop on Cool Stars, Stellar Systems, and the Sun, at Flagstaff, Arizona, June 8-13 • gave an invited paper and joined a panel at the Clavius Group Symposium "God's Action in the World" at the University of Notre Dame, Indiana, on July 16 and 17. The Symposium honored the memory of Father William STOEGER • presented a paper with Margaret Boone Rappaport during the 2014 International Big History Association (IBHA) Conference, at Dominican University of California, San Rafael, California, August 6-10 • completed with Margaret Boone Rappaport the draft of an educational book on Space Science and Astronomy, North Fork, Virginia, from August 11-September 13.

FUNES gave keynote addresses on the scientific work of the Society of Jesus at the Jnana-Deepa Vidyapeeth Centre for Science-Religion Studies 2- 6 February in Pune, and at the Institute of Philosophy and Religion 7-11 February in Kochi, Kerala, India • participated at the 57th Meeting of the Argentine

Association of Astronomy in Córdoba, Argentina (15-19 September) and gave a public lecture on the beginning and the end of the universe • participated in the Plenary session of the Pontifical Academy of Sciences giving the paper "A Cosmic End: from the Earth to the Universe", October 24-28 • participated in the presentation at the Pontifical Gregorian University of the book by Ileana Chinnici and Antonella Gasperini on the correspondence between Fr Angelo Secchi and Pietro Tacchini at the origins of the Italian Astronomy • gave talks on Science and Faith to the students of Engineering and Physicians of the Universidad Católica de Córdoba.

GABOR gave a talk on the Vatican Observatory at a meeting entitled Seven Years in Chile: The Accomplishments and Goals of Czech Astronomers in ESO, Prague, April 14-16 • gave two lectures at Civitas Academia 2014, an annual retreat of the Philosophical Faculty of the Catholic University of Slovakia, Predna Hora, June 19-22 • participated in the 46th meeting of the Division of Planetary Sciences of the American Astronomical Society, held in Tucson on November 10-14.

GIONTI participated in the 2014 CERN Winter School in Gauge Theory, Supergravity, Superstrings at CERN, Geneva, February 3-7 • was respondent to Prof. Don Antonio Nitrola during the one-day Conference meeting "La Fine dell'Universo", at the Gregorian University, March 31 • gave a talk on "Comparing Double String Theory Actions" at the Meeting "Problemi Attuali di Fisica Teorica", Vietri sul Mare, April 11-16 • participated at the STRINGS 2014 Conference in Princeton (NJ), June 23-27, where he presented a poster with Dr. Franco Pezzella (INFN Naples Division) • participated and gave a talk on "Comparing Double String Theory actions" at the meeting of the "SIGRAV" (Italian Society for Gravitational Physics) in Alessandria, September 14-19.

HELLER gave a paper titled "Selfdefending mechanisms of science" at the Congress of Academic Culture, Kraków, Poland, March 20-22 • gave a paper titled "Dum Deus Calculat" at Revolutions Science Festival, Kraków, Poland, May 7-11 • gave a paper titled "The Sphere Paradigm in Cosmology" at Fifty Years of Cracow Astronomy, Kraków, Poland on May 17 • gave a paper titled "From the Big Bang to Gulags: How to Justify History?" at the 4th Congress of Polish Scientific Societies on exile in Kraków, Poland, September 4-7 • gave a paper titled "Cosmic Time and Human Time" at Science, a Polish Perspective in Oxford, U.K, October 24-25.

Fr. Michael Heller

KIKWAYA participated in the 46th meeting of the Division of Planetary Sciences of the American Astronomical Society, held in Tucson AZ, on November 9-14.

MACKE attended the 45th Lunar and Planetary Science Conference, The Woodlands TX, March 17-21 • the 77th Annual Meteoritical Society Meeting, Casablanca Morocco, September 8-13 • the 46th AAS Division for Planetary Science Meeting, Tucson AZ, November 9-14 • participated in the fourth AsRoMap workshop at the Italian Space Agency, Rome November 19-20.

MUELLER delivered the inaugural lecture of the academic year at the Newman Institute in Uppsala, Sweden, entitled "Looking Up: Should Theology and Philosophy Pay Attention to Astronomy?" September 1 • delivered the John Calvin McNair Lecture on Science and Theology entitled "Here's Looking at You: Science and Religion in Mutual Regard", at St. Andrews University, Laurinburg, North Carolina, October 21 • gave presentations concerning his recent co-authored book, Would You Baptize an Extraterrestrial, at the Newman Center of the University of Arizona on October 9 and at St. Mary's Student Parish at the University of Michigan on October 16.

MINNITI gave an invited talk on "Life in the Universe", at II Congreso de Cultura Científica, Centro Cultural La Moneda, Santiago, Chile, 22 October • talk on "The VVV Survey: Lessons Learned" at CNTAC LP Workshop, Cerro Calan, Santiago, Chile, September 10 • invited Colloquium on "The Millennium Institute of Astrophysics", at ESO Vitacura, Santiago, Chile, August 13 • invited talk on "The VVV Survey", Carnegie Observatories, Pasadena CA, USA, June 10 • invited talk on "Star Clusters with the VVV Survey", at ESO Workshop on Formation and Evolution of Star Clusters, ESO Vitacura, Santiago, May 15 •

Prof. Dante Minniti

invited Talk on "The ABRAS Project", at the ABRAS Workshop, Córdoba, Argentina, April 24 • organizer and lecturer of the Fifth VVV Science Workshop, held in Con Con, Chile, April 3 • invited talk on "Exoplanet Searches with the VVV Survey", at the Workshop of Planetary Sciences TCP 2014, Cordoba, Argentina, February 27 • invited talk on "The VVV Survey: New Results", at Workshop on the Formation and Evolution of the Milky Way, Sexten Center for Physics, Sexten, Italy, January 20 • talk at SOCHIAS Annual Meeting on "Half Way through the VVV Survey", Los Andes, Chile, January 13 • invited Talk on "Search for Extraterrestrial Life", at III Congreso del Futuro, Chilean Senate, Santiago, 9 January.

Educational and Public Outreach
BROWN gave a presentation to the students of the University of Dallas Rome Campus in Frattochie, Italy on "Faith and Science" January 20 • gave a presentation to the students of Trivium Preparatory School in Goodyear, AZ on "A Tour Through Space" March 7.

CHINNICI and Antonella Gasperini (INAF-Osservatorio Astrofisico di Arcetri) gave a public conference on the correspondence between Secchi and Tacchini in Palermo on January 15 and in Bologna March 6 • gave a public conference on Women in Astronomy in Reggio Calabria, March 8 • gave a public conference on the history of lunar cartography in Reggio Calabria, September 6 • together with Antonella Gasperini (INAF-Osservatorio Astrofisico di Arcetri) presented their book on the correspondence between Secchi and Tacchini at Gregorian University, November 20 • collaborated in preparation of the exhibition "Magistri Astronomiae from 16th to 19th century: Cristophorous Clavius, Galileo Galilei, Angelo Secchi", Rome, November.

CORBALLY and Margaret Boone Rappaport presented a talk on "Matrix Thinking in Science, Religion, and Art," accompanied by astronomy skits, to The Marian Club at St. Thomas the Apostle Church, Tucson, Arizona, on January 8 • on February 20 spoke about "An Astronomer's Faith" at the Manchester University Chaplaincy, England, and next day paid the first visit of a Vatican astronomer for 70 years to the Godlee Observatory. This visit was hosted by Anthony Cross, Past President of the Manchester Astronomical Society • on March 13, with Margaret Boone Rappaport, presented a talk, illustrated with skits, on "The Prehistory of Artistic Thinking: From the Sophisticated Inca Back to the Dawn of Sentience in Africa" at the John David Mooney Foundation, Chicago, Illinois • spoke on "Galileo – History, Science and Faith" for the Socorro Faith & Science Lecture Series, New Mexico, March 27 • gave a similar talk, "Galileo," on March 29 at the Immanuel Presbyterian Church, Albuquerque, New Mexico • on October 16, in the Third-Thursday Star Talks series of the Prescott Astronomy Club, presented a dialogue and skits with Margaret Boone Rappaport on "Astronomy Skits for Secondary School Science Education" at the Prescott Public Library, Prescott, Arizona.

FUNES gave presentations and public lectures on Astronomy, the Vatican Observatory, and Science-Faith Dialog at Vatican Observatory Foundation Seminar in Tucson, at the Universidad Católica de Uruguay and Colegio del Seminario, Montevideo; Universidad Católica de Córdoba, Universidad de Navarra, Pamplona, Spain, Maglie and Martina Franca, Italy, Villa Mercedes, San Luis, Argentina, where he was declared illustrious visitor by the city Council.

GABOR gave four talks in Klatovy and Jihlava May 22-23 • participated in the 31st year of Ebicycle, a seven-day cycling tour of observatories in former Czechoslovakia, celebrating 10 masses and giving 6 talks (Liptovský Mikuláš, Stará Ľubovňa, Spišská Nová Ves, Revúca, Zvolenská Slatina, Banská Bystrica) August 2-10.
GIONTI was invited invited by Rockhurst University (Kansas City, MO U.S.A.) as one of the speakers of the Visiting Scholar 2013-2014 Lectures. He gave a talk on "The Higgs Boson and its Relevance" on March 4 • gave a talk at the Specola in Castel Gandolfo for the employees of the Jesuit High School in Rome "Il Massimo" on September 2 • took part, as a speaker, at "la Notte dei Ricercatori" at the National Laboratories of Frascati of the Italian National Institute (INFN), September 27.

MUELLER taught two masters-level courses in philosophy at the Pontifical Gregorian University in 2014. During the spring semester Fr. MUELLER taught 29 students in his course "The Concept of 'Force' in Cosmology". During the fall semester he taught 16 students in his course "Philosophy in Science" • was invited to conduct a session on preaching for Jesuit scholastics at the International College of the Gesu, March 3.

OMIZZOLO gave various public lectures in the fields of observational cosmology and science-faith relations in Novara, Milano, Belluno, Brindisi and Padova.

News and Media Coverage
CORBALLY was interviewed by Drew Mariani, Relevant Radio, on December 23 about the Christmas Star. He was also interviewed by Ann Posegate, for Tucson Weekly, January 09, "Man of Science, Man of Faith," http://www.tucsonweekly.com/tucson/man-of-science-man-of-faith/Content?oid=3941322

FUNES gave interviews to Centro Televisivo Vaticano, Vatican Radio, Rai Educational Italy, ZDF Germany, DPA Germany, Famiglia Crisitiana Italy, Cadena 3 Argentina, Radio Mitre Argentina, RAIUNO, Rai Scuola (Nautilus).

GABOR gave interviews in the Czech Republic to Katolicky tydenik published on September 9 and in Slovakia to postoy.sk published on July 25 and Mozaika published on September 14. GIONTI has been interviewed on two different occasions by the on-line news agency Aleteia on September 15, regarding Godel's theorem on the existence of God and on October 27, and on Pope Francis's address to the Pontifical Academy of Sciences on the Origins of the Universe.

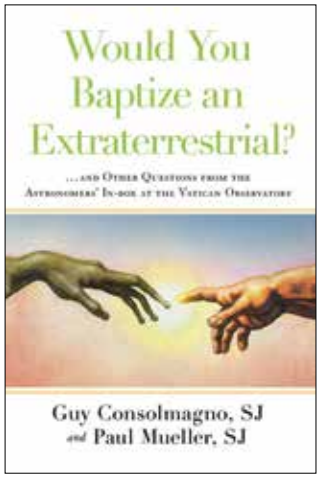
MACKE gave an interview on the Rai Scuola program "Nautilus" which aired December 22.

An extract from the cartoon produced by the Italian magazine 'A sua immagine' depicting the visit by His Holiness Pope Francis to the VO in 2013. This page shows VO director Fr. Funes showing Pope Francis a piece of meteorite found in Buenos Aires.

Publications

BOOKS

CONSOLMAGNO, G. J. and MUELLER, P. R. (2014). *Would You Baptize an Extraterrestrial?* New York: Image Books. 293 pp.



In Would You Baptize an Extraterrestrial? planetary scientist Br. Guy CONSOLMAGNO and philosopher of science Fr. Paul MUELLER explore a variety of questions at the crossroads of faith and reason: How do you reconcile the Big Bang with Genesis? Was the Star of Bethlehem just a pious religious story or an actual description of astronomical events? What really went on between Galileo and the Catholic Church – and why do the effects of that confrontation still reverberate to this day? Will the Universe come to an end? And could you really baptize an extraterrestrial? Written in a dialogue form, as a series of conversations over a six day period, the two men seek to answer some of the most frequently asked questions that arise when people think of faith and science. Published in October 2014 and available in hardback and paperback, the book appeals to people from all walks of life, is eminently readable, witty and ultimately thought provoking.

ACADEMIC PUBLICATIONS

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Straižys, V., BOYLE, R. P., JANUSZ, R., Laugalys, V., Kazlauskas, A., (2013). VizieR Online Data Catalog: Vilnius Photometry of IC 1805 Stars. VizieR On-line Data Catalog: J/A+A/554/A3.

Wlodarczyk, I., Černis, K., BOYLE, R. P., Laugalys, V., (2014). Discovery and Dynamical Characterization of the Amor-class Asteroid 2012 XH16. MNRAS 438, 2621 - 2633.

Milašius, K., BOYLE, R. P., Vrba, F. J., JANUSZ, R., Straižys, V., Černis, K., Laugalys, V., Zdanavičius, K., Zdanavičius, J., Kazlauskas, A., Smilgys, R., (2013). Seven-color Photometry and Classification of Stars in the Direction of Open Cluster M 29 (NGC 6913) in Cygnus. *Baltic Astronomy* 22, 181-221.

Straižys, V., Maskoliunas, M., BOYLE, R. P., Zdanavičius, K., Zdanavičius, J., Laugalys, V., Kazlauskas, A., (2014). The Open Cluster NGC 7142: Interstellar Extinction, Distance and Age. *MNRAS* 437, 1628-1635.

Straižys, V., Maskoliunas, M., BOYLE, R. P., Prada Moroni, P. G., Tognelli, E., Zdanavičius, K., Zdanavičius, J., Laugalys, V., Kazlauskas, A., (2014). The Distance to the Young Cluster NGC 7129 and its Age. *MNRAS* 438, 1848 - 1855.

Pakstiene, E., Laugalys, V., Qvam, J., BOYLE, R. P., (2013) New Analysis of ZZ Ceti Star PG 2303+243. *Precision Asteroseismology, Proceedings IAU Symposium* #301, pp. 469-470.

BOYLE, R. P., JANUSZ, R., Straižys, V., Laugalys, V. (2014). Deep Seven-color Photometry and Classification of Stars in the Cyg OB2 Association. *AAS Meeting* #223, #442.03 (Abstract)

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Visitors

VISIT OF THE SECRETARY OF STATE

On the evening of July 29, the community and staff at the VO headquarters were honored with the visit of Cardinal Pietro Parolin, Vatican Secretary of State. Fr. FUNES presented the activities and projects of the Observatory to Card. Parolin in the Buffetti lecture room. After the presentation, the Secretary of State visited the meteorite laboratory and the library and stayed for dinner with the Community. Card. Parolin encouraged us to continue with our mission in the service of the Church promoting dialogue between Science and Faith.

Vatican Secretary of State, Cardinal Pietro Parolin (centre) is shown some of the old texts housed in the VO Headquarters Library during his recent visit

Br. Guy Consolmagno invites Vatican Secretary of State, Cardinal Pietro Parolin, to view samples of meteorites through a microscope at the VO's newly refurbished Meteorite Lab

Vatican Secretary of State, Cardinal Pietro Parolin, holds one of the VO's collection of meteorites

THE APOSTOLIC NUNCIO VISITS THE VATICAN OBSERVATORY IN ARIZONA

On March 3 the community and staff of the Vatican Observatory Research Group in Tucson, Arizona were honored and very pleased to welcome the Pope's representative to the United States, Archbishop Carlo Maria Viganò.

Archbishop Viganò met with the Jesuit astronomers and the technical staff responsible for the development of the Vatican telescope. He also visited the Steward Observatory Mirror Lab where Prof Buell Januzzi, director of the Steward Observatory, and Prof. Roger Angel offered a tour of the facilities. Archbishop Viganò joined the faculty of the Steward Observatory for a luncheon. In the evening a reception and dinner were held in his honor.

Bishop Gerald Kicanas, authorities of the University of Arizona, directors of the Observatories in Southern Arizona, and benefactors of the Vatican Observatory Foundation joined the Jesuit astronomers on this happy occasion.

In his address Archbishop Viganò pointed out: "In many ways, as we see here from this Observatory, science and technology, when applied correctly, can help deepen our faith". The Apostolic Nuncio added, "we are in a state of constant discovery of the Truth, so ever present and so much beyond ourselves. This discovery frees us and makes us so fully alive. How blessed we are to be part of all this. May your invaluable mission for the Church and for all humanity continue to prosper and bear much fruit".

The following day Archbishop Viganò accompanied by Fr. FUNES and Fr. CORBALLY visited the VATT and the LBT at the Mount Graham International Observatory. Dr. Christian Veillet, director of the LBT, showed the impressive giant LBT in motion.

Apostolic Nuncio to the United States, Archbishop Carlo Maria Viganò, at VATT with VO director Fr. Jose Funes

Archbishop Viganò is given a tour of theSteward Observatory Mirror Lab by Prof Buell Januzzi, director of the Steward Observatory, and Prof. Roger Angel

Visitors to the Vatican Observatory headquarters in Castelgndolfo

Cardinal George Pell, Prefect of the Vatican Secretariat for the Economy, visited the VO Headquarters on September 10.

H.E. Mr. Filip Vucak, Ambassador of Croatia to the Holy See, H.E. Mr. Rodney Alejandro Lopez Clemente, Ambassador of Cuba to the Holy See also visited the Headquarters.

During the VOSS 2014, we welcomed the following diplomats to the Holy See:

H.E. Mr. Juan Pablo Cafiero, Ambassador of Argentina; Ms. Anahit Sirunyan, First Secretary of Armenia; H.E. Mr. John McCarthy, Ambassador of Australia; H.E. Mr. Denis Fontes de Souza Pinto, Ambassador of Brazil; H.E. Mrs. Monica Jimenez de la Jara, Ambassador of Chile; H.E. Mr. German Cardona Gutiérrez, Ambassador of Colombia; H.E. Mr. Bahr Budiarman, Ambassador of Indonesia; H.E. Mr. Mariano Palacios Alocer, Ambassador of Mexico; H.E. Mr. António Carlos Carvalho de Almeida Ribeiro, Ambassador of Portugal; H.E. Mrs. Maja Marija Lovrencic Svetek, Ambassador of Slovenia; Ms. Apha Thirakaroonwongse, First Secretary of Thailandia; H.E. Mr. Kenneth Francis Hackett, Ambassador of the U.S.A.

During the VOSS 2014 we also received a visit from Mons. Fernando Vérgez Alzaga, General Secretary of the Governatorate, and Fr Garcia de la Serrana Villalobos, director of the Technical Services of the Governatorate.

Professor Jack Wisdom, MIT had an extensive stay in Castel Gandolfo from March 7 - 30.

The IAU Working Group on Planetary System Nomenclature met at Castel Gandolfo from April 6 -9, hosted by CONSOLMAGNO.

On 13 May, students from the Science and Engineering program of Duquesne University paid a visit to the telescopes of the Observatory at the Summer Apostolic Palace. The tour was accompanied by a lecture on Science and Faith.
A group of 15 nuns visited the Apostolic Palace and VO Headquarters in July as part of the CMSWR 2014 Summer Program of Religious Renewal in Rome.

The astronomy students attending the VOSS2014 visited the telescopes at the Summer Apostolic Palace during the first week of the school in June 2014.

On June 24, 24 librarians of various astronomical institutions visited the domes of the Apostolic Summer Palace in Castel Gandolfo. They were part of a conference in Naples called, Library and Information Services in Astronomy (LISA VII), held at INAF - Astronomical Observatory of Capodimonte, June 17-20.

Lorenzo Spina, astronomer at Osservatoria Astrofisico di Arcetri, INAF, Firenze visited the domes and VO headquarters on August 22.

On October 11, Prof. Salvatore Capozziello (Full Professor in Astrophysics at the University "Federico II", Physics Department, Naples) paid a working visit to GIONTI at the VO headquarters in Castel Gandolfo.

On October 10, Prof. Raffaele Marotta (INFN, Naples Division) paid a visit to the VO headquarters.

Stephan Geier, ESO Fellow at Garching, Germany, visited on October 16.

Tours of the Observatory.

MUELLER accompanied the following groups on visits to the Vatican Observatory and the telescopes at Castel Gandolfo:

Group from the Gregorian Foundation, including Fr. Michael Hilbert S.J.

Group of VOF friends/benefactors, including Jerry Bannan, Sheila Bannan, Deirdre Coyne, Siri Rochin, Mark Rochin, Maria Finney

Karrie Grasser (representative of Santa Clara University) and her husband Phil Grasser

Group of VOF friends/benefactors, including Ernest Lee Go, Jane Huang Go, Yvonne Go Joson, Neil Harlan Joson, Gregory Scott Joson, Madeleine Elise Joson, Megan Lauren Joson, Phyllis Monique Go, Clarence Liu Co, Benjamin Bernard Co, Ryan Benedict Co.

Group of VOF friends/benefactors, the Doyle family.

Board of Trustees, Santa Clara University.

Group of VOF friends/benefactors, the Fitzpatrick family.

Members of the Board of Regents, St. Ignatius High School, San Francisco.

Members of the Faculty of St. Ignatius College Preparatory School, Chicago.

VOF friends/benefactors, Andy and Heather Cracchiolo.

Members of the faculty of Loyola High School, Detroit.

A group of 25 officials from the Roman branch of Caritas Internationalis visited the telescopes at the Apostolic Summer Palace on October 2.

GIONTI has given several guided tours to many groups to the domes and telescopes located on the top of the Papal Palace in Castel Gandolfo. These include: students and some professors from the Josephinum Gymnasium, in Hildesheim, Germany led by Prof. Dr.

Arndt Latusseck on September 23. On October 16, the board members (who are Presidents of the main Italian banks) of the UBI Consortium (a Consortium established among the main Italian Banks for networking reasons) lead by her President, Dr. Liliana Passi Fratini.

Other notable visitors to the VO headquarters in Castel Gandolfo:

Bishop Marcello Semeraro of Albano

Patrick and Teresa Nielsen Hayden, Tor Books

Board of Trustees, Santa Clara University

Board of The Papal Foundation

Eurpean Space Agency "Spacetweeps" group

Millarca Valenzuela, PUC-Chile.

Other notable visitors to the VORG in Tucson, Arizona include:

Richard Gray from Appalachian State University, NC.

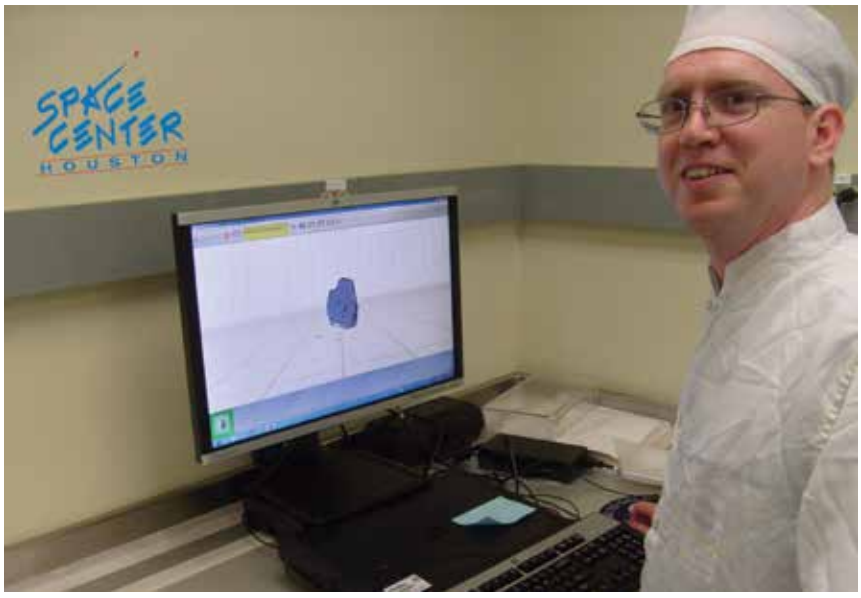
Visits to scientific institutions and universities

CORBALLY paid an overnight visit on March 28 to the 2.4-m telescope of the Magdalena Ridge Observatory, New Mexico Institute of Mining and Technology, at the invitation of Dr. Eileen Ryan (Director). He was hosted by Dr. William Ryan.

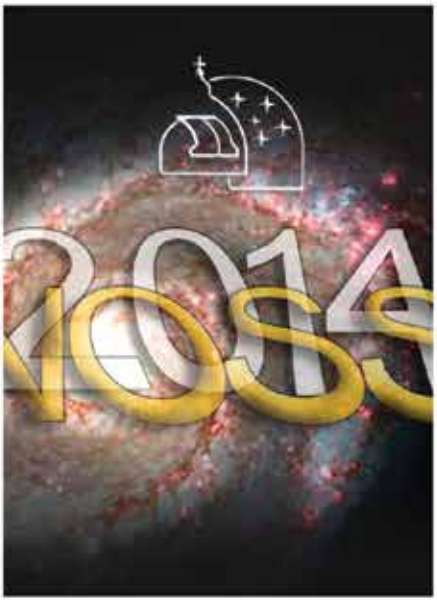
On August 19, GABOR visited the headquarters of ProjectSoft in Hradec Kralove, Czech Republic, and the Astronomical Institute of the Czech Academy of Sciences in Ondrejov.

On October 28-29, GABOR, JOHNSON and SWINDELL met with Todd Boroson (Director), Eric Saunders (Head of Software), Brian Haworth (System Administrator), Ann Hjelstrom (Mechanical Engineer) and Tim Lister (Astronomer) at Las Cumbres Observatory Global Telescope Network headquarters in Goleta, California, to discuss robotic telescope network design, scheduling, operation and maintenance.

MACKE visited NASA Johnson Space Center in Houston TX from October 13-24 to perform density and porosity measurements on Apollo moon rocks and lunar and martian meteorites. While there, he experimented with using a laser scanner for measuring bulk volumes of moon rocks. He was hosted by Ryan Zeigler and Kevin Righter, curators of the Apollo collection and the Antarctic meteorite collection, respectively.



Br. Macke during his visit to NASA Johnson Space Center in Houston, TX


2014


Welcome to the
Vatican Observatory!