The Vatican Observatory

annual REPORT 2024

Touching the Sky

THE VATICAN OBSERVATORY

annual REPORT 2024

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Letter from the Director

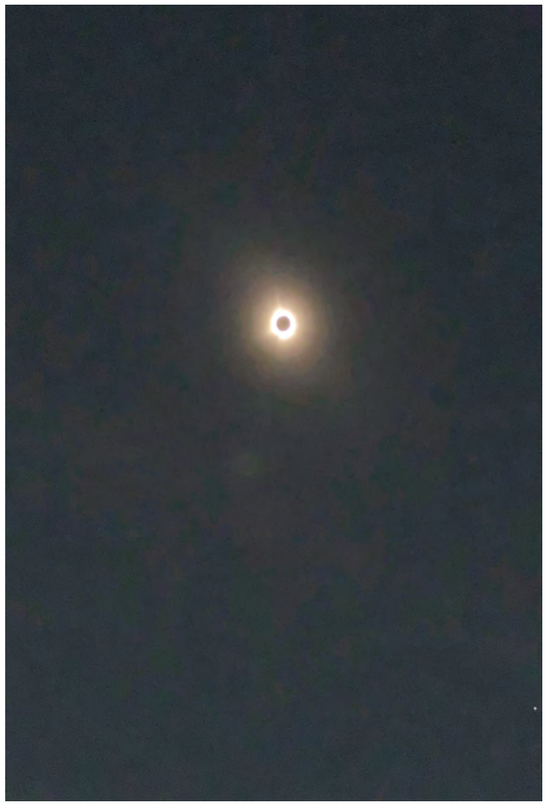
Chapter ONE

It seems odd to speak of hope in a world beset by ecological crises, injustices, and wars. And yet, perhaps paradoxically, in these shadows I do see light.

Perhaps an analogy might help. For me, one of the most remarkable events of the past year was watching the total eclipse of the Sun in April, which I viewed at the Mother of the Redeemer Retreat Center in Bloomington, Indiana. The Sun is of course the source of the light and warmth that makes life on Earth possible, so you would think that blotting out the Sun would be a potent sign of things going wrong. But in fact, the eclipse was awe-inspiring. I wasn't the only one at our "eclipse-retreat" who stood up and cheered at the magnificent ring of the corona around the Moon at the moment of totality.

Yes, the absence of the Sun gives us reason to appreciate what we normally take for granted. But the joy also came from knowing that this event was completely predictable… and short-lived. We know enough now not to be afraid of an eclipse.

But most of all, it was simply beautiful.



My little cell phone camera was able to capture this view of the eclipse. I know there are more professional images out there; this is just my own little souvenir

Astronomy calls us to pay attention to a beautiful universe that endures overhead in spite of all we try to do to blind ourselves to it down here on Earth. And in particular, astronomy in the service of the Church this year has seen many signs of hope here at the Vatican Observatory.

The words of Pope Leo XIII establishing the Specola Vaticana in 1891 continue to define who we are and why we do what we do: to show the world that the Church supports good science. The changes and achievements of the Observatory this year fulfill both criteria… doing good science, and showing the world what we have done.

The science we're doing at the Vatican Observatory makes up the bulk of this annual report. Here you'll read about how our scientists are measuring returned samples from asteroid Bennu; the spectral analysis of a thousand stars that may host planets; the theoretical study of alternative theories of gravity; the first resolved stellar halo kinematics of a Milky Way-mass galaxy at a distance of 3.56 megaparsecs away, far outside the Local Group. And more!

Perhaps the most exciting single development in our scientific activity was the successful installation by ProjectSoft HK of the "Don" robotics package at our flagship telescope, the Vatican Advanced Technology Telescope (VATT) at the Mt. Graham International Observatory in southeastern Arizona.

Since VATT's inauguration more than thirty years ago (see last year's annual report), our telescope has had two important components, the Alice P. Lennon telescope

itself, and the Thomas Bannan Astrophysical Laboratory that allows us to interpret what the telescope can see. Now we have a third major component: Don, the robotics package that allows the telescope to be controlled remotely from anywhere in the world, without the need for someone to make the difficult trip up the mountain and stay up all night babysitting the equipment.

More than that, however, this new hardware and software is a tremendous upgrade to the telescope's ability to find and track deep sky objects as they rise and set above the southern Arizona mountain. We're so grateful to the donors who made this installation possible — The Thomas Lord Charitable Trust, Mrs. Judy Alstadt (whose late husband Don Alstadt is honored) and Mr. Mickey Pohl. The renewed support that the Vatican Observatory Foundation has received from donors like these is a great source of hope for our future.

Fr. Paul Gabor and a team of local astronomers who have advised us on the upgrade of the telescope are now ready to take the final step, to purchase a new electronic camera. It will replace the "VATT 4K CCD" that has been a workhorse for us for the past twenty years. Meanwhile, the VATT's optical qualities remain unsurpassed for a telescope of its size. With these upgrades, we'll be ready to continue our current observing projects and branch out into the new challenges for the next twenty years. VATT's future looks grand; and full of hope.

Of course, the VATT is not our only telescope. Back in Castel Gandolfo, we still have the joy of maintaining four historic telescopes, dating as far back as 1891. For most of the last forty years these telescopes have been out of service; since the 1980s, light pollution spreading out from Rome spelled their doom as useful scientific instruments. But they are nonetheless functioning instruments, and beautiful monuments to the engineering (and science) of the last century.

Now, after a decade of preparation going back to the vision of Fr. José Funes and the hard work of Fr. Paul Mueller and Claudio Costa, these telescopes are all open to visits guided by docents of the Vatican Museums. I especially appreciate the efforts of Dr. Barbara Jatta, director of the Museums; Dr. Alberto Albanesi, the vice-director; Dr. Luciano Gagliano, responsible for the visits organized by the Museums in Castel Gandolfo; and Davide Mariani, one of the guards of the Museums, who have worked so hard to make these visits possible. I eagerly await the promised new Museum web site that will facilitate these visits for the general public. In this way we can fulfill the second part of Pope Leo's mission to the Specola… showing the world.

Finally, nothing speaks of hope for the future like the arrival of new members of the Specola. This year, we were delighted to add three new young Jesuits to our community. Fr. Jacek Olczyk and Fr. Bayu Risanto have joined the community in Castel Gandolfo, while Mr. Robert Lorenz has joined us in Tucson. They introduce themselves in the diaries that follow; let me merely say here that the continued infusion of new blood to this hundred and thirty five year old institution is a sign both of the Society of Jesus's commitment to what we do, and of God's generosity in having encouraged such men to join our least society.

(We also recognize with enormous gratefulness the long-term contributions of Fr. Giuseppe Koch, newly assigned to the Canisio community in Rome, and Fr. Justin Whittington, who has moved on to the Tertianship phase of his Jesuit formation.)

I'll close with one more eclipse story. A number of Jesuit schools and universities were in the path of totality, and they all wanted a Vatican astronomer to come and talk about the event. While I could not be everywhere, Zoom could. So I arranged a program via Zoom where Fr. James Martin would interview Chris Graney and me about the science and history of eclipses. But then Chris and I arrived in Bloomington, only to discover that there was neither internet nor even cell phone coverage at the retreat center!

I was in a bit of a panic… I drove back into town to see if there might be a parking lot someplace where we could at least connect via cell phone, only to receive a message from a friend from Michigan who had actually driven down for the eclipse and was staying a few miles away, in the home of her third cousin… who just happened to be an IT specialist at Indiana University. His home had great connectivity. So at the last minute, Chris and I invaded the living room of total strangers (they even treated us with local donuts and coffee) and the show was saved!

My Michigan friend whispered to her cousin, "Br. Guy is probably going to claim that this was an answer to a prayer." Indeed, that is exactly what I claim!

It's because God keeps looking out for us in the small things as well as the large that I face the world with great hope.

Br. Guy Consolmagno, S.J.
Director, Vatican Observatory

Fr. Timothy Sauppé of the Diocese of Peoria, Illinois, organized a three day retreat at the Mother of the Redeemer Retreat Center in Bloomington, Indiana, in the center of the path of the April eclipse. More than a dozen scientists and theologians, including several bishops, spoke to a gathering of about fifty participants. To the left, the retreat grounds were a perfect and comfortable site for seeing the event

To the right, Dr. Deana Weibel and her husband (NASA historian Glenn Swanson) and son were viewing the eclipse from her cousin's home, where Br. Guy and Chris Graney broadcast their Zoom event to a number of Jesuit institutions. Dr. Weibel is a cultural anthropologist at Grand Valley State University, specializing in the overlap of astronomy and religion. She spent a month with us in Castel Gandolfo in 2019

PERSONNEL

CORBALLY

In August Corbally completed 40 years in the Vatican Observatory Research Group at the University of Arizona. He has served in the roles of Administrator, Project Scientist for VATT, Vice Director, and currently Staff Astronomer.

GRANEY

On February 10 Joseph Lense Graney, the younger son of Chris and Tina Graney, married Stephanie Grace Cesare at St. Louis Bertrand Church in Louisville, Kentucky (USA). On November 19, Stephanie gave birth to Chris and Tina's first grandchild, Boethius Alfonsus Giuseppe Graney. On December 1, Boethius was baptized at Our Lady of the Caves Church in Horse Cave, Kentucky; Joseph's brother, John Henry Graney, and Stephanie's sister, Siena Smith, served as godparents.

LORENZ

Mr. Robert Lorenz S.J., a Jesuit scholastic of the Eastern United States province, has been missioned to the Vatican Observatory in Tucson. Born in Kentucky, he earned a degree in biology from Xavier University in 2000. After two years with the Jesuit Volunteer Corps in northern California, he spent seventeen years as a Park Ranger with the US National Park Service. As part of his duties he spent a significant effort in public education in astronomy and training other rangers on this topic.

He entered the Society of Jesus in 2019 and completed his novitiate and first study courses in philosophy and theology in 2024. Now in his period of Jesuit formation called "regency", his Jesuit province has sent him to the Specola to work in a number of areas involving education and outreach. These include coordinating public presentations among our Tucson staff on the topics of faith and science; helping out in the Astronomy for Catholics in Ministry and Education (ACME) program in 2026; working with our staff to prepare press releases and social media posts about our work; and learning the practical skills of fundraising.

KIKWAYA

This year on September 13, 2024, Kikwaya celebrated his 40th anniversary of Jesuit life.

KOCH

In the fall of 2024, Fr. Giuseppe Koch transferred from the Specola to his new assignment at the Canisio retirement community in Rome. Now approaching 88 years old, his new community will be able to care for the inevitable needs of a man approaching old age.

After a career of teaching physics at a number of Jesuit schools in the Italian province, Giuseppe first joined the Specola in 2002 as the vice director to Fr. George Coyne, and superior of the Jesuit community. Serving under both Fr. Coyne and Fr. Funes, during this time Giuseppe had the difficult task of overseeing the construction of the Specola's new quarters in the Papal Summer Gardens and then moving the observatory and community out of the Papal Palace, where we had lived and worked for 75 years.

In 2010, Giuseppe left the Specola for other assignments in Rome. But when Br. Guy Consolmagno became director of the Specola in 2015 his first act was to request Fr. Koch's presence back in the Specola. For the past nine years he has served as the Specola's librarian, while also helping out in our outreach efforts, both scientific and spiritual, with the local community in Albano and the Vatican.

Through all that time he also served us as a spiritual model… sometimes gentle, sometimes cantankerous, but always beloved. We will sorely miss his presence at the Specola.

Fr. Koch at office, 2021

Fr. Koch at Papal Audience, 2021

OLCZYK

Fr. Jacek Olczyk S.J. is a Jesuit priest who has joined us in Castel Gandolfo from the North Poland province. Born and raised in Lodz, he earned MA and Engineer degrees in Food and Nutrition Technology at the Lodz University of Technology in 2004, and then joined the Jesuits. After studies both in Poland and Rome, he was ordained in Warsaw in 2013. Since then he has held a number of chaplaincy and administrative posts, including Director of the Evangelization Center "Mocni w Duchu" in Lodz.

In Castel Gandolfo he does administrative and outreach work with the Specola, acting as minister of the community and assistant to the director. As such he takes a load off the shoulders of our community superior, Fr. Richard D'Souza S.J., and the Observatory's vice director, Fr. Gabriele Gionti S.J., allowing them to concentrate more on their science.

RISANTO

Fr. Christoforus Bayu Risanto S.J., or just "Bayu" for short, had been a part of the Jesuit community in Tucson since 2016 while pursuing his doctorate in Hydrology and Atmospheric Science at the University of Arizona (which he received in 2021). Since then, he worked as a postdoctoral fellow in climate and weather modeling in Arizona. As of summer 2024, he has joined us full time as a member of the Vatican Observatory in Rome, expanding his research on the numerical modeling of climate and planetary atmospheres.

Bayu is originally from Indonesia, where he entered the Jesuits in 2000. After his novitiate he was sent to the Driyakara School of Philosophy where he wrote a thesis on the epistemology of Newton and Einstein, and a Master's from Sanata Dharma University on Teilhard de Chardin and Ecology. He came to the US in 2012 to study Atmospheric Sciences at Creighton University, where he earned his Master's in 2016. In between those studies, he also served his regency as a high school teacher at Xavier High School in Micronesia.

WHITTINGTON

While never a staff member of the Specola, Fr. Justin Whittington S.J. had been in residence with the Jesuit Community of the Vatican Observatory in Tucson since 2015, serving as the assistant to the President of the Vatican Observatory Foundation. In that role he worked diligently in supporting and maintaining the Foundation's web based fundraising systems, as well as accompanying Jesuits in their public outreach and other functions within North America. Given his degree in classics, he also performed the unusual function of assisting Br. Consolmagno in his duties on the International Astronomical Union's nomenclature committees, which often involved finding the appropriate Latin terminology and grammar for features on various solar system bodies!

In the summer of 2024, Fr. Whittington was assigned to participate the Jesuit program of Tertianship, in Oregon, after which he will take up new duties within the American assistency.

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Touching the Sky

Chapter TWO

Brother Guy has often said that astronomers only study light. The objects that they study are so far away that the only thing we can receive is the light (electromagnetic waves) that those objects emanate. By studying that light in as many ways as possible, astronomers try to infer what they can about the objects that emitted it. (I should note that these days, we can also add gravity waves to the list, though that science is still in its infancy.) The field of planetary science called "meteoritics" is a notable exception. Meteorites are rocks that originate on asteroids or other planetary bodies that have, through the course of their orbital evolution, found their way to the surface of the Earth. There, they can be picked up and studied directly in the laboratory. Astronomers study light, but meteoriticists study the objects themselves!

We have learned a lot about meteorites over the past couple of centuries, most of it within the last 50 years. Most of these rocks formed in the earliest days of the solar system, about 4.56 billion years ago, in what are called "parent bodies". These then broke apart and left a few remnants that today we call "asteroids". Because this material is so old, it preserves an important record of the earliest days of our solar system and can help us to understand that history and the processes that led to planet formation. A few rare other meteorites originate from the surface of Mars or the Moon. At some point in the past, those bodies received impacts so violent as to throw Martian or Lunar material into space. Over time the orbital paths of that debris brought it to the Earth as meteorites.

In the laboratory, we can study many different things about meteorites, such as mineralogy, petrology, and isotopes; and physical properties such as density, porosity, heat capacity, thermal conductivity, and so much more. Anything that you can think of that might be important about a specimen, you can study using some instrument. Here at the Vatican Observatory, where we house the Vatican meteorite collection of over 1200 specimens, we have a laboratory where we study mostly density and porosity of meteorites. I (Br. Bob Macke, S.J.) have gained a reputation as an expert in measuring meteorite density and porosity, and that is how I got invited to participate in the sample analysis team of the NASA OSIRIS-REx mission.

Why Sample-Return?

OSIRIS-REx is a sample-return mission that visited the asteroid Bennu and collected specimens from the surface, returning them back to the Earth for study. It is not the first sample-return mission, nor will it be the last. The earliest sample-return mission was in fact Apollo 11, which brought astronauts Neil Armstrong and Buzz Aldrin to the surface of the Moon, where they collected many specimens. The six successful Apollo missions together collected over 382 kilograms of moon rocks and regolith. Over a similar time period, three unmanned Luna probes launched by the Soviet Union returned about 300 grams of material. More recently, China added to the list of lunar surface samplers with two Chang'E probes. Other sample-return missions include Stardust, which collected dust from a cometary halo, and two Japanese Hayabusa missions, which sampled asteroids Itokawa and Ryugu. (Ryugu has many similarities with Bennu, so comparing results from the two is important.) Future sample return missions are also planned for Mars.

You may wonder, "if we have such an abundance of meteorites available for study, why do we need something as complicated and expensive as a space mission?" There are two good answers for that.

The first answer is context. Meteorites provide an abundance of material, but we don't know exactly where it came from. Even the Martian and Lunar meteorites lack context. We can be sure that the meteorites came from those objects. (How can we be sure? That question requires a long discussion that I won't get into here.) However, we don't know where exactly on the Martian and Lunar surfaces they originated. Likewise, with meteorites of asteroid origin, we have ways of connecting meteorite type with asteroids (generally through spectra), but it is imprecise.

In a few cases, meteorites have been collected after their fall was observed by sky-watching cameras. (The Vatican Observatory's own Jean-Baptiste Kikwaya is a participant in a couple of camera networks. See the 2016 Annual Report.) By backtracking the streak of light made as the rock came through the atmosphere, its orbit may be calculated. That gives us some idea of where these specimens came from, but only in their most recent orbits. Over time, orbits change by various processes.

With sample-return missions, we know exactly where the sample came from, down to exact coordinates. We can study the geology of the area, so we know as much as possible about the context. The OSIRIS-REx mission, for example, orbited and mapped Bennu for two years before finally sampling the surface. We have a sense of the local geology as well as some idea of what *wasn't* collected.

The second answer has to do with collecting and preserving a pristine specimen. As soon as a rock enters the Earth's atmosphere, it begins to change. First, there

is the rather violent encounter with the atmosphere itself, which melts and ablates away a good amount of the rock's surface materials. (Contrary to popular belief, the interior keeps cool and remains largely unaffected by this process.) Next, oxygen and moisture in the air begin to chemically react with the various minerals in the rock, leading to what meteoriticists call "weathering". This skews many studies of mineralogy and petrology. Also, life on Earth is ubiquitous, and even a short exposure to the air leads to implantation of biological materials and even bacteria and other life. If you are interested in astrobiology, meteorites are too contaminated to be useful.

The way to avoid contamination is to collect material in-situ and keep it hermetically sealed as you deliver it to Earth and store it, right up to the critical moment when you do your research. If it never encounters a terrestrial environment, it cannot be contaminated by it.

Vatican Observatory and OSIRIS-REx

Initially, the Vatican Observatory was not involved in the OSIRIS-REx mission. That changed after the spacecraft successfully grabbed a specimen from the surface and started its journey back to Earth. That's when it became time to assemble the sample analysis team—a group of scientists from around the world who would study the specimens in their laboratories. Andy Ryan, the working group lead for the Sample Physical and Thermal Properties Working Group (SPTAWG), contacted me for some ideas about determining specimen density and porosity.

Initially, he was simply consulting me for advice, particularly about pycnometry (using a gas to measure the volume of specimens). Because we wanted to make the measurements in the pristine environment of a "glove box" (not like in an automobile, but rather a sealed chamber where a scientist can manipulate objects using gloves attached to holes in the side of the chamber), which has very strict limits on materials, it quickly became apparent that an off-the-shelf instrument wasn't going to work. We would have to design a custom device from scratch. My advice evolved from sharing my expertise to presenting some basic design ideas for the device itself.

Eventually, in 2021, Andy asked me to join the sample analysis team, take charge of building the device, and also be responsible for the actual measurements on samples. I jumped at the chance. This is not the first time that the Vatican Observatory has been involved in a space mission—I am also a collaborator on the Lucy mission to visit several Trojan asteroids out by the orbit of Jupiter—but it is rare.

As the mission came close to delivering the sample in the fall of 2023, and the press started to take an interest in anything related to OSIRIS-REx, the involvement of the Vatican Observatory was noteworthy enough to be the subject of several articles. They often were given catchy and amusing titles, like "NASA needed help with a mission. The Vatican came to the rescue" (*Mashable.com*, September 16, 2023). Some months later in an interview with *Vatican News*, even the administrator of NASA, Bill Nelson, mentioned the involvement of the Vatican Observatory in the OSIRIS-REx mission (*Vatican News*, May 10, 2024).

Designing a Pycnometer

The OSIRIS-REx mission headquarters is at the University of Arizona in Tucson, which also conveniently hosts the US branch of the Vatican Observatory. Most of my time is spent in the other half of the Vatican Observatory in Castel Gandolfo, Italy. Over the 2021-2022 academic year, I remotely advised a group of engineering students at UA who were building the device for their senior Capstone project.

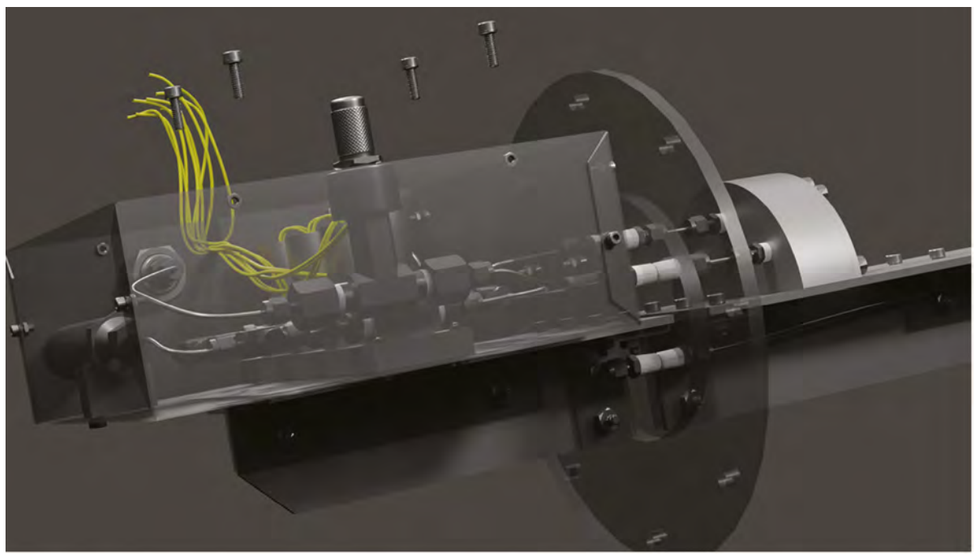
A pycnometer basically consists of two chambers of known volumes, with a valve between them. The specimen is placed into one chamber, which is sealed and pressurized with a gas. The pressure is measured, and then the valve is opened into the other chamber, letting the gas expand into the combined volume of the two chambers. As the gas expands, the pressure drops according to Boyle's Law. By comparing the initial pressure and the final pressure, one can easily calculate the volume displaced by the specimen. But, since the gas penetrates any pore space, the volume is just that of the solid rock, omitting any porosity. Taking the specimen mass (measured separately) and dividing by this volume yields what we call grain density. This is effectively the average density of all the mineral components, so it is also a relatively quick first-order way of distinguishing rocks with different mineralogies.

With the students, we quickly settled on a two-part design, with the chambers located securely inside the glove box but the valves, pressure-measuring transducer, and other less-clean components located just outside the glove box; tubes connecting the parts pass through a plate in the glove box wall. The gas would be the same high purity nitrogen gas that is used in the glove box itself, so that no gas contaminant would be added. The students then got to work on designing the chambers.

Initial pycnometer design (without support structure)

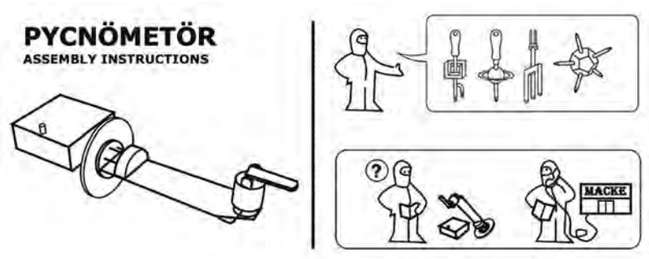
The project proved more complex than either they or I had assumed, and by the end of the year they had a few components assembled that did not work quite as well as needed. I came to Tucson for few weeks over the summer, during which time I overhauled the instrument, redesigned the chamber lid closure which was giving us problems, and assembled a basic working prototype that I could run several tests on. However, it was far from ready for installation. Over the next academic year, we hired another student to work on it while I again advised from Italy, with a bit of time back in Tucson over the winter to work again directly with the device. This led to a complete prototype design that could interface with the glove box.

In February of 2023, it was decided that the various components we had been using had been handled too much, and we got permission to build a second device from fresh components. We spent the next several months sourcing materials, coordinating with machine shops, and planning the construction. During this time, I created a computer model of the device in Blender. It included every single component, so I could account for all of the more than 200 pieces. Once everything was acquired, it was shipped to NASA Johnson Space Center where each component was individually cleaned and sterilized.



Screen shot from Blender animation of pycnometer assembly

The Blender model proved valuable in another way as well. I needed to be in Italy when the device would be assembled, so Andy Ryan would do the actual assembly in a NASA clean room. From the model, I was able to produce a detailed step-by-step assembly guide to direct the operation (complete with IKEA-style cover).



Assembly manual cover art

Touching the Sky: Measuring the specimens

OSIRIS-REx returned its valuable cargo on September 24, 2023. A few days later, I found myself at NASA Johnson Space Center watching a live feed from a conference room as technicians opened it up and carefully bagged and tagged any asteroid dust captured on the surface of the container before revealing the real treasure inside. The plan was that, after a couple of weeks, we would jump directly into measuring selected stones from inside the sample collection apparatus (called the TAGSAM head). Unfortunately, due to delays that I won't discuss here, nothing much really happened until January of 2024. In the interim, I did have the opportunity to install the machine properly in the glove box and, while I was there, to see the precious asteroid sample with my own eyes.

The TAGSAM head opened to reveal the part of the Bennu sample that hadn't already been collected (Photo: NASA / Erika Blumenfeld and Joseph Aebersold)

Br. Bob Macke, S.J. examining a portion of the Bennu sample at NASA Johnson Space Center

By the time we got around to pycnometry, I was once again in Italy, so I had to rely on Andy Ryan and another colleague, Ron Ballouz, to perform the measurements. They were simultaneously performing their own Structured Light Scanning (SLS; using light patterns to measure a specimen) analysis for bulk density. We stayed in constant communication over WhatsApp and Mattermost, so I could give guidance and correct their procedure where necessary.

Ten stones were initially selected for analysis, representing three different candidate lithologies. Prior to analysis we could only choose stones based on appearance, so we didn't know for certain what was different and what was the same. The pycnometry and SLS procedures were intended as triage to distinguish different lithologies based on densities.

Pycnometer installed in the glove box

One of the Bennu specimens in the sample chamber of the pycnometer (with the lid off)

The work proceeded well, but the results were very strange. I won't cover specific data here (that's for the official publications). However, grain density measurements were much too high. The specimens would have to be solid metal to produce the kind of results we saw, and we knew that they were mostly composed of phyllosilicates and other low-density minerals. After months of racking our brains, we realized that the problem was precisely that we were measuring pristine specimens in a protected environment. The nitrogen was interacting with the surface of the grains inside the rocks in a way that normally would have been blocked by moisture from the air, and this was throwing the data off. This shifted the focus of my research from measuring grain density to understanding this phenomenon, which we had not seen in meteorites. And unfortunately, we decided not to continue pycnometry to characterize further stones as was originally planned.

Thankfully, the SLS results for bulk density were not affected, so we at least had that measurement to rely on as well as x-ray tomography scans which revealed the internal structure of the specimens. The stones we studied were later subdivided and distributed to the dozens of other members of the sample analysis team around the globe (including a friend of the Observatory, Fr. Cyril Opeil, S.J. at Boston College). We have started seeing some absolutely amazing results coming out of their research. Over the next couple of years, expect to see a flood of publications from them all.

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Diary

Chapter THREE

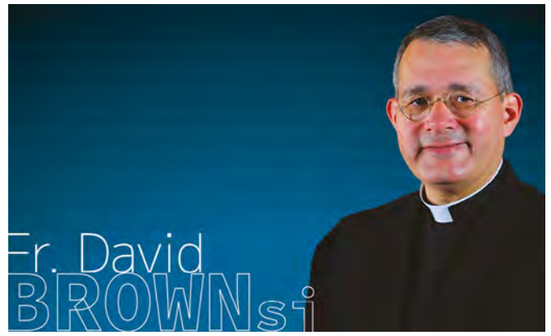
ASTRONOMERS OF THE VATICAN OBSERVATORY

I was last at Castel Gandolfo during the summer of 2019, owing in part to the COVID-19 pandemic. This summer I did go, from Tucson via Boston. I worked with Robert JANUSZ from mid-July to mid-September on our VATT observations of ten Galactic star clusters. Justas Zdanavicius and Dmitrij Semionov of Vilnius University had proposed ten Galactic star clusters for me to observe at VATT. This set may reveal aspects of cluster age, from a recent 10 million years to a much older 1 billion years. Consider that the Sun is known to be 4.5 billion years old. Any of its companions that were forming (like almost all stars do) out of a giant molecular cloud and that would have comprised a cluster when young are now lost in the rotating Galaxy.

The Gaia space telescope of the European Space Agency has freely provided data on 2 billion stars. So, any cluster of stars we observe with VATT has been observed by Gaia with its prisms to give an optical spectra for each star. Robert JANUSZ downloads the spectra and makes synthetic photometry we can compare to our VATT-Vilnius photometry for the work of designating spectral type and luminosity class. The data for the stars in a cluster are of a one percent quality from VATT and Gaia for the research of cluster age and evolution.

I have now completed VATT deep observations of the ten clusters. The now retired method of doing stellar photometry in most all filter systems has been replaced by CCD panoramic photometry. To progress on to new star fields we use the method of "tie-in" where we calibrate the new by the previously known. We compare the tie-in calibration from three telescopes: VATT, the Maksutov of Moletai Observatory, and even Gaia.

The new telescope control system for VATT, called "Don", has automated VATT operation, and we observers are exercising it so that any problems can be resolved. On my latest VATT run in the beginning of October, with the waxing moon, asteroid searching filled the second part of the dark night. My wise collaborator for this, Casimir Cernis of Vilnius University, related that by my observations we have discovered more than thirty previously unknown asteroids. Of course, these wait for confirming observations for the official Minor Planet Center acceptance.



I was able to return to my scientific duties in a more involved capacity in 2024 once my temporary mandate as Vatican Observatory Foundation Treasurer expired on December 31, 2023. Nevertheless, I continued to assist with the transition to a new treasurer, John Lally, for a few weeks in January.

One of the most exciting events I attended during the year was the 243rd Meeting of the American Astronomical Society (AAS) in New Orleans, LA during 7-11 January. In addition to attending several sessions and presentations and plenary talks, I was able to present the PEPSI project results (Potsdam Echelle Polarimetric and Spectroscopic Instrument Potsdam Echelle) of the VO's project collaboration with the Leibniz Institute of Astrophysics in Potsdam, Germany on Monday 8 January. On Sunday 7 January, I also took part in the day-long workshop "Python and Astropy for Astronomical Data Analysis." I then returned to Tucson, AZ to resume my regular research duties. February and March were different for me in that both months involved preparation for and recovery from a non-surgical operation undergone in mid-February.

Having been restored to full health, I then departed from the USA on 26 March for VO headquarters in Castel Gandolfo in order to assume the mandate given to me by the Roman Delegate of the Superior General of the Society of Jesus. I would temporarily assume the

responsibilities of guiding the Jesuit community at the Roman half of the Specola in the absence of the superior of the community, who travelled to Kenya to finish the last part of his Jesuit formation. The responsibilities connected with this mission (from March through early-August) involved much time, but the work helped in continuing to provide the stable atmosphere for the Jesuit community needed for the day-to-day-work of the scientific mission of the Observatory.

Once my mandate ended in early-August, I was able to return in a more consistent way to my scientific research there in Castel Gandolfo. Such research still concerns the ongoing analysis of the majority of the 1000 stars observed during the PEPSI project. The next few weeks would also involve some travels. I travelled to France to do my 8-day silent retreat required by the Jesuit Rule. During 19-21 September, I travelled to Avila, Spain in order to participate in the Third Meeting of the Spanish chapter of the Society of Catholic Scientists. Then on 1 October, I returned to the USA in order to resume my work at the Arizona branch of the VO. In the succeeding weeks, I gave talks at Jesuit Dallas High School, the Newman Centers in Lafayette (LA), ASU in Tempe (AZ), and at the University of Arizona location in Tucson, AZ. With the exception of guiding a retreat at the Jesuit Manresa House of Retreats in Convent, LA during 14-17 November, the remainder of the year has been one of quiet research in astronomy. Having been appointed as Dean of the 2025 Vatican Observatory Summer School, I am beginning to turn my attention more to preparing for the school, which will be held in June 2025 at Castel Gandolfo.

Every year, it seems, some breathless announcement comes from NASA that they've "discovered water on Mars." Yet again! It's become something of a joke. So when I gave a paper at the Meteoritical Society meeting in late July, on the measurements that Br. Bob MACKE, S.J. and Fr. Cy Opeil, S.J. and Dan Britt and I had done on certain Martian meteorites, it was with a smile that I was able to announce that we, too, had just discovered water on Mars.

The issue of water on Mars is important, of course. Liquid water is necessary for life as we know it, which always makes a good press release. And since 1972, when the Mariner 9 spacecraft first saw dried-up river valleys, we've known that Mars must have had lots of water at some time, even though its surface is too cold and its atmosphere too thin to support liquid water there today. So knowing when that water was present can also help us understand the history of the Martian climate.

In fact, actual water was first extracted from Martian meteorites in 1992. But Martian meteorites come in a limited number of types; and, so far, most of the meteorites with minerals that contain water are in the group associated with the Nakhla meteorite (like the one in our collection). The other common meteorite type, associated with the meteorite Shergotty, is chemically and mineralogically different; they are pieces of basalt crystallized from hot lavas and in general they don't have water.

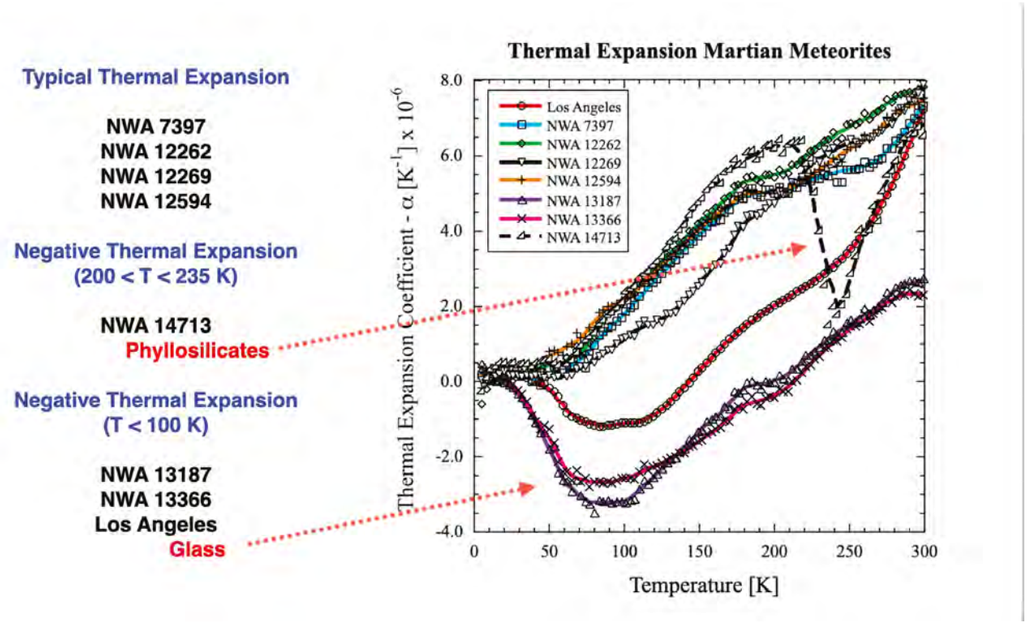
Our experiments, run by Cy Opeil at his lab in Boston College, centered on eight of the Shergottite type meteorites. Among the measurements we reported were the details of how the samples grow or shrink when they change temperature.

Four of those meteorites behaved the way that you would expect a typical mineral would act … as they get warmer, they get slightly larger, at the rate of about ten parts per million from near absolute zero to room temperature. Nothing exciting there. Three more of them show the peculiarity that as the temperature rose from 50 K to 100 K the heating actually made them shrink slightly. That is the same sort of behavior that we had found for certain lunar basalts, and we think that means that there is glass in the rock; the lava cooled quickly enough that it didn't have time to completely crystalize.

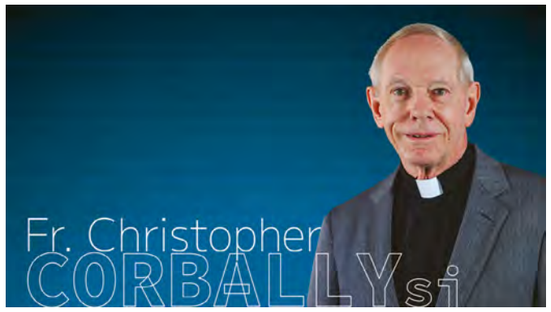
But there was one Martian meteorite that showed a completely different behavior. At 200 K the rock suddenly shrank as it warmed up from 200 K to 240 K. Of course, we have seen this before; this is how water-bearing minerals, such as phyllosilicates, behave due to the water molecules they contain. This was an important feature of the CM meteorites we had reported a few years previously. Seeing it here was, indeed, evidence of water in a Mars rock.

But is it Martian water? Two other groups have reported finding water in shergottite meteorites. One group suggests that this is merely water from Earth that has weathered and contaminated the rock; the other group insists that the mineralogical form is most consistent with the water being Martian. What about our sample? We're still checking that out. Stay tuned!

In this work, I mentioned the collaboration with Fr. Cy Opeil, S.J., of Boston College. Opeil spent his sabbatical year with us at the Vatican Observatory, arriving in Tucson in the fall of 2023 and staying with us through June of this year. Not only did his presence help out the research I've described here, and research for other papers that we have worked on, but he also gave us wonderful, specific advice for ways we could improve our meteorite laboratory. And his presence as a Jesuit in our community was a blessing to all of us.



The coefficient of thermal expansion was one of the characteristics measured of eight Shergottite Martian meteorites. Four of them behave as is typical for most rocks, expanding slightly as the temperature increases. Three show a decrease in size at low temperature, indicating the presence of volcanic glass. And one sample shows a sharp shrinkage at around 235K, suggesting the presence of water-rich phyllosilicate minerals



I always look forward to the International Astronomical Union's General Assembly (IAU-GA). If I borrow the Scouts' word and call it an "astronomers' jamboree", this may give a good idea of why I find these exciting. A General Assembly occurs every three years in different parts of the world and, while some business is attached to the two weeks, the main experience is of sharing research and collaboration. This one, the thirty-second General Assembly, took place in Cape Town, South Africa.

Three of us were able to go: Guy CONSOLMAGNO, Jean-Baptiste KIKWAYA, and myself. Months before it, Jean-Baptiste had contacted the Jesuits in Cape Town. They kindly accommodated us in two of their houses, about a mile apart, and a taxi ride would take us daily to the Convention Center in the town center about six miles away. (Specola adjunct astronomer Ileana Chinnici also attended; she stayed in a local convent, arranged as well by the Jesuits in Cape Town.)

We each have our own stories to tell about the boost in research and collaborations we experienced, but a main result of this IAU-GA was both to shine a spotlight on astronomy in Africa and to support it. In this we can all agree that it succeeded magnificently. You may see this for yourself at **astronomy2024.org**.

My own IAU-GA story includes discussions about the preservation of photographic plates for the invaluable time-domain astrophysics they contain, and enjoying the talk by Marcia Rieke (University of Arizona), which she gave on receiving the 2024 Gruber Cosmology Prize. Her talk emphasized the impact of infrared detectors on cosmology, not least now with the JWST, and she frequently mentioned the fruitful collaboration with her husband, George Rieke.

I presented a much briefer talk on "Weird Binaries" in the session of Division G, Stars. One of the binaries was that of TU Tau A and B, which I described in my report last year; the other was HD5501, an innocuous name until my colleague, Richard Gray (Appalachian State University) discovered that this "star" we can see is not only surrounded by a shell of material but also varies periodically in brightness and in its spectrum. It is an eclipsing binary system, and quite weird at that. But more on this in next year's report when we have a paper published. "We" includes both professional astronomers and those whom I call "small telescope scientists" (STS) rather than amateurs. In my talk at the IAU-GA I emphasized the really significant observations contributed by the latter, and the point was well taken by those present.

Another group of professionals and STSs to which I belong, the GNAT team, has submitted a paper on MG1-1995959. This is also an eclipsing binary system, whose secondary star we cannot see. We know there is a companion to the primary star by the way the brightness of the primary varies (Figure 1). The deep dip in brightness, at Phase 1.0, is when the secondary moves in front of the primary (the "primary eclipse"), while the shallow dip shows the primary moving in front of the secondary (the "secondary eclipse"). However, there is something weird about the variations. When the two stars are out of eclipse as occurs twice in the cycle, and one would expect their combined brightness side-by-side to be the same from our line of sight, the maxima are in fact unequal, as in Figure 1. This is the so-called O'Connell Effect, named after Fr. Daniel O'Connell, S.J., who in 1951 published a paper based on his observations from Australia of the phenomenon. A year later Father O'Connell became the director of the Vatican Observatory until his retirement in 1970.

Of the three main explanations for this effect, our observations of MG1-1995959 suggest that in this case there is an asymmetric distribution of starspots on the primary star (Figure 2). Those starspots, as with sunspots, are cooler than the other parts of the star's surface and so dimmer. Three spectra that I took with VATT a year ago contributed to the confirmation of starspot activity on the primary, to its orbital velocity, and to a classification of its primary with an "educated guess" about the classification of the secondary. These data supported measures of the brightness variations supplied by the other members of the team. I have recently obtained three more spectra from VATT, and these will contribute to our next paper. The probing of MG1-1995959's variations continues since these change from one season to another.

On the interdisciplinary research front, Margaret Boone Rappaport (Human Sentience Project) and I were pleased to find that our book, *The Emergence of Religion in Human Evolution*, now has a paperback edition. The hardback edition was quite expensive. More people can now read its Chapter 7 which this year, during increasing attention to Artificial Intelligence, has led to our writing two papers for the *Journal of Social Computing*. One is published and concerns comparing cognitive competition of Neandertals and early humans, to our coming contest with AIs. The other paper discusses whether we can program AI forms with the foundations of sentience to protect humanity.

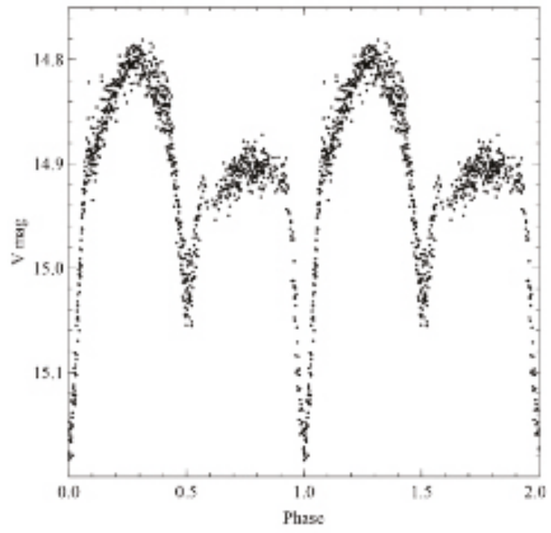


Fig. 1. Phased light curve of MG1-1995959 using GNAT collaboration observations (observations made 2023 July–August). It shows the primary eclipse at phase 1.0, the secondary eclipse at phase 0.5, and the two maxima at phases 0.25 and 0.75. Note how the latter maximum is distinctly fainter than the former - the O'Connell Effect

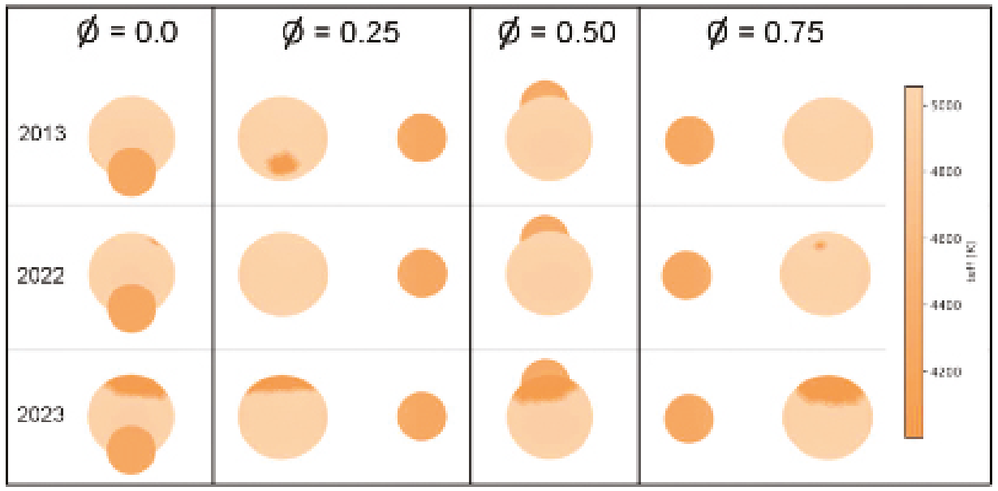


Fig. 2. Graphical representation of the MG1-1995959 system modeled for each of the three years with a starspot that reproduces the observed light curves. That for 2023 is shown in Figure 1. The color scale represents the perceived colors of the hotter primary star and the cooler starspot and secondary star surfaces

This year my Superiors assigned me to complete my last stage of Jesuit formation in Nairobi, Kenya. The tertianship program which ran from the 1st of January to the end of June, is often considered the third year of the novitiate (hence the name in Italian *terzanno*), and generally takes place many years after ordination and a few years before final vows (full integration into the Society of Jesus). After years of studies, it offers a young Jesuit the chance to redo the Spiritual exercises of St. Ignatius and to reread the primary sources of the Society of Jesus through the lens of some years of apostolic experience. For the Jesuits of the Specola, this usually implies integrating one's Jesuit experience after one has spent a few years doing research at the Observatory.

This was my first visit to the African continent, and I was very curious about life in Nairobi. We were nine Jesuits from all over the world who took part in the program, and we were directed by two senior Jesuit masters. It was a great experience where I learned a lot, both about the Society of Jesus, but also about Jesuit life in African context, which is a part of the world where the Society of Jesus is growing the fastest. The distance from Rome also gave me the space to reflect about my Jesuit life at the Specola. But the break from research also gave me the mental space to re-evaluate the many scientific projects I am involved in, and to reconsider my scientific priorities for the next few years.

I returned to Rome at the beginning of August. Even though I was out of scientific action, my colleagues were busy at work as the progress of science continued. One of the highlights of this year was that Camila Beltrame, a student from Chile who I helped direct, was finally able to publish the first resolved stellar halo kinematics of a Milky Way-mass galaxy (NGC 4945) at a distance of 3.56 Mpc far outside the Local Group. This difficult measurement took advantage of stacked observations with the MUSE spectrograph on the VLT and pre-existing HST imaging—where we actually measure the velocities of individual stars in the halo of this galaxy. Surprisingly, we found that the stellar halo at a galactocentric distance of 35 Kpc along the major axis was not rotating. Unpacking the result from this pencil beam observation is difficult, though, as the field of view of MUSE is very small. However, having demonstrated that such a measurement is possible, it now paves the way for us to ask for more time on MUSE and other instruments to measure the kinematics of the stellar haloes of these distant galaxies.

Two things occupied me most this year, both described in the "Instrumentation and Technical Services" section. These were the procurement process for the VATT's new camera and the installation and shake-down of its new telescope control system, *Don*. Let me share a little about *Don*'s installation. I am happy to say that there were no accidents, and nobody fell ill. The challenges were primarily from my anxiety levels.

The first challenge chronologically, was the electricians contracted by the University of Arizona. In early 2023, I had requested that they conduct an inspection of our facility's electrical system and prepare it for the installation of *Don*. They kept pushing the date back further and further, until they finally committed to coming in the last week of March. Miracle of miracles, they did come (in one of the snowstorms!) and did most of the work, but not all of it. They had to make another trip, this time while ProjectSoft's crew were already hard at work. Fortunately, ProjectSoft was able to work around this, and *Don* was not delayed.

The second challenge was a brief but intense time when the crates arrived at the Sky Harbor Airport in Phoenix. It started when the crates were loaded onto a British Airways plane at London Heathrow. Our customs broker sent me an urgent email that she needed $16,000 transferred to her immediately because once the cargo was at the airport in Phoenix, things would need to be dealt with pronto. She explained that it would not take the customs officials more than a few hours to request the customs and import duties, from which point the customer has less than a business day to pay, have the goods released by the customs, and remove them from the airport. The alternative is to pay the air carrier a stiff storage charge per day. After a few hectic hours it all worked out.

The weather was another challenge. The original plan was to perform the installation during July and August, the customary summer shutdown for telescopes in Southern Arizona. Southern Arizona typically gets a light and fairly dry monsoon in July and August with some lightning storms. In the proximity of lightning, we protect our sensitive electronic equipment by disconnecting it from the grid. Hence the July-August shutdown. ProjectSoft would have been able to work around a few lightning storms but in the last few years the number and duration of these hazardous conditions have increased. So, I decided to ask ProjectSoft to come in the Spring instead. I told them that April was a pleasant month, the winter storms being over by then. Hence the plan to install *Don* in April-May. Unfortunately, the last two snowstorms of the season on Mount Graham came in the last week of March and the first week of April. Thanks to the good thinking of GRAY, the crates with the shipment (see the "Instrumentation and Technical Services" section) were moved to the summit in between those two storms.

I cover the rest in this Report's instrumentation chapter. I am happy to say that the news of Don are very positive. Unfortunately, two other issues caused us some stress. One was a close call with the main line bringing power to all three telescopes at Mt Graham, and the other was an issue with the derotator ball bearings.

MGIO's electrical power is provided by the Graham County Electrical Cooperative, Inc. via a power line installed by the University of Arizona in 2001. Astronomical operations powered thanks to this cable started on November 13, 2001. The line, consisting of a bundle of three cables, one for each phase, is at 25 kV and is buried under the surface, first following the historic US Army trail from Fort Grant to Heliograph Peak from the point of sale at Bonita until it reaches the paved portion of the Swift Trail (SR 366). Then it continues under the bottom of the roadside ditch. This is the arrangement both in the paved and the unpaved portion of the road. There are about 10 splices per mile, and one of them was damaged.

In early October, serious issues were discovered with the primary power line. For about 70 days, MGIO provided power generated on-site, using rental Empire Power Systems generators, while the legacy generator served as a backup. MGIO with Sabino Electric located the damage point on the cable. Apparently, water seeped into one of the splices, close to mile post 135 (paved part of SR 366), causing one of the phases to be effectively but destructively grounded at that point. MGIO with Sabino Electric located the problem and excavated the cable. The splice was virtually obliterated by arcing, destroying the the cable carrying the shorted-to-ground phase and severely damaging the other two. Unsurprising, considering that these lines are at 25,000 Volts! We returned to commercial power on December 12.

On the night of November 18 the field derotator (some prefer "field rotator") function of the VATT failed. The matter was diagnosed as a failure of the bearings providing a high-precision, rotating connection between the VATT's optical tube assembly and the instrument interface ("guide box"). FRANZ with GRAY and John Morris (Mtn Ops) dismounted the assembly housing the bearings, and took them to Tucson. These are two 27-inch diameter angular contact bearings supplied by Kaydon (now a part of SKF). FRANZ dismounted the bearings from the assembly and cleaned them, discovering that they resumed to move smoothly with little resistance, and that there is no apparent damage to the surfaces of the balls or of the races. We hope to reinstall everything and resume operations in early January, and so this affair will merit its own paragraph in the Instrumentation chapter of next year's Annual Report.

Never a dull moment…

This year was my second as deputy director. The year immediately opened with several not insignificant challenges for the Specola. Towards the end of 2023, we requested a whole series of maintenance and consolidation works on the buildings of the Specola headquarters and the telescope domes in Castel Gandolfo from the technical office of the Governorate of the Vatican City State, which involved producing a cost estimate for 2025. There was also paperwork for the participation of our employees in the incentivization program of the Governorate of the Vatican City State and for the transfer of our system manager, Antonio CORETTI, to the Telecommunications Directorate of the Governorate.

To celebrate the 30th anniversary of the VATT, Guy CONSOLMAGNO and I delivered a seminar on March 1 drescribing the history and activity of the Vatican Observatory in the Vatican for the employees of the Vatican City Governorate.

On April 26, we celebrated the feast of Our Lady of Good Counsel, the Patron Saint of the Specola. We had the celebration in the Pilgrim Chapel of the Vatican Gendarmerie, presided over by the President of the Governorate, H.E. Card. Vergez, L.C. Present were The Secretary General of the Governorate, Rev. Mother Sr. Raffaella Petrini, S.F.E. and the council of directors and vice-directors of the Governorate.

Three years ago, the legal office of the Governorate wrote a new regulation for the Specola Vaticana, based on the new law of the Vatican City State. The new regulation is "ad experimentum" for three years. Last year the Governorate asked us if we wanted changes to the new regulation. At the suggestion of Fr. Vershueren, S.J., I asked Card. Ghirlanda, S.J. an expert in canon law. After a meeting of Father General, Fr. Sousa, the DIR delegate, Fr. Vershueren, Card. Ghirlanda, S.J., myself and Br. CONSOLMAGNO S.J., we proposed changes to the Governorate.

The biggest event I organized, together with Fr. Matteo GALAVERNI, Massimo Bianchi, Sergio Cacciatori and Fabio Scardigli was the second Lemaître Conference. We had outstanding participants: two Nobel laureates and first-class scientists like Edward Witten from IAS. All participants were received in a private audience by the Pope. Another event at the Specola was the Spirituality and Astronomy conference organized with Sr. Irene Tranquillini, O.FM.I, Fr. Matteo GALAVERNI, and Fr. Robert JANUSZ, S.J. It was very successful as well (more details in the conference section of this Annual Report).

As regards my own research, I finished, with Fr. Matteo, an article on the Hamiltonian equivalence between the Jordan and the Einstein frames. We proved that, fixing the values of some redundant variables, those that do not contain any important physical feature (gauge-fixing of the primary first class constraints, in technical terms) and reducing the degrees of freedom in a careful way following the formalism introduced by Dirac (replace the Poisson Bracket with the Dirac's Bracket defined using the second class constraints derived by the gauge-fixing), the transformations from the Jordan to the Einstein frames are Hamiltonian Canonical. This implies that the solution of the equations of motion in the Jordan frame can be mapped, by the transformation between the two frames, into the solutions of the equations of motion in the Einstein frames. This does not mean that the two frames are physically equivalent. We proved that there exists a "restricted" mathematical equivalence as regards some solutions of the equations of motions that can be mapped between the two frames. There exist solutions of the equations of motion in one frame that cannot be mapped in the other frame. We were able to publish this paper in *European Journal of Physics C*.

Along this line, and in collaboration with Fr. Matteo, we have analyzed the equivalence of the Jordan and the Einstein frames in the case of spherical symmetry. This case is very important for the study of Black Hole Physics. We have derived the equations of motion in the Jordan Frame and in the Einstein frame. We have noticed that, in the Jordan frame, the equations of motion get a contribution from the boundary terms in the action. This does not happen in the Einstein frame. We stressed that, in particular cases, when the transformations from Jordan to Einstein frames are singular, we can map solutions of the equations of motion that are not physically equivalent. Therefore, one important feature is that the transformation from the Jordan to the Einstein Frames is a generator of solutions. This article will be soon completed, and we will send it to a journal.

I also started a research project with Sergio Cacciatori, from the Insubria University. In the past, mainly in my Ph.D. thesis, I inquired into the possibility of developing a discrete approach to Einstein General Relativity which has also a local invariance under the Lorenz group. The discrete approach to Einstein General Relativity is based on the basic idea of replacing continuum Space-Time made out of continuum surfaces with discrete Space-Time made by gluing flat triangles. This discretization of Space-Time, and the Einstein General Relativity theory built on it, is called Regge Calculus, named for its inventor, the Italian physicist Tullio Regge. Regge Calculus deals with invariant quantities (mainly, in two dimensions, lengths of triangles), and so does not depend on any local coordinates. In my Ph.D. thesis, I showed that introducing a local reference frame in each triangle, it is possible to build a discrete theory of Gravity which is locally invariant under Lorentz transformations. Furthermore, this theory contains Regge Calculus. But, both Regge Calculus and this "Local" version of Regge Calculus are "Euclidean" in order to simplify the mathematical structure of the theory and avoid cases of edges with "zero measure". This implies that the time variable could be interpreted as "imaginary" (in the mathematical sense) and does not have a direct physical meaning. This summer Sergio and I were successful in extending the basic building blocks of my approach to Euclidean Local Regge Calculus and develop a Lorentzian Local Regge Calculus. In this discrete approach, we have, in each triangle, a Local "causal" structure of Space-Time given by Minkowski light cones. We hope that quite soon we will succeed in writing an article on this research.

One of the highlights of the year was our collaboration with Richard BOYLE, who came to Castel Gandolfo, as he used to do before the Coronavirus pandemonium. Our work consisted of three parts. The first involved a rather unexpected problem that we had not anticipated when we constructed our procedures for reducing photometric images from the VATT telescope years ago. The issue is that prior to reduction, our data are carefully prepared and repeatedly checked for image header key parameters, which also include the quality of the sky during observation, the so-called "seeing" parameter. For the VATT, it is usually not only excellent, but also stable.

Of course, weather conditions sometimes caused the visibility of the sky on Mt. Graham to drop significantly, which did not usually cause a problem, as observations were simply not made. However, with the method of tying images together from multiple observational fields, the so-called "tie in", very high fluctuations in visibility on many nights could not be avoided, despite Richard's careful efforts during observations. Since the observations tied together multiple fields, it was crucial to modify our calculations, reprogramming the system to be immune to these inconvenient events, which of course involves more careful processing of the images before analyzing them. This situation, of course, affects the calculation of averages, as even transparent nights with variable seeing change the order of reference images and offsets, and even eliminate some, due to the declining quality of image linkage. These details required a lot of discussion to avoid similar situations in the future. We must test it on more data.

So we worked on a few selected VATT observation fields to tie in, with deep fields from VATT and shallower fields, from both VATT and Moletai in Lithuania (provided by Justas Zdanavicius). The Lithuanian method of observation is fundamentally different from what is done at VATT, not least because one has to take into account the so-called camera dark current, and differences in the collection of data. We have only been able to use some of this data so far, but it has allowed us to compare tie-in methods, which, with our fields, agreed very well. This is interesting because the VATT telescope is of a much better class.

Another part of our work has been to use the synthetic photometry model of the Vilnius system, which I am trying to model on our server, to calibrate fields from VATT observations directly, without using tie in. Although this model is still in its infancy, due to the constant need to revisit past publications in search of the optimal calibration and other important ways to move from spectroscopy to photometry (which I will probably write about on another occasion), my model seems to be working reasonably well. The trouble is the extrapolation of the Vilnius U (ultraviolet) filter, since the spectral data from the Gaia space telescope of the European Space Agency, which we use, do not cover its range widely enough. We also have another problem with the P filter, which is admittedly well reflected by Gaia, but the detail of the XP spectrum seems to be too low for this sensitive spectral region.

In the end, Richard and I were able to systematize and complete together our descriptions of observations and analysis so that they can be understood and used by future generations wishing to benefit from VATT observations.

Other major events this year include my participation in preparing and conducting the "Spirituality and Astronomy" conference, and many presentations and support on science-faith issues. I try to do these in a special way when guiding groups of religious people, for whom our work is undoubtedly a source of rich experiences—not merely matters of curiosity, but also of our spiritual apostolate and heritage of seeking and finding the Creator speaking to us also through His gifts to us, which are all the riches of the Cosmos and each other.

Last year, I celebrated 25 years of priesthood. This year, September 13 marked my 40th anniversary of Jesuit life. I entered the Society of Jesus in 1984. As Jesuits, we don't officially celebrate 40 years, but only 50 years, which will occur in 2034. Knowing that the future does not by any means belong to me, but only to God, I decided to celebrate the 40th anniversary with those Jesuits from my year of the novitiate.

Scattered around the world, we could not all meet for the event. I was able to gather with only one in Kinshasa, Democratic Republic of Congo. Fifteen of us entered the Society of Jesus in the Jesuit Province of Central Africa, made of three countries: Congo (then called Zaire), Burundi, and Rwanda. At the end of the novitiate, only twelve of us professed vows. Later, five left the religious life or chose married life, and one passed away. Six of us became priests, and today, we remain only five, as one left the religious life while a priest.

My 40th anniversary celebration of Jesuit life was simple. With the only priest of my novitiate year, Fr. Jacques Ngoma, we had mass. For the homily, we shared our life as Jesuits. I based my reflection on one question: what have I done for God? I ended up saying that my life as a Jesuit is not about doing things for God, but instead about being able to testify to God's mercy in the world, being myself witness of that very mercy from God.

My first research project of the year 2024 was not on science, but on the relation between science and faith. For this project, I wanted to answer the question: Does science discredit religious beliefs? I wanted to take time and reflect upon the question once for all. In fact, any time I give a talk to adults or kids, questions related to my double identity (priest and scientist) come out.

I started by putting together a bibliography on the subject from a European perspective and an American perspective. The books I read from a European perspective are mainly in French and from one author, François Euvé, a French Jesuit, scientist and theologian, Professor of Theology at Facultes Loyola Paris, former Centre Sevres where I myself got trained in theology and earned a master's degree in theology. He wrote the books *Création ou Evolution, and La Science, l'épreuve de Dieu*.

From reading these, I can point out: 1) For Euvé, the relation between science and faith is to be understood in historical perspective. Science emerges from a faith background. 2) The development of science is intimately related to the understanding of reality (the object of science, nature) in its relationship with God (did God create the reality, the nature, once for all? does this reality have anything to do anymore with God?). The answer to these questions is at the base of modern science and could also help us to understand the enlightenment period. We can also understand Voltaire's idea of God as a clockmaker or watchmaker in the sense that God must intervene sporadically to correct and relaunch the reality. The effort here is to see the connection of God with his creation, in contrast to, for instance, Laplace's idea confessed to Napoleon that God would no longer be evoked to explain any reality because Physics alone would be enough.

From the American perspective, I focused mainly on two authors: Ian G. Barbour and John F. Haught. From Barbour, I read several books: *Religion and Science*; *When Science Meets Religion: Enemies, Strangers, or Partners?*; *Issues in Science and Religion*; *Religion in an Age of Science*. From Haught, I read: *The Cosmic Vision of Teilhard de Chardin*; *Resting on the Future: Catholic Theology for an Unfinished Universe*; *God After Darwin: A Theology of Evolution; Making Sense of Evolution: Darwin, God, and the Drama of Life*. Two main ideas emerge from all my readings of Barbour and Haught: 1) Based on Darwinism, as it was expressed by the Jesuit paleontologist, Pierre Teilhard de Chardin, the creation is still evolving toward God's will. This idea opens to hope. 2) Einstein's idea of time is not necessarily physical time that could be analyzed because it has passed, but time as the future. This demonstrates that God has not ceased to create. Therefore, the current state of the world (war, hunger, injustice, etc.) is not necessarily the final one. It will pass and our hope makes us believe that God is moving his creation toward a better place.

I published a paper with the title: "Lightcurves and Color of Seven Small Near-Earth Asteroids; 2023 LQ1, 2023 LT1, 2023 MC, 2023 VQ5, 2023 VE6, 2023 VF6, 2023 VV7". In this work, most of the analyzed asteroids fell among C-type asteroids (Fig. 1 and Fig. 2). While meteorites, mainly originating from asteroids, are more often chondrites linked to S-type asteroids than carbonaceous chondrites attached to C-type asteroids, our result seems to revisit the old belief that carbonaceous chondrites, while large in number, are fragile in composition and don't survive the flight through the Earth's atmosphere. Might our sample be explained instead only by selection effect? We need to extend our collection before we can come out with a solid and acceptable conclusion.

I attended in August the General Assembly of the International Astronomical Union. The IAU was founded in 1919 and this was the first time ever that the general assembly took place in Africa. This 32nd general assembly met in Cape Town, South Africa. It worked very well and was a great success.

After my participation in the general assembly, I went to spend three weeks in Kinshasa. It happened that secondary school was already opened. As I always do, I went to talk with the students of two of the Jesuit high schools. On September 6, I travelled 120 kilometers east of Kinshasa to Kisantu, to the Jesuit high school, College Kubama. On September 13, I met with the students of the College Bonsomi school in Kinshasa (Fig. 3).

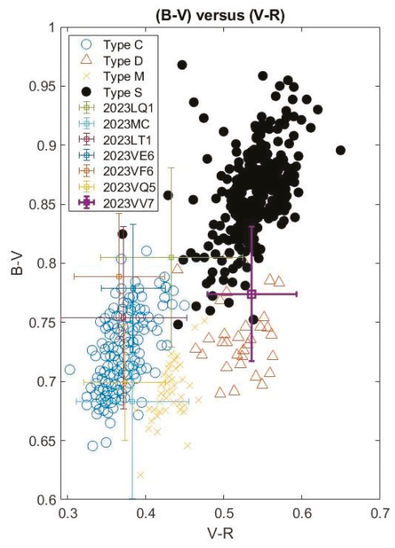


Fig. 1. Two-color B-V versus V-R of 7 asteroids

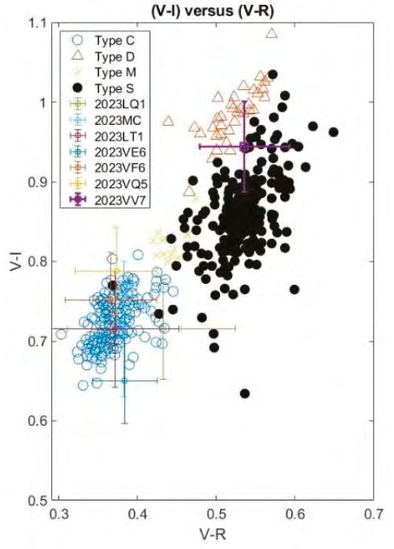


Fig. 2. Two-color V-I versus V-R of 7 asteroids

Fig. 3. Fr. Kikwaya and students of Bonsomi High School, September 13

Because I just started working for the Vatican Observatory in August, I suppose that introductions are in order! A brief History of Me:

I grew up in the Greater Cincinnati area, on the Kentucky side of the Ohio River. After college I fell in love with America's National Parks and started a career as an interpretive ranger, a title that simply meant that I researched, prepared, and presented natural and cultural history programs for the public—both in the parks where I worked and in schools. Although as a government employee I didn't directly use the Jesuit mantra "finding God in all things", I loved helping people uncover the connections between the beauty of park resources and the sacredness of their own lives. My favorite programs to present to visitors were astronomy and night sky talks. After about 15 years into my ranger career, I happened to come across *WouldYou Baptize an Extraterrestrial*, by Br. Guy CONSOLMAGNO and Fr. Paul Mueller, S.J., one of several chance events that awakened in me a desire to be a Jesuit. In 2019, I entered the Society of Jesus at age 41.

This past May, I finished my philosophy studies at Fordham University in the Bronx. My current stage in Jesuit formation is a period of full-time work and ministry, called "regency". Because of my science communication background in the National Parks, I was missioned to the Vatican Observatory as an outreach coordinator. In keeping with the task entrusted to the Observatory by Pope Leo XIII, my job is to spread the word as much as possible that the "Church and her pastors are not opposed to true and solid science … but that they embrace it, encourage it, and promote it with the fullest possible dedication."

Before I arrived, I spent a month at Creighton University in Omaha, Nebraska, taking secondary education courses. This was partially to hone my skills in working with high school students (a significant part of my job as outreach coordinator) and partially to build relationships with teachers at Jesuit high schools across the country. So far this has paid off: I'm slated to speak in many classrooms via Zoom and in person about astronomy, the work of the Observatory, and the relationship between faith and science.

I already have a few in-person talks in schools under my belt. Recently I accompanied Br. Guy on a trip to Cincinnati, where he gave keynote talks at Xavier University (where I went to college) and Thomas More University (where I *almost* went to college). Also at both universities, Guy and I, along with Chris GRANEY, did presentations in individual religion and science classes. I arranged for Br. Guy to be on a vocations panel at St. Xavier High School, and the next day I did a talk at the same school for junior year science classes. Finally, since the diocesan pastor of my hometown church is very supportive of my own vocation, he arranged for me to talk to about 75 middle school students at my old grade school! It was quite a productive trip.

My outreach has not been limited to Catholic audiences. On behalf of the Observatory, I attended a few local Star Parties sponsored by the Tucson Amateur Astronomy Association: one at the Chiricahua Astronomy Complex and one at Saguaro National Park. I also gave talks to docents at the Kitt Peak Observatory and at the Huachuca Astronomy Club.

So far I've enjoyed my time at the Vatican Observatory immensely and look forward to building up more relationships with schools, dioceses, and other organizations across the country!

Rob Lorenz (right) with Br. Guy Consolmagno visiting the artist's community of Covington, Kentucky… including this marvelous image of a famous Kentuckian (Coloner Sanders of fried chicken fame) as a character in a Japanese manga!

This has been a rather busy year for me at the Vatican Observatory. Most notably, as the cover illustration of this Annual Report indicates, was my activity with the OSIRIS-REx space mission, which recovered 121 grams of material off the surface of the asteroid Bennu and returned it to earth last fall. As a member of the sample analysis team, I had designed and constructed an ideal-gas pycnometer for measuring the grain densities of the specimens in a glove box at NASA's Johnson Space Center. Though my work on specimens was scheduled for last fall, owing to delays we didn't get to the actual measurements until February of this year. This was unfortunately a few weeks after I already returned to Castel Gandolfo. I had to virtually look over the shoulder of my colleagues Ron Ballouz and Andy Ryan as they did the measurements, assessing their procedure and making decisions real-time over WhatsApp and Mattermost.

And the results of this activity were, well, not what we expected. It turns out that this particular kind of material—with a very fine-grained structure and abundance of phyllosilicates—produces some odd effects on nitrogen when introduced in the pristine glove box environment. A large quantity of nitrogen gets adsorbed on the surface of grains, leading to unrealistically high grain density values. We don't normally see this effect in meteorites because they adsorb water from the air, which blocks the nitrogen adsorption. The Bennu specimens, however, had never been exposed to Earth's atmosphere and its moisture. We plan to explore the mechanism of this effect a bit more and write a paper detailing our results and what we have learned.

Another major project this year is also a continuation from last year. I was asked by the rector of the Church of St. Ignatius in Rome to make a model of the church, complete with the observatory of Fr. Angelo Secchi, S.J. on the roof. I had already built a smaller version for our Visitor Center in the Pontifical Villas at Castel Gandolfo, but this one is massive, with a base measuring 60 x 110 cm (about 2 ft x 3 ½ ft). As the year began, I had only made the façade, so this year was spent making the entire body of the church. The process proved to be much more complicated than I had imagined it to be. It involved over 1400 hours of 3d printing alone. I finally finished the model toward the end of October, and it is scheduled to be installed in the Church in early to mid December. It will be displayed in the Church of St. Ignatius for the entire Jubilee Year 2025.

The build process is documented on my YouTube channel, "Macke MakerSpace". Speaking of my YouTube channel, I scaled back operations a bit this year. That is mostly due to the work on OSIRIS-REx and the model. I just didn't have a lot of time for video editing. Aside from the videos for the church build, I attempted a stop-motion construction of the LEGO diorama of Galileo Galilei. It's a lot of fun to watch.

This year also marked the first large in-person scientific meeting I attended since the COVID crisis. In August, I attended the Meteoritical Society meeting in Brussels, Belgium. This included a meteorite curator's workshop the weekend before the regular meeting. It was great seeing old colleagues in person. Many ideas were shared, and I regained a lot of excitement for the science that we are all doing. There is so much that can be accomplished in an in-person meeting that cannot be easily replicated by virtual attendance. I also presented results from the OSIRIS-REX pycnometry in a talk that was well-received.

I also went to Tempe, Arizona in November for the Lucy science team meeting. I hope to increase my involvement in the Lucy space mission, which will visit several Trojan asteroids out at the orbit of Jupiter.

I am new to the observatory, so a brief introduction is in order. I was born September 9, 1980, in Łódź (Lodz), Poland. I graduated from the Technical University of Lodz in 2004 with a master's degree in biotechnology and food sciences, and joined the Society of Jesus. After the novitiate, I studied philosophy in Kraków (2006-2008) and theology in Rome (2009-14). I served as vice-director for the Jesuit pastoral program MAGIS—World Youth Day, Kraków 2016 (2014-16), minister of the Jesuit community and coworker in Bydgoszcz parish (2016-20), then as director of an evangelization center (Lodz, 2020-22), and finally as parish priest and Jesuit community superior in Lodz (2022-23).

I moved to the observatory in Castel Gandolfo on August 26, exactly on the 20th anniversary of my entrance into the Society of Jesus. My mission at the Specola encompasses three roles: minister and treasurer of our religious community and assistant to the Director of the Vatican Observatory. In this short time since my arrival, I have started to familiarize myself with both the works of the Observatory and the life of the Jesuit community here.

My first weeks in Castel Gandolfo were occupied in navigating various Italian and Vatican administrative and bureaucratic processes. I also assisted the newly arrived Fr. Bayu RISANTO to go through these same procedures after he transitioned from the community in Tucson to Castel Gandolfo at the beginning of September. Additionally, I took on the role of assisting Fr. Giuseppe Koch as he relocated to the retirement community of Canisio in central Rome in the month of October. While the move was both complex and demanding due to various technical issues at the Canisio house, it gave me a chance to get to know more deeply a fellow Jesuit with rich life experiences (and a fount of information about my new house in Castel Gandolfo) as well as be a support to him in this sensitive transition into a retirement home.

Since the beginning of October, Br. Guy has entrusted to me the task of handling visitor requests to the observatory and its historical sites, and coordinating these with our partners at the Vatican Museums. With Fr. Richard D'SOUZA, I am also working through the various economic aspects of our Jesuit community. One project I immediately took up on arrival is the re-organization of our publication storeroom—often called the "magazzino"; decades of various publications of the observatory were piled up and needed reorganizing. It was a momentous task, but something that urgently needed to be done. Also, at the beginning of November, together with our office staff, Assunta and Romano, we prepared a new office space for Fr. Bayu, our new meteorologist, who inherited the old office of Fr. Giuseppe Koch.

My small role in organizing two symposia—"Stelle e Spiritualità" and the "Assembly of the Alliance of Historic Observatories"—provided me a glimpse of the work of organizing and coordinating events at the Observatory. I was also present at the Observatory's stand at the "Night of Researchers [*Notte dei Ricercatori*]", organized by the *Istituto Nazionale di Astrofisica* at the University of Tor Vergata's research area, where participants could touch a meteorite and look through a telescope. For the first time, I saw Saturn's rings and several moons through our portable telescope, and I helped many visitors, including numerous families, share in this experience. I was especially struck by the awe on children's faces upon seeing the planet. These events brought home the great potential of the Specola in reaching out to scientists and the public at large, and I hope to contribute substantially to promote its effectiveness in these areas.

I published a paper on candidate ram-pressure stripped galaxies, where the ~0.5-degree diameter circular field of the Ultraviolet Imaging Telescope was utilized to image six galaxy clusters at $z < 0.06$ that are known to contain "jellyfish" galaxies. We searched for stripping candidates in the ultraviolet images of these clusters, which revealed 54 candidates showing signs of unilateral extra-planar emission, due to ram-pressure stripping. Seven candidates had already been identified based on optical B-band imaging. We identified 47 new candidates through UV imaging, which we examined, as outlined in the paper (see the "Publications" section).

I gave some public talks about cosmology, faith and philosophy in Peschiera del Garda (VR), Città di Castello (PG) and to the priests of Padova. I collaborated with some nuns of the Società San Paolo "Apostoline", whose main house is at Madonna delle Mole (Albano); every two months I prepare for them a short paper on arguments related to astronomy and faith. And I do the work of a priest, and I take care of my fragile health (and this is a work in progress).

I am a new staff member working as an atmospheric scientist at the Vatican Observatory as of July. However, I arrived in Castel Gandolfo on the 10th of September. Prior to my assignment to the Vatican Observatory, I was a postdoctoral research associate at the Department of Hydrology and Atmospheric Science (HAS) at the University of Arizona. There I worked on two projects:

1) Assessing the impacts of data assimilation on the operational weather forecast called the WRF-HRRR run by the HAS with the long-term goal of establishing the mesoscale observation network (MesoNet) in Arizona. Basically, the data assimilation is an attempt to improve the moisture initial condition of the model by ingesting real observed moistures into the model. The observed moisture data was collected from 30 Global Positioning System (GPS) receivers in Arizona. This project was funded by the National Science Foundation which gave me access to the Derecho supercomputer for running the model in parallel. The preliminary results, which are very promising, had been presented at the American Meteorology Conference on Mountain Meteorology in Boise, Idaho, from the 22nd to the 26th of July. More results will be presented at the European Geoscience Union General Assembly from April 27 to May 2, 2025 in Vienna, Austria.

2) Establishing sub-seasonal high-resolution weather forecast analyses over the Arabian Peninsula for operational use. "Sub-seasonal" means that we forecast the weather out to 45 days into the future. This method allows us to predict heatwaves in the summertime and precipitation in the wintertime with up to a four-week lead time. The former is very important when the Hajj pilgrimage falls in the summertime so that necessary preparation can be made for the safety of the pilgrims. This project is funded by the King Abdullah University of Science and Technology (KAUST), which gave me access to the Shaheen supercomputer for running the model and analyzing the big data output.

About two weeks after I arrived in Castel Gandolfo, I attended the 7th MedCLIVAR and 12th SISC Annual conference in Lecce, Southern Italy, September 23-27. This conference, which is my first conference in Europe, mainly discussed research and studies on the European and Mediterranean climates, both observational analyses and future projections. Since my only purpose was simply to get to know the scientists in the region, learn what they work on, and see some possible opportunities for collaboration, I did not make any presentation. As a result, I got in touch with and began to work with a land surface modeler group in the UK that collaborates with research scientists in Turkey, Brazil, and Taiwan. I also began to communicate with a sub-seasonal forecast group in Ireland for possible opportunities for collaboration. Working with them is my new adventure.

To speak Italian is very important, and thus I started a 5-week long (100 hours) Italian language course in the second week of October at Scuola Leonardo da Vinci in Rome. I learned Italian together with many other students coming from all over the world. The course gave me some basic Italian that enables me to communicate with local people in simple sentences. Since the second week of November, I have been taking classes twice a week in Castel Gandolfo. At the same time, I continue my research with my group at the University of Arizona on improving monsoon precipitation forecasts using high resolution models and expanding my study to modifying the calculation for the distribution of moisture in atmospheric columns. For this project, I collaborate with a postdoctoral research associate from the Department of Mathematics at the University of Arizona. This study involves a lot of mathematical equations, and I am looking forward to seeing the results.

ADJUNCT SCHOLARS

My work at the Vatican Observatory is centered on the study of the history of astronomy with particular regard to the development of astrophysics in the Roman area from its foundation in the middle of the nineteenth century to the present time.

I took also part in the general internal discussions on communicating science as part of the Vatican Observatory's projects in the field of outreach and education.

In collaboration with Rome Astronomical Observatory, I worked on different activities for the bicentenary of the birth of Lorenzo Respighi (1824-1889), director of Campidoglio Astonomical Observatory during the pontificate of Pius IX, and cofounder of the Società Italiana degli Spettroscopisti (today Società Astronomica Italina).

Respighi was the inventor of the objective prism which allows the simultaneous collection of thousands of spectra. The objective prism technique is currently employed in many observatories. The Specola historical collection of instruments includes some objective prisms which were used at the Vatican Schmidt Telescope.

In view of the holy year 2025, I participated in a working group promoted by the Rector of St. Ignazio Church (Rome), Father Vincenzo D'Adamo, which aims to organize events for students and the public. In this context, a model of St. Ignazio as it appeared in the nineteenth century will be placed in the church. This model, constructed by Br. Robert MACKE, shows the observatory of Fr. Angelo Secchi, S.J. atop St. Ignazio.

In my everyday life, in addition to family commitments, I am an active member of my parish community of San Fulgenzio in Rome as a lay minister of the Word and the Eucharist.

As in previous years, my activities in 2024 circled around teaching and research at the Gregorian University, nearly always on topics related to science, philosophy, and theology. I offered a graduate course on the idea of cause and effect, more specifically on how our understanding of causes in science relates to our understanding of causes in the social sciences and in everyday life. I also offered undergraduate courses on philosophy of ecology and on philosophy of science and nature.

Obviously, this kept me quite busy, but I did find time for some research, especially with my research group that works on "The Scientific Mentality and Questions about God". This group meets about once a month for a presentation and a discussion on a specific topic, but we also have an annual one-day workshop during May, normally held at the Vatican Observatory premises at Albano. This year's workshop focused on the concept of life, and one of the presentations, I am happy to say, was kindly delivered by the Director of Vatican Observatory, Guy CONSOLMAGNO, S.J. His presentation was entitled "Recent Advances in Astrobiology". For the group members, all of whom will probably end up as full-time faculty in philosophy or theology departments, such interdisciplinary work is very valuable. Another interesting point about our research group is that, on June 20, a member of the group, Tiago de Quadros Esteves, successfully defended his doctoral thesis. His research was on the way two major theologians, Bernard Lonergan and Alister McGrath, integrated their work in theology with empirical science.

After the summer, I spent the last few months of 2024 as a Boston College visiting fellow. This was a fruitful time for my personal research and writing. Apart from my philosophical work on some key concepts in ecology, I was engaged in a couple of research activities organized by the Jesuit Institute. On September 26, we had a seminar on my forthcoming paper "Artificial intelligence and the person: a dynamic, reciprocal relationship", and on November 14 we had another seminar on my paper "Aquinas and Anthropocentrism", which forms part of my forthcoming book.

2024 has been a very busy year. After editing a book on the Italian contribution to planetary astronomy with my collaborator, Manuela Coniglio, we published the Secchi-Denza correspondence, a project that started many years ago from an idea of Fr. Sabino Maffeo, S.J., and that Observatory Director Br. Guy CONSOLMAGNO, S.J. recently asked me to accomplish. I willingly accepted, as a tribute to Fr. Maffeo, who welcomed me as a student in the 1990s to explore the archival sources of the Specola that were related to the Carte du Ciel project. The publication was more time-consuming than expected because it required a deep revision of transcriptions already made, owing to missing dates or errors in reading dates of the letters. This implied a complete reordering of the letters' sequence, based on an internal coherence of the contents. The final result is a book where, though its scientific contents are less relevant, the amount of historical information is abundant and interesting.

In August, I gave an invited talk at the IAU General Assembly in Capetown. That was an opportunity for me to visit this beautiful town, where nature and landscape are amazing. The excellent organization of the South African colleagues provided a stimulating context for meeting, exchanging and sharing between astronomers from all over the world. I am very happy to have had this enriching experience.

This year I have concluded my service in the Organizing Committee of the International Astronomical Union Commission C3 (History of Astronomy), but I have been appointed member of the Comitato Nazionale Respighiano, established by the Italian Ministry of Culture in order to promote initiatives on the occasion of the bicentenary of the birth of Lorenzo Respighi (1824-1889), director of the Campidoglio Observatory in Rome and contemporary of Fr. Angelo Secchi, S.J. In October, I participated in an interesting scientific meeting in Rome and a public conference in Cortemaggiore (Piacenza), Respighi's native town; I have fond memories of the short stay in that nice land.

Moreover, I have been elected President of the Scientific Instrument Commission (an institution affiliated to UNESCO for the safeguarding of historical collections of scientific instruments) for the next quadrennium. As the Specola has hosted the Annual Meeting of the Alliance of Historic Observatories, I have actively collaborated with the organization by providing contacts with European historic observatories. I participated in person and it was an interesting opportunity for exchange and sharing in the field, reflecting together on sustainable strategies to preserve both active historic observatories and inactive ones.

I have also started a collaboration with the International Centre for Mathematical Sciences in Edinburgh on a project regarding the study of the 1860 total solar eclipse. That eclipse was important because the comparison of the photographic plates taken during the totality phase showed that solar prominences are not optical illusions but phenomena really pertaining to the Sun.

On a strictly personal note, before leaving for Capetown in August I spent a wonderful week in Poland at Czestochowa that regenerated me both spiritually and physically, escaping the awful hot season in Italy. In October, I lost a dear friend with whom I shared a long spiritual path in a missionary group. I am still processing this loss, helped by his wonderful testimony of faith and prayer. In December, I will travel to Kinshasa in order to visit a new dispensary of the missionary institute that I am presently guiding.

During most of 2024 I continued assisting and coordinating the operations to complete the restoration of the historical Carte du Ciel telescope (CdC) and to carry on the maintenance of the other two Zeiss telescopes in the Papal Palace. The following were my main activities:

At the CdC:

- A new objective for the CdC finder was added and the finder wires have been replaced;
- A neutral solar filter was added to allow looking at the full solar disk through the finder;
- New temporary covers for the two objectives of the CdC have been produced: they will be replaced again with more stable ones;
- A new gasket sealing the door on the terrace of the CdC dome has been put in place;
- The marble pillars of the CdC mount have been newly cleaned;
- New bakelite light shields for the eyepieces have been made.

At the Zeiss Double astrograph (DA):

- The sliding contacts have been cleaned so that the drive is no longer discontinuous
- Some gears in the DA mount have been lubricated

At the Zeiss 40 cm refractor ("Visuale"):

- The telescope has been fully cleaned to host visitors into the dome
- A second handrail has been added to the stairs leading to the entrance to the Visuale Dome
- Railings have been added to the terrace above the Papal Palace to host visitors safely
- Assistance was provided to trained operators of the telescope during the public visits to the Specola

A number of public visits to the historical Carte du Ciel telescope and the museum (Visitors' Center), operated in cooperation with the Vatican Museums, have been held during 2024. I assisted in many of them to help the young astrophysicists to correctly operate the Carte du Ciel telescope which now allows the visitors to look at the Moon and the planets directly through the eyepiece. During the year I led or assisted in a number of observing sessions with the Carte du Ciel telescope for the Specola's meetings, for private visitors, and for schools and many amateur astronomer groups. Among the most significant groups were the participants of the second Lemaître Conference in June, and those of the Alliance for Historical telescopes in October. Also, a series of visits to the Zeiss telescopes in the Palace was held to coordinate with the Vatican Museums' responsible parties concerning the right and safe procedure to host visitors.

On January 24 of this year, *Steeped: The Chemistry of Tea* was published by Royal Society of Chemistry Press. Little did I know how controversial the research on salt and tea I referenced in the book would become. Later that morning, the US Embassy in London released a statement saying, "an American professor's recipe for the 'perfect' cup of tea has landed our special bond with the United Kingdom in hot water." They went on to assure "the good people of the U.K. that the unthinkable notion of adding salt to Britain's national drink is not official United States policy. And never will be." The UK Cabinet Office responded. There was a State Department briefing.

Over the next week I gave dozens of media interviews, defending the science: sodium ions will block human perception of bitterness in tea, as well as in coffee. I spoke with the BBC, NPR, and the *NY Times* among others, but perhaps was most excited to be a limerick on the NPR game show, "Wait, Wait, Don't Tell Me!" on the episode featuring Janet Yellen:

> *Before all you Britons find fault,*
> *Take a sip and your whingeing will halt.*
> *While sugar is nice, it's not quite the right spice,*
> *Because your tea needs a wee pinch of … salt."*

Since the book's launch I have given many talks for audiences ranging from readers at a local library, to a group of tea professionals, to chemists. As fun as the kerfuffle has been, I take a greater delight in giving people a way to see more deeply into their cups of tea and hope that the science can let them better appreciate what they are drinking. The created world is a wildly wonderful space to explore.

In early April, I gave a weekend retreat on reading God's "other book", that is, the created world, linked with the total solar eclipse on April 8. The retreat house was in the path of totality, and though the day turned out to be overcast, the experience of totality was an amazing one.

I continue to be a part of a grant out of Notre Dame exploring the ways in which the development of intellectual humility might aid students in their paths to becoming scientists and build a stronger, more ethical framework for science. This is the last full year of the grant and I am working on a team to develop curricular materials for undergraduate science classrooms that address intellectual humility.

I am on a year-long sabbatical leave from Bryn Mawr. Among my other sabbatical travel, I enjoyed a short fall visit to the Specola in Rome, with a chance to explore some of the meterorite collection in preparation for writing an essay about these chemical aliens.

I will return to the classroom next fall only part time. I am looking forward to having more time to write and have begun my next book, a collection of reflections for the Lenten season to be published by Liturgical Press in 2026.

I continued to teach a course on Philosophy of Nature at the Universidad Católica de Córdoba. This expansive subject encompasses a wide range of topics, including History of Science, Cosmology, the origins of life and humanity, and technology through which Homo Sapiens modifies nature and the human environment. This year, I delved specifically into the topic of Artificial Intelligence, a field that is radically reshaping our thinking and teaching. Two specific examples of my work in this regard:

1) "The Search for Extraterrestrial Intelligence, Artificial Intelligence and the Noosphere": I examined how advancements in AI and its integration into the noosphere might broaden our capacity for understanding and communication, proposing that AI could represent a modern phase in the noosphere's evolution. In light of the interdisciplinary challenges associated with exoplanet discovery, it is hypothesized that advanced technology from extraterrestrial intelligence (ETI) might appear indistinguishable from natural phenomena, making its identification particularly challenging. A thought experiment is also presented, exploring the notion of encountering an advanced extraterrestrial AI as a model for potential future interactions with ETI. This speculative approach underscores the philosophical and technological implications of such an encounter, emphasizing the need to reconsider our epistemological frameworks in anticipation of a possible "first contact". I presented a paper on this topic at the II Jornadas de Epistemología e Historia de la Astronomía, Córdoba, in November 2023. It will be published next year.

2) "Artificial Intelligence, the Noosphere, and Ethical Dilemmas": Reflecting on the global crisis from the COVID-19 pandemic and other significant, unintended effects of AI and social media, we might conclude—especially from a Big History perspective—that a second axial age is more necessary than ever to realign our existence ethically. Karl Jaspers called the Axial Age the period of 800-200 B.C. during which the spiritual foundations of humanity were established simultaneously and independently in China, India, Persia, Judea and Greece. Using Teilhard de Chardin's concept of the noosphere, this study employs a thought experiment in the context of the Search for Extraterrestrial Intelligence, proposing AI as part of the noosphere and as a progressive step in humanity's evolution. The study also explores discerning God's role in this cultural evolution, referencing Teilhard's notion of the Omega Point.

During 2024 I, continued an important research project with Fr. Gabriele GIONTI, S.J. We made some progress in the study of the transformation that maps the solutions of alternative theories of gravity into General Relativity, a mathematical trick of looking at the problem through two different mathematical "frames", known as the "Jordan" and "Einstein" frames. The question is whether the solutions given through these two frames are equally applicable to the real world that astronomers observe. Our work led to the publication of a new paper in the *European Physical Journal C*. We also studied in detail the consequences of these transformations for spherically symmetric solutions. These could be useful for investigating various kinds of objects within the universe, including black holes.

I continued my long-term collaboration with Fabio Finelli and Daniela Paoletti at INAF-OAS Bologna. Recently hints of isotropic cosmic birefringence (a signal of new physics beyond the Standard Model) were spotted in the Cosmic Microwave Background polarization data of the Planck satellite. These claims increased the interest in the field of cosmic birefringence research, and I was invited to give some talks both online and in person (Milano, Bologna, Trieste, Catania).

I also had the opportunity to support GIONTI in the organization of the Lemaître Conference 2024: "Black Holes, Gravitational Waves and Space-Time Singularities" as part of the Local Organizing Committee together with Massimo Bianchi, Sergio Cacciatori and Fabio Scardigli. This was very inspiring, and it was a unique opportunity to get in contact with some of the best cosmologists and theoretical physicists.

This year, I also helped organize a three-day meeting on Spirituality and Astronomy in Castel Gandolfo. A few years ago, I had the opportunity to attend the 2019 Faith and Astronomy Workshop in Tucson; I was positively impressed by that program and I thought it would be important to organize a similar program here in Castel Gandolfo. Later the pandemic came, and many projects stopped, but last January I received a call from Sr. Irene Tranquillini, O.FM.I., a high school math teacher and long-standing amateur astronomer, asking me if I was interested in organizing a small workshop on Astronomy and Faith. Also, GIONTI and Fr. Robert JANUSZ, S.J. showed interest in this project and together we organized three days on "Spirituality and Astronomy" at the end of the summer.

In 2024, there was also an increase in the number of requests for public presentations and visits. I gave many popular talks all around Italy. I also supported the participation of the Specola in the outreach event "Notte da Scienziati" (Scientist Night) in Tor Vergata on the outskirts of Rome; more than one thousand people attended this event organized by the National Institute for Astrophysics (INAF) and the National Research Council of Italy (CNR).

People know about Galileo's tidal theory. They know about Fr. Georges Lemaître's Big Bang theory and the idea of an evolving universe. I learned some things this year about these, however, that no one seems to know.

It is generally understood that Galileo's tidal theory, in which he attributed the tides to the combined daily and yearly motions of the Earth, failed to explain the twice-daily nature of high and low tides seen in seas all over the world. By Galileo's theory, some seas should feature tides that are once-daily. It is not generally known, but should be, that in an essay in 1616 Galileo claimed that once-daily tides were found in the Atlantic, in agreement with his theory.

Learning that Atlantic tides were not, in fact, once-daily should have prompted him to revisit the theory. Yet in his 1632 *Dialogue* he did no such thing. Rather, he merely discarded his reference to Atlantic tides, seemingly suppressing data contrary to his theory—a big no-no!

However, I discovered that he had other data, from a reference book on navigation that a friend found for him, indicating that once-daily tides did exist, but in Indonesia (and indeed they do). Galileo only had to mention this in the *Dialogue*, and his claims about the tides would have been much stronger. Given that he viewed his tidal theory as powerful support for Copernicus (he initially envisioned including the words "on the tides" in the *Dialogue*'s title), did he simply omit this inadvertently? (Note—even if it was inadvertent, someone reading his published material would reasonably think he was suppressing data.)

"Galileo and Buonamici on the Tides of the Sea: Was Something Omitted from the Dialogue?" appeared this year in the *Journal of Astronomical History and Heritage* (vol. 27). I've made a pretty cool and significant new discovery in an area where a lot of people have been working for decades. And there is a funny thing about this paper—it began in March 2023 when I was quarantined with COVID-19 at the Specola at Castel Gandolfo. I caught it from (I believe) a rather mature man on my flight to Rome who coughed his head off continually. I got sick enough (despite vaccination) to run a serious fever, but not so sick as to be incapacitated. To keep busy, I availed myself of the Specola library. My reading of that material led to this line of inquiry.

My work with the Specola also led to my inquiries into evolution. Last year Br. Guy CONSOLMAGNO and I published our book *When Science Goes Wrong: The Desire and Search for Truth* (Paulist Press). There we delved into the subject of nineteenth-century ideas regarding evolution and spontaneous generation, in connection with "scientific racism" and eugenics—clear examples of science going wrong. Over this past year I have been expanding on that work, studying how discoveries that the universe is not eternal but evolving and that life is not regularly generated from matter bear on the question of life broadly, especially in a universe that began in a "Big Bang" so hot that even atoms did not initially exist, never mind life.

Will this work result in future publications? Being a part of the Vatican Observatory certainly seems to stimulate my work, so I think "yes".

This year I published one book and four papers, as detailed in the other sections of this Annual Report. I participated in our annual mathematical workshop in September in Kielnarowa (near Rzeszów): "Quantum mechanics, category theory and robot consciousness". We decided to publish the results of our work in a special bulletin. The idea was implemented, and during the workshop we were able to announce the creation of a new journal, entitled *Kielnarowa Review*. It is an open access journal (**journals.wsiz.edu.pl/kr**), available not only to the participants of the workshops in Kielnarowa, but to others who are interested, too.

Niagara Falls is a popular tourist destination within easy striking distance from Toronto, and I have consequently visited several times. This spring, though, I had the Falls almost all to myself. I was in town to give a keynote talk at the annual general meeting and conference of the Ontario Catholic Supervisory Officers' Association (OCSOA), and the hotel was right on the river, about a kilometer downstream of the Horseshoe Falls. Of course, my main reason for being there was for my presentation to the OSCOA, which represents the leadership of the twenty-nine publicly-funded Catholic school boards in Ontario. My talk was called "Space for Faith: Inspiration from Astronomy for Integrating Science and Faith in Catholic Education". Even though I do not directly use data from the James Webb Space Telescope (JWST) for my own research, I showed lots of JWST images to convey the vast distances and timespans that our universe contains. I also highlighted the contributions that Catholic clergy have made to astronomy, including some connected to the Vatican Observatory. Not only did I introduce some ideas on faith and science from Angelo Secchi (1818-1878), the "Father of Astrophysics", but I also shared illuminating words from Fr. Gabriele GIONTI, S.J. and Fr. Matteo GALAVERNI, quoted from recent interviews they have done about their work in cosmology.

I may not use cutting-edge data from JWST, but I am excited about another frontier that I and my colleagues are exploring. Time domain astronomy is the study of objects that have variable brightness: either objects that are constantly changing, like the bright jets coming out of active galactic nuclei (AGN), or else "transients" that suddenly appear and then disappear on time scales ranging from a fraction of a second (like fast radio bursts) to many months (like the afterglows of extragalactic explosions). We are exploring the time domain at millimetre wavelengths, using data from cosmic microwave background (CMB) telescopes. In April we published a paper where we looked in our archival data from the Atacama Cosmology Telescope (ACT) for signs of emission from transients that had been detected at other wavelengths (Hervías-Caimapo et al. 2024—see "Publications"). Although we would have had to have been lucky to see any of these events—and unfortunately we were not lucky!—it was the first time we had explored our data in this way. Just as importantly, this paper prepares the way for future time domain astronomy with Simons Observatory (SO), which will begin full operations in 2025, once the mirrors for its Large Aperture Telescope arrive on site in Chile. As I write this, they are about to start their journey by ship across the Atlantic Ocean, after having been manufactured in Germany! We have started working on the software pipeline that will process our large quantities of data so that we can have quick alerts of any new transients. Meanwhile, with one of my PhD students and several other colleagues I am busy studying the "light curves" (brightness vs. time) of AGN data seen with ACT. I presented some of this work in a poster at the "Hotwiring the Transient Universe VII" conference held here in Toronto in May 2024.

I also continue to study the cosmic web, working closely with colleagues at the "La Sapienza" University of Rome, who I was happy to see when I was in Italy in the summer, both at the European Astronomical Society Annual Meeting in Padua and at the Vatican Observatory when I hosted Valentina Capalbo, Giovanni Isopi and Eleonora Barbavara, all PhD students in Rome, for a day visit. I am the co-supervisor of the latter student, Eleonora, together with my colleague Prof. Elia Battistelli, who was not able to join them that day, unfortunately. All three of these PhD students made great presentations on our work at the conference in Padua, and we recently submitted one related journal paper and have another only a couple of weeks behind.

After my stay at the Specola—where I also had the privilege of attending the Lemaître Conference in June—I returned to Toronto via the University of Chicago to attend the Simons Observatory collaboration meeting. We are now over 400 members, and even though not everyone came, it was still a large and energizing meeting.

Now I am in the middle of the fall term at the University of Toronto and am being kept as busy as ever. I am teaching the graduate cosmology course, which is very enjoyable even though it does take up lots of my time as I re-learn the details of my own field and try to write up the problem sets in time! My research group currently contains one postdoctoral fellow (co-supervised with another faculty colleague), two PhD students and two undergraduates.

Finally, to close by explicitly reconnecting science to faith, I concelebrated our local, annual Gold Mass for scientists and their family and friends with my Jesuit confrere Fr. John McCarthy. This was on 15 November, the feast of Albert the Great, patron of scientists. It was at the University of Toronto's Newman Center. Fr. John is a fellow scientist, but unlike me, who looks up to the skies for my research, he looks *down* to observe lichens, his area of expertise. He does extensive field work in the Canadian wilderness and has even discovered new species of lichen, including *Cladonia ignatii*, named, as you might have divined, after St. Ignatius of Loyola!

This year I was very sad not to be able to visit the Specola and interact with the Specola staff in October as I so often do. I visited the Department of Physics of the Universidade Federal de Santa Catarina, to collaborate with Prof. Roberto Saito in January, February and March. In April I finished my term as the Director of the Institute of Astrophysics at Universidad Andres Bello in Chile, with Prof. Matias Gomez as our new Director. I was very happy to attend the ceremony to become a member of the National Academy of Sciences of Buenos Aires on April 18. This year I was awarded the Physics of the Year 2024 Award in Chile from Research.com. I was also appointed to the Galactic Plane Survey Definition Committee of the Nancy Grace Roman Space Telescope, to be carried out after launch in late 2026. I was also elected to the steering committee of the Division H ("Interstellar Matter and Local Universe") of the International Astronomical Union.

Among other milestones, we finished the 13-year long observations for our program VISTA Variables in the Via Lactea Extended Survey (VVVX). This megaproject is an ESO public survey, that was published recently in *Astronomy & Astrophysics*, in collaboration with Fr. Richard D'SOUZA and Fr. David BROWN from the Vatican Observatory (VO). The associated press release received ample coverage worldwide, being translated into many languages (**www.eso.org/public/news/eso2413/**).

The readers of this Report may have followed, in recent years, the Dark Matter search saga with the LUX-ZEPLIN (LZ) experiment. In 2022, we announced a world-record result of "not finding Dark Matter, with unprecedented sensitivity". In 2023, a journal reviewer found a subtle statistical mistake in our analysis, which led us to present a revised result at the UCLA Dark Matter Conference. As luck would have it, I had the pleasure of announcing our revised result at that conference.

Earlier this year, we were getting ready to announce an even more record-breaking result of not finding dark matter, when we identified another subtle inaccuracy in our analysis methods. While observing the ultra-rare phenomena of electron capture and double-electron capture on Xenon nuclei, we realized that the measurable energy was suppressed due to the complex topology of the phenomenon in question, which causes localized X-ray and Auger cascades in the Xenon nucleus. This slight discrepancy between data and model was already visible in our 2022 result, but an explanation eluded us until recently. After completing the first empirical measurement of this energy suppression effect, we announced a new result in August which, as expected, surpassed our previously established record.

This result represented a stark improvement in the reliability of our measurements, because it included, for the first time, the bias mitigation framework called "salting": a technique that adds fake WIMP signals during data collection. By obfuscating the real data until "unsalting" at the very end, researchers can avoid unconscious bias and keep from overly interpreting or changing their analysis. I was especially proud of this effort, because it proved technically and scientifically challenging, and was led by two long-time members my team: Stanford postdoc (and former grad student) Tyler Anderson, and Berkeley Lab emeritus scientist Simon Patton. And yes, I appreciate the irony of calling out the reliability of our result, when year after year I've been telling a saga of "our result was slightly wrong". I am indeed looking forward to being wrong again next year, because it means that we will have learned something new.

June saw a review of LUX-ZEPLIN operations organized by the Department of Energy in Berkeley, California. This prevented me from attending the Lemaître Conference at the Vatican Observatory in person. However, the great news was that our experiment was extended through 2027, with additional data analysis in 2028. Luckily, I still managed to visit the Specola in the summer, because I was invited to give an overview talk at the 15th International Workshop on the Identification of Dark Matter (IDM) in nearby L'Aquila.

The conference was co-chaired by my dear friends Paolo Gorla, Alfredo Ferella and Natalia Di Marco. It was a treat to reconnect with colleagues from my graduate and postdoctoral years. Additionally, I had the pleasure of sitting next to my postdoctoral advisor, Elena Aprile of Columbia University, while an exciting result from her experiment was announced: the first "hint" of coherent scattering from solar neutrinos. Elena's experiment and mine are technically rivals, but I am unable to really "feel" the competition, because we are all pursuing the same goal of pushing the goalpost of knowledge a little bit further. This allowed me to feel joy and pride for my former advisor, while witnessing her success… and I am delighted to share that my field has learned something new, even if my team didn't get there first.

In addition to looking for dark matter, I continued my exploration of artistic pursuits. In May, I attended an iconography workshop at the Holy Transfiguration Monastery in Redwood Valley. Painting is the hardest art form for me, but in the words of my teacher, abbot Damian Higgins, iconography is ideal for those who are "artistically challenged", because it requires humility. At the retreat, I painted the Byzantine Icon "Our Lady of the Sign", which depicts the Mother of God during the Annunciation, at the moment of saying "May it be done to me according to your Word". This style of Icon is also called the Platytera: poetically, by welcoming the Creator of the Universe in her womb, Mary has become "More spacious than the Heavens" (Πλατυτέρα των Ουρανών), because "She contained He who could not be contained". In many Byzantine churches (both Catholic and Orthodox, as this style of Icon predates the Great Schism), the Platytera is prominently displayed on the half-dome that stands above the altar: it is visible above the iconostasis, directly facing the congregation, and represents the unity between heaven and earth.

Our Lady of the Sign, Holy Transfiguration Monastery, Redwood Valley, California

As in previous years, my main activity in 2024 was to hold the Chair of Fundamental Theology at the Pontifical University of the Holy Cross in Rome, where I promote activities of dialogue between science, philosophy, and theology. These include directing the Research Center on Science and Religion, the Advanced International School for Interdisciplinary Research (Italian acronym SISRI, **sisri.it**), and the web portals **inters.org** (Interdisciplinary Encyclopedia of Religion and Science) and **disf.org** (Italian website on science and faith). In fact, to be honest, the purpose of my work is not only to promote the dialogue between science and faith, but also to help my theologian colleagues to use more the natural sciences in their studies. Most theologians have long been using the humanities and historical sciences, but still find it difficult to handle the results of contemporary sciences, such as physics, astrophysics, chemistry or biology. Precisely to bridge this gap and to promote cross-fertilization between theology and other disciplines, I have given a 24-hour course at my university entitled "Lectures on Science and Theology: Historical and Philosophical Perspectives". An abridged version of the course, adapted for the web audience, will soon be offered free online.

I would like to mention here two collective volumes to which I contributed this year. The first was conceived by SISRI and is entitled *Origins: The Great Questions about the Cosmos, Life and Intelligence in Science, Philosophy and Cultures*. Philosophers, historians of religion, theologians, physicists, biologists, and computer scientists contributed to it. I have edited two chapters respectively entitled "The Cosmos as Creation in Judeo-Christian Revelation", and "Intelligence and Personal Self in Theological Perspective: The Human Being in the Image of God". The volume includes a foreword by the renowned Italian physicist Carlo Rovelli, known for his work in quantum mechanics.

The second volume was designed by the Catholic University of the Sacred Heart in Milan and is entitled *Understanding and Communicating Science*. In fact, the book aims to help the public understand how the media and popular science "translate" the results of scientific research, remembering that these results must be read in their correct perspective. I contributed to the book by writing the chapter entitled "Conjectures, Predictions and Results in Astronomy, Astrophysics and Cosmology".

As a Catholic priest, I am also concerned that the catechesis and explanation of the Christian faith should take into account the results of science and show, especially to young people, the harmony between science and faith. This is one of the objectives of the work of the Research Center that I direct, especially of the web platform DISF Educational (**disf.org/edu**), which is now a tool used in many Italian schools, with about one million pages read every year. One of my dreams is to find a benefactor who will finance the English translation of this web platform in order to reach an even wider school audience. If there are any among the readers of this report who would like to join this project, they are welcome! Also, with the aim of helping priests and catechists to give a catechesis attentive to the results of science, I have written an article entitled "Scientific Thinking and the Transmission of the Faith: Some Guidelines for Catechesis".

This year I was again invited to participate in the Space Festival, organized every year by Italy's first astronaut Franco Malerba. As in previous years, SISRI organized a competition for young researchers and awarded a special prize to the best paper submitted. The title of this year's competition was "Shared Horizons: The Path of Social Inclusion and Equal Opportunities in Space Exploration". Maria Giulia Andretta, with a double degree in astronomy and philosophy, won the 2024 prize. The Space Festival is attended by astronauts, scientists, journalists and space economy operators. It has become a tradition that my presence covers not only the astronomical aspects—I also play the role of … chaplain there! In fact, for several years now, the Sunday Mass I celebrate has been officially included in the Festival schedule, so that the Catholic faithful and those who wish to participate can attend the liturgy.

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Workshops

Chapter FOUR

LEMAÎTRE CONFERENCE 2024:

"BLACK HOLES, GRAVITATIONAL WAVES AND SPACE-TIME SINGULARITIES"

"Georges Lemaître was a priest and an exemplary scientist. His human and spiritual journey represents a model of life from which we can all learn." With these words Pope Francis welcomed the participants in the Georges Lemaître 2024 conference, the theme of which was, "Black holes, gravitational waves and space-time singularities".

Following the success of the first Lemaître conference in 2017, the Specola Vaticana welcomed scientists from all over the world to Castel Gandolfo, from 16 to 21 June 2024. Among the 40 participants at the meeting were Nobel Laureates Adam Riess and Roger Penrose; cosmologists and theoretical physicists Andrei Linde, Joseph Silk, Wendy Freedman, Licia Verde, and Cumrun Vafa; and the Fields Medal recipient Edward Witten.

The participants were welcomed on Sunday evening, June 16, with an official reception at the Specola headquarters attended by several officials, including Sr. Raffaella Petrini, F.S.E., Secretary General of the Governorate of the Vatican City State. The days were characterized by a very intense discussion among the scientists who had the opportunity not only to expound their ideas during their oral presentations, but also to contribute, at the end of each day, to an in-depth discussion on the main topics of debate that emerged during that day. This debate formula, together with the special atmosphere of hospitality and intellectual inspiration that is peculiar to the Vatican Observatory, allowed for an extraordinarily creative and productive confrontation between exponents of different scientific communities, even those far apart. Scientists specializing in the latest observations, theoretical physicists, and historians of science had the opportunity to find a common language and to focus on the most important challenges in astrophysics, cosmology, and quantum gravity.

The discussions revolved in particular around the enigmatic nature of spacetime singularities encompassing the Big Bang and black holes, the perplexing "Hubble tension", gravitational waves, and the tantalizing pursuit of quantum gravity and its connections with entanglement and the foundations of Quantum Theory.

"It was stimulating and enlightening to learn more about Georges Lemaître", writes one of the participants, "and the latest developments in so many areas of research that descend from Lemaître's vision and contributions. In addition, visiting the Specola, the Vatican and meeting Pope Francis were stimulating and enlightening experiences!… I think Georges Lemaître would have been very happy to attend the meeting, and in fact I felt his presence and imagined him there in the room with us."

During the private audience on Thursday, 20 June, Pope Francis also reminded participants how,

> *The Church is attentive to such research and promotes it, because it stirs the sensibility and the intelligence of men and women of our time. The beginning of the universe, its ultimate evolution, the deep structure of space and time confront human beings with an anxious search for meaning, in a very vast scenario where they risk getting lost. This makes us rediscover the relevance of the words of the Psalmist:*
>
> > *When I look at thy heavens, the work of thy fingers,*
> > *the moon and the stars which thou hast established;*

what is man that thou art mindful of him, and the son of man that thou dost care for him? Yet thou hast made him little less than God, and dost crown him with glory and honour (Ps 8:3-5).

It is thus clear how these themes have a particular relevance for theology, philosophy, science and also for spiritual life.

This year the Vatican Observatory decided to also organize an outreach event open to all the people interested in knowing more about the latest results in this very active field of research. Thus Viviana Fafone (University of Roma Tor Vergata and INFN) and Gabriele Venziano (CERN and Collège de France) spoke about "Black Holes, Gravitational Waves and the Universe before the Big Bang".

The conference was also supported by the INFN (Istituto Nazionale di Fisica Nucleare/National Institute for Nuclear Physics), one of the most important Italian public research institutes. More information about the conference and all recordings of the talks are available at: ***https:// www.vaticanobservatory.va*** and ***https://indico.cern.ch/e/lemaitre2024***. A dedicated collection of papers will appear on General Relativity and Gravitation at Springer Nature: ***https://link.springer.com/collections/fcfibbicbi***

Private audience with Pope Francis and the presence of Cardinal Fernando Vérgez Alzaga, L.C. and Sr. Raffaella Petrini, F.S.E.

The Local Organizing Committee of the Lemaître Conference 2024: Sergio Cacciatori, Massimo Bianchi, Fabio Scardigli, Gabriele Gionti and Matteo Galaverni

Sr. Raffaella Petrini, F.S.E observing at the telescope during the welcome reception

Group photo of the Lemaître Conference 2024

SPIRITUALITY AND ASTRONOMY WORKSHOP 2024

"*Spirituality and Astronomy 2024 – 'When they saw the star they felt great joy' (Mt 2:10)*": this was the theme of the workshop that took place from 30 August to 1 September at the Vatican Observatory in Castel Gandolfo. The meeting included introductory lessons, moments of prayer and sharing, as well as a visit to the historic telescopes at Castel Gandolfo and evenings dedicated to observing the sky. Participants were accompanied by members of the Jesuit community, by researchers from the Vatican Observatory, and by professors and amateur astronomers.

The workshop opened on Friday, 30 August, with a general introduction given by Br. Consolmagno, followed by a presentation from Gabriele Gionti on the theme of "The Scientific Apostolate of the Society of Jesus: Jesuit Scientists from Clavius to Coyne". Subsequently, a Mass was celebrated in Castel Gandolfo, followed by a guided tour of the telescopes of the Papal Palace. After dark, Claudio Costa showed participants the Visitor Center of the Observatory and facilitated observations of the sky.

The following day, Saturday, 31 August, Monsignor Tomasz Trafny, of the General Secretariat of the Synod, spoke on "Spirituality and Astronomy", followed by "Look at the Sky and Count the Stars" by Sr. Irene Tranquillini of the Ursuline Daughters of Mary Immaculate. A discussion session was then held among the participants, who were divided into groups.

Following an observation of the sun from the courtyard of the Specola, Monsignor Carlo Maria Polvani, Adjunct Under-Secretary of the Dicastery for Culture and Education, gave an afternoon talk on "The Impact of Scientific Culture on Contemporary Culture". He was followed by Fr. Matteo Galaverni speaking on "Open Questions in Cosmology: What We (Don't) Know". Mass in the headquarters of the Vatican Observatory concluded the day.

On Sunday, 1 September, the program included early observations of the sky from the courtyard of the Vatican Observatory, followed by a moment of prayer led by Father Guidalberto Bormolini. Subsequently, Robert Janusz gave a presentation on "Christian Spirituality and Creation". Then Father Bormolini spoke on "Cosmology from Ancient Peoples to the Fathers of the Church". The workshop ended with final discussion and Mass at the Observatory.

https://www.vaticanstate.va/it/novita/507-un-workshop-alla-specola-vaticana.html

Group photo of the participants to the Spirituality and Astronomy workshop 2024

Fr. Robert Janusz and participants in the Specola Visitor Center

Participants to the Spirituality and Astronomy workshop 2024

Msgr. Tomasz Trafny, General Secretary of the Synod

Msgr. Polvani Carlo Maria, Under-Secretary Dicastery for Culture and Education

THE FIFTH ASSEMBLY OF THE ALLIANCE OF HISTORICAL OBSERVATORIES. OCT 3-5, 2024

The Assembly of the Alliance of Historic Observatories (AHO) was hosted by the Vatican Observatory in Castel Gandolfo on October 3-5, 2024.

Before we discuss this event, we must address a point of confusion which seems to persist, mistaking the Alliance of Historic Observatories (AHO) for the Antique Telescope Society (ATS; ***https://antiquetelescopesociety.org/***). Visual aids may help. The two logos side by side ought to highlight the contrast between the two societies. The logo of the ATS clearly shows that its focus is the telescope while AHO is about observatories.

Antique Telescope Society's logo

Logo of the Alliance of Historic Observatories.

AHO is an association of institutions, while ATS is a society of individual telescope experts, professional and amateur, who collect antique telescopes, restore them, and research their history.

The confusion may be less baffling if we note that on October 9-13, 2023, the ATS held its 32nd Annual Convention in Rome, and toured the Vatican Observatory. Claudio COSTA and Adriano LOLLI are esteemed ATS members.

In contrast, consider the following from AHO's mission statement:
"Historic observatories are places of awe and discovery where modern astronomy was born, and humankind's understanding of the physical universe emerged."

Note that the adjective "historical" denotes things of the past, while the adjective "historic" describes something that made and/or makes history. This is what AHO's membership criteria elaborate:

An observatory / institute is eligible for regular membership in AHO if it is "widely recognized as having made historic and on-going contributions to one or more of the following:

- *astronomy, astrophysics, or closely related disciplines;*
- *public engagement and/or information on astronomy or closely related disciplines;*
- *and/or having notably served the public, national, or international interests through the application of astronomy or closely related disciplines.*

Even stronger words resounded during the debate (highlighted in quotation marks). Humanity is "coming of age in the Milky Way" (to paraphrase a book title) and historical observatories were places where the "book of the universe" was opened to us.

At the October Assembly, our Palomar colleagues shared what effect their observatory has on visitors, especially the children. When they enter the dome of the Palomar 200-inch (5-meter) telescope, they find not just information, but inspiration. This breathtaking work of 1930's engineering (picture) is a "sacred place" and visitors become "pilgrims" because this "cathedral of science" is part of our story, shaping our identity as a civilization. We marvel that we, so tiny on a cosmic scale, have been given, against all reasonable expectations, the ability to explore the amazing Universe of which we are a part.

Here we see a confirmation of the thesis that reading the book of Creation (cf. Rom. 1:20) naturally leads to the insistent impression that we are incredibly gifted. And gratitude is the foundation of religion.

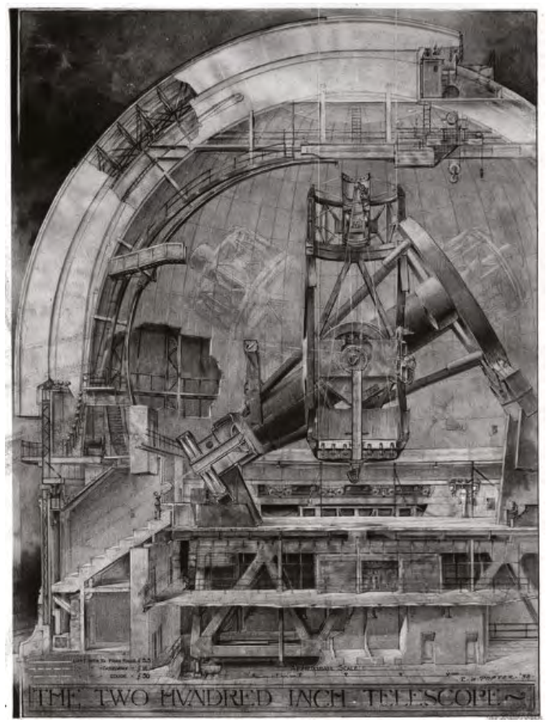
AHO's first two meetings were held on June 15-16 and October 19-20, 2019. Both were in Southern California, the first was at Mt. Wilson, the second at Palomar. In addition to these two hosts, AHO founding members are Lick, Griffith, and Lowell Observatories, as well as the Vatican Observatory.

After a pandemic hiatus, the Assembly at Lowell Observatory in Flagstaff on November 4-5, 2022 recaptured the group's momentum and enthusiasm. We agreed to draft bylaws, which we adopted at the fourth Assembly at Yerkes Observatory on October 5-7, 2023.

The AHO is primarily a forum for sharing. One of our common concerns is financial support. Our sponsors share in our mission and their contribution is not limited to finances. The first joint project was held at Lick Observatory on April 29 - May 1 of 2024, focusing on our docents. These are enthusiastic volunteers who are valuable collaborators in our broader mission to communicate the science of our universe.

We at the Vatican Observatory were very happy to host the AHO's fifth Assembly at the Specola in Castel Gandolfo. This was the first time we met in Europe. Thanks to CHINNICI several notable European representatives came to present their institutions: Armagh, Edinburgh, Greenwich, Hamburg, Heidelberg, Naples, Padua, Palermo, Pic du Midi…

After a nice reception at the domes in the garden in the evening of Thursday October 3, we had a busy day of updates from members and presentations of guests (potential new members) on Friday October 4, followed by the official dinner (catered in the Clavius Hall). The morning of Saturday October 5 was devoted to a business meeting for members only, discussing and approving



The Two Hundred Inch Telescope. Drawing by Russell W. Porter, 1958

changes to the bylaws and electing the board and officers, etc. (GABOR was reelected to the board). In the afternoon, we visited the domes at the "Palazzo".

A notable point under discussion were the initiatives to include historic observatories as a category of World Heritage recognized by UNESCO. Professor Gudrun Wolfschmidt from the Hamburg Observatory (University of Hamburg) gave a presentation on this work at the level of the International Astronomical Union, and some information was added regarding the activities within the American Astronomical Society by Harvard's Sarah Schechner.

As of December 20, 2024, the AHO membership is, in addition to the six founding members mentioned above: Detroit, Dominion Astrophysical, McCormick, McDonald, Pic du Midi, Sommers-Bausch, Van Vleck, Yerkes, University of Illinois, Washburn (U Wisconsin), Armagh. The following observatories applied for membership: Heidelberg (Landessternwarte), Maria Mitchell, Boyden, Harvard, and Cincinnati.

The meeting went very smoothly thanks to GIONTI, OLCZYK, BALZONI, REGGIO, and CORETTI, as well as GALAVERNI, CONSOLMAGNO and others. Special thanks to COSTA for the much appreciated tours of the telescopes, and to CONSOLMAGNO for a well-received dinner talk. Last but not least, thanks to ProjectSoft for generously sponsoring the meeting.

Some of the moments of the AHO group's visit to the visitor center of the Vatican Observatory in Castel Gandolfo. The guests observed through the telescope Carte du Ciel, under the guidance of Claudio Costa

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Technical News

Chapter FIVE

VATT UPGRADES

Minor upgrade projects continued. Robert Crawford joined the efforts of Daewook Kim, Heejoo Choi and Solvay Blomquist (University of Arizona) on the automated collimation and collimation maintenance procedures. Gary Gray continued to supervise the work on the hydrostatic-bearing oil chillers. We acquired a new chiller directly through a vendor and had it installed by Rhodes Enterprises LLC, Safford. Franz replaced the dome's bogies. Johnson with Navarro worked on the software environment for the astronomical instruments (mostly ASCOM/Alpaca), and towards fully autonomous operations, including remote shutdown and startup of the facility. Thomas Reeve oversaw work on the facility's electrical installation, performed by Sturgeon Electric.

DON

We installed *Don*, a new telescope and facility control system, thanks to the Vatican Observatory Foundation, the Thomas Lord Charitable Trust, and Mrs Judith Alstadt in memory of Mr Donald Alstadt. The contractor was ProjectSoft HK (Czechia).

The system was complete by January 15, and connected to a set of motors simulating the telescope at ProjectSoft's site in Hradec Kralove, Czechia. Johnson, Franz and Gabor conducted a Factory Acceptance Test there on January 15-19. Shortly after that, everything was taken apart and shipped by air to Mount Graham International Observatory's Base Camp in two crates, one weighing 709 kg and the other 784 kg. They arrived on February 22, and were stored there until late March when they were moved, during a sunny spell between two snowstorms, first to the Large Binocular Telescope's loading dock, and from there to the VATT using an articulated front loader equipped with a fork.

On Thursday March 28 one crate was stored in the VATT's loading dock, the other outside, by the VATT building, covered with a tarp. The ProjectSoft crew arrived on Saturday March 30: Vlastislav Andrle, Tomas Vlastnik (electricians), and Vit Talacko (electrical engineer). They made their first trip to the VATT on Monday April 1, accompanied by Gray and Gabor. They unloaded the crate already in the loading dock, moving the equipment to prepared shelving, moving the Control Cabinets to their future locations. Then they took apart the wooden crate and Gray removed it from the loading dock. The second crate (the one that had spent the weekend on the ground by the VATT building) was lifted into the loading dock again using the front loader. They unloaded the crate and took it apart.

There were a few crew changes in the following weeks. Thursday May 9: departure of the two electricians Andrle and Vlastnik; arrival of Petr Langer (software engineer); Talacko staying. Thursday May 23: departure of Talacko, arrival of Tomas Turek (lead engineer); Petr Langer staying. Tuesday June 4 departure of Langer and Turek.

The Final Acceptance Protocol was signed on June 3. This schedule was determined more than a year ago, the details were set by November 22. ProjectSoft delivered on schedule and, considering that we had a Fixed-Price Contract, also on budget.

During most of June, Gabor led a "shake-down" effort to identify any bugs and other issues ahead of the summer shutdown. Long-term users of the telescope, Boyle, Corbally, Kikwaya, as well as the team Lebofsky, Crawford and Trueblood, came up for two or three nights at a time. Gabor provided them some training on the new system, and helped them run the telescope and its new control system through its paces, taking note of issues and evaluating performance.

Pointing is about 3 arcsec rms, with excellent unguided tracking for more than 20 minutes. The new system still needs to experience a whole range of weather conditions and user cases. ProjectSoft continues to work with us remotely during the "shake-down" period which will last until they make their on-site visit in Spring 2025.

NEW INSTRUMENTATION

Mark Trueblood led the procurement effort on a new science camera, destined to replace the VATT 4k CCD Imager. The need for a new imager has been apparent for some time. The current VATT4k detector has bad cosmetics (hot and dark pixels in large patterns), obsolete electronics and computer interface, as well as a damaged output amplifier (doubling the readout time) and a liquid-nitrogen based cooling system requiring vacuum pumpdown periods of a few days as well as operators to keep the Dewar filled with liquid nitrogen. With Don permitting remote and scripted operation a new camera became a strategic need, since the old camera would neutralize some of *Don*'s operational advantages.

In late 2022, Trueblood was appointed to chair a Science Advisory Committee composed of 17 VATT users and a technical advisor. The committee provided input into the desired characteristics of the new imager through science cases focused on detector characteristics, supported by questionnaires on specific topics. The Committee Final Report was delivered in September 2023, in time for the VATT 30th anniversary celebration.

Trueblood and Gabor then continued discussions with vendors to narrow the options for the camera. Considerable time was spent in discussions with Teledyne concerning their COSMOS CMOS camera. In the Spring of 2024, it became clear that this camera had a problem with high dark current that could not be addressed satisfactorily. Attention was then centered on vendors of CCD-based imagers.

In early summer, a Request for Quote was sent to three vendors that set forth the topics to be covered in a proposed solution and price quotation. We received quotations for five cameras from the three vendors in late July, and produced a set of follow-up questions customized for each vendor. The responses to these questions were received in mid-August. This final report was then prepared, listing the product parameters, and summarizing the strengths and weaknesses of the bids.

METEORITES

This year the Vatican meteorite collection grew by three specimens: a 2.96 gram specimen of the lunar feldspathic breccia NWA 11898 donated by James Shorten (Nighthawk Meteorites); a 0.93 gram piece of the lunar basalt NWA 14188 donated by Dustin Dickens (Top Meteorite); and a 0.72 gram piece of the H chondrite Monte Costone, donated by the discoverer of the meteorite Federico Pogliani.

The growth of the Vatican meteorite collection is largely dependent on the generosity of donors, and we are grateful for their donations.

Left to right: Gabor, Johnson, Langer, and Turek on June 3, 2024. The monitor on the left shows TomPack, Don's GUI, the one on the right shows the globular cluster M3 captured the previous night with GUFI. Credit: Turek

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Meetings and Outreach

Chapter SIX

SCIENTIFIC CONGRESSES

BROWN

243rd Meeting of the American Astronomical Society (AAS), New Orleans, LA, 7-11 January

III Meeting of the Society of Catholic Scientists (Spain), Catholic University of Avila, 19-21 September

CHINNICI

IAU General Assembly 2024 (9-15 August, Capetown, South Africa)

Lorenzo Respighi, astronomo, matematico e fisico nel bicentenario della nascita (9-11 October, Rome)

A Global History of Eclipse Reckoning (18-22 November, Edinburgh)

CONSOLMAGNO

The Sister Computers of the Vatican Carte du Ciel Telescope, Milan, December 11-13, 2023

Planetary Taxonomy Workshop, Houston, February 21-22

Pontifical Academy of Sciences James Webb Space Telescope Workshop, Rome, February 27-29

Georgetown University/SETI Institute Climate Change Workshop, Washington, DC, April 17-19

Meteoritical Society annual meeting, Brussels, July 28-August 2

IAU General Assembly, Cape Town, August 5-15

Pontifical Academy of Sciences Plenary Assembly, Sciences for a Sustainable Anthropocene, Rome, September 23-25

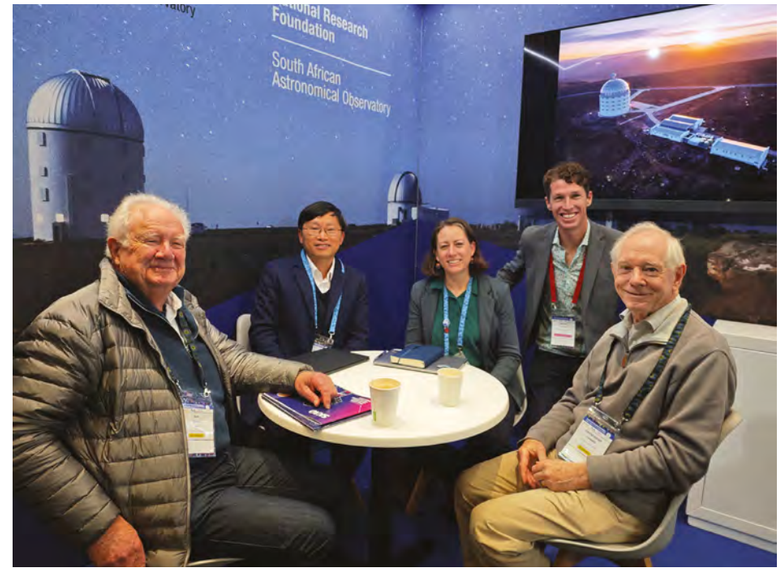
CORBALLY

PDPP Workshop 2024: Technical Requirements for Digitizing Direct Photographic Plates, Shanghai Astronomical Observatory, China (online), June 18-21

International Astronomical Union General Assembly XXXII, Cape Town, South Africa, August 6-15; represented the National Committee of the Vatican City State

XX European Conference on Science and Theology, Split, Croatia, August 28-31

Space Education and Strategic Applications Conference, September 19-20 (online)



From left to right, Ian Glass, Zheng-Hong Tang, Rosalind Skelton, Daniel Cunnama, and Chris Corbally discuss photographic plate preservation and scanning at the IAU General Assembly. (Photo courtesy of Zheng-Hong Tang)

GABOR

Fifth assembly of the Alliance of Historic Observatories, Specola headquarters, October 3-5

ECOPOSS congress at the Catholic University of Lille, France, October 9-11

GALAVERNI

BabyIAXO Research on Axions via Observation of the Sun (BRAVO SUN) kick-off meeting, INAF Brera, Milano, December 12, 2023

Cosmology and Fundamental Physics with CMB and LSS Meeting, INAF OAS, Bologna, February 6-7

Quantum Architectures for Analogues and Theory Applications, Fondazione Bruno Kessler, Trento, February 13

UniVersum 2024, La Sapienza, Roma, February 21-23

Parity violation through CMB observations, Institute for Fundamental Physics of the Universe (IFPU), Trieste, May 27-31

Lemaître Conference 2024 - Black Holes, Gravitational Waves and Spacetime Singularities, Specola Vaticana, Castel Gandolfo, June 16-21

Spiritualità e Astronomia 2024, Specola Vaticana, Castel Gandolfo, August 30-September 1

2nd General Meeting of COST Action COSMIC WISPers, Istanbul, September 3-6

4th International FLAG Workshop: The Quantum and Gravity, Catania, September 9-11

Lorenzo Respighi: astronomo, matematico e fisico nel bicentenario della nascita, Roma, October 11

20th IAXO Collaboration Meeting, Brera, Milano, 14 October

Parity Violation from Home 2024 Conference, November 19-22

GIONTI

FLAG (INFN) meeting, Department of Physics University of Bologna, December 21-22, 2023.

Lemaître Conference 2024 - Black Holes, Gravitational Waves and Spacetime Singularities, Specola Vaticana, Castel Gandolfo, June 16-21

Intersecting Feynman Integrals International School, Mellerio-Rosmini College of Domodossola, Domodossola (Italy), July 15-19

Spiritualità e Astronomia 2024, Specola Vaticana, Castel Gandolfo, August 30-September 1

The 4th FLAG International Workshop: The Quantum and Gravity, Villa Cerami, Catania (Italy), September 9-11

Humanity between Earth and Sky, Prato (Italy), San Leonardo al Palco Monastery, September 13-15

11th International Workshop DICE 2024 Spacetime-Matter-Quantum Mechanics, Quo Vadis Physics, Castello Pasquini, Castiglioncello, Tuscany (Italy), September 16-20

Evolving Universe: Theory and Observations, Starobinsky Memorial Conference, Yerevan, October 7-12

GRANEY

Astronomy Week, ITESO: Jesuit University of Guadalajara, Guadalajara, Mexico, October 28-November 1

Unity & Disunity in Science: Philosophical, Historical, and Theological Perspectives (Spring 2024), University of Notre Dame, April 4-6

Simon Marius und der Wandel im Weltbild, Ansbach, Germany, June 21

HELLER

September 27-30, Workshop in Kielnarowa: Quantum mechanics, category theory and robot consciousness

HINCKS

Simons Observatory Collaboration Face-to-Face Meeting, Chicago, July 22–26

Hotwiring the Transient Universe VII conference, Toronto, May 15

Canadian Astronomical Society Annual Meeting (served on the scientific organizing committee), Toronto, June 3–6

2024 Lemaître Conference, Black Holes, Gravitational Waves and Space-Time Singularities, Specola Vaticana, June 16–21

European Astronomical Society Annual Meeting, Padua, July 2

Simons Observatory Collaboration Face-to-Face Meeting, Chicago, July 22–26

KIKWAYA

ACME, Picture Rocks, January 17

IAU General Assembly, Cape Town, South Africa, August 6-15

MACKE

Meteoritical Society Meeting, Brussels, Belgium

Lucy Mission Science Team Meeting, Tempe, AZ, USA

MINNITI

CATA Dia de la Astronomia, Congreso Nacional, Santiago, March

CATA Area 6 Workshop on Exoplanets and Astrobiology, Universidad Andres Bello, Santiago, Chile, May

5th S-PLUS Workshop on Mapping the Milky Way: Insights from Large Surveys, University of Sao Paulo, Brazil, June (online)

5th CCAT Collaboration Meeting (CCM5), Cornell University, Cornell, USA, June (online)

Astrobiology Workshop, Termas del Corazon, Chile, August

Workshop on Galactic Science with the Nancy Grace Roman Space Telescope, Yerkes Observatory, Chicago, Illinois, USA, 13-15 June

First UNAB Workshop on Astrochemistry, Universidad Andres Bello, Santiago, Chile, October

MONZANI

LUX-ZEPLIN Collaboration Meeting, University of Edinburgh (UK), January 10-12 (attended virtually)

St. Albert Initiative, Notre Dame Seminary, New Orleans (LA, USA), February 2 (attended virtually)

La Settimana dei Ricercatori, Liceo Scientifico Amaldi, Alzano Lombardo (BG, Italy), March 11-15 (attended virtually)

Conference on Accessibility in Science (SciAccess 2024), May 10-11 (virtual conference)

LUX-ZEPLIN Collaboration Meeting, Brown University (RI, USA), June 10-12 (attended virtually)

Lemaître Conference 2024: Black Holes, Gravitational Waves and Space-Time Singularities, Vatican Observatory (Castel Gandolfo), June 15-21 (attended virtually)

Department of Energy review of LUX-ZEPLIN Operations, Lawrence Berkeley National Laboratory (LBNL), Berkeley (CA, USA), June 24-25

15th International Workshop on the Identification of DarkMatter 2024, L'Aquila (Italy), July 8-13

Dante Minniti taking advantage of a break in the unsettling weather at Les Invalides in Paris, France, October. Paris is the headquarters of the journal Astronomy and Astrophysics, which published observations from his 12 year long VVV survey of the Milky Way

Specola Vaticana, Castel Gandolfo (Italy), July 14-17

Physics colloquium and department visit, Georgia Tech, Atlanta (GA, USA), September 8-10

Bridging the Farm: AI for Science at SLAC and Stanford, Stanford University (CA, USA), October 2

NERSC @50: Then, Now, and Into the Future, Berkeley (CA, USA), October 22-24

Space 4 All Workshop, King's College London (UK), October 29 (attended virtually)

Artificial Intelligence (AI) Initiatives in the Office of Science Roundtables: User Facility Science and Operations Roundtable, Sponsored by the U.S. Department of Energy (DOE), Washington DC (USA), November 6-9

Dark Matter Day 2024 at Tor Vergata, INFN Roma Tor Vergata, Rome (Italy), November 20 (virtual event)

TANZELLA-NITTI

Blaise Pascal tra scienza, filosofia e teologia nel IV centenario della nascita conference, Facoltà Teologica del Triveneto, Padova, December 14, 2023

Riflessioni sull'unitarietà delle culture scientifiche ed umanistiche. Il contributo dell'astronomia e dell'astrofisica dall'antichità ai nostri giorni; Astro-Sardegna Meeting, Cagliari, April 22

PRESENTATIONS

BROWN

"VPNEP Survey of TESS Stars", 243rd Meeting of the American Astronomical Society (AAS), New Orleans, LA, 8 January

"El Observatorio Astronómico Vaticano: Origen, Historia, Investigaciones", III Meeting of the Society of Catholic Scientists (Spain), Catholic University of Avila, 19-21 September

"Finding Our Ways in Space and Time: Perceptions of the Universe Confirmation" panel discussion (virtual), Leibnitz Institute of Astrophysics, Potsdam, Germany, 6 February 2026

Talk to Dallas Jesuit College Prep Pro-Life club, 10 October

"A Day in the Life of a Priest-Astronomer", Fall 2024 Newman Lecture Series at Our Lady of Wisdom Newman Center in Lafayette, LA, 15 October

"Witness with Fr. Brown, A Priest-Astronomer", Newman Night at the Arizona State University All Saints Catholic Newman Center in Tempe, AZ, 23 October

"Are Faith and Science Compatible?", Lumen Series at the University of Arizona St. Thomas More Newman Center in Tucson, AZ, 24 October

Vatican Observatory booth, Tucson Festival of Books, Arizona, 9-10 March

CHINNICI

"Lorenzo Respighi, pioniere dell'astrofisica" (Cortemaggiore, 26 October)

CONSOLMAGNO

Conducted the monthly Full Moon Meetups for the Vatican Observatory Foundation and numerous on-line presentations and podcasts

Vatican Observatory booth, Tucson Festival of Books, Arizona, March 9-10

Detroit, Michigan, March 17: Cranbrook Institute of Science; March 18, Polish Institute of Culture and Research at Orchard Lake

De Pere, Wisconsin, March 19: St. Norbert College

Chicago, March 25-26: Cristo Rey and St. Ignatius College Prep High Schools

Whitehouse, Ohio, April 1-5: Lial Renewal Center, Retreat for Sisters of Notre Dame

Bloomington, Indiana, April 5-8: Mother of the Redeemer Retreat Center, Eclipse Retreat

Connecticut, April 10: Greenwich Retired Men's Club and Fairfield University

Toronto, Ontario, April 12-14: Manresa Retreat Center

Waterloo, Ontario, April 15: St. Jerome's University, Lectures in Catholic Experience

Spokane, Washington, April 26-28: Retreat, Immaculate Heart Retreat Center

Lisbon, Portugal, June 18: Brotéria Institute

Observatoire De Haute-Provence, France, June 24-28: Summer School on Sample Return Missions

Cape Town, South Africa: August 11, University Chaplaincy; August 13, St Michael's Parish

New Bern, North Carolina, October 20: St. Paul Catholic Church; Rothermel Foundation

Crestview Hills, Kentucky, October 28: St. Thomas More University

Cincinnati, October 29: Xavier University; October 30, St. Ignatius High School

Cleveland, Ohio, October 31: Cardinal Mooney High School; November 2: ITE Project, Origins of the Universe

Cambridge, UK, November 20: St. Edmund's College, Von Hügel Lecture

CORBALLY

"Gateway to the Path of Totality" dinner presentation as Guest of St. Lawrence University President, Kathryn A. Morris, Canton NY, April 7

IRAS webinar respondent to Michael Summers, "Astrobiology of Pluto", April 25 (online)

"Weird Binaries Under Surveillance: TU Tau and HD 5501", presentation with Richard Gray to IAU Division G Session, Cape Town, August

"Methods for Using Narrative Drama to Explore the Origins and Functions of Religion" with Margaret Boone Rappaport, XX European Conference on Science and Theology, Split, Croatia, August

"Weird Binaries Under Close Surveillance: TU Tau and HD 5501", Embry-Riddle Aeronautical University (Prescott AZ), College of Arts and Sciences Speaker Series, October 3

"Weird Binary Stars, and their Discovery by Stellar Spectral Classification", for Dr. Roger Thompson's University of Arizona ASTRO 296 class, February 14

"Weird Binary Stars", for Dr. Aileen O'Donoghue's Physics and Astronomy Classes, St. Lawrence University, Canton NY, April 8

"The Vatican Observatory in Arizona", Fort Wayne Astronomy Club, IN, September 17 (online)

"Fifty Years of Astronomy in Arizona", Prescott Astronomy Club 50th Anniversary Lecture, October 2

"Cosmic Expansion", Sabbatical Groups at the Redemptorist Renewal Center, Tucson, April and November

FRANCL-DONNAY

VOF Moonthly Meet-up 25 January

"The Chemistry of Tea", Michigan section of AICHE, February 22

"Steeped" Bryn Mawr College, March 27

"Pitching Science" at Interdisciplinary Science Communication Workshop, CSU, April 1

"The Heavens Declare the Glory of God," Notre Dame Retreat House, April 5-6

"The Chemistry of Tea" Athaneum, Bryn Mawr, April 25

"The Secret Life of Tea", Main Line School Night, May 2

"Steeped", Ambler Public Library, June 5

"Steeped", Philadelphia Section of the ACS, June 10

"The Chemistry of Tea" , Temple University, September 12

"A Molecular Tea Party", Chestnut Hill College, September 15

"The Chemistry of Tea", Vanderbilt University, September 18

"The Chemistry of Tea", Nashville ACS Section, September18

"Coding the Universe: What God has written for scientists to read", Judith O'Brien Lecture, University of Rochester, September 28

"Steeped", Portland Tea Class, November 9

FUNES

Sarmiento-Gould lecture on the 153th anniversary of the Observatorio Astronómico de Córdoba, 24 October: "Memories of the Universe: Reflections on Astronomy and the Human Condition"

"Search for Extraterrestrial Intelligence", School of Mathematics, Physics and Astronomy of the Universidad Nacional de Córdoba, 24 November

GABOR

Teacher in a a tier II general education course on the history and philosophy astronomy, ASTR 320, in the Spring 2024 and Fall 2024 semesters at the UA

GALAVERNI

"Birefringence in CMB anisotropies due to cosmological pseudoscalar fields", INAF Brera, Milano, December 12, 2023.

"Isotropic birefringence from cosmological pseudoscalar fields", INAF OAS, Bologna, February 6

"Faith and Science", Università Cattolica, Piacenza, March 6

"La Specola Vaticana", Circolo culturale "Il Domenichino" APS Grottaferrata, March 16 (with Fr. Giuseppe Koch)

"Viaggio nell'Universo", Cooperativa sociale Hesèd, Reggio Emilia, April 18

"Pianeti, stelle, galassie: viaggio nell'universo", Missionarie di San Carlo, Roma, April 30

"Isotropic birefringence from cosmological pseudoscalar fields", IFPU Focus Week Program "Parity violation through CMB observations", Trieste, May 29

"Sacerdotes para la ciencia", 4th International Priesthood Symposium Priest in times of commitment, Fundación Padre Jaime, Bogotá, Colombia (online), June 2

"Domande aperte in cosmologia", Parrocchia Natività di Maria Santissima, Roma, July 11 (with Fr. Gabriele Gionti)

"Cosa (non) sappiamo: domande aperte in cosmologia", Spiritualità e Astronomia 2024, Castel Gandolfo, August 31

"Isotropic birefringence from cosmological pseudoscalar fields", 4th International FLAG Workshop "The Quantum and Gravity", Catania, September 9

"Dalla polvere cosmica all'essere umano: alla ricerca delle nostre origini", Guastalla, September 19

"Equilibrio del Cosmo e cura della Terra", Reggio Emilia, October 5

"Pianeti, stelle, galassie: viaggio nell'universo", Unione Cristiana Imprenditori Dirigenti (UCID), Reggio Emilia, October 18

"Big Bang nascita dell'universo tra scienza e fede", Circolo di Cultura "Inventori di strade", Sant'Ilario d'Enza, October 24

"Looking for Quantum Gravity imprints in the Universe", Polish Chapter of the Society of Catholic Scientists (online), October 31 (with Fr. Gabriele Gionti)

"Speranza e astronomia. Sperare guardando il cielo. Che cosa cerchiamo al di là della terra?", Almo Collegio Capranica, Roma, November 12

"Scienza e Fede", Università Cattolica, Piacenza, Novembre 20

"Redshift evolution of isotropic cosmic birefringence", Parity Violation from Home 2024 Conference, November 19-22

Fr. Koch and Fr. Galaverni presenting a seminar about the Specola in Grottaferrata (March 16, 2024)

GIONTI

"Beginning and End of the Universe", "Village Saturdays" Fiamignano (RI), December 30th, 2023

"The History of the Vatican Observatory and the Science with the VATT on the 30th Anniversary of the telescope" with Guy Consolmagno, Hall of the Old Synod, Vatican City Sate, March 1

"A Journey in the Universe", Child Neuropsychiatry Department, Salesian Hospital, Ancona, (Italy), March 16 & October 21

"The History of the Vatican Observatory between Science and Faith", online seminar, Master in Science and Faith, University Regina Apostolorum, Rome (Italy), April 9

"The Scientific Apostolate of the Society of Jesus", to Rome "Keplero" High School students at the Specola outreach facility of the Domes on the Apostolic Palace in Castel Gandolfo, April 24

"The History of the Vatican Observatory between Science and Faith", INAF Monte Porzio Catone Observatory, Annual meeting CNAI, Monteporzio, Rome, (Italy), May 11

"Lo Spazio per la Fede, la pace per il future dell'uomo " panel participant, Villa Nazareth, Rome, (Italy), May 11

"Open questions in Cosmology", Holy Mary Nativity parish, Rome, July 11 (with Matteo Galaverni)

"The Spiritual Roots of Scientific Apostolate of the Society of Jesus", Spirituality and Astronomy meeting at the Specola, August 31

"Lo Spazio per la Fede, la pace per il future dell'uomo " panel participant, Villa Nazareth, Rome, (Italy), May 11

"The Spiritual Roots of Scientific Apostolate of the Society of Jesus", Spirituality and Astronomy meeting at the Specola, August 31

"Aspects of Spherically Symmetric Geometrodynamic in the Jordan and Einstein Frames", 4th FLAG International Workshop: The Quantum and Gravity, Villa Cerami, Catania (Italy), September 11

"Jordan and Einstein frames analyzed from a canonical perspective", 11th International Workshop DICE 2024 Spacetime-Matter-Quantum Mechanics, Quo Vadis Physics, Castello Pasquini, Castiglioncello, Tuscany (Italy), September 18

"Quo Vadis Physics" panel participant, 11th International Workshop DICE 2024 Spacetime-Matter-Quantum Mechanics, Quo Vadis Physics, Castello Pasquini, Castiglioncello, Tuscany (Italy), September 18

"Spherically Symmetric Geometrodynamic in the Jordan and Einstein Frames", Evolving Universe: Theory and Observations, Starobinsky Memorial Conference, Yerevan, October 9

"A Short Introduction to Quantum Gravity", online seminar, Astronomy Club, Physics Department, Loyola College, Chennai, India, September 23

"Cosmic Evolution and the Question of God", "Laudato Si" Club, Archdiocese of Amalfi-Cava dei Tirreni, Cava dei Tirreni, October 25

"From Galileo to the Vatican Observatory", "Laudato Si" Club, Archdiocese of Amalfi-Cava dei Tirreni, Cava dei Tirreni, October 26

"Looking for Quantum Gravity imprints in the Universe" with Matteo Galaverni, online seminar, Astronomy Club, Society of Catholic Scientists of Poland , (Poland), October 31

GRANEY

"Star-Crossed: How St. Augustine, UFOs, and 19th-century racists illustrate what we have wrong about Truth, Christianity and Science" (invited talk), University of Dayton (Ohio), January 25

"The Multiverse: A Very Old Idea", University of Louisville Public Astronomy Lecture Series, April 3

"The Vatican and the Fallibility of Science: Augustine, Copernicus, Darwin and Race", University of Notre Dame, April 4

"The Church and Astronomy: Forgotten Stories" (invited talk), Mother of the Redeemer Total Solar Eclipse Retreat (Bloomington, Indiana), April 5

"The Church and Astronomy: More Forgotten Stories—'The Strange and the Beautiful'" (invited talk), Mother of the Redeemer Total Solar Eclipse Retreat (Bloomington, Indiana), April 6

"The Vatican Observatory and Me" Holy Spirit Church, Jamestown, Kentucky, April 28

"Simon Marius and the Challenging History of other Earths" (invited talk, on-line), Simon Marius conference, Ansbach, Germany, June 21

"I Got Something to Say About Galileo: Fr. Giovanni Battista Riccioli, 17th-century astronomer, talks about Galileo Galilei", Louisville Astronomical Society, September 20

Classroom discussions with Br. Guy Consolmagno, S.J. and Rob Lorenz, S.J., St. Thomas More University Crestview Hills, Kentucky, October 28

"An Introduction to the Vatican's Astronomical Observatory" (invited talk), ITESO: Jesuit University of Guadalajara, October 30

"Astrology & Jesuits: The Stars can tell us it will be colder in January; what else can they tell us?" (invited talk), ITESO: Jesuit University of Guadalajara, October 31

"Jesuits and Other Earths and Intelligent Life in the Universe" (invited talk), ITESO: Jesuit University of Guadalajara, November 1

"Sun, Moon, and Ascending: Astrology from the Perspective of an Astronomer", University of Louisville Public Astronomy Lecture Series, December 4

HINCKS

"The Simons Observatory: Part I: The Experiment" (invited seminar, via Zoom), Canadian Astronomical Society (CASCA) Graduate Student Committee (GSC) , Canadian Telescope Seminar Series, November 19, 2023

"Science & Faith: Context for Eco-Theology" (invited short presentation), Science, Suffering and (Eco)-Theology, Critical Conversations in Catholic Education, Durham Catholic District School Board, Oshawa, April 18

"Space for Faith: Inspiration from Astronomy for Integrating Science and Faith in Catholic Education" (keynote talk), Ontario Catholic Supervisory Officers' Association AGM & Conference, Niagara Falls, April 24

"Big Bang ex Nihilo? The Relationship Between Modern Cosmology and the Theological Tradition of Creation" (keynote talk), Recalling Our Roots and Charting the Future: Theology Yesterday, Today, and Tomorrow, Emerging Scholars Colloquium, Université Saint-Paul University, Ottawa, April 29

"Millimetre Light Curves of Active Galactic Nuclei from the Atacama Cosmology Telescope" (poster), Hotwiring the Transient Universe VII conference, Toronto, May 15

"Revealing the Cosmic Web with CMB Data" (invited seminar), The Nordic Institute for Theoretical Physics (Nordita), Stockholm, June 10

"Multifrequency Fitting of the Sunyaev-Zeldovich Effect in Galaxy Cluster Bridge Systems" (contributed talk), European Astronomical Society Annual Meeting, Padua, July 2

JANUSZ

"Kontekst odkrycia w fizyce a doświadczenie religijne—w ujęciu T. E. Thooiga, S.J. [The context of Discovery in Physics and Religious Experience—in the Perspective of T. E. Thooig, S.J.]), SCS Warsaw (via video), June 27

"Spiritualità cristiana e creazione", Specola Vaticana, Castel Gandolfo, September 1

Conducted tours of visitor groups and nuns around the telescopes and resources of the Observatory.

KIKWAYA

"History of the Vatican Observatory", Holy Trinity Parish (Roman Catholic Archdiocese of Johannesburg), August 18

"Space Return mission", for students of Saint Martin of Porres High School, Soweto, Johannesburg, August 21

Discussion with students of College Kubama, Jesuit High School, Kisantu, Democratic Republic of Congo, September 6

Discussion with students of College Bonsomi, Jesuit High School, Kinshasa, Democratic Republic of Congo, September 13

Conversation with Students of the Chaplaincy of UCT (University of Cape Town), August 11

Parishioners of Saint Michael Parish (Roman Catholic Diocese of Cape Town), with Guy Consolmagno, August 14. ***https://youtu.be/CXl3r0Zac8s?si=LED7cdJ3QwzWr2iE***

MACKE

"Density and Porosity of Meteorites and Extraterrestrial Materials: Including Samples of Asteroid (101955) Bennu", INAF/IAPS, Tor Vergata, Italy, 29 May

MINNITI

"The Search for Life in the Universe" (invited talk), X Encontro de Física e Astronomia da UFSC, Department of Physics, Universidade Federal de Santa Catarina, Florianopolis, Brasil, March

"Rediscovering the Milky Way" (invited talk), Universidad de Los Andes, Bogotá, Colombia, March

"Una perspectiva astronomica sobre la vida en el Universo"(invited talk), Academia Nacional de Ciencias de Buenos Aires, Argentina, April, ***https://www.youtube.com/watch?v=Pg2LcaVbDoo***

"What Is This" (invited talk), Museo Interactivo Mirador, Santiago, Chile, March

"Aventuras de un Telescopio en la Luna", CATA Dia de la Astronomia, Congreso Nacional, Santiago, March

"The Innermost Region of the Milky Way: New VVVX Globular Clusters", Friends of Friends Meeting, Observatorio Astronómico de Córdoba, Córdoba, Argentina, April

"Free Floating Planets", CATA Area 6 Workshop on "Exoplanets and Astrobiology", Universidad Andres Bello, Santiago, Chile, May

"The Legacy of the VVVX Survey" (invited talk), 5th S-PLUS Workshop on "Mapping the Milky Way: Insights from Large Surveys", University of Sao Paulo, Brazil, June (online)

"CCAT-VVVX Synergy", 5th CCAT Collaboration Meeting (CCM5), Cornell University, Cornell, USA, June (online)

"Free Floating Planets", Astrobiology Workshop, Termas del Corazon, Chile, August

MONZANI

"A Sparkle in the Dark: The Outlandish Quest for Dark Matter," St. Albert Initiative, Notre Dame Seminary, New Orleans (LA, USA), February 2

"Data-Intensive Dark Universe Cosmology", Rubin@SLAC talks: the challenges of LSST scientific computing. SLAC National Accelerator Laboratory, Stranford (CA, USA), 27 February

"La Materia Oscura Illuninata," La Settimana dei Ricercatori, Liceo Scientifico Amaldi, Alzano Lombardo (BG, Italy), March "La Materia Oscura Illuninata," La Settimana dei Ricercatori, Liceo Scientifico Amaldi, Alzano Lombardo (BG, Italy), March 13-14

"The First-Ever Parastronaut Selections: A Candidate's Experience," Conference on Accessibility in Science (SciAccess 2024), May 11

"Experimental Dark Matter Search at Mass > 1 GeV" (invited overview talk), 15th International Workshop on the Identification of Dark Matter 2024, L'Aquila (Italy), July 11

"A sparkle in the dark: Data intensive searches for Dark Matter with LUX-ZEPLIN," Physics Colloquium, Georgia Tech, Atlanta (GA, USA), September 9

"Anomaly Detection for Rare Event Searches," Bridging the Farm: AI for Science at SLAC and Stanford, Stanford University (CA, USA), October 2

"Data intensive searches for Dark Matter with LUX-ZEPLIN," NERSC @50: Then, Now, and Into the Future, Berkeley (CA, USA), October 23

"The First-Ever Parastronaut Selections: A Candidate's Experience," Space 4 All Workshop, King's College London (UK), October 29

"La Materia Oscura Illuninata," Dark Matter Day 2024 at Tor Vergata, INFN Roma Tor Vergata, Rome (Italy), November 20

TANZELLA-NITTI

"Blaise Pascal fra libertini e post-modernità: sono le Pensées ancora attuali per l'odierna teologia fondamentale? [Blaise Pascal between libertine and post-modernity: are the Pensées still relevant for today's fundamental theology?]", invited Lectio magistralis at conference Blaise Pascal tra scienza, filosofia e teologia nel IV centenario della nascita, Facoltà Teologica del Triveneto, Padova, December 14, 2023

"Artificial Intelligence. Some guiding ideas for understanding the phenomenon and its implications," Dicastery for the Doctrine of Faith, Vatican City, January 23

"La dimensione contestuale e interdisciplinare della teologia [The contextual and interdisciplinary dimension of theology]" (invited talk), Annual Meeting of the Pontifical Academy of Theology, "Quale razionalità per i credenti del XXI secolo? Dalla Fides et ratio alla Veritatis gaudium. Fede e ragione a 1700 anni da Nicea", Rome, March 7

"The problem of two cultures and the humanistic dimension of science" (invited talk), Astro-Sardegna Meeting, "Riflessioni sull'unitarietà delle culture scientifiche ed umanistiche. Il contributo dell'astronomia e dell'astrofisica dall'antichità ai nostri giorni, Cagliari, April 22

"Does the universe have a beginning? Cosmology, Philosophy and Theology in Dialogue", invited Lectio Magistralis to the VIII Festival dello Spazio, Busalla-Genova, June 29.

"Artificial Intelligence and Human Progress: A theological Perspective", Aosta City Hall, July 7

"Miracles between Theology and Science", Dicastery for the Causes of the Saints, Vatican City, October 29

COMMITTEES AND BOARDS

BROWN
Board of Advisors to the Vatican Observatory Foundation

CONSOLMAGNO
Science Advisory Board, SETI Institute

IAU Working Group on Planetary System nomenclature; chair, Mars Task Group

Vice President, Meteoritical Society

CORBALLY
Scientific organizing committee and Zoom-master, "PDPP Workshop 2024: Technical Requirements for Digitizing Direct Photographic Plates", Shanghai Astronomical Observatory, China (online)

Secretary (re-elected), IAU Working Group on Preservation and Digitization of Photographic Plates

Invited Member, "Virtues for Space" Advisory Board, a project led by Antony Milligan, King's College London

Invited Member, Scientific Committee for the Scientific Journal of Astrobiology

COSTA
Elected as Honorary Member of the International Astronomical Union, sponsored by the Specola Vaticana

FRANCL-DONNAY
Board, Institute for Religion and Science

GABOR
Board, Alliance of Historic Observatories

GALAVERNI
Italian Astronomy Championship committee

GIONTI
Member of the Internal Board for the "incentivization program" of the lay employees of the Vatican Observatory

GRANEY
Chair, Archdiocese of Louisville Faith and Science Dialogue Group / Archdiocese of Louisville Society of Catholic Scientists Chapter

HINCKS
Governing Council, Regis College, Toronto

Literary Trustee, Estate of Bernard Lonergan

Membership Committee (chair), Simons Observatory Collaboration

Board Member, Toronto Chapter of the Society of Catholic Scientists

Committees in the Dept. of Astronomy & Astrophysics, University of Toronto:

Community Climate Committee (chair)

Graduate Programme Committee

Academic Appeals Committee

Colloquium Committee (until June; chair)

MACKE
Deputy working group lead, OSIRIS-REx
Sample Physical and Thermal Properties Working Group

MINNITI
Scientific Organizing Committee, Workshop on "Galactic Science with the Nancy Grace Roman Space Telescope", Yerkes Observatory, Chicago, Illinois, 13-15 June

Co-organizer (with Matias Gomez and Claudio Caceres) of the first UNAB Workshop on Astro-chemistry, Universidad Andres Bello, Santiago, Chile, October

TANZELLA-NITTI
Vincenzo Ferraro International Award Committee, Sorrento, October 12

MEDIA

BROWN
"Vatican has history of 'finding God in all things'", Galveston Daily News, 6 September

CONSOLMAGNO
In the past year, Guy Consolmagno participated in more than a dozen interviews, including:

• Interview with Vatican television, December 22, 2023

• Vittoria Prisciandaro for the Italian religious magazine Credere, which ran on January 7, 2024

• Interview on the April eclipse for Templeton Ideas, March 29

• Press conference (with Gionti and Galaverni) at the Vatican concerning the Lemaître Workshop, June 11

• Interview with Alexander Hecht of the Austrian broadcasting corporation ORF, June 21

• Interview with BBC Radio Ulster, July 2

• Interview with Alain Cirou, editorial director of the French magazine Ciel et Espace, September 13

• Two interviews for RAI including Una Mattina Rai 1, September 27

• Interview with Swiss National Television SRF, October 15

• An interview with Kaya Burgess of the Times (London) that ran November 18 (along with a leader article endorsing the reconciliation of faith and science)

• Archdiocese of Chicago, for video filmed November 14, posted December 2

• An interview on the BBC Radio 4 show Sunday, November 24

• Participation in an episode of the America Media podcast "Hark" concerning the carol "We Three Kings", posted November 30.

CORBALLY
Interviewed by Drew Mariani, Relevant Radio, on June 20, about the expected T CrB eruption and a Solar Magnetic field flip and rotation

FRANCL-DONNAY
La Civiltà Cattolica, "A taste for heavy water", January 17

New York Times, "The Biggest British-American Tea Kerfuffle Since … Well, You Know", January 24

BBC, "US scientist recommends adding salt to make perfect cup of tea", January 24

Washington Post, "Salt in tea? U.S. chemist's recipe brews controversy in U.K.", January 24

The Telegraph, "US disavows American academic who puts salt in tea … but says it's fine to microwave it", January 24

NPR, "A U.S. scientist's tea recipe has Brits aghast. Salt? Warm milk? The horror!", January 25

CBS News, "Tea with salt? American scientist's 'outrageous proposal' leaves U.S.-U.K. relations in 'hot water,' embassy says", January 27

NPR: Wait, Wait Don't Tell Me, January 27

The Guardian, "Deja brew: chemistry professor's latest advice on tea drinking—try grapefruit", February 17

Catholic Courier, "Eclipse in Rochester Diocese to convey 'work of God's hands'", 3 April. *https://catholiccourier.com/articles/eclipse-in-rochester-diocese-to-convey-work-of-gods-hands/*

This is a sample—there are many more!

GALAVERNI
Telereggio, "Astronomia e fede", aired November 28, 2023

TV2000, "Indagine ai confini del sacro - Specola Vaticana, nuove teorie per capire il mistero del Big Bang" (with Fr. Gabriele Giorti), aired March 30

Telereggio, "Specola Vaticana", aired November 19

GIONTI

Interviewed by RAI Vaticano on the Star of Bethlehem December 13, 2023

TV2000, "Indagine ai confini del sacro - Specola Vaticana, nuove teorie per capire il mistero del Big Bang" (with Fr. Matteo Galaverni), aired March 30

Interviewed by Giorgio Pacifici "Tg2 Scienza", April 6

Interviewed by RAI 1 "Sulla via di Damasco", April 18

Interviewed by the SPAM (Students of Physics and Maths), European Physics Society, Section of the Vanvitelli University, Caserta, Italy, April 20

Interviewed by TV France on the Gregorian Calendar, April 29

Interviewed by TG TF1 (France TV), April 30

Interviewed by the first channel of the French Swiss TV, October 29

GIONTI interviewed by TV 2000 in the visitor center of the "Specola Vaticana" at the Barberini domes

GRANEY

"Preparations Underway for Monday's Total Solar Eclipse in the US", EWTN News Nightly, April 5. *https://www.youtube.com/watch?v=YdhPAvCzE9E*

"Total Solar Eclipse Through a Lens of Faith", National Catholic Register, April 4. *https://www.ncregister.com/news/total-solar-eclipse-2024-divine*

"The Great American Eclipse: A Jesuit Conversation" (with Br. Guy Consolmagno and Fr. James Martin, S.J.), Vatican Observatory & various Jesuit Universities. *https://www.youtube.com/watch?v=V4hGCuIghWY*

"A Dazzling Display in the Sky & Why to Watch the Perseid Meteor Shower", EWTN News Nightly, August 13. *https://www.youtube.com/watch?v=NV4Gtfg0HMo*

HINCKS

"Busted Halo" radio show, 20 August; podcast version: "God of the Universe: Examining Faith and Science With Astrophysicist and Priest, Father Adam Hincks, S.J.", *https://bustedhalo.com/podcasts/god-of-the-universe-examining-faith-and-science-with-astrophysicist-and-priest-father-adam-hincks-s-j*

"When worlds collide: Faith & Physics course takes a wide-ranging approach to life's most fundamental questions", Faculty of Arts & Science News, University of Toronto, 30 November, *https://www.artsci.utoronto.ca/news/when-worlds-collide-faith-physics-course*

KIKWAYA

"Vatican, Des Religieux, la tête dans les étoiles" by Anna Kurian, Famille Chrétienne, Noel, Suivons l'Etoile du Messie, 18 décembre 2023

"Vatican Observatory Workshop, sense of wonder about universe and God" by Carissa Krautscheid, New Outlook (Diocese of Tucson Online News), January 20. *https://news.diocesetucson.org/news/vatican-observatory-workshop-nourishes-sense-of-wonder-about-universe-and-god*

Mwangaza Meditation, Nairobi, Kenya, February 6

"Jesuit Fr. Kikwaya Eluo is Going After the 'Shooting Stars'", La Civiltá Cattolica, March 10. *https://www.laciviltacattolica.com/jesuit-fr-kikwaya-eluo-is-going-after-the-shooting-stars/*

Benedict Mayaki, "Faith inspiring science – Vatican Observatory || Jesuits at the Frontiers", Jesuits Global Network. *https://www.youtube.com/watch?v=kPyZYdoEmXQ*

Franck Menant, "Vatican and Astronomy: The Institution of the Holy See", A toi les étoiles, June 16. *http://franck.futura-sciences.com/IDFM/ATLE2024-06-16.mp3*

MACKE

Interview with Flavio Castellani, Coelum, October 5

Interview with Luca Nardi, Wired Italia, about the meteorite collections, July 7. Used in "L'incredibile collezione di meteoriti del Vaticano" (video Youtube: Luca Nardi) July 14

"Vatican Astronomers Aid the Search for Solar System Origins", Mercury, February 28

Interview with Guy Consolmagno for The Vatican Observatory Podcast: "Man on a Mission (or two)", February 9

Macke MakerSpace YouTube channel (https://www.youtube.com/@MackeMakerSpace):

• LEGO Galileo Stop-Motion Animation (14 January)

• LEGO Galileo Stop-Motion Animation / Abridged (no talking) Version (21 January)

• HO Scale model Church with Secchi's Observatory, for 2025 Public Display Part 1 (10 May)

• HO Scale model Church with Secchi's Observatory, for 2025 Public Display Part 2 (5 July)

• HO Scale model Church with Secchi's Observatory, for 2025 Public Display Part 3 (9 September)

MONZANI

"LZ Experiment Sets New Record in Search for Dark Matter" by Lauren Biron, Berkeley Lab press release, August 26

"LZ Experiment Sets New Record in Search for Dark Matter" by SLAC Communications, SLAC news center, August 28

Br. Bob Macke poses with his model of the Church of St. Ignatius with the Observatory of the Roman College on the roof, as it was in the time of Fr. Angelo Secchi S.J.

VISITORS TO THE OBSERVATORY

Fr. Cyrus Opeil S.J., Boston College, on Sabbatical with the Specola; January-June

Robert Trembley, Technology Support, Vatican Observatory Foundation; at Tucson; January 12-20

Satya Gontcho A Gontcho, Berkeley Lab; at Tucson; February 22 – 24

Mark Larsen, SETI Institute; at Castel Candolfo; April 6

Researchers from the Istituto di Astrofisica e Planetologia Spaziali (IAPS)—INAF Roma; at Castel Gandolfo; April 11

Group of missionaries accompanied by Fr. David Gentry; at Castel Gandolfo; May 4

Group of the Circolo Culturale P. Frassati from Correggio; at Castel Gandolfo; May 23

High school student winner of the Italian Astronomy Championship; at Castel Gandolfo; May 31

Sisters of Union of Major Superiors of Italy (USMI); at Castel Gandolfo; June 6

Members of the Vatican Gendarmerie; at Castel Gandolfo; June 6

A group of French seminarians and their formators; at Castel Gandolfo; June 8

Fordham University Board of Trustees, Castel Gandolfo; June 12

A group of friends from Capua (CE), Italy; at Castel Gandolfo; June 30

Novices of the Salesian Sisters; at Castel Gandolfo; July 9

Prof. Randy Boyagoda, University of Toronto; at Castel Gandolfo; June 13-18

Ms. Eleonora Barbavara, Ms. Valentina Capalbo, and Mr. Giuseppi Isopi, University of Rome "La Sapienza" and University of Rome "Tor Vergata"; at Castel Gandolfo; July 11

Inter-religious group consisting of members of Cambridge Muslim College and Muslim students of the University of Tubingen; at Castel Gandolfo; July 17

Prof. Pierpaolo Mastrolia, University of Padua; at Castel Gandolfo; August 24

Members of the Swiss Guard; at Castel Gandolfo; September 11

The Board of Trustees of Fairfield University guided by Fr. Paul Rourke, S.J.; at Castel Gandolfo; November 14

Sr. Linda Pocher and a group of professors from Salesian University in Rome; at Castel Gandolfo; November 21

VISITS TO OTHER INSTITUTIONS

CONSOLMAGNO

Cambridge University Institute for Astronomy, November 19-22

FRANCL-DONNAY

Royal Society of Chemistry July 11

Specola Vaticana October 27 to November 2

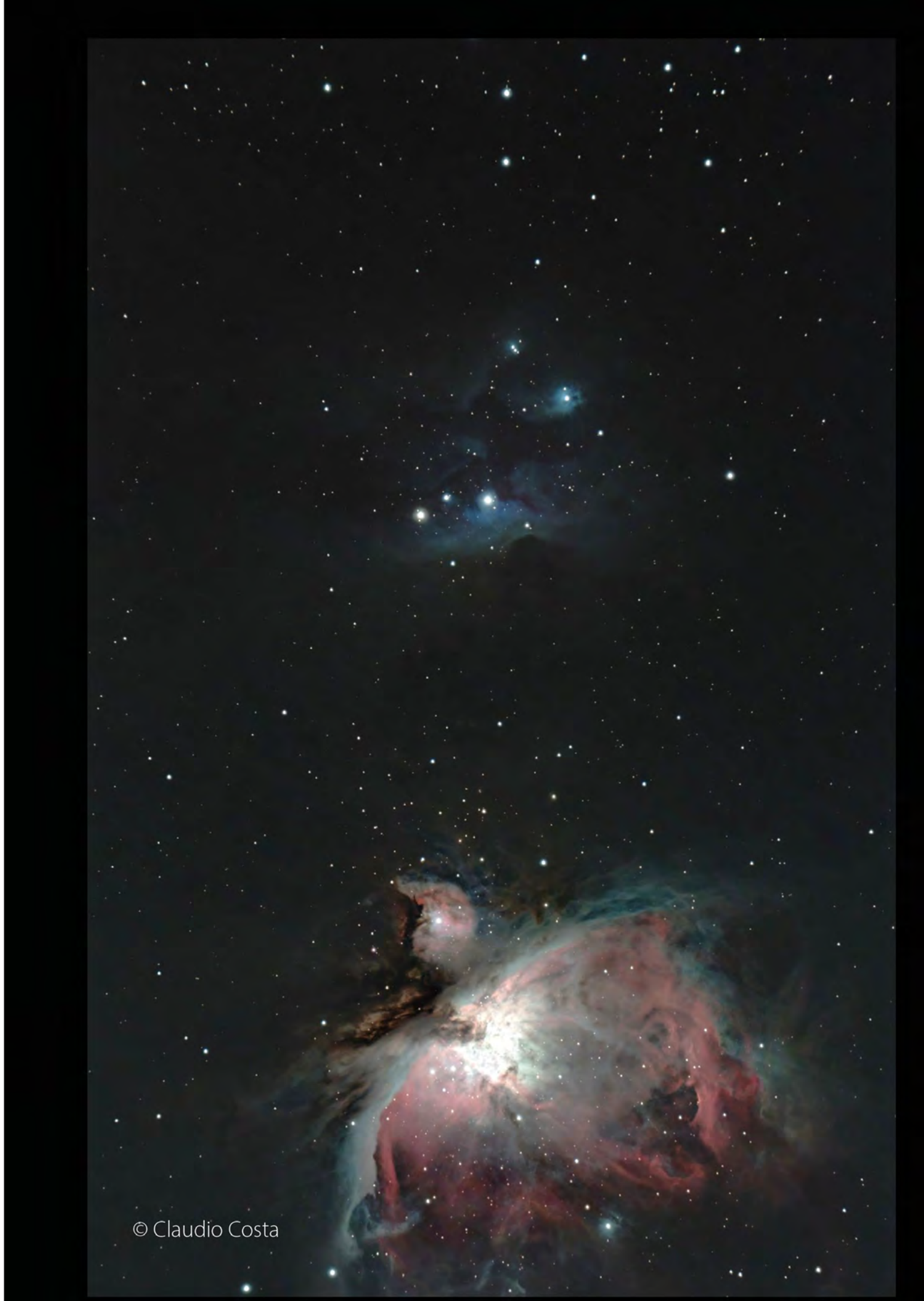
GRANEY

University of Dayton, January 25

ITESO (Jesuit University of Guadalajara), October 30 - November 1

HINCKS

Specola Vaticana, June 12-30, July 6-19



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Publications

Chapter SEVEN

PUBLICATIONS

ALTAMORE

Altamore A., Poppi F. 2024. Planetary and Cometary Astronomy at the Collegio Romano. In Chinnici I. (ed.). *Italian Contributions to Planetary Astronomy: from the Discovery of Ceres to Pluto's Orbit*, Springer.

BOYLE

Dulaimi S., Boyle R. P., Fitzgerald K., Butler R. F., Golden A. 2024. Spin-orbit Alignment in Very Low Mass Tight Binaries: Results for the 2MASS J0746425+200032AB and 2MASS J1314203+132001AB Systems Using Spectroscopic and Optically Derived Rotational Estimates. *Astronomy &Astrophysics*, 690, A320.

Semionov D. et al. [multiple co-authors including Boyle R.] 2024. Searching for Signs of Recent Member Loss Events in Open Clusters of the Cyg-Cep-Lac Region. *IAUGA*, poster id. 1431.

BROWN

Saito R. K. et al. [multiple co-authors including Brown D.]. 2024. The VISTA Variables in the Vía Láctea eXtended (VVVX) ESO public survey: completion of the observations and legacy. *Astronomy &Astrophysics*, 689A, 148S (arXiv:2406.16646).

CHINNICI

Chinnici I. (ed.). 2024. *Italian Contributions to Planetary Astronomy: from the Discovery of Ceres to Pluto's Orbit*, Springer.

Maffeo S., Chinnici I., Coniglio M. (eds). 2024. *Angelo Secchi, Francesco Denza. Corrispondenza (1858-1877)*, Biblioteca di Nuncius. Studi e Testi, LXXXI, Olschki, Firenze.

Ermolli I., Chatzistergos T., Giorgi F., Carrasco V. M. S., Aparicio A. J. P., Chinnici I. 2024. Solar Observations by Angelo Secchi. I. Digitization of Original Documents and Analysis of Group Number over 1853—1878. *The Astrophysical Journal Supplement Series*, Volume 269, Number 2.

CONSOLMAGNO

Consolmagno G. J. 2024. Intelligenza? Comprensione? Saggezza? *La Civiltà Cattolica*, 175, 20 April, 189-196

Consolmagno G. J. 2023. Reach for the stars. *The Tablet*, 277, December 2, 32.

Consolmagno G. J. 2024. A lost star in the east. *The Tablet*, 278, January 6, 32.

Consolmagno G. J. 2024. The Moon in a box. *The Tablet*, 278, February 3, 32.

Consolmagno G. J. 2024. Object of our affection. *The Tablet*, 278, March 2, 32.

Consolmagno G. J. 2024. Planet waves. *The Tablet*, 278, April 6, 32.

Consolmagno G. J. 2024. Always look on the bright side. *The Tablet*, 278, May 4, 32.

Consolmagno G. J. 2024. Crowning glories. *The Tablet*, 278, June 1, 32.

Consolmagno G. J. 2024. A 50-year voyage. *The Tablet*, 278, July 6, 32.

Consolmagno G. J. 2024. Life on Mars. *The Tablet*, 278, August 3, 32.

Consolmagno G. J. 2024. Cosmic catastrophes. *The Tablet*, 278, September 7, 32.

Consolmagno G. J. 2024. A future that looks rubbish. *The Tablet*, 278, October 5, 30.

Consolmagno G. J. 2024. Labours of love. *The Tablet*, 278, November 2, 32.

Consolmagno G. J. 2024. *Encontrando Deus no Universo* (tr. Alexandre Chermain). Curitiba: PUCPress.

Consolmagno G. J. (ed.). 2024. *Os Céus Proclamam: Astronomia no Vaticano*, tr. Alexandre Chermain. Curitiba: PUCPress.

Consolmagno G. J. and Davis D. M. (2023). *Na Lewo od Oriona, Przewodnik dla amatorów nocnego nieba*. Warsaw: PWN Scientific Publishers. 344 pp.

Macke R. J., Opeil C. P., Britt D. T., Consolmagno G. J., Irving A. 2024. Low-temperature thermal and physical properties of lunar meteorites. *Meteoritics & Planetary Sciences*, 59, 1610-1631.

Opeil C. P., Consolmagno G. J., Britt D. T., Macke R. J. 2024. Aguas Zarcas (CM2) low temperature thermophysical properties. *55th Lunar and Planetary Science Conference*, abstract #1661.

Opeil C. P., Consolmagno G. J., Britt D. T., Macke R. J. 2024. Low temperature thermodynamic properties of Martian shergottites. *55th Lunar and Planetary Science Conference,* abstract #1707.

CORBALLY

Corbally C. J., Graney C. M. 2024. Weird star research continues at the Vatican Observatory. *La Civiltà Cattolica*, June 5. English: ***https://www.laciviltacattolica.com/weird-star-research-continues-at-the-vatican-observatory/***. Italian: ***https://www.laciviltacattolica.it/osservatorio/la-vera-luce-delle-stelle/***.

Corbally C. J., Gray R. O., Karmo T. 2024. Spectroscopy of Stars. In Edgar J. S. (ed.), *Observer's Handbook 2025*, Toronto, Canada: Royal Astronomical Society of Canada, 282.

Karmo T., Corbally C. J., Gray R. O. 2024. The Brightest Stars. In Edgar J. S. (ed.), *Observer's Handbook 2025*, Toronto, Canada: Royal Astronomical Society of Canada, 273-281.

Rappaport M. B., Corbally C. J. 2024. Bio-Medical Research on Response to Spaceflight for Emerging Civilian and Commercial Sectors in Cislunar Space, Mars and Beyond. *Journal of Neuro and Oncology Research*, 4(2):1-14. DOI: 10.46889/JNOR.2024.4205

Rappaport M. B., Corbally C. J. 2024. Hypothesis and Thought Experiment: Comparing Cognitive Competition of Neandertals and Early Humans, to Our Coming Contest with AIs. *Journal of Social Computing*, 5(2), 122-131. DOI: 10.23919/JSC.2024.0012

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D'SOUZA

Velguth B. N. et al. [multiple co-authors including D'Souza R.J. 2024. A Timeline of the M81 Group: Properties of the Extended Structures of M82 and NGC 3077. *Astrophysical Journal*, 974, 189. doi:10.3847/1538-4357/ad6cd8

Beltrand C. et al. [multiple co-authors including D'Souza R.J. 2024. First resolved stellar halo kinematics of a Milky Way-mass galaxy outside the Local Group: The flat counter-rotating halo in NGC 4945. *Astronomy & Astrophysics*, 690, A115. doi:10.1051/0004-6361/202450626

Saito R. K. et al. [multiple co-authors including D'Souza R.J. 2024. The VISTA Variables in the Vía Láctea eXtended (VVVX) ESO public survey: completion of the observations and legacy. *Astronomy & Astrophysics*, 689. A148. doi:10.1051/0004-6361/202450584

Ahvazi N., Sales L. V., Doppel J. E., Benson A., D'Souza R., Rodriguez-Gomez V. 2024. The progenitors of the intra-cluster light and intra-cluster globular clusters in galaxy groups and clusters. *Monthly Notices of the Royal Astronomical Society*, 529, 4666. doi:10.1093/mnras/stae848

FRANCL-DONNAY

Francl M. M. 2024. What if Marie Curie's greatest legacy was not her two Nobel prizes? *Nature* 634, 289-290.

Francl M. M. 2024. Chemistry to hand. *Nature Chemistry*, 16, 1567-1568.

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Francl M. M. 2024. $WT^{19}F$. *Nature Chemistry*, 16, 1-2.

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Francl-Donnay M. M. 2024. Nada te turbe. *Give Us This Day*, July.

Francl-Donnay M. M. 2024. From the depths. *Give Us This Day*, March.

Francl-Donnay M. M. 2024. Gritty Grace. *Philadelphia Inquirer*, 30 September.

FUNES

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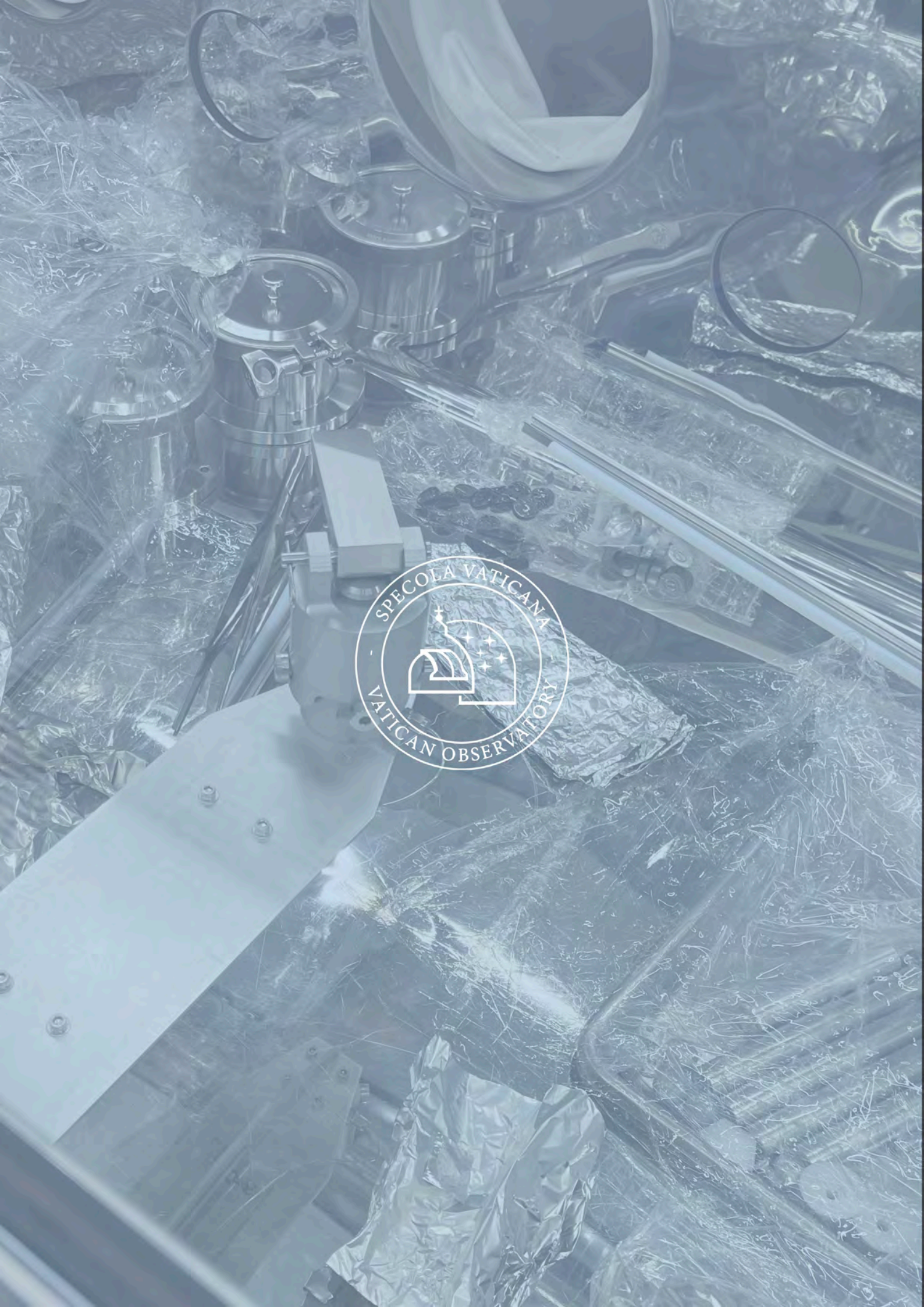
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