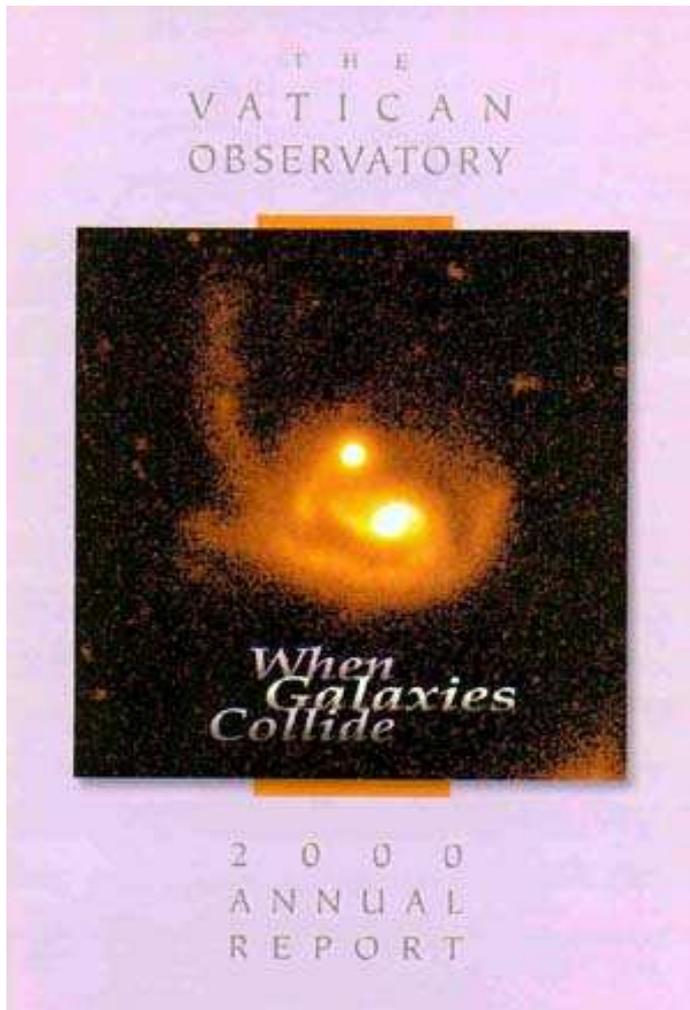




Cover: When Galaxies Collide



Front Cover:

Vatican Observatory astronomer José Funes, S.J., and Colleagues used the VATT to capture this cosmic merger act. The galaxy is known as Mkn 975, but there are telltale signs that it is really two galaxies coalescing into one: two nuclei (bright white areas) and long tails of material along the outside. The astronomers are looking for other evidence of such galactic close encounters. In addition to Funes, the team that observed Mkn 975 and elaborated this image were Piero Rafanelli (University of Padua, Italy), Gotthard Richter (Astrophysikalisches Institut Potsdam, Germany), and Jaan Vennik (Tartu Observatory, Estonia).

Cover Artist: **Dave Fischer**



THE VATICAN OBSERVATORY
2000 ANNUAL REPORT

Staff & Directors

From Director

Editor: Elizabeth J. Maggio

2000 ANNUAL REPORT

Cover

Vatican Observatory
Annual Report 2000



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From the Director

From the Director

Celebrating the Jubilee Year

The Church celebrated its Jubilee Year throughout 2000, providing us at the Vatican Observatory with an opportunity to reflect on the significance of our work in light of the Church's mission. Here I would like to share with you some thoughts on this topic by describing two events during the Church's Jubilee celebration that inspired us to see our work in a fresh and more comprehensive way.

The first event took place on 25 May when John Paul II celebrated the Jubilee of Men and Women from the World of Learning in St. Peter's Basilica. In his address to the scientists, the Pope spoke of the great challenge that faces us to know how to move from phenomena to fundamentals and to go beyond mere experience to the spiritual realities that truly explain those experiences. His Holiness insisted that rigorous scientific research is a genuine way to arrive at the source of all truth revealed to us in the Scriptures. The exploration of both the micro and the macro cosmos, he said, is a song to God's glory, which is reflected in everything in the universe. During this exceptional occasion, the Pope reflected on why the true scientist is drawn, even unknowingly, to marvel at every new discovery and why he or she is both astonished and humbled at the immensity and complexity of it all and, at times, is brought to a silent gasp. In this sense, every true scientist is a contemplative.

The Holy Father continued his reflections on science and the Church's mission in his address to the members of the Pontifical Academy of Sciences, whom he received on 13 November in a Solemn Audience on the occasion of the Academy's plenary assembly. The Pope echoed the assembly's theme, *Science and Humanity's Future*, by frequently referring to the anthropological and humanistic dimension of science. John Paul II challenged scientists when he said: Science shines forth in all its value as a good capable of motivating our existence, as a great experience of freedom for truth, as a fundamental work of service. Through research each scientist grows as a human being and helps others to do likewise. Thus, in addition to being contemplatives, we scientists are to be servants to those who wish to grow as human beings.

What a challenge—contemplatives and servants! Our Annual Reports describe the Vatican Observatory's research, international collaborations, and public outreach. To all of you who read them, I submit that there is more to their content than meets the eye. I invite you to keep in mind the thoughts expressed by John Paul II on the occasions described above when you peruse these reports.

On that note, I would like to make one last reflection. The Superior of the Jesuits addressed a message during the Jubilee Year to all Jesuits during a meeting of those responsible for the various regions of our works throughout the world. The meeting was held at the birthplace of the Jesuits in Loyola, Spain. The Superior pleaded with Jesuits to see their works as universal, touching all of humankind. He asked us to respond to the fact that people have become more internationally minded, moving out beyond their religious, cultural, national, and linguistic boundaries.

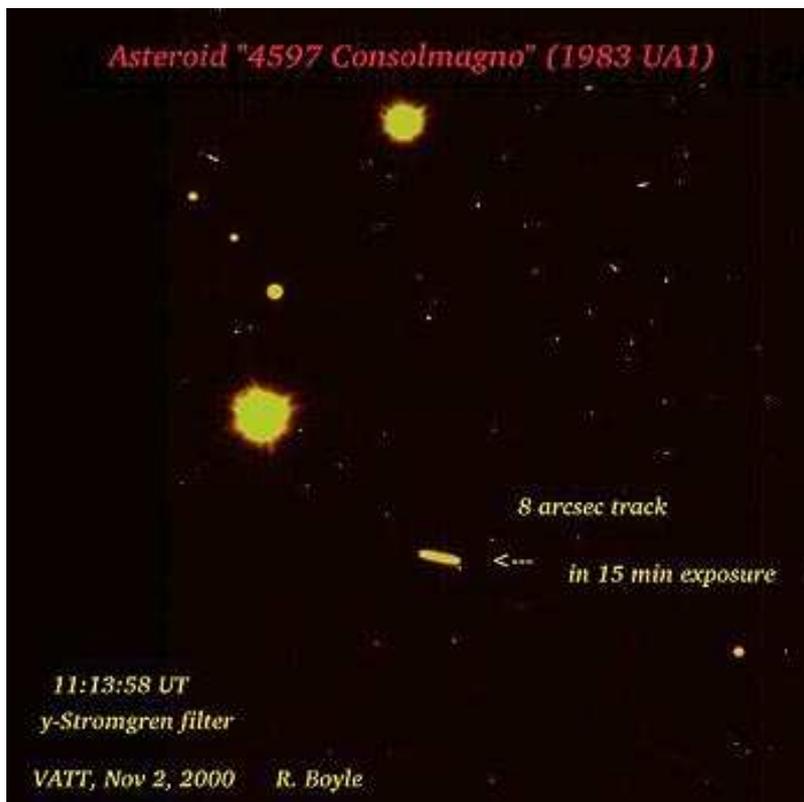
So, in addition to being contemplatives and servants, we scientists at the Vatican Observatory must be so to all peoples! I hope that this Annual Report will be judged as the Observatory's modest response to that challenge.

Research Highlights

The Vatican Observatory's Annual Reports routinely cover the wide variety of research pursued by the Observatory's staff. This year we would like to give our research special emphasis. The Table of Contents provides a snapshot of the diversity of our work: theoretical studies, astrophysics, and cosmology; extragalactic research; the galaxy and galactic objects; planetary sciences; as well as the history and philosophy of science and interdisciplinary studies. Here are some highlights from our current studies:

- Christopher Corbally, Richard Boyle, and their colleagues are exploring the evolution of stars in our Milky Way galaxy.

William Stoeger and Michael Heller, along with their collaborators, are pursuing theoretical studies that could lead to a better understanding of the origin of the universe and provide insight into the universe's structure and evolution during its early phases.



Vatican Observatory astronomer Guy Consolmagno, S.J. finally got his secret wish: an asteroid named after him. 4597 Consolmagno is now the official International Astronomical Union designation for a small, 20-km-wide space rock that orbits relatively close to the Sun at 2.6 AU (arrow). Richard P. Boyle, S.J. used the VATT to snap this photo of the asteroid, which is casually referred to as Little Guy. The asteroid's motion left a short track against the background stars during the 15-minute exposure. Consolmagno was honored for his contributions to the study of meteorites and asteroids.

- Guy Consolmagno continues to investigate the possibility that some meteorites may come from icy objects that formed very early in the outer parts of the solar system. He is also trying to understand how the early moon evolved.

- Alessandro Omizzolo is trying to understand the later stages in the universe's evolution through observations of the enigmatic quasars.

· Jos, Funes is investigating the rate at which stars formed in the first galaxies and how this helps us to understand the formation of galaxies themselves. With his colleagues, Funes is also finding evidence that the early universe witnessed dramatic interactions as young galaxies collided and merged. The photograph on the [cover](#) of this year's Annual Report documents one such galactic collision.

Although we at the Vatican Observatory share the results of our research with colleagues around the world through professional publications and meetings, we also continue to be very much involved in spreading the good news about the universe to the public through lectures, popular books, and articles, as well as through the communications media. With this modest array of activities we hope to respond in some small way to the call to serve all peoples that the Pope and our Jesuit Superior made to us this year.

Observatory–Sponsored Events

Galaxy Disks and Disk Galaxies Conference In June the Vatican Observatory sponsored an international meeting at the Pontifical Gregorian University that brought together 230 astronomers to discuss the latest research on galaxy formation and evolution. The conference provided a unique opportunity for many young astrophysicists to associate closely with some of the most renowned senior scholars in the world.

Members of the Galaxy Conference organizing committee included (left) Jos, Funes, S.J., Vatican Observatory, and (right) Enrico M. Corsini, University of Padua. At center background is conference participant Fernando Comerón, European Southern Observatory. (Photo by Christopher Corbally, S.J.)



This was the first time in its history that the Pontifical Gregorian University hosted an international meeting sponsored by the Vatican Observatory. The university, located two blocks from Rome's Trevi Fountain, is a descendant of the sixteenth-century Roman College. Such great personages in astronomy as Christoph Clavius and Angelo Secchi worked at the Roman College, paving the way for the foundation of the Vatican Observatory. The meeting is described in section III (Observatory and Staff Activities) of the Annual Report (and also in [its website](#)).

Scientific Perspectives on Divine Action Conference Series Inspired by the 1988 message of John Paul II to the Director of the Vatican Observatory on the relationship of science and religion, the Observatory has collaborated with the Center for Theology and the Natural Sciences (CTNS) in Berkeley, California, on a series of conferences with the theme of Scientific Perspectives on Divine Action. The fifth and last conference was held in June. This conference series treated a range of scientific topics, including the origin of the universe, the evolution of life, neuroscience, and personality. The conferences sought to respond to the statement by John Paul II that Science can purify religion from error and superstition; religion can purify science from idolatry and false absolutes. Each can draw one another into a wider world, a world in which each can flourish. The conference is described in section III (Observatory and Staff Activities) of the Annual Report.

The Cosmology Prize The Vatican Observatory helped to organize the inaugural awards ceremony for the Peter Gruber Foundation's Cosmology Prize, which was given to distinguished astronomers Allan R. Sandage of the Observatories of the Carnegie Institution of Washington and Philip James E. Peebles of Princeton University. The award was presented on 9 November at the Pontifical Academy of Sciences. Both recipients had participated in several epoch-making meetings of the Academy and of the Observatory.

Martin F. McCarthy Scholarship The Vatican Observatory awarded the Martin F. McCarthy Scholarship in Astrophysics to Nadezhda Gorlova of the Ukraine. A graduate of the Vatican Observatory Summer School 1999, she will pursue graduate studies in the Department of Astronomy at the University of Arizona. This is the sixth time that the scholarship, which honors retired Observatory astronomer Martin F. McCarthy, S.J., has been awarded.

Personnel News

Christopher Corbally, S.J., was appointed to serve a second term as president of the Institute on Religion in an Age of Science. He also received a number of appointments during the 24th General Assembly of the International Astronomical Union (IAU): chairman of the Working Group for Standard Stars; vice president for Commission 45 (Stellar Classification); national liaison for Vatican City State to Commission 46 (Astronomy Education and Development); and member of the Resolutions Committee for the IAU's 25th General Assembly. Corbally remains the Vatican City State's national representative to the IAU.

Guy J. Consolmagno, S.J. held the MacLean Chair for Visiting Jesuit Scholars during the Spring 2000 semester at St. Joseph's University, Philadelphia. His duties included teaching two regular classes in the Physics Department, conducting a special seminar on astrophysics for senior physics majors, and delivering the MacLean Lecture.

The Vatican Observatory joined with family, friends, and colleagues to celebrate the more than 40 years of service given by Martin F. McCarthy, S.J. to the Observatory. The event was held 15 April at the Campion Residence and Renewal Center in Weston, Massachusetts, where McCarthy has resided since retiring in 1999. On this occasion McCarthy was awarded the *Pro Pontifice et Ecclesiae* award by His Holiness John Paul II. He also received a personal congratulatory letter from the Very Reverend Peter-Hans Kolvenbach, Superior General of the Society of Jesus.

News of the Jesuit Community in Tucson

To celebrate the Jubilee Year, Richard J. Murphy, S.J., Vice Superior of the Jesuit Community of the Vatican Observatory in Tucson, organized a series of evening events to which various ministries of the Diocese of Tucson were invited. The gatherings featured popular presentations about the Observatory's work followed by dinner.

From 10 to 14 May, Guillermo Rodríguez-Izquierdo, S.J., Delegate of the Father General of the Jesuits, together with his assistant, Jos. M. Feliu, S.J., paid an official visit to the Vatican Observatory Research Group in Tucson.

Vatican Observatory Foundation Annual Meeting

The annual meeting of the members and directors of the Vatican Observatory Foundation was held on 25 February in Tucson, Arizona. The following were elected to serve as members and directors for a 3-year period: RICHARD P. BOYLE, S.J.; EMMANUEL M. CARREIRA, S.J.; CHARLES L. CURRIE, S.J.; KAREN DALBY; SHEILA GRINELL; and BRENDAN D. THOMSON. On the day before the annual meeting members of the Observatory staff made popular presentations of their research during a seminar for friends of the Observatory and members of the Board. On the day after the annual meeting, the same group was accompanied on an excursion to the Mt. Graham International Observatory where the Vatican Advanced Technology Telescope is located.

Through the efforts of Development Director NANCY KNOCHE and Chair of the Development Committee JAMES MCGEE, the Foundation initiated two giving plans through its [Vatican Observatory](#)

Guild. The guild's annual giving program is called *Reaching for the Heavens* with different levels honoring Copernicus, Galileo, Newton, and Hubble. Major donors are invited to join the *Circles of Giving*, with levels honoring the following eminent persons in the history of the Church and science: John Paul II, Leo XIII, Gregory XIII, Pius XI, Angelo Secchi, S.J., Eusebio Kino, S.J., Christoph Clavius, S.J., and Georges Lemaître. A festive dinner is planned for the next Board meeting to welcome 49 major donors into the *Circles of Giving*.

The official 2001 Vatican Observatory calendar was once again published through the efforts of BRENDAN D. THOMSON. The theme is *New Beginnings*.

George V. Coyne, S.J., Director



Astronomical Research

Theoretical Studies, Astrophysics, and Cosmology

STOEGER and ARAËJO (Universidade Federal do Rio de Janeiro) are making progress on setting up the equations in the general Friedmann–Lemaître–Robertson Walker perturbation case in observational coordinates using the fluid–ray tetrad formalism. Once that is done, they will study how to solve these equations and apply them to a variety of cases, including the cosmic microwave background radiation (CMBR).

With ELLIS and DUNSBY (Department of Mathematics, University of Cape Town), STOEGER has begun studying the evolution of the density parameter, the radius of curvature, and the distance to the particle horizon in closed inflationary cosmological models with a non-zero vacuum energy (cosmological constant). These models have recently become more attractive, as a result of best-fits to supernova–distance, galaxy–velocity, and CMBR anisotropy data, which yield a closed model with substantial vacuum energy. Theoretically, these models possess some interesting peculiarities that may hold the answer to some cosmological enigmas.

STOEGER and ELLIS are beginning to review the problem of gravitational lensing and the formation of caustics in cosmology. A great deal has already been done on this topic, but it is important to see whether all the effects of such phenomena have been properly taken into account in CMBR anisotropy analyses and in more traditionally astronomical cosmological work.

LISZKA (Swedish Institute of Space Science, Sfrs), PACHOLCZYK (Steward Observatory, University of Arizona), and STOEGER are pursuing the extraction of energy spectrum information from ROSAT and Chandra data sets for variable X–ray flux from Active Galactic Nuclei (AGN) to test their ballistic black hole scenario for these objects. They are also examining the possible application of this scenario to other astrophysical phenomena (e.g., gamma–ray bursts) and are improving aspects of the model that relate to the reprocessing of the original high–energy burst radiation through its interaction with the surrounding AGN matter and radiation fields.

JUST (Department of Physics, University of Arizona) and STOEGER are continuing work in quantum field theory on a number of topics related to fundamental issues. These include the measurement problem with sharp masses; realistically combinable operations in quantum theory and their relationship to the consistent histories approach; the spinless components of the electromagnetic and gravitational fields; and the allowed polarization states and the small virtual masses of interacting photons and gravitons. They are also continuing to pursue development of the quantum induction program, especially by incorporating gravity into it.

WHITMAN continues his work in the universe of geometric structures. Since the Einstein model for our universe is such a structure, his work has a direct bearing on the astrophysical studies of this universe. The possible structures are quite limited, and WHITMAN is trying to find them and describe their characteristics. At the meeting of the Clavius Group of Mathematicians he gave the details of a rather exotic geometrical structure, which has also found much application in quantum mechanics, namely, the spin representations of the Clifford algebra. In particular, he showed how these surprising geometric structures could have been discovered.

HELLER, with SASIN (University of Warsaw), continues to explore noncommutative geometries with special application to our knowledge of classical singularities and to the unification of quantum theory and general relativity. Interesting results have been obtained with respect to the emergence of time from classical singularities.

Extragalactic Research

FUNES and KENNICUTT (Steward Observatory, University of Arizona) have started a deep H α imaging survey using the Vatican Advanced Technology Telescope (VATT). The goal of this program is to obtain a better understanding of star formation in the local universe (galaxies within 11 megaparsecs). One of the major problems in astrophysics is the understanding of galaxy formation, where the history of the star formation rate in the universe plays a very important role. Data from the survey will provide information on the distribution of local star formation in terms of galaxy types, luminosities, and interstellar environments.

FUNES continues the study of the gaseous kinematics in the inner regions of disk galaxies. This work has been done in collaboration with BERTOLA, CAPPELLARI, CORSINI, PIZZELLA, SARZI, and SCARLATA (Department of Astronomy, University of Padua) and with VEGA BELTRAN (Instituto de Astrofísica de Canarias). Recent reports show that the supermassive black hole (SMBH) mass scales with the central stellar velocity dispersion. The relation is very well defined and has been computed on a sample of 26 galaxies. However, most of the SMBHs have been detected in elliptical or lenticular galaxies, and therefore it is not clear whether the relation holds also in the case of disk galaxies. By studying the bi-dimensional shape of the emission lines obtained from high spatial resolution, long-slit spectra along the major axes of disk galaxies, it is possible to put constraints on the mass of the central SMBH. The goal of this project is to extend demographic studies about SMBHs in disk galaxies to better define the relation between their mass and those of the spheroidal components of the host galaxies. This relation offers strong clues to galaxy formation and evolution.

FUNES, in collaboration with RAFANELLI (Department of Astronomy, University of Padua) and RICHTER (Astrophysikalisches Institut Potsdam), continues to investigate the relationship between gravitational interaction and galactic activity, as described in last year's Annual Report. Using images obtained with the VATT, they are searching for disturbed morphologies, such as distortions in the circumnuclear regions and small bars, double nuclei, faint companions, and faint tidal tails, that can be interpreted as the effect of gravitational interaction.

OMIZZOLO continues his program on the luminosity function of X-ray emitting quasars, using a sample of 800 objects selected from the ROSAT satellite data. In collaboration with CORBALLY and CRISTIANI (Department of Astronomy, University of Padua), he has obtained additional low-resolution, red-region spectra of X-ray emitting QSO candidates with the Steward Observatory's 2.3-m telescope. He has also obtained spectroscopic data from the European Southern Observatory at La Silla, Chile. Thus far, all but 150 objects have been observed.

In collaboration with FALOMO and RAFANELLI (Department of Astronomy, University of Padua), OMIZZOLO has initiated a program to study the environment of Active Galactic Nuclei in order to understand how the cosmic ambient has influenced the evolution of these energetic objects.

The Galaxy and Galactic Objects

CORBALLY and GRAY (Appalachian State University, Boone, North Carolina) finished observing spectra of late B, A, and early F-type stars in 11 young and intermediate-age open clusters. The MK classifications are nearly complete, and analysis with a view to investigating peculiar A-type stars, including lambda Bo^otis stars, is underway.

CORBALLY continues an investigation of heavily reddened stars in clusters and of peculiar stars continues. These have been selected by STRAIZYS (Institute of Theoretical Physics and Astronomy, Vilnius, Lithuania) from photometric classifications in the Vilnius seven-color system. CORBALLY has classified cluster stars in the area of NGC 1333, IC 348, the Taurus dark clouds, NGC 1750, and field stars from spectra he obtained with the Steward Observatory's 2.3-m telescope.

RUEGER (Diocese of Brooklyn) continued to process *UBVRI* observations of two calibration fields in the North Galactic Pole. These fields will help provide G-dwarf star candidates for further spectroscopic investigation by CORBALLY and GARRISON (David Dunlap Observatory, University of Toronto).

As part of the Nearby Stars (NStars)/Space Interferometry Mission preparatory science project, CORBALLY, GRAY, and GARRISON have started to obtain 1.5–4.5 resolution spectra in the blue–violet for all of the approximately 3600 nearby stars with spectral types earlier than M0 within 40 parsecs of the sun. These spectra will be used for five purposes: (1) to obtain homogeneous, precision MK spectral types of these stars; (2) in conjunction with existing Strömgren and Johnson photometry and synthetic spectra and fluxes from Kurucz ATLAS9 atmosphere models, to derive the basic astrophysical parameters for these stars, namely T_{eff} , $\log g$, $[M/H]$, and the microturbulent velocity; (3) to use the Ca II K–line included in the proposed spectral range (3800–5100 Å) to obtain a measure of the chromospheric activity of these stars; (4) to provide a medium–resolution, high S/N (> 100) spectrum for each star in the sample, which will become a permanent part of the NStars database; (5) to provide a list of suitable candidates for solar analogs and observing lists for extra–solar planetary systems. These purposes fulfill a number of important goals of the NStars project and help to provide necessary science data for the Space Interferometry Mission.

COYNE, with MAGLIHAES (Istituto Astronomico e Geofisico, University of São Paulo), is initiating a new survey of interstellar polarization in dark clouds to obtain better data for the magnetic field structure of these clouds.

KAZLAUSKAS and SPERAUSKAS (Institute of Theoretical Physics and Astronomy, Vilnius, Lithuania), in collaboration with BOYLE, spent 50 nights observing at the 1.5–m, 1–m, 1.54–m, and 2.3–m telescopes of Steward Observatory, University of Arizona. They observed about 800 stars of various spectral and luminosity classes, metallicities, and peculiarities for calibration of the Stromvil medium–band 7–color photometric system in terms of stellar physical parameters. This work now continues under STRAIZYS (Institute of Theoretical Physics and Astronomy, Vilnius) with a Chretien International Research Grant.

BOYLE and PHILIP (Union College and Institute for Space Observations, Schenectady, New York) are using the Stromvil standard stars to calibrate their VATT CCD star–field observations. Their collaborators SMRIGLIO and DASGUPTA (University of Rome) are doing the same for CCD observations made at the Loiano Telescope of the University of Bologna. JANUSZ (Krakow, Poland) and RUEGER (Diocese of Brooklyn) are collaborating with data processing and software development.

In October, the European Space Agency (ESA) selected the GAIA space mission to be Cornerstone 6 of its Science Program. It is likely that ESA will choose the Stromvil Photometric System for this mission to chart the billion brightest objects in our Galaxy to learn its composition, formation, and evolution.

Planetary Sciences

Meteorites

CONSOLMAGNO continued research on the structure of meteorites, including measurements of meteorite density and porosity and electron microscope imagery of meteorite fabric. In addition, he developed several theories to try to account for the observed lithification state of ordinary chondrite meteorites.

Over the past five years, BRITT (University of Tennessee) and CONSOLMAGNO have collaborated on efforts to provide a systematic measurement of meteorite density and porosity, including measurements of meteorite types previously undersampled. BRITT has received a grant from the NASA Office of Geology and Geochemistry –with CONSOLMAGNO, FLYNN (State University of New York, Plattsburgh), and ROBINSON (Northwestern University) as nonfunded co–investigators–to carry out this research. The helium pycnometer apparatus used in this work and described in previous Annual Reports has now been delivered to the Field Museum, Chicago, where measurements by WILKINSON (Northwestern University) and WADWA (Field Museum) are being made on samples from the museum's extensive collection.

CONSOLMAGNO has continued the mapping of porosity in meteorite thin sections. He produced an extensive Scanning Electron Microscope (SEM) image of a thin section of the ordinary chondrite *Ochansk* at the London Museum of Natural History (MNH), with the collaboration of RUSSELL (MNH). This meteorite is known to have uniform porosity measured at 11% in hand samples from the Vatican meteorite collection. This SEM image and others will be analyzed quantitatively by STRAIT (Alma College, California) during 2001. It is clear even from a preliminary examination of the thin section that on a scale of 100 mm, the porosity varies significantly across this sample. More importantly, the porosity visible in these images continues to confirm the idea proposed earlier by CONSOLMAGNO and colleagues that the porosity measured in hand samples can be accounted for by post-lithification shock cracks. This means that the lithification of meteorites in space compacted them to near-zero porosity in the apparent absence of water, heat, or pressure normally associated with such lithification in terrestrial rocks.

How and where this lithification occurred remains a mystery. At the annual meeting of the Meteoritical Society, CONSOLMAGNO presented one speculative possibility: that some meteorites might come from deep inside originally ice-rich bodies comparable to the current population of the Kuiper Belt. But he concluded that many other possibilities need to be explored. Discussions on this point continued with the collaborators listed above, as well as with VELBEL (Michigan State University), whose background includes extensive work in both carbonaceous chondrites and in terrestrial sedimentary rocks; with BLAND (Open University, Milton Keynes, England), an expert in meteorite weathering; and with WEIDENSCHILLING (Planetary Science Institute, Tucson), who has extensively modeled the impact and accretion environment of the early solar system.

Meteorites from the Vatican collection continue to be made available to other researchers. DURANTI and MENCHETTI (University of Florence) separated crystal fragments of melilite from small fragments of the CV-class meteorites *Vigarano* and *Lanc*, taken from the Vatican collection. These minerals were analyzed with an automated single-crystal diffractometer and an electron microprobe, revealing a peculiar chemical composition compared with other extraterrestrial melilites in the literature. The tiny samples used are now exhibited on permanent loan at the Mineralogical Museum of the University of Florence, which had previously lacked carbonaceous chondrites in its collection.

BRUCATO (Capodimonte Observatory, Naples) made spectral measurements in the UV-IR range of the meteorites *Renazzo* and *Ornans* from the Vatican collection. These meteorites are the type specimens of the CR and CO classes, respectively, of carbonaceous chondrites. Such measurements are useful for comparison with data expected from the NASA Stardust and ESA Rosetta missions to comet nuclei.

Asteroids

With the new data on the structure of asteroid Eros returned by the NEAR spacecraft, BRITT and CONSOLMAGNO have applied their data on meteorite and asteroid density to produce models of asteroid structure. Eros has been shown to have a density of 2.7 g/cm^3 , appears to be uniform throughout its interior (judging from its gravity figure), and its surface features strongly imply a relatively coherent structure. Yet its surface composition is comparable to L chondrites, a meteorite class that the Vatican data have shown to be 30% more dense than this asteroid. This raises a number of questions about how such a scenario is possible.

BRITT and CONSOLMAGNO note that a number of asteroids now have reasonably reliable density measurements. Mass estimates come from several sources. The best are spacecraft measurements, such as the NEAR measurements of Eros and Mathilde, and Mars orbiter measurements of Phobos and Deimos. But several moons of asteroids have been detected, and the masses of the parent asteroids can be determined from the moons' orbits by both spacecraft and adaptive optics, ground-based observations.

Furthermore, measurements to within a kilometer of the orbital perturbations of Mars have allowed celestial mechanics to estimate the masses of several of the larger asteroids and to put limits on the average densities of the inner (primarily S class) and outer (primarily C class) main belt asteroids.

Volume estimates for these objects are quite difficult, given their extremely irregular shapes, but reasonable limits on possible densities can nonetheless be estimated. A pattern begins to emerge by comparing these data with data on the densities of proposed meteorite analogs measured by CONSOLMAGNO and coworkers. Not surprisingly, the largest asteroids (Ceres and Vesta) appear to be well compacted, with densities not very different from the kinds of meteorites thought to represent their compositions.

Of the smaller asteroids, CONSOLMAGNO and colleagues find that the relatively high albedo S-class asteroids, like Eros, are thought to be made up of ordinary chondrite material, and they are systematically 25–35% less dense than their meteorite analogs. However, their meteorite data show that most ordinary chondrites are about 10% porous (pore spaces due to mm-size cracks); subtracting this porosity means that the asteroidal bodies must be about 15–25% macro porous, with cracks that are centimeters to meters wide. This sort of porosity is not all that uncommon in terrestrial sedimentary structures. The emerging picture suggests that these bodies can be considered "coherent rubble piles." Though held together by self-gravity alone, with significant cracking running throughout these bodies, the rubble pieces, nonetheless, fit together well enough that the body as a whole behaves as a coherent object when subjected to impacts and faulting. By contrast, the darker C-class asteroids have densities at least 50% lower than the densities of the dark meteorites thought to represent their composition. These bodies are clearly loose piles of rubble. As the severe impact history of Mathilde demonstrates (this asteroid has six large craters, comparable in size to the radius of the asteroid itself), such a loosely packed system will respond to geological processes in a very different manner than does coherent rock, absorbing impact energies that would completely shatter and disrupt a more coherent body.

The Nomenclature Working Group of the International Astronomical Union has officially designated asteroid 1983 UA1, discovered by BUS (Massachusetts Institute of Technology) in 1983, as asteroid 4597 Consolmagno. In support of this designation, the IAU citation from McCoy (Smithsonian Institution) acknowledged CONSOLMAGNO's work on basaltic achondrites and meteorite density measurements. Asteroid 4597 Consolmagno is small, about 20 km across, and orbits at an average distance of 2.6 AU from the Sun.

The Moon

An old link between basaltic achondrite meteorites and the lunar surface is leading to new insights into the chemical evolution of Earth's nearest neighbor. In a series of review presentations before the Geochemical Group of the British Geological Society and at the International Conference on Earth–Moon Relationships held in Padua, CONSOLMAGNO discussed the group of basaltic meteorites classified as either howardite, eucrite, or diogenite and collectively referred to as HED. These meteorites are closely related chemically and isotopically and almost certainly originate from the same parent asteroid, which is thought to be asteroid 4 Vesta. CONSOLMAGNO suggested that our understanding of the relatively simple HED parent body might lead to new insights into how the early Moon evolved. In particular, he noted that the purported chilled crust of anorthosite suggested by the magma–ocean model of the Moon is not a necessary element in successful models of the evolution of Vesta. Orbital data suggest that the aluminum-rich rocks of the Moon, thought to be evidence of the primordial chilled crust, may not be as abundant over the average Moon as once believed. CONSOLMAGNO suggests that a plagioclase/pyroxene basalt, similar in composition to the eucrites and howardites, might be a better match for the composition of the average lunar highland crust. Meanwhile, detailed analysis of the HED suite of basaltic achondrites has led to a fairly detailed picture of the evolution of their parent body (Vesta).

Small Outer Solar System Objects

Analysis of the broadband colors and light curves of seven small outer solar system objects observed at the VATT in 1999 by RETTIG (University of Notre Dame), TEGLER (Northern Arizona University), ROMANISHIN (University of Oklahoma), and CONSOLMAGNO, and described in last year's Annual Report, revealed a number of unexpected oddities. While the general trend of distinct gray and red color populations as first proposed by TEGLER and ROMANISHIN still appears to hold true, one object

in this group (1998 VG44) does appear to have a color in the transitional region between the two groups. When this is considered along with data by other observers, it appears that the two groups might be better understood as two populations each spread about an average color and with some amount of overlap between groups. More intriguing are hints of strong variations in brightness for these objects. The most complete analysis was performed for the odd outer solar system object 1999 TD10. This body is unusual in that it has a perihelion distance of 12 AU, similar to Centaurs (comet-like objects that cross the orbit of Saturn but do not reach Jupiter or the inner solar system). But 1999 TD10's large semi-major axis of, 190 AU, places it during much of its orbit among the variety of trans-Neptunian bodies known as "scattered disk" objects.

CONSOLMAGNO and colleagues found that 1999 TD10 exhibits large variations in brightness, with a light curve with an average V magnitude of 20.20 and a 0.68 magnitude amplitude, which can be fit with a period of 5.8 h. They found an absolute magnitude, H, of 9.07. If one assumes an albedo of 0.04, then 1999 TD10 has a mean diameter of 100 km. If the variation in brightness is due to the rotation of an object with an irregular shape, then the ratio of a/b is 1.88, giving the object dimensions of 130 × 70 km. Such an irregular shape for such a large object would be unusual for a main belt asteroid. However, the largest Trojan, 624 Hektor, may be larger and even more irregular in shape, and the largest irregular moon (Hyperion) has a similar a/b with much larger dimensions (410 × 260 × 220 km). The B-V color of 0.77 ± 0.02 and a V-R color of 0.47 ± 0.01 place 1999 TD10 in the "gray" population of Centaurs and Edgeworth-Kuiper Belt Objects, comparable to the Trojan asteroids.

Other objects observed in 1999 showed enigmatic hints of strong light curves, but the data taken at that time were insufficient to resolve possible ambiguities. As a result, light curves were observed again for a number of these objects at the VATT in late September 2000. Analysis of these results may reveal new insights into the shape and collisional histories of these mysterious outer solar system objects.

History and Philosophy of Science; Interdisciplinary Studies

CARUANA published a book entitled *Holism and the Understanding of Science*, in which he presents the research he has been conducting for the last 5 years. He starts with a detailed philosophical analysis of holism, concentrating on two complementary aspects—cognitive holism and social holism. Using these conceptual tools, he investigates the relevance of holism to science studies. He thus arrives at new perspectives on how to bridge the gap between the analytical, historical, and sociological accounts of science within the context of realism.

CORBALLY has studied complexification in the scientific story of the evolution of life. He finds that it is only through some kind of faith that the "story" of life becomes the "scheme" of life. What starts as a natural wonder can then take on Divine dimensions.

COYNE has completed a study of the changing relationship of the Church to the culture of science during the papacy of John Paul II. He has investigated the Pope's thought, especially as expressed in the encyclical *Fides et Ratio* on the role of the sciences in the search for ultimate meaning.

STOEGER recently completed work on the interaction between cosmology and the other natural sciences with eschatology (the theology of cosmic destiny and human destiny) under the auspices of the Center of Theological Inquiry in Princeton, New Jersey. He also contributed work on the epistemological and ontological implications of quantum theory to the meeting on "Quantum Mechanics and Quantum Field Theory," sponsored by the Vatican Observatory and the Center for Theology and the Natural Sciences, Berkeley, California. The meeting held at Castel Gandolfo in late June (see section III). In addition, STOEGER has been formulating more carefully a description of the universe that contemporary cosmology claims to study, and he is also working on related issues in the philosophy of cosmology.



Instrumentation and Technical Services

Major improvements in telescope performance and reliability were made to the Vatican Advanced Technology Telescope (VATT) under the Science Initiative Grant awarded to the Vatican Observatory Foundation by the Kresge Foundation in December 1998. The final technical report for this grant was presented to the Foundation on 1 March 2000, and it is available on the Observatory [website](#). The report includes many photographs and summary descriptions of the technical advances completed and those still underway. The Kresge Foundation grant made it possible to make progress on the VATT improvements at an exciting and rewarding rate. Support for this work continues through the concurrent and subsequent successful fundraising by the Vatican Observatory Foundation.

A radar dish, part of a precipitation detector system fabricated through the Kresge grant, stands guard outside the VATT. The detection electronics are at right. The system senses weather conditions a kilometer or more above the VATT and triggers an alarm to warn observers of any unexpected bursts of rain or snow that can damage the telescope's primary mirror. (Photo by Christopher Corbally, S.J.)



Principal contributors to the VATT improvements during the past year include the following people from the University of Arizona Steward Observatory: scientists CROMWELL and NELSON; engineers McKENNA, BRAR, CORDOVA, DAVISON, and LANDGREEN; technicians FRANZ, SWIFT, PHILLIPS, and TARDIF; several technical people from the Steward Observatory Technical Services group, directed by DeRIGNE; and people from the Mount Graham International Observatory operations crew, directed by RATJE.

Other recent VATT advances, aside from those described in the Kresge report, include: the discovery and elimination of servo tuning errors in the elevation drives (and lesser errors in the azimuth and derotator drives as well), resulting in improved star-tracking performance; the addition of black felt baffles in critical parts of the telescope optical path, resulting in the elimination of scattered skylight in VATT images and in a concurrent improvement in the accuracy of photometric measurements; the discovery and elimination of mechanical coupling between the dome building and telescope pier, resulting in reduced image motion due to vibration of the telescope in strong winds; and the discovery and reduction of vibration in the secondary-mirror mounting structure, resulting in reduced image spread due to secondary-mirror vibrations.

CORBALLY continued to maintain the Vatican Observatory website (<http://clavius.as.arizona.edu/vo/>), which gets an average of 150 visits per day, and added both the 1999 Annual Report and the Kresge

Foundation grant final technical report. The Vatican Observatory website is included in the Wider View of Things, an interactive exhibit on science at the soon-to-open [John Paul II Cultural Center](#) in Washington, D.C.

In collaboration with KENNICUTT (Steward Observatory, University of Arizona), four interference filters were purchased for the VATT. The 3.47-in. filters are designed for H-alpha imaging and are being used principally by FUNES.

NELSON (Steward Observatory, University of Arizona), together with COYNE and MAGALHAES (Instituto Astronômico e Geofísico, University of São Paulo), is designing a module for the measurement of polarization that will make it possible to carry out both point-source and imaging polarimetry with the VATT.



Observatory and Staff Activities

Conferences

In June the Observatory sponsored a conference titled "Galaxy Disks and Disk Galaxies" held at the Pontifical Gregorian University in the very center of Rome. The meeting hosted 230 participants from 30 countries. Through 28 review papers, 35 invited talks, and approximately 180 posters, the astronomers presented the latest research on the structure, formation, and evolution of the Milky Way and other disk galaxies. They gave particular attention to the stellar and gaseous disk of the Milky Way; the global characteristics, morphology and dynamics of disks; the gaseous component; star formation; chemical evolution; interactions; and scaling laws, as well as galaxy formation and evolution from a theoretical and observational point of view. Social events included a visit to the Vatican Observatory and the Papal Villas at Castel Gandolfo followed by a buffet supper served on a terrace of the Papal Summer Residence, which houses the Vatican Observatory.

Together with the Center for Theology and the Natural Sciences at Berkeley, California, the Vatican Observatory sponsored a meeting on "Quantum Physics and Quantum Field Theory," which was the last in a series of five conferences on the theme of "Scientific Perspectives on Divine Action." The meeting was held at Castel Gandolfo from 25 June to 1 July with the participation of CORBALLY and COYNE. STOEGER's paper was discussed in his absence.

The 38th Summer Meeting of the Clavius Group of Mathematicians was organized by WHITMAN and held from 29 June to 3 August at the University of Notre Dame.

Presentations and Academic Activities

CARREIRA • Gave a paper on "Metaphysics and Science" at the International Congress on Metaphysics, Science, Culture and Religion, held in Rome 4–8 September as a prelude to the celebration of the Jubilee for University Professors and Administrators. • Made five presentations at the Congress on Miracles, Universidad Bolivariana de Medellin, Colombia. • Spoke on "The Concept of Matter and the Risen Body" at a symposium at the University of Munich.

CASANOVAS • Gave a lecture on Ferdinand Verbiest in Peking. • Presented a seminar on Christoph Scheiner at the Astronomisches Rechen-Institut, Heidelberg.

CONSOLMAGNO • Presented his work on "Meteorite Porosity and Asteroid Structure" at the following venues: Physics Department Seminar, Drexel University, Philadelphia; Sigma Xi Colloquium, St. Joseph's University, Philadelphia; Department of Geology, Michigan State University; Space Telescope Science Institute, Baltimore; Princeton University Interstellar Medium Seminar; Goshen College Physics Department, Goshen, Indiana; Krakow Observatory Weekly Seminar, Poland. • Was reelected to the organizing committee and appointed secretary of Commission 16 (Planets and Satellites) of the International Astronomical Union. • Continued his term as a member of the Committee of the Division for Planetary Sciences (DPS), American Astronomical Society (AAS), and took part in two meetings of the DPS Committee in Pasadena. He paid a site visit to the University of Michigan, which is bidding to host the 2002 Annual Meeting of the DPS, and a site visit to the University of Warwick, England, bidding to host the 2005 Annual Meeting. He also joined members of the DPS Committee in Washington, DC, on 18–19 April to meet with Edward Weiler, Director of NASA Code S, and other officials at NASA Headquarters to discuss future prospects for the U.S. government's support for space science. At that time, the group also met with officials of the AAS, of the National Science Foundation, and with members of Congress. • Continued his work as chair of the organizing committee for the 2001 Annual Meeting of the International Meteoritical Society, to be held at the

Pontifical Gregorian University, Rome. He met several times with various members of this committee, in Rome, Tucson, London, and Padua. • Participated in a meeting of the South Carolina State Board of Education, Columbia, South Carolina, as part of a delegation of religious and scientific leaders defending the inclusion of evolution and modern cosmology in the state school system. The board voted unanimously to accept the recommended K–12 science curriculum. • At the Lunar and Planetary Institute, Houston, served on a NASA panel to review planetary astronomy proposals and rank them for funding. • Paid several working visits to the Natural History Museum, London; to Cambridge University Press, Cambridge, UK; to the State University of New York at Stony Brook; and to the Massachusetts Institute of Technology, Cambridge.

CORBALLY • Was reappointed President of the Institute on Religion in an Age of Science for the 2000–2001 year. He chaired council meetings in January at Winter Park, Florida, and in July at Portsmouth, New Hampshire, and he chaired the annual meeting on Star Island, New Hampshire. • Presented a lecture on "Big Telescopes Now and in the Near Future" at the Vatican Observatory Foundation seminar on 24 February. • Represented the Vatican Observatory at the rededication of the Multiple Mirror Telescope on 20 May. • From 27 September to 1 October made a working visit to Iowa State University to collaborate with Dr. Alfred Kracher and to give a Physics and Astronomy Department Seminar on "The Vatican's Little–Big Telescope." While there, he also contributed to the seminar sponsored by the CTNS Science and Religion Course Program, Midwest Region, on *Extraterrestrial Intelligence: Are We Alone?*, talking on "Complexification and Evolution in the Scheme of Life." • Joined the Board of the St. Albert the Great Forum at the Catholic Newman Center, University of Arizona.

COYNE • Served on the Advisory Board for The Cosmology Prize of The Peter Gruber Foundation. • Participated at the meeting "Humanity and the Cosmos" at Brock University, Ontario, Canada, and gave the keynote Thomas Aquinas Lecture. • Gave the inaugural Templeton Lecture at Methodist College, Durham, North Carolina. • Participated in the XII Symposium on the "Epistemology of the Natural Sciences" at Santa Marja de la Armonja, Cobo, Buenos Aires, Argentina, and gave a lecture on "Our Knowledge of the Universe." • Gave the keynote lecture at the meeting on Naturalism organized by the Institute for Philosophy, Religion and the Life Sciences at Grand Canyon University in Phoenix, Arizona. • Taught the course Natural Sciences 102 during the Spring semester at the Department of Astronomy, University of Arizona. • Gave a talk at the National Institute for Science and Technology, Gaithersburg, Maryland, on "The Scientific Method and Religious Belief Systems." • Attended the three meetings of the Executive Council of the Pontifical Academy of Sciences. • Also attended the annual meetings of the Governing Board of the International Center for Relativistic Astrophysics (Rome) and of the Scientific Advisory Board of the Institute for Scientific Exchange Foundation (Turin). • Paid a working visit to the Instituto Astronómico e Geofísico, University of São Paulo, Brazil. • Gave a seminar on "Big Telescopes of the Future" at the Astronomical Observatory of Cordoba, Argentina. • Spoke on the thought of John Paul II with respect to the dialogue between science and faith at the inauguration of the Intercultural Forum of the John Paul II Cultural Center in Washington, DC. • Presented a paper on "A Brief History of the Age of the Universe" at a meeting on "The Faces of Time" held in Varenna, Italy, and a paper on "Origins and Creation" at the meeting, "First Steps in the Origin of Life in the Universe," held at the Abdus Salam International Center for Theoretical Physics, Trieste, Italy. • Gave the introductory talk at the meeting on "The Far Future Universe: Eschatology from a Cosmic Perspective," sponsored by the Templeton Foundation and held at the Pontifical Academy of Sciences. • Serves on the Coordination Committee of the European Science Foundation Project on Science and Human Values and met with the Committee at Strasbourg, France, and at Oxford, UK.

FUNES • Gave seminars on the main results of his dissertation entitled 'Kinematics of the Ionized Gas in the Inner Regions of Disk Galaxies' to the following: Department of Astronomy, University of Padua, Italy; the National Optical Astronomy Observatories, Tucson, Arizona; Instituto de Astrofísica de Andalucía, Granada, Spain; Department of Physics, Pontificia Universidad Católica, Santiago, Chile; Observatorio Astronómico de Córdoba, Argentina; Observatorio Astronómico, La Plata, Argentina. • Paid a working visit to the Calar Alto Observatory, Spain.

HELLER • Gave the following papers: "Dynamics without Time" and "Mathematics, the Language of Physics?" in Krakow, Poland; "The Faith in Rationality" in Rome; "From Quantum Mechanics to God" at Castel Gandolfo; "The Big Bang Singularity and Penrose" in Warsaw; "The Classical Singularity

Problem— History and Current Research" in Valencia, Spain. • Presented the annual course on "Cosmology for Philosophers" at the Faculty of Philosophy of the Pontifical Academy of Theology in Krakow. • Supervised several masters and Ph.D. theses. • Was an editor for the Polish journal *Zagadnienia Filozoficzne w Nauce* (Philosophical Questions in Science).

MAFFEO • Prepared a new, revised edition of *In the Service of Nine Popes*, his history of the Vatican Observatory. • Collaborated in the preparation of the French edition, translated by François Evain, S.J., of *Galileo: For Copernicanism and for the Church* by Annibale Fantoli. He had already worked on the preparation of the original Italian and of the English and Russian language editions and is currently helping to negotiate a Spanish edition.

STOEGER • Taught the "Science and Theology" course in the Molecular and Cellular Biology Department, University of Arizona, with Thomas Lindell and Martinez Hewlett in both the spring and fall semesters 2000. • Also taught the "General Relativity" course with John Cocke in the Astronomy Department, University of Arizona, in the fall semester 2000. • Convened and chaired the Theology and Natural Sciences continuing group session at the Catholic Theological Society of America meeting in San Jose, California. • Served as a consultant to the Princeton Center of Theological Inquiry at the Pastoral Theologians workshops in Redondo Beach, California, and in New Orleans. • Participated in a series of talks and discussions on Science and Theology at McMaster University in Hamilton, Ontario, Canada, and gave a lecture on "Science, Evolution and Eschatology." • Gave a talk on Science and Eschatology at the general meeting of the Princeton Center of Theological Inquiry. • Gave the keynote address, "Cosmology and Geometry" at the Mathematics Appreciation Day in the Department of Mathematics, University of Arizona. • Spent October 2 to November 4 working on cosmology with George Ellis and his group in the Department of Mathematics at the University of Cape Town, South Africa. While there, he gave a seminar on "Restricted Test Functions and the Polarization of Photon and Graviton States."

WHITMAN • Continues to advise on financial matters to the Jesuit Social Center Presidente Kennedy in the city of Campinas in the state of São Paulo, Brazil. He was present there for five weeks during the months of March and April.

Public and Educational Outreach

CARREIRA • Lectured on the "Origin of the Universe and the Origin of Life" at the University of Monterrey and at the University of Guadalajara in Mexico. • Also gave public lectures in Spain at the Universidad Autonoma, Madrid; at the State University in Barcelona, in Badajoz, and in San Sebastian. • He spoke to the Cleveland Astronomical Society on the "Anthropic Principle" and to the Northeast Geological Society meeting at Kent State University on the "Earth as a Habitable Planet."

CARUANA • Gave a talk entitled "Divine Omnipotence and Modern Science" at the Scuola Grande di S. Teodoro, Venice, as part of an ongoing cultural seminar organized by the Centro Pattaro di Venezia. • Spoke on "Galileo and the Church: A Reappraisal" to the Malta Astronomical Society at the University of Malta.

CONSOLMAGNO • In connection with the release of his book *Brother Astronomer*, gave readings and presentations at the following institutions: Einstein Planetarium, Smithsonian Institution, Washington, DC.; the Stars Our Destination Bookstore, Chicago; Adler Planetarium, Chicago; the Book Revue Bookstore, Long Island, New York; Barnes and Noble, Madison, Wisconsin; Barnes and Noble, Bryn Mawr, Pennsylvania; the Tattered Cover Bookstore, Denver; Page One Books, Albuquerque; Book Expo America, Chicago; Barnes and Noble, Knoxville, Tennessee; Notre Dame University Bookstore, Notre Dame, Indiana. • Gave the following public lectures: Haverford (Pennsylvania) Township Community Recreation Center on "Walk Under the Full Moon"; Legatus, Bloomfield Hills, Michigan, on "God, Astronomy, and the Search for Elegance"; St. Joseph's Preparatory School, Philadelphia, on "The Rift of Popular Culture"; Department of Geological Sciences, University of Tennessee, Knoxville, on "History of the Vatican Observatory"; Vatican Observatory Foundation Reception, Philadelphia, on "A Tour of the Solar System"; Chester County (Pennsylvania) Astronomical Society on "Turn Left at Orion"; Rittenhouse Astronomical Society, Franklin Institute of Science, Philadelphia on "Visitors from Another Planet—Collecting Meteorites in Antarctica"; Philadelphia Center for Religion and Science, Chestnut Hill College, Philadelphia, on "Astronomy and Religion, Science and Science Fiction: the Rift

of Popular Culture"; SciTech Science Museum, Aurora, Illinois, on "Science and Religion: Is there a Conflict?"; Steward Observatory Public Night, University of Arizona, Tucson, on "Brother Astronomer, Adventures of a Vatican Astronomer"; Planetary Sciences Institute, Tucson, on "A History of the Vatican Observatory"; Sun City Astronomy Club, Oro Valley, Arizona, on "Searching for Meteorites in Antarctica"; Goshen College, Goshen, Indiana, on "Finding God in Creation"; Cranbrook Institute of Science, Bloomfield Hills, Michigan, on "Science, Religion and the Rift of Popular Culture" and on "Religion and Science" to 500 middle-school students from Cranbrook and neighboring schools; Vatican Observatory Foundation at the Arizona Science Center, Phoenix, on "Brother Astronomer, Adventures of a Vatican Scientist"; Berchmanskolleg Hochschule f r Philosophie, Munich, Germany, on "When Physics Meets Philosophy: The Role of World-Views in Science and Religion"; University of Krakow Program on Science and Religion on "When Physics Meets Philosophy: The Role of World-Views in Science and Religion." • Gave the following talks at the Duckon Science Fiction Convention, Chicago: "Visitors of Another Planet: Searching for Meteorites in Antarctica"; "Selling Space"; "Meteorites and Meteorwrongs"; "Stargazing for Children"; "Europa and Extrasolar Planets." • At the Chicon World Science Fiction Convention, Chicago, spoke on "Antarctica"; "Brother Astronomer"; "Settling Cold Worlds"; and "Asteroids and Comets." • Lectured at the Universe Semester Seminar of the Columbia University Biosphere 2, Oro Valley, Arizona.

CORBALLY • Visited the Sun City Astronomy Club on 2 March to talk on "The Lives and Personalities of Single Stars." • On 29 September contributed to an Iowa State University and CTNS sponsored public series on *Extraterrestrial Life: Scientific and Human Implications* with a lecture on "Talking about God and Extraterrestrials." • Spoke to Discovery Park's Astronomical Society about "The Vatican and Astronomy" on 12 October. • Hosted various visits to the VATT on Mt. Graham and to the Steward Observatory Mirror Laboratory.

COYNE • Spoke on "New Frontiers: The Search for Life in the Universe" at the Community Library of Misano Adriatico, Italy. • Delivered the dinner address to the Chicago Jesuit Companions. • Gave a talk on "The Sacred Cows of Science and Religion" to: Arizona Science Center, Phoenix, Arizona; Philosophy Seminar, Pontifical Gregorian University, Rome; Science and Religion Forum, Arizona State University West, Phoenix, Arizona; San Diego Science Center, California; Arizona Association of Engineers, Tucson; the Grace Museum of Abilene, Texas; Cultural Forum, Our Mother of Sorrows Church, Tucson, Arizona; Niles Memorial Lecture, St. Lawrence University, Canton, New York; the *Mathematics and Mysticism* class at the University of San Francisco; *Spirit of the Senses* seminar, Phoenix, Arizona; Diocesan Cultural Center, Reggio Calabria, Italy; Center for Intercultural Exchange, Lecco, Italy. • Presented a seminar on "God and the Big Bang" to the Brophy College Preparatory School, Phoenix, Arizona. • Gave a talk on "Faith, Reason and Pope John Paul II: Understanding *Fides et Ratio*" to the Catholic Newman Center, University of Toronto, Canada. • Spoke on "Animals in the Arizona Sky" at the Phoenix Zoo. • Presented a talk on "New Telescope Technology and the Vatican Telescope on Mt. Graham" to the Arizona Optics Association, Tucson, Arizona. • gave a public lecture on "The Search for Extrasolar Planets" at the Capitoline Museum for the lecture series "Beyond the Heavens" sponsored by the City of Rome and the Italian Astronomical Society • Received visits in Tucson from astronomy groups from Brophy College Preparatory School, Phoenix, Arizona and Belem Jesuit School, Miami, Florida, and gave talks to them on the "Evolution of the Universe." • Received visits at Castel Gandolfo and gave talks to *Legatus*, a national association of business leaders in the United States.

FUNES • Spoke about galaxies to the students of the Collegio Antonianum, Padua, Italy, and to the children of a primary school at Piove di Sacco, Italy. • In Argentina, gave presentations to the general public in Cordoba and a series of lectures to the Philosophy Faculty of the Universidad del Salvador, San Miguel, as part of the Philosophy of Nature course. • Gave two talks to the students of middle and high school of the Colegio del Salvador, Buenos Aires, Argentina. In the same school gave a lecture to the general public with the title "Pilgrims in the Universe: Science and Faith."

HELLER • Gave various interviews to Polish media on science, philosophy and the relationship to theology. • Spoke on recent developments in cosmology during the "open door" days at the Physics Department of Jagiellonian University, Krakow, Poland.

STOEGER • Lectured on cosmology at the Santa Fe Community College Planetarium. • Spoke twice on cosmology at the Smithsonian Institution *The New Astronomies* Seminars in Tucson. • Addressed

the Spiritual Directors of the Tucson Diocese on the topic, "God's Struggle to Create through the Evolutionary Process." • Gave a talk and led a discussion on "Religion and Science" at Kolbe House, the Catholic Chaplaincy at the University of Cape Town, South Africa. • Presented a session of the St. Albert the Great Forum on "Quantum Theory, Veiled Reality and Divine Action," at the Catholic Newman Center, University of Arizona. • Talked to the Youth Group at St. Mark's Parish, Tucson, on "Astronomy, Science and Christian Belief."

TERES • Presented the following talks to students, professors and other visitors in colleges and cultural centers of five cities in Hungary (Budapest, Szeged, Kecskemet, Felegyhaza, Vasarhely): "Effects of the Solar Activity on the Earth and Geomagnetic Field"; "The History and Research Work of the Vatican Observatory, from Rome to Arizona," illustrated with the film *People with Long Eyes*; "The star of Bethlehem and Our Historical Time Reckoning"; "The Big-Bang Model: Birth, Life and Death of the Universe"; "Natural Science and Theology: New Perspectives and Possibilities."

News Media Coverage

With the guidance of **CORBALLY**, *Sky and Telescope* published a feature article on the Vatican Observatory Summer Schools, "The World and the Universe Meet at Castel Gandolfo," by I. B. Joson and E. L. Aguirre in the May 2000 issue.

CONSOLMAGNO • Was a guest in Madison on the Wisconsin Public Radio show *To The Best Of Our Knowledge* and on the WKNX television newsmagazine program *Live at Five* in Knoxville; he also gave two cable television interviews in Long Island. • Interviews and articles about his book *Brother Astronomer* ran in the *Philadelphia Inquirer* (24 February); the *New Scientist* (25 March); the *Chicago Tribune* (4 April); *Our Sunday Visitor* (21 May); and the *Chronicle of Higher Education* (28 July). • Gave the following media interviews: with David Gibson for the *Newark (NJ) Sunday Star Ledger* (9 April); interviewed along with MAFFEO for Jubilee Radio, *Radio Vaticana* (21 July); with Susan Blackmore for *BBC Radio 4* (18 August); with *Canadian Science Fiction Cable Television* (2 September); with Christina Hughes for *Green Umbrella*, Bristol, UK.

CORBALLY • Provided interviews to the following journalists: Walter Goobar, *Channel 13 TV* in Argentina; Karin Mainview, *John Paul II Cultural Center*; Jim Erickson, *Space.com*; Stuart Becker, *Eastern Arizona Courier*; Christof Wolf and Godehard Bruntrup, *German Jesuit TV*; Mark Pendergrast, writing on "Mirrors"; Rex Graham, for *Science & Spirit*; Sandi Dolbee, religion and ethics editor for *The San Diego Union-Tribune*. • Hosted a visit to VATT for *Overseas Film*. • Answered news media questions from: Charles Petit, *US News & World Report*; Linda Hurst, *Toronto Star*; Tom Adams, *Mentorn Barraclough Carey TV* productions. • Was featured in a story, "God's Telescope," in *Veja*, a Brazilian national magazine.

COYNE • Provided interviews to the following journalists: David Malone of *Mentorn Barraclough Carey* for a three-part series, "Testing God," on *BBC Channel 4* television; Mathias Schulenburg of *DeutschlandRadio*, Cologne, Germany; Kishi, Yuki, and Forzan of *NHK, Japan Broadcasting Corporation* for the program "Space Millennium"; Alexandre Vigne of *Haute Terre*, France for the program "Conquest of Space"; Olivier Mille of *Artline Films*, Paris, for the program "The Cities of God"; Marie-Pierre Olphand of *Ciel et Espace*, France; Luigi dell'Aglio, *Avvenire*, Italy; Einauda Medi, *RAI 2*, Italy; John Robbie of *South African National Broadcasting*. • Participated in the following television programs: "Filo d'Arianna" by Francesca Apollonio of *RAI 2*; "Le Frontiere dello Spirito" by Maria Cecilia Sangiorgi of *RAI 5*.

FUNES • Was featured in articles in the following newspapers: *Corriere della Sera*, Milan, Italy; *Die Welt*, Berlin, Germany; *La Voz del Interior*, Cordoba, Argentina; *Revista Viva* of *Clarín*, Buenos Aires, Argentina. • Provided interviews to the following radio stations: *Radio Vaticana*; *Radio RAI Uno*, Rome; *Radio España*, Madrid, Spain; *Cadena Caracol*, Bogota, Colombia. • Was also interviewed by the following journalists: Magdalena Ruiz Guiáz, *Canal 13*, Buenos Aires, Argentina; Franco Foresta Marin, *Corriere della Sera*, Milan, Italy; Julio Argámaraz, *Clarín*, Buenos Aires, Argentina.

MAFFEO • Provided an interview to Luise Wagner-Ross of *Digital Drama*, Germany.

International Meetings

During 2000 representatives of the Vatican Observatory took part in the following international meetings:

11–15 January: Atlanta, Georgia. 195th Meeting of the American Astronomical Society. RICHARD BOYLE, S.J. and CHRISTOPHER CORBALLY, S.J. gave papers.

10–14 April: Frascati, Italy. Meeting of the Italian Astronomical Society. JUAN CASANOVAS, S.J. was a member of the organizing committee and gave a paper.

12–13 April: Tarnow, Poland. The "Future and Unity," Ecumenical Symposium. MICHAEL HELLER served on the scientific organizing committee.

12–13 April: Paris, France. International Meeting in Science and Religion, hosted by The Universit, Interdisciplinaire de Paris and UNESCO. CHRISTOPHER CORBALLY, S.J. was an invited respondent.

14–19 April: Lyon, France. Eighth European Conference on Science and Theology. CHRISTOPHER CORBALLY, S.J. chaired a plenary session.

27–30 April: Tucson, Arizona. Twelfth Annual Meeting of the International Dark–Sky Association. CHRISTOPHER CORBALLY, S.J. participated.

11–12 May: Krakow, Poland. 6th Krakow School on Philosophy of Science: On Time. MICHAEL HELLER served on the scientific organizing committee and gave a paper.

23–25 May: Vatican City State. Jubilee for Men and Women from the World of Learning: The Human Search for Truth. MICHAEL HELLER gave a paper; GEORGE V. COYNE, S.J. participated.

12–16 June: Rome, Italy. Galaxy Disks and Disk Galaxies. JOS FUNES, S.J. served on the organizing committee and gave two papers; RICHARD P. BOYLE, S.J., CHRISTOPHER CORBALLY, S.J., and GEORGE V. COYNE, S.J. participated and assisted the organizing committee.

25 June –1 July. Castel Gandolfo (Rome), Italy. Scientific Perspectives on Divine Action: Quantum Physics and Quantum Field Theory. MICHAEL HELLER gave a paper; GEORGE V. COYNE, S.J. and WILLIAM R. STOEGER, S.J. served on the organizing committee; CHRISTOPHER CORBALLY, S.J. participated.

20–21 July: Warsaw, Poland. COSPAR Cosmological Symposium. MICHAEL HELLER gave a paper.

29 July–5 August: Star Island, New Hampshire. Annual Conference of the Institute on Religion in an Age of Science. CHRISTOPHER CORBALLY, S.J. participated and chaired the IRAS Council and annual meetings.

7–18 August: Manchester, England. International Astronomical Union, 24th General Assembly. RICHARD BOYLE, S.J. served on the nominating committee. GUY CONSOLMAGNO, S.J. served on the finance committee. CHRISTOPHER CORBALLY, S.J. served as national representative for Vatican City State; gave an invited paper at the special session on "Astronomy for Developing Countries"; served on the scientific organizing committee for the joint discussion on "Hipparcos and the Luminosity Calibration of the Nearer Stars"; was secretary for the meeting of the Working Group on Standard Stars (elected chairman); attended the meetings of Commission 45 (elected vice president) and Commission 46 (appointed national liaison); and advised on the scientific session of Commissions 29 and 45 on "Ultra Cool Dwarfs."

27–31 August: Chicago, Illinois. Meteoritical Society Annual Meeting. GUY J. CONSOLMAGNO, S.J. presented a paper.

18–22 September: Valencia, Spain. Historical Development of Modern Cosmology. MICHAEL HELLER gave a paper.

18–22 September: Trieste, Italy. EuroConference on First Steps in the Origin of Life in the Universe. GEORGE V. COYNE, S.J. gave a paper.

25–28 September: Varenna, Italy. International Seminar on "The Faces of Time." JUAN CASANOVAS, S.J. and GEORGE V. COYNE, S.J. gave papers.

29–30 September: Krakow, Poland. Images of the World: Science, Humanities, Arts. MICHAEL HELLER served on the scientific organizing committee and gave a paper.

22–27 October: Pasadena, California. Annual Meeting, Division for Planetary Sciences, American Astronomical Society. GUY J. CONSOLMAGNO, S.J. presented a paper.

2 November : London, England. Annual Meeting, Geochemistry Division, British Geological Society. GUY J. CONSOLMAGNO, S.J. presented a paper.

8–10 November: Padua, Italy. International Conference on Earth–Moon Relations. GUY J. CONSOLMAGNO, S.J. presented a paper.

10–13 November: Vatican City. "Science and the Future of Mankind," Jubilee Plenary Session of the Pontifical Academy of Sciences. GEORGE V. COYNE, S.J. participated.

16 November: Oxford, UK. Coordination Committee meeting for "Science and Human Values," European Science Foundation. GEORGE V. COYNE, S.J. participated.



Publications

Cover

Publications

(The names of Vatican Observatory staff and visiting astronomers are noted in boldface.)

ABT, H. A. and **CORBALLY**, C. J. "The Maximum Age of Trapezium Systems," 2000, *ApJ*, 541, 841

BOYLE, R. P., SMRIGLIO, F., DASGUPTA, A., KAZLAUSKAS, A., STRAIZYS, V. and PHILIP, A. G. D. "Knowing the Error of Your Flat" (abstract) 1999, *BAAS*, 31, 150

BRITT D. T. and **CONSOLMAGNO**, G. J. "The Porosity of Dark Meteorites and the Structure of Low-Albedo Asteroids," 2000, *Icarus*, 146, 213–219

_____. "Modeling the Structure of High Porosity Asteroids," 2000, submitted to *Icarus*

_____. "Modeling the Structure of High Porosity Asteroids," 2000, *Lunar Planet. Sci.*, XXXI

_____. "Asteroid Bulk Density Implications of Recent Data," 2000, *Meteoritics and Planet. Sci.*, 34, A34–A35

CARUANA, L. *Holism and the Understanding of Science: Integrating the Analytical, Historical and Sociological*, 2000, Series Title: *New Critical Thinking in Philosophy*, ed. Ashgate (UK: Aldershot)

CASANOVAS, J. "Gruáwort," 2000, in *Sonne Entdecken, Christoph Scheiner 1575–1650* (Ingolstadt, 2000)

_____. "L'astronomia nei collegi della Compagnia di Ges—," in *Alle origini dell'universit... dell'Aquila* (Rome: Bibliotheca Instituti Historici S.I.), 251–260

_____. "El antiguo observatorio de Pekin y los instrumentos astronómicos de 1660," 2000, *Astrum*, 34–37

_____. "Contributo della Specola Vaticana al progetto Carte du Ciel," 1999, in *Atti del Convegno di Storia dell'Astronomia*, ed. P. Calledda and E. Proverbio (Cagliari), 123–132

_____. "Insegnamento dell'astronomia nei Collegi dei Gesuiti nel Settecento," 1997, in *Atti del convegno su Giuseppe Toaldo e il suo Tempo*, ed. L. Pigatto (Padua), 411–423

_____. "A New Approach to Spherical Astronomy," 2000, in *Astronomical Amusements, Papers in Honor of Jean Meeus*, ed. F. Bonoli, S. De Meis, and A. Panaino (Milan), 23–32

CONSOLMAGNO, G. J. *Brother Astronomer: Adventures of a Vatican Scientist*, 2000 (New York: McGraw Hill)

_____. "Scientist in the Vatican," 2000, *Catholic Digest*, 64, June, 66–71

_____. "Al sole di mezzanotte," 2000, *Popoli*, June/July, 32–38

_____. "Basaltic Achondrites, the Moon, and the Earth Geochemical Constraints on Origin Theories," 2000, Abstracts, Annual Meeting, Geochemistry Group, British Mineralogical and Geological Societies

_____. "Apollo Samples and the Geochemical Determination of Basaltic Achondrite Parent Bodies," 2000, submitted to Earth Moon Plan

_____. "Lithification Scenarios for Ordinary Chondrites", Meteoritics and Planet. Sci., 34, A45

_____. Book review of *Asteroids, A History* by Curtis Peebles, 2000, in Sky and Telescope, in press

_____. Book review of *Turn Right at Orion* by Mitchell Begelman, 2000, in Meteoritics and Planetary Science, submitted

CONSOLMAGNO, G. J. and Davis D. M. *Turn Left at Orion: A Hundred Night Sky Objects to See in a Small Telescope— and How to Find Them*, Third Edition, 2000 (Cambridge, UK: Cambridge University Press)

CONSOLMAGNO, G. J., TEGLER, S. C., RETTIG, T., and ROMANISHIN, W. "Size, Shape, Rotation, and Color of the Outer Solar System Object 1999 TD10," 2000, BAAS, in press

CORBALLY, C. J. "The 'Widening Center' of ZCRS," 1999, ZCRS Reports, 1, 3

_____. "The Heavens Declare God's Glory," 2000, Bible Alive, June

_____. "The Vatican Observatory Summer Schools in Observational Astronomy and Astrophysics" (abstract), 2000, in XXIV meeting of the IAU, Special Session on *Astronomy for Developing Countries*, IAUSS, 24, 7

CORBALLY, C. J., ed. Standard Star Newsletter No. 28, 2000, for IAU Working Group on Standard Stars

CORBALLY, C. J., GARRISON, R. F., RUEGER, W., and STAGG, C. R. "G-Dwarf Stars in the Galactic Halo," 1999, Ap&SS 265, 187

CORBALLY, C., STRAIZYS, V., and LAUGALYS, V. "Interstellar Extinction Law in the Vicinity of the North American and Pelican Nebulae," 1999, BAAS, 31, 1478

COYNE, G. V. "Il Dio che si svela nell'universo," 2000, L'Osservatore Romano, 25 May, 3

_____. "Preuves scientifiques de l'existence de planŠtes habitables hors du systŠme solaire. Un dŠfi pour la pens,e religieuse," 2000, in *Dieu, L' glise et Extraterrestres*, ed. Alexandre Vigne, trans. M-C. Grun,lius-de-Neuville (LuŁon, France: ditions Question), 29-46

_____. "The Scientific Venture and Materialism: False Premises," 2000, in *Space or Spaces as Paradigms of Mental Categories* (Milan: Fondazione Carlo Erba), 7-19.

_____. "The Evolution of Intelligent Life on the Earth and Possibly Elsewhere: Reflections from a Religious Tradition," 2000, in *Many Worlds: The New Universe, Extraterrestrial Life, and the Theological Implications*, ed. S. Dick (Philadelphia and London: Templeton Foundation Press), 177-188

_____. "Introduction: Eschatology from a Cosmic Perspective," 2001, in *The Far Future Universe*, ed. G. F. R. Ellis (Philadelphia and London: Templeton Foundation Press), submitted for publication

_____. "The Church in Dialogue with Science: The Wojtyla Years," 2000, in *New Catholic Encyclopedia* (Washington, DC: The Catholic University of America Press, Gale Group)

_____. "A Brief History of the Age of the Universe," 2001, in *The Faces of Time*, ed. E. Sindoni and G. Giorello (Casale Monferrato, Italy: Piemme), submitted for publication

_____. "Origins and Creation," 2001, in *First Steps in the Origin of Life in the Universe*, ed. J. Chela-Flores, T. Owen, and F. Raulin (Dordrecht: Kluwer Academic Publishers), submitted for

publication

_____. "Direzione della Specola Vaticana," 2000, *Attivit... della Santa Sede 1999*, 1456–1468

_____. "Vatican Observatory," in *Interdisciplinary Dictionary of Faith and Science*, ed. A. Strumia and G. Tanzella–Nitti, to be published

COYNE, G. and **OMIZZOLO**, A. *Viandanti nel Cosmo: Astronomia e Senso della Vita*, 2000 (Arnaldo Mondadori Editore, S.p.A.: Milan)

CRISTIANI, S., GRAZIAN, A., **OMIZZOLO**, A., and **CORBALLY**, C. "Mining the Local Universe: The QSO Space Density," 2000, in *Mining the Sky*, Proceedings of the MPA/ESO/MPE Joint Astronomy Conference, astro-ph/0010562 (preprint)

FUNES, J. G. and **CORSINI**, E. M. "Galaxy Disks and Disk Galaxies" Conference Highlights, 2000, PASP 112, 1510

_____. "Galassie a disco alla Pontificia Universit... Gregoriana," 2000, *Civilt... Cattolica*, 3611, 444–450

FUNES, J. G., and **CORSINI**, E. M., ed. *Galaxy Disks and Disk Galaxies* (San Francisco: Conference Proceedings of the Astronomical Society of the Pacific), to be published

GRAY, R. O. and **CORBALLY**, C. J. "A Spectroscopic Search for Peculiar A–Type Stars in Open Clusters," 1999, BAAS, 31, 1441

GRAZIAN, A., CRISTIANI, S., D'ODORICO, V., **OMIZZOLO**, A., and PIZZELLA, A. "The Asiago–ESO/RASS QSO Survey. I. The Catalog and the Local QSO Luminosity Function," 2000, AJ, 119, 2540

GUPTA, R. D. and **RICHARDS**, D. St.P. "Moment Properties of the Multivariate Dirichlet Distributions," 2000, J. Multivariate Analysis, in press

HELLER, M. Book review of *The God of Evolution: A Trinitarian Theology* by D. Edwards, 1999, in *Tarnowskie Studia Teologiczne*, 18/2, 333–335

_____. "Report on Science and Religion Forum," 1999, *Zagadnienia Filozoficzne w Nauce*, 25, 103–105

_____. "Science et Transcendence, Convergences," 2000, Num,ro special: Science et religion, Universit, Interdisciplinaire de Paris, Spring, 14–19

_____. "Cosmological Singularity and the Creation of the Universe," 2000, *Zygon*, 35, 665–685

HELLER, M., **LAMBERT**, D., and **MADORE**, B. "A Brief History of Noncommutative Space–Time," 1998, *Acta Cosmologica*, 2D.4, no. 1, 51–69

_____. "Some Conceptual Problems of the Groupoid Approach to Noncommutative Quantization of Gravity," 1998, *Acta Cosmologica*, 24, no. 1, 71–85

HELLER, M., **SASIN**, W., and **ODRZYGÀYDY**, Z. "State Vector Reduction as a Shadow of Noncommutative Dynamics," 2000, J. Math. Phys. 41, 5168–5179

LISZKA, L., **PACHOLCZYK**, A. G., and **STOEGER**, W. R. "Extraction of a Deterministic Component from ROSAT X–Ray Data Using a Wavelet Transform and the Principal Component Analysis. II. The Data Analysis," 2000, A&A, 354, 847–852

_____. "Active Galactic Nuclei. VI. ROSAT Variability of Seyfert Galaxies," 2000, ApJ, 540, 122–130

MAGLIHAES, A. M., PEREYRA, A., MELGAREJO, R., and **COYNE**, G. V. "A Survey of Interstellar Polarization," 2000, *Bull. Astron. Soc. Brazil*, in press

OMIZZOLO, A. "Astronomy," in *Interdisciplinary Dictionary of Faith and Science*, ed. A. Strumia and G. Tanzella–Nitti, to be published

PIGNATELLI, E., CORSINI, E. M., VEGA BELTRAN, J. C., SCARLATA, C., PIZZELLA, A., **FUNES**, J. G., ZEILINGER, W. W., BECKMAN, J. E., and BERTOLA, F. "Modeling the Gaseous and Stellar Kinematics in the Disk Galaxies NGC 772, NGC 3898, and NGC 7782," 2000, *MNRAS*, accepted for publication

SARZI, M., CORSINI, E. M., PIZZELLA, A., VEGA BELTRAN, J. C., CAPPELLARI, M., **FUNES**, J. G., and BERTOLA, F. "NGC 4672. A New Case of an Early–Type Disk Galaxy with an Orthogonally Decoupled Core," 2000, *A&A*, 360, 439

STOEGER, W. R. "The Mind–Brain Problem, the Laws of Nature and Constitutive Relationships," 1999, in *Neuroscience and the Person: Scientific Perspectives on Divine Action*, ed. R. J. Russell, N. Murphy, T. C. Meyering, and M. A. Arbib (Vatican City: Vatican Observatory Publications), 129–146

_____. "Scientific Accounts of Ultimate Catastrophes in Our Life–Bearing Universe," 2000, in *The End of the World and the Ends of God*, ed. J. Polkinghorne and M. Welker (Harrisburg: Trinity Press International), 19–28

_____. "Cultural Cosmology and the Impact of the Natural Sciences on Philosophy and Culture," 2000, in *The End of the World and the Ends of God*, ed. J. Polkinghorne and M. Welker (Harrisburg: Trinity Press International), 65–77

_____. "Can God Really Act in the World and in Our Lives," 2000, in *God for the 21st Century*, 2000, ed. R. Stannard (Philadelphia and London: Templeton Foundation Press), 166–168

_____. "Epistemological and Ontological Issues Arising from Quantum Theory," 2001, in *Quantum Mechanics and Quantum Field Theory*, ed. R. J. Russell, J. Polkinghorne, and P. Clayton (Vatican City: Vatican Observatory Publications), to be published

_____. "Cosmology," 2001, in *Interdisciplinary Dictionary of Faith and Science*, ed. A. Strumia and G. Tanzella–Nitti, to be published

_____. "Cosmology. VI. Modern History of Science," 2001, in *Religion in Geschichte und Gegenwart*, New Edition, ed. H. D. Betz (J. C. B. Mohr Publishing House), to be published

_____. "What is 'the Universe' Which Cosmology Studies?" 2000, in *Philosophy in Science*, Vol. IX, ed. W. R. Stoeger, M. Heller, and J. Zycinski (Tucson, Arizona: Pachart Publishing House), to be published

_____. "Aesthetics and Theology and Science," 2000, in *Proceedings of the 55th Annual Convention of the Catholic Theological Society of America* (Report on the Theology and Natural Sciences Group Session), ed. M. Downey (Washington, DC: CTSA), 144–145

STRAIZYS, V., **CORBALLY**, C., and LAUGALYS, V. "Interstellar Extinction Law in the Vicinity of the North American and Pelican Nebulae," 1999, *Balt. A.*, 8, 355

TERES, G. "History and Research Work of the Vatican Observatory, From Rome to Arizona," 1998, in *Scientia unit in Fide*, ed. E. Nemesszeghy (Kecskemet: Korda), Vol. II, 273–311, in Hungarian

_____. "Christian Chronology and the Star of Bethlehem," 2000, in *Uj Ember* (Budapest: Uj Ember), in Hungarian

_____. *The Bible and Astronomy*, 2000 (Budapest: Springer Orvosi Kiado)



Observatory Visitors



Observatory Visitors

The Vatican Observatory at Castel Gandolfo, Italy, and the Vatican Observatory Research Group in Tucson, Arizona, hosted many visitors throughout the year. The number of school groups received by MAFFEO at Castel Gandolfo was particularly noteworthy.

We were privileged to have a visit by the Ambassador of the United States to the Holy See, Mrs. Corinne C. Boggs.

The Vatican Observatory hosted several visits to its headquarters in Castel Gandolfo: participants at the meeting "Galaxy Disks and Disk Galaxies" visited the Observatory and the Pontifical Villa at Castel Gandolfo. Hosted also were the members of the Pontifical Academy of Sciences on the occasion of the Plenary Session of the Academy in November, as well as groups from the John Templeton Foundation and the Peter Gruber Foundation.

The following individuals paid extended working visits to the Observatory:

AJOY K. DASGUPTA, Institute of Astronomy, University of Rome "La Sapienza," Rome, and South Glamorgan Education Department, Cardiff, UK

FRANÇOIS EVAÏN, S.J., Jesuit Community, Rouen, France

JAVIER IGEA, priest of the Diocese of Toledo, Spain

ROBERT JANUSZ, S.J., Krakow, Poland

ALGIS KAZLAUSKAS, Institute of Theoretical Physics and Astronomy, Vilnius, Lithuania

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

JULIUS SPERAUSKAS, Vilnius University, Vilnius, Lithuania

JACK WISDOM, Massachusetts Institute of Technology, Cambridge, Massachusetts, USA

The following participated in the meeting on "Quantum Physics and Quantum Field Theory" held at Castel Gandolfo from 25 June to 1 July:

MICHAEL BERRY, H. H., Wills Physical Laboratory, Bristol, UK; JEREMY BUTTERFIELD, Cambridge, UK; RAYMOND CHIAO, Department of Physics, University of California, Berkeley, California, USA; CHRIS CLARKE, Faculty of Mathematical Studies, University of Southampton, UK; PHILIP CLAYTON, Department of Philosophy, Sonoma State University, California, USA; JAMES T. CUSHING, Department of Physics, University of Notre Dame, South Bend, Indiana, USA; GEORGE F. R. ELLIS, University of Cape Town, South Africa; MICHAEL HELLER, Pontifical Theological Academy, Krakow, Poland; PAVEL KAPUSTA, S.J., Frankfurt am Main, Germany; JOHN LUCAS, Somerset, UK; ERNAN T. MCMULLIN, University of Notre Dame, South Bend, Indiana, USA; NANCEY MURPHY, School of Theology, Fuller Theological Seminary, Pasadena, California, USA; TED PETERS, Pacific Lutheran Seminary, Berkeley, California, USA; JOHN POLKINGHORNE, Cambridge, UK; MICHAEL REDHEAD, London, UK; ROBERT J. RUSSELL, Center for Theology and the Natural Sciences, Berkeley,

California, USA; ABNER E. SHIMONY, Wellesley, Massachusetts, USA; OWEN THOMAS, Berkeley, California, USA; THOMAS F. TRACY, Department of Philosophy and Religion, Bates College, Lewiston, Maine, USA; KIRK WEGTER-MCNELLY, Center for Theology and the Natural Sciences, Berkeley, California, USA; CARL YORK, Center for Theology and the Natural Sciences, Berkeley, California, USA.

Other professional guests of the Observatory at either Castel Gandolfo or Tucson during the year included: CLAUDIO CASACCI, Alenia Aerospazio, Turin, Italy; ENRICO M. CORSINI, Asiago Observatory, University of Padua, Italy; DARBY DYAR, Mount Holyoke College, Massachusetts, USA; FRANÇOIS EUV, S.J., Centre Sevres, Paris, France; JOHN FALLON, Diocese of Fargo, North Dakota, USA; JEAN-BAPTISTE KIKWAYA, S.J., Bureau de Longitude, Mecanique Celeste, Paris, France; DANTE MINNITI, Pontificia Universidad Catolica de Chile, Santiago, Chile; FRANCISCO PRADA, Calar Alto Observatory, Spain; GIUSEPPE RACCA, Scientific Projects Department, European Space Agency, Paris, France; PIERO RAFANELLI, Department of Astronomy, University of Padua, Italy; REMO RUFFINI, University of Rome "La Sapienza," Italy; FILIPPO SMRIGLIO, Institute of Astronomy, University of Rome "La Sapienza," Italy; ROBERTO SOMMA, Alenia Aerospazio, Rome, Italy; DAVID VAN DE PUTTE, Astronomy Centre, University of Sussex, UK; FRANK YOUNGER, Dominion Astrophysical Observatory, Victoria, Canada.

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