Some 80 eminent scientists convene biennially to bend the ear of the pope—and help shape global attitudes toward new technologies

Science and Religion Advance Together at Pontifical Academy

Pontifical Academy of Sciences

Created: 1936, by Pope Pius XI

Number of members: 80

Purpose: "To promote the progress of the mathematical, physical and natural sciences and the study of epistemological problems relating thereto."

Recent publications:

- The origin and early evolution of life
- Geosphere-biosphere interactions and climate
- Food needs of the developing world in the early 21st century

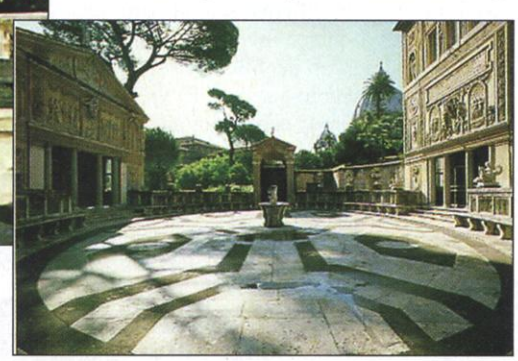
VATICAN CITY—The Casina Pio Quattro is a distracting location for a scientific meeting, to say the least. Outside the templelike structure, high on a hill behind St. Peter's Basilica, immaculate gardens teem with squawking parrots. Inside, gleaming marble and brilliant frescoes glorify God and the heirs of St. Peter. A statue of the goddess Cybele, temporarily hidden in a thicket of scaffolding, graces the Casina, whose walls are adorned with quotations from Seneca and Cicero.

The pagan motifs are fitting, because the Casina—erected in the 1550s as a residence for Pope Pius IV—now serves as a meeting place for the religious and secular worlds. It is the headquarters for the Pontifical Academy of Sciences: 80 esteemed scientists appointed for life to make their cumulative collective wisdom available to the pope. Members run the gamut of disciplines, backgrounds, nationalities, and religious beliefs. Twenty-five of them are Nobel laureates. Some of the most famous scientists in the world are members, such as physicists Stephen Hawking and Carlo Rubbia, astronomers Martin Rees and Vera Rubin, biologist David Baltimore, and numerous others. Every other year, the group gathers in the Vatican Gardens for a plenary session at which members hold forth on the state of science and the world, pass resolutions for improving the latter, and renew acquaintances. They have, by all accounts, a heavenly time. As member Joseph Murray, a 1990 Nobel laureate who performed the first kidney transplant, puts it, "Every day is like Christmas." If so, the gift giving is mutual. The pope gets access to the scientific expertise of people at the top of their fields in astronomy, cosmology, genetics, and other areas that interest the church. In return, the scientists get the ear of one of the most important people in the world—and, through him, a chance to influence whether people accept or reject new knowledge and technology.

In recent years, the academy has weighed in on both urgent practical issues—environmental concerns, neurological research, breast feeding, fertility—and deeper ones, such as the origins of life, the implications of genetics, and the formation of galaxies in the early universe. And it has been credited with influencing the church's positions on issues ranging from gene splicing to evolution. "All these things raise big, important philosophical questions," says academy member Peter Raven, director of the Missouri Botanical Garden in St. Louis and new president of the American Association for the Advancement of Science (publisher of *Science*). "If you don't have good scientific advice, you're going to make all sorts of screwy statements. No organized body of people can operate efficiently without some input of science." At its latest plenary session, held last November, members prepared to make an announcement that could shift the debate over one of today's most controversial science-policy issues, the use of genetically modified foods.

"Broadly speaking, the Pontifical Academy is very similar to a national academy," says member Charles Townes, inventor of the laser and winner of the 1964 Nobel Prize in physics. In some ways it's better, Raven adds. Its small size allows it to meet and make decisions as a whole, unlike most national academies, yet it also fields an unusually broad range of scientific expertise. With members drawn from 27 countries, the Pontifical Academy has served as the inspiration for other international academies. "The idea for the Third World Academy of Sciences was actually born in this academy," says chemist C. N. Rao, a member of the Pontifical Academy and president of the Third World Academy. "This campus was its birthplace."

The Pontifical Academy itself traces its ancestry to the Accademia Lincei. Founded by the 18-year-old son of a duke in 1603, the Lincei was named in hopes that science would enable people to perceive nature with eyesight as keen as a lynx's. Over the centuries, the Lincei assumed numerous incarnations, both secular and pontifical. In 1936, during the reign of Mussolini, Pope



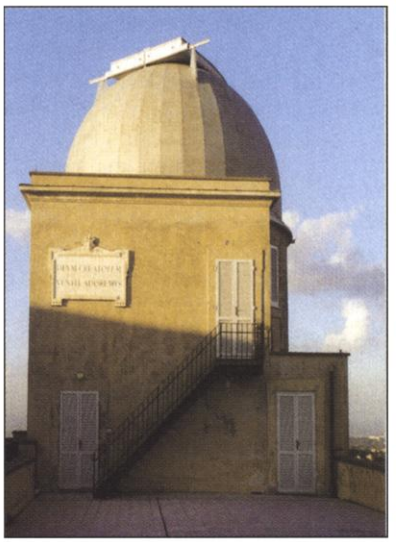
Heavenly headquarters. The 16th-century Casina Pio IV, surrounded by the splendor of the Vatican gardens, is home for the Pontifical Academy of Sciences.

CREDITS: THE PONTIFICAL ACADEMY

Vatican Observatory Takes Long View Of Exploring the Heavens

VATICAN OBSERVATORY, CASTEL GANDOLFO, ITALY—For more than 400 years, the astronomers of the Vatican Observatory have kept the church's gaze fixed on the heavens. Begun with the modest aim of tracking the course of the sun, the observatory has become the Vatican's eye on a few frontier areas of modern astronomy.

The headquarters of the observatory is at Castel Gandolfo, the pope's summer residence in the Alban Hills several kilometers southeast of Rome. Father George V. Coyne, director of the Vatican Observatory, spends half the year here in his office atop the pope's bedroom (he jokingly warns visitors not to toss beer cans over the ledge) and half on Mount Graham in Arizona, since 1993 the home of the 1.8-meter Vatican Advanced Technology Telescope (VATT). The telescope was the first to sport a mirror made in a rotating furnace, which slopped the glass into the parabolic shape required, saving weight and material. It also drew fire from protesters who feared that its construction would threaten the habitat of an endangered red squirrel (*Science*, 14 July 2000, p. 228).



Eye on the heavens. High atop the Alban Hills, the telescopes at Castel Gandolfo have been surpassed by one in Arizona.

The Arizona observatory is just the latest incarnation of a scientific enterprise that started within the Vatican walls. The first was the Tower of the Winds, a small, boxy tower that juts from a building overshadowed by the dome of St. Peter's. The tower—probably the most ornate scientific laboratory the world has ever known—was built in the 16th century by order of Pope Gregory XIII to help Jesuit astronomers assess the need for calendar reform. Its interior is one large, lavishly decorated scientific instrument. The walls are covered with frescoes showing the storm on the Sea of Galilee described in the gospel of Luke, as well as astronomically accurate paintings of the signs of the zodiac. On each wall, one of the four winds huffs away; by day, sunlight streams through a hole in the mouth of the south wind. By charting how the sun moved across the paintings and against a meridian line in the floor of the room, Jesuit astronomers calculated how far the old Julian calendar had strayed from astronomical reality, a discrepancy the pope corrected by wiping 10 days out of existence in October 1582.

"The Jesuits did such a good job that they gave us spaghetti and wine and told us to keep doing it," Coyne says. Church-sponsored astronomers have been scanning the firmament ever since. In 1868, Father Angelo Secchi became the first person to classify stars by their spectra, lumping them into four major classes. His method paved the way for current spectral classification schemes. By the end of the century, Pope Leo XIII had established an official Vatican Observatory on the Vatican grounds. In the 1930s, the astronomers moved to Castel Gandolfo in hopes of finding darker skies; 50 years later, they moved to Arizona.

Today's Coyne-operated observatory fields a team of eight Jesuit astronomers and eight staff members; it shares its telescope with the University of Arizona, which has other telescopes on Mount Graham and at other sites. The topics studied there range from galactic tidal forces to Coyne's own specialty, cataclysmic variables—stars that undergo dramatic changes in brightness. Results appear in scientific journals. "They are a very good crew of professional astronomers," says Mark Sykes of the Steward Observatory in Tucson, Arizona. "Though few in numbers, they contribute quite a bit, and they do a lot of public outreach."

In one long-standing line of research, Father Guy Consolmagno has spent decades trying to determine whether asteroids are solid chunks of rock or piles of gravitationally bound rubble, long a matter of debate (*Science*, 4 July 1997, p. 30). Using simulations, meteorite samples, and images from the VATT and other telescopes, Consolmagno—working with astronomer Daniel Britt of the University of Tennessee, Knoxville—has determined that some asteroids may be at least 35% empty space. They have speculated that asteroid 16 Psyche is more void than rock.

The Vatican Observatory also grapples with issues that most astronomers shy away from. Coyne occasionally explores the theological implications of astronomical research in papers such as "Evidence for the Existence of Extra-solar Planets: Challenges for Religious Thought," which appeared in 1999 in an anthology published by the Templeton Foundation (*Science*, 21 May 1999, p. 1257). **–C.S.**

Pius XI split the modern Pontifical Academy off from the Lincei, which survives as the Italian national scientific academy.

Since its founding, the Pontifical Academy has numbered among its members such scientific luminaries as Alexander Fleming, Niels Bohr, Chandrasekhara Raman, and Werner Heisenberg (elected in 1955). (Prominent nonmembers have included Albert Einstein, James Watson, Francis Crick, and Wolfgang Pauli.) Candidates are nominated and elected by the members, although technically they are appointed by sovereign act of the pontiff—who looks for more than mere scientific eminence. The institution's charter specifies that members must possess "acknowledged moral personality." Members say they don't know how the church verifies that clause. Townes says he found out about it when his nomination was under consideration in the early 1980s. A woman from the church phoned and told him that members were required to have good moral character.

"How do you decide if I do?" Townes asked.

"We have our ways."

Once on board, members share a simple set of duties: to meet and talk. Members say they choose their own speakers and topics and debate issues freely. "The Catholic Church is supporting this academy," says Crodowaldo Pavan, a geneticist at the University of São Paulo and a member of the academy. "They pay for this meeting and don't say what we should say—they give us total freedom." Yet religion does make its presence felt. "You have to be respectful of it to work in this body," Raven says. At times, he acknowledges, "there is a little bit of tension there."

The academy's November session drew an eclectic mix of people: physicists, biologists, philosophers, theologians, and clerics. Dominican robes and Jesuit collars mingled with suits that had seen more than their share of chalk dust. From 8:30 in the morning until past six in the evening, members sat at dark wooden desks while their colleagues and guest speakers lectured from a podium at the open end of the chamber on such subjects as the biology of the brain, technology for pre-

CREDIT: C. SEIFE

dicting and mitigating natural disasters, the evolution of the universe, and how Christianity influenced Isaac Newton's discovery of his laws of motion. Speakers delivered their talks in English, French, and occasionally Italian; no interpreters were provided.

The audience listened alertly to the scientific presentations, but many shifted uncomfortably in their seats during talks such as "Natural Theology in the Light of Modern Cosmology and Biology," in which guest speaker Richard Swinburne, a philosopher at Oxford University, outlined a probabilistic argument for the existence of God. According to Pavan, this session, which coincided with the Jubilee—a spiritual celebration held every 25 years—featured an unusually high dose of theology. "We don't usually talk about religion," Pavan said apologetically.

What the Pontifical Academy does talk about, at length, is policy. Twenty years ago, for example, it left its mark on the debate about recombinant DNA technology. "There was a great deal of alarm at the time whether it was appropriate to use," says Alexander Rich, a biophysicist at the Massachusetts Institute of Technology. But academy members, including Baltimore, drafted a statement supporting the use of recombinant DNA. The pope followed with his own statement giving the nod to genetic research. "Some said, 'Let's not unleash this technology at all,' " says Sheldon Krimsky, a science policy scholar at Tufts University in Medford, Massachusetts, and a nonmember of the academy. "The Vatican's position on [recombinant DNA] helped to blunt ideological opposition to the use of recombinant DNA technology."

Collective wisdom. Academicians pose in front of the Casina during their plenary session last fall on "Science and the Future of Mankind."

The academy has also long advised the pope about the science behind nuclear weaponry and the probable environmental effects of a nuclear war. Some observers credit papal diplomacy in the late 1970s with helping change the superpowers' nuclear doctrines. Herbert York, a physicist and the former head of Lawrence Livermore National Laboratory in California, who was active in formulating nuclear-weapons treaties at the time, says the pope was having difficulty developing a statement that would have any effect. The academy briefed the pope so that he could speak at a United Nations Educational, Scientific, and Cultural Organization meeting in Paris. "The speech, as far as I'm concerned, was a bust—it was highly formal," adds York. But that doesn't mean that the Vatican had no effect. The Catholic bishops in various countries came out with several statements that were influential in reformulating nuclear policy. "The whole Catholic Church took a stance and wrote a number of documents that were seriously considered," says York. The Vatican's antinuclear efforts continue to this day.

"By picking our issues carefully, our views can be very influential," Raven says. Although members may differ with church policy on specific issues, they quickly develop a sense of which agendas to push and which to soft-pedal. Contraception, for example, is out of bounds, but overpopulation is very much a live issue. "The pope has come out stating that population is a problem," Townes says. "He didn't before." (The church stresses education and general improvement of living standards as indirect means of controlling population.)

Occasionally, however, the academy ventures into territory that the church finds sensitive. In 1987, for instance, members drew up a protocol for radiocarbon dating of the Shroud of Turin. Church investigators ignored key parts of the recommendations, and the shroud's provenance remains controversial today. The academy had better luck in the early 1990s, when it pressed the church to reexamine the case of the 16th-century scientist Galileo Galilei, whom the Inquisition tried for spreading the then-heretical idea that Earth moves through space. Three hundred and fifty-nine years after Galileo's conviction, the church admitted that its prosecutors had failed to "interpret with great circumspection the biblical passages that declare the Earth immobile," although it faulted Galileo for making unproven assertions. The pope decried the "tragic mutual incomprehension" that had caused Galileo's imprisonment. "The church looked silly doing it so late, but they finally did it," Rao says. "It is a nice thing."

In 1996, the pontiff took a further step toward shedding the church's ancient anti-scientific taint when he declared evolution "more than just a theory." Members say the Pontifical Academy deserves part of the credit for counseling the pope to make the statement and pushing him to reconcile the Catholic faith with Darwinian biology.

At the November meeting, the academy continued its activist tradition by agreeing to draft a statement supporting the responsible use of genetically modified foods. The church has long been cautiously sympathetic to the use of gene technologies because of their promise for feeding the hungry in Third World nations, but it is wary of the ethical and theological consequences. "[Biotechnologies] cannot be evaluated solely on the basis of immediate economic interests," Pope John Paul II told a gathering of farmers 2 days before he addressed the Pontifical Academy. "They must be submitted beforehand to rigorous scientific and ethical examination, to prevent them from becoming disastrous for human health and the future of the Earth."

Academy members hope that a carefully worded statement, expected to be issued this month, will prompt the pope to voice his own support for genetically modified foods. "This might have a lot of consequences for those living and working in developing countries—and it might make it possible for a country like France to continue working on this stuff," says French physicist Paul-Marie Germain. "I regret that we have not said anything before."

At the end of the meeting, the church had the last word. Dressed in a scarlet tunic, cape, sash, and beanielike *zuchetto*, Cardinal Paul Poupard, president of the Pontifical Council for Culture, pronounced that "the right understanding of the links between science and faith is absolutely essential if scientists are to avoid foundering in dire straits." He then invited the assembled scientists to join him in the study of Christ as the "supreme science of life."

Some of his listeners, however, privately demurred. Even devout members say they are wary of theological influence on science. "There is no scientific teaching in Genesis," says George V. Coyne, a Jesuit priest, member of the Pontifical Academy, and director of the Vatican Observatory (see sidebar on p. 1473). Coyne decries attempts to invoke God as a catch-all explanation for mysteries in cosmology and evolution, or to cite science to prove God's existence. "The understanding of origins has nothing to do with the existence of God or not, but it has a lot to do with my understanding of God," he says.

Pavan draws a firmer line. "My point of view is that religion and science are two parallel worlds that should not try to cross. Put together, the two would not work," he says. Yet the Pontifical Academy shows that they can at least move in the same direction.

—CHARLES SEIFE

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