

Looking for GOD?

The Catholic Church runs two private observatories and a staff of Jesuit scientists. **Terena Bell** went to meet them to find out more about their research projects

The Vatican and astronomy



ABOUT THE WRITER
Terena Bell is a technology, health and science writer based in the US who's contributed to *The Washington Post*

The current Vatican Observatory moved to Castel Gandolfo in 1935. You can see its two domes at the far end

“We don't live by bread alone.” That's one reason Brother Guy Consolmagno, director of the Vatican Observatory, gives for why the Catholic Church funds astronomy research. “We're human beings,” he says. “We need to feed our souls, we need to feed our curiosity, we need to feed our love for beauty... our sense of worship.” This worship is not separate from science, but linked: “You can be a scientist and be religious,” he explains. “There isn't a conflict.”

Georges Lemaître, the priest who developed the Big Bang theory, would have agreed. Lemaître's writings, Consolmagno says, state, “that God creates out of nothing and nothing is more than just a vacuum. Even a vacuum has space and time. And God creates that space and time. If God creates outside of time, then creation is not something that happened 13.8 billion years ago; it's something that's also happening right now.” Just as a chair only has meaning because someone sits in it, Consolmagno says only God “can give meaning to the Universe, by being outside the Universe”.

So as this Universe changes, Consolmagno and other Jesuit astronomers seek to understand it. The Catholic Church has a team of eight astronomers at two observatories, studying everything from Martian meteorites to quantum theory to near-

Earth asteroids. Nearly half of their projects focus on stars: Chris Corbally studies peculiar stars, Richard D'Souza researches the outer light of galaxies and David Brown models subdwarf B stars.

“Something odd is happening in the atmospheres of Lambda Boötis-type stars,” says Corbally. “Their peculiarity lies in having a solar-like proportion of carbon, oxygen, nitrogen and sulphur in their atmospheres, while elements such as iron, magnesium, aluminium and other ‘iron-peak elements’ are 10 to 100 times less abundant than would be expected.” It's an anomaly that scientists have been trying to understand since 1943.

Going deeper in

Lambda Boötis-type stars behave normally in volatile elements but are weak in refractory ones. Using asteroseismology, a technique that interprets frequency spectra to determine a star's internal structure, Corbally's research is looking into whether this is true throughout the entire star or just an exterior phenomenon. He reveals that he also, “just incorporated the very first release of distances from the Gaia space observatory to refine the evolutionary status of Lambda Boötis stars.”

Richard D'Souza wants to know how galaxies grow. Not Big Bang, expansion-like growth, however; D'Souza is analysing galaxies' outer light to determine how accretion and the combination of smaller galaxies enlarge the Universe. Because of ▶



▲ Father Giuseppe Lais (1845-1921) at the Carte du Ciel Telescope during its time in the Vatican's Leonine Tower



▲ Pope Pius X appointed Father Johann Georg Hagen (1847-1930) as head of the Vatican Observatory in 1906



Brother Guy Consolmagno at the eyepiece of the Carte du Ciel Telescope

“We need to feed our souls, we need to feed our curiosity, we need to feed our love of beauty... our sense of worship. You can be a scientist and be religious. There isn't a conflict” - Brother Guy Consolmagno

of galaxies in the Universe and thus provide a revised estimate of the GSMF.”

Meanwhile, David Brown is studying small, hot stellar objects. He believes these subdwarf B stars give us a glimpse at the kind of star the Sun could become in five billion years. “Unlike young stars

A short history of Catholic scientists

Throughout the ages there have been many of religious conviction who have mixed science with faith

Roger Bacon, the 13th century empiricist who laid the groundwork for the science of chemistry, was not an astronomer but he was a monk. So were Albert the Great, another well-known natural scientist of the 13th century, and Gregor Mendel (1822-1884), father of modern genetics. Isaac Newton

(1643-1727) was the father of classical mechanics – and two nuns. The first astronomer to classify stars with spectroscopy, Angelo Secchi (1818-1878), was a priest. Big Bang theorist Georges Lemaître (1894-1966) was a Catholic monsignor. In the world of science, Brother Guy Consolmagno points out, “There’s no shortage of devout Catholics.”

Consolmagno is director of the Vatican Observatory, founded by



▲ George Lemaître believed the Big Bang helped prove God's existence

Pope Leo I in 1891, a time when, he says, “people were beginning to buy into the idea that maybe church and science were opposed.”

But Catholic scientists have long contended they aren't. Lemaître, whose theory is often heralded as proof against God, instead wrote that the Big Bang *proves*

God: an ever-expanding Universe is evidence of infinity, and infinite paradise is what Christ promised those who follow. “We may speak of [this Big Bang] as of a beginning. I do not say a creation,” he wrote shortly after World War II. “The question if it was really a beginning or rather a creation – something starting from nothing – is a philosophical question which cannot be settled by physical or astronomical considerations.”

► the low density of stars in the outer regions of galaxies, he explains, accretion histories are encoded deep within stellar structures. Low surface brightness makes this information difficult to uncover, so D'Souza has stacked approximately 5,000 images from galaxies with similar characteristics. This, he says, helps him, “study the average outer light of galaxies as a function of various galaxy properties [and] detect all that faint light in the outer part of the galaxy, which is generally not visible in a single image.” As a result, D'Souza has proven how outer light increases as a function of a galactic stellar mass and shape.

Shedding new (faint) light

D'Souza says this research has fixed a problem in commonly-used Galaxy Stellar Mass Function (GSMF) measurements.

“The extra light we detect in the outer part of the galaxy from the deep image stacks is generally unaccounted for in a normal, photometric, all-sky survey,” D'Souza explains. “By previously failing to measure the outer light of galaxies, the estimates of the GSMF are generally biased.” Corrections will be applied to “the already-measured stellar mass

The Pope's scopes

The Catholic Church's scientific instruments comprise historic refractors, reflectors and cutting edge instruments

Contrary to popular belief, the Catholic Church does not own a telescope called LUCIFER. However, there is one called that at the Vatican Observatory's American outpost in Arizona, which is part of a shared facility used by various organisations. It was built by the Max Planck Institute for Extraterrestrial Physics, and the Vatican astronomers there do have access to it. With two 8.4m mirrors on a single mount, this large binocular telescope (LBT) has a light-gathering power equivalent to a single 11.8m instrument, but its binocular setup gives it the same resolving power as a 22.8m instrument. The

telescope has been at the observatory since 2002, but was renamed LUCI in 2012.

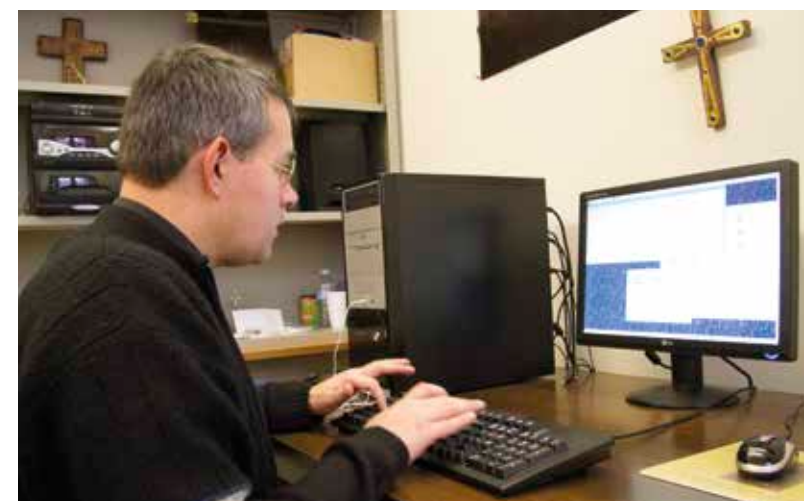
The Church can trace its observational roots back to the late 16th century, when astronomical research helped to reform the Julian calendar. From the mid-19th century, the Papacy supported astronomical research with several observatories in Rome, but by the 20th century the Eternal City's lights had begun to impact the view. So in 1935 the observatory was moved 30km from Rome to the Pope's official summer residence, Castel Gandolfo. Its rooftop domes now house the Zeiss Visual Refractor Telescope, the Zeiss

Double Astrograph, the Carte du Ciel Telescope and the Schmidt Telescope.

Inaugurated in 1957, the Schmidt is the newest and is joined to the same dome as the Carte du Ciel, a double refractor originally installed in the Vatican and moved to Castel Gandolfo in 1942. The Schmidt has a usable field six times larger – around 5x5 square degrees – and its 98cm spherical primary mirror has a 65cm corrector plate at its centre, which serves as its aperture. This 2.4m focal length instrument is capable of taking 20x20cm photographic plates and can also carry out spectroscopy.



▲ L-R, the Zeiss Visual Refractor, the Zeiss Double Astrograph, the Carte du Ciel Telescope and newest addition the Schmidt Telescope



▲ US-born Jesuit Father David Brown believes his research into subdwarf B stars will help shed light on stellar evolution

like the Sun, which generate and radiate energy from the fusion of hydrogen in their cores, subdwarf Bs derive their energy from the fusion of helium: a by-product of the previous fusion of hydrogen.”

These stars are also five times hotter than the Sun, with a lifespan 1,000 times shorter. While many theories exist about how they're formed, no one knows for sure. One idea, Brown explains, is that subdwarf B stars, “form in binary systems

– two stars revolving around one another, where the progenitor transfers most of its outer envelope to the companion star close to the point when it ignites its helium core. The result is a hot [subdwarf B] star orbiting around a companion star, the orbital period depending on how the two stars interact.”

So Brown is developing a stellar evolution computer program that models subdwarf B evolution. Once complete, the tech will also perform asteroseismology, the same approach Corbally uses. Additionally, the priest is working on hypotheses that explain why only five per cent of clustered subdwarf Bs are in binaries compared to two-thirds of non-clustered stars.

In all Observatory work – stellar or not – Brother Consolmagno stresses the importance of, “being, able to praise the Creator by studying creation and studying it honestly,” explaining that astronomy is a way, “to come to know the Creator by seeing the things He has created.”

For the Church, science is a means with faith as its end. While this may not be how astronomers of different or no faith approach their research, the Vatican's results can still add value. After all, a better understanding of the Universe is what all astronomers seek. ☺