Judith Cohen gazes briefly at a cluster of computer and video monitors, assures herself that photons of light from a distant star are trickling into an electronic detector, then returns to the topic of conversation for the last couple of hours: her historic surroundings.

Cohen, a professor of astronomy at the California Institute of Technology, is sitting inside a bright control room just a few paces from the 200-inch telescope at Palomar Observatory northeast of San Diego. For more than four decades, it reigned as the most powerful telescope on the planet, boosting human knowledge of everything from the craters of the Moon to the age of the universe.

“I was a graduate student at Caltech from 1967 to ‘71, but I did my thesis research at Mount Wilson,” Cohen says. “Palomar was for the gods, not graduate students.”

But like the gods of Olympus, the gods of astronomy are a fickle lot. Show them more glass — a telescope with the ability to gather more light — and they’re off to new observatories, new mountaintops, even new countries in their quest to see ever deeper into the universe.

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When the 10-meter (400-inch) Keck telescope opened in Hawaii a decade ago, Palomar lost its number-one ranking and much of its cachet. It remains one of the biggest telescopes in the world, but it’s dropping down the list in a hurry. What’s more, it lacks the technological finesse of newer models, like an old Victrola compared to a modern CD or MP3 player.

Palomar’s 200-inch telescope isn’t alone in its fall from Olympian heights. Two other telescopes that helped open the frontiers of astronomy — telescopes at least a half-century old, that ranked first or second in the world when they entered service — are being relinquished to backup roles, like aging running backs relegated to the bench because younger guys cut upfield or explode away from closing defensive backs better than the old vets.

The 100-inch telescope at Mount Wilson, California — the instrument with which Edwin Hubble proved that the universe is expanding — faces increasingly troublesome light pollution and electromagnetic interference. And the 82-inch telescope at McDonald Observatory in West Texas — second only to Mount Wilson at its dedication in 1939 — sometimes is described as a cranky beast that requires an experienced hand to operate. Most
astronomers prefer the more modern 107-inch, just down the mountain, or the slick new 9.2-meter Hobby-Eberly Telescope one mountain-top away. Yet few astronomers suggest retiring any of these grand old telescopes — at least not yet. The telescopes themselves have lost none of their ability to eye the heavens; they still perform as well as they did when they were built; if not better. With improved detectors and control systems, they remain effective tools for certain types of research. “You would have to keep the star in the telescope while he was a high school student,” Hale realized that he needed a telescope — at least not yet.

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Mount Wilson: The Grandaddy

Television announcers often describe college football’s Rose Bowl game in Pasadena as “the grandaddy of them all.” It was first played in 1902, decades before any other major bowl game, then disappeared until the 1990s. By then, another “grandaddy” was under construction overlooking Pasadena — the 100-inch telescope atop Mount Wilson.

The telescope was the handiwork of George Ellery Hale, the son of a wealthy Chicago industrialist. Hale had already built two “world’s-largest” telescopes: a 40-inch refractor (which uses lenses to gather and focus light) at Yerkes Observatory in Wisconsin, and a 60-inch reflector on Mount Wilson, which saw “first light” in 1908. Both telescopes are still in use today.

Hale yearned for bigger telescopes to advance the science of astrophysics, which seeks to understand how the universe began. While astronomers of the 19th century largely contented themselves with measuring the positions and brightnesses of stars, new techniques in the new century were making it possible to decipher more about the stars themselves.

In particular, astronomers were using a technique called spectroscopy to split the light from an astronomical object into its individual wavelengths or colors. This rainbow of light carries an enormous amount of information, including the object’s composition, temperature, mass, and motion through space. From these bits of data, astronomers were trying to understand the processes that powers stars, how stars are born and how they evolve, and much more.

Hale realized that he needed a telescope with a bigger primary mirror, which could collect and focus more starlight, to study faint, distant stars. So he ordered the 100-inch mirror even before the 60-inch telescope was completed. (The size of a telescope mirror refers to its diameter; the 100-inch mirror spans a bit more than eight feet, or 2.5 meters.)”

The day the 60-inch mirror was brought to the mountain for installation, the mirror blank for the 100-inch arrived from France,” says Don Nicholson, associate director of the nonprofit institute that operates Mount Wilson Observatory. “That’s courage.”

Today, the telescope looks like about it did on the night it first gazed at the heavens — November 2, 1917, just a few months after the United States entered World War I. The mirror, open steel tube, and support structure are original equipment. The way astronomers use the telescope has changed dramatically, though. For one thing, they record data on electronic detectors instead of photographic plates. For another, they operate the telescope from an enclosed control room instead of sitting directly beneath it and guiding it by hand.

“You would look through an eyepiece to line up on a guide star,” explains Nicholson, who helped Hale as a staff astronomer, operate the telescope while he was a high school student. “You would have to keep the star in the crosshairs for hours. In the wintertime it gets cold in here, but you couldn’t get up to go to the bathroom, or even move around to keep warm.”

Despite the lack of creature comforts, Mount Wilson was “the place astronomers dreamed to be,” Nicholson says. The most famous of its astronomers was Edwin Hubble, for whom the Hubble Space Telescope is named. “Hubble was the right guy in the right place at the right time,” Nicholson says.

By the 1920s, a great debate was raging about the “spiral nebulae” that astronomers had discovered throughout the cosmos. Some thought these structures were motes of matter inside our Milky Way galaxy, and that the Milky Way encompassed the entire universe. Others thought the nebulae were galaxies of stars outside the Milky Way.

Hubble settled the matter when he discovered several Cepheid variable stars in M31, the Andromeda Nebula. A Cepheid pulsates like a beating heart, and the length of its pulsations reveals its true brightness; comparing this to its apparent brightness yields its distance. With the great light-gathering power of the 100-inch mirror, M31’s Cepheids are far outside the Milky Way, proving that the nebula is actually a galaxy containing billions of stars. This discovery increased the size of the known universe by many orders of magnitude and assured both Hubble and the telescope a place in history.

Hubble’s work was just beginning, though. As he studied M31 and other newly identified galaxies, he noticed something startling: Almost all of the galaxies are moving away from us. And the more moving fastest. Hubble had discovered that the universe itself is expanding, and provided the first piece of evidence that eventually would lead to the big bang theory.

The 100-inch telescope remained the largest in the world for three decades. But today, it doesn’t even rate in the top two dozen. Light pollution and other interfering factors in Los Angeles overpowers faint astronomical objects, and a jumble of nearby broadcast antennas sets up an electromagnetic clatter that interferes with telescope operations. Many astronomers consider the problems insurmountable, and aren’t sure the telescope will reach its centennial.

But a new technology is extending the telescope’s life. Called adaptive optics, it passes light from the main mirror through a smaller mirror that flexes to compensate for the turbulence in the atmosphere, sharpening the view of distant objects. Using the adaptive optics system, astronomers have discovered several brown dwarfs — objects that are more massive than planets but massive enough to shine as stars. Other astronomers are trying to map the surfaces of several asteroids.

“So far, we’ve kept pace, and this continues to be a useful instrument,” says Nicholson. “It’s no longer the biggest in the world, but you don’t need the biggest in the world to do a lot of things... There’s a tremendous amount of work that can be done, and I see no reason why this [telescope] shouldn’t continue.”

McDonald: A Grand ‘Beast’

Anita Cochran was afraid one of her first observing runs with McDonald Observatory’s 82-inch telescope would be her last. In 1977, as a University of Texas graduate student, she and a colleague were studying a class of hot stars. “We snagged a cable across the railing, and as the telescope continued to track, the cable got pulled tighter and tighter,” Cochran recalls. “Something had to give. Instead of simply unplugging, the cable ripped out of the control end with loads of sparks. I thought they’d never let us use a telescope again.”

The cable was repaired, though, and Cochran, now a senior research scientist, has spent the last quarter-century using McDonald telescopes to study stars, planets, moons, and the solar system’s little monsters, comets and asteroids.

On a chilly night in November, with the Leonid meteor shower building toward its dramatic peak and fog creeping up from the valley below Mount Locke, Cochran handles the 82-inch like an aging family pet. Yes, it’s a “cranky old beast,” she says as she scrabbles around under the scope to correct a minor problem, but it’s also “a classic beast” — "a grand old telescope.” It looks the part, too, from the art-deco dome of McDonald Observatory’s 82-inch telescope (top); the telescope today, inspecting the 82-inch mirror before the telescope was built; workers pose on the dome framework in 1934.

The art-deco dome of McDonald Observatory’s 82-inch telescope (top); the telescope today, inspecting the 82-inch mirror before the telescope was built; workers pose on the dome framework in 1934.
A handful of asteroids that may chran studies a bright comet and 82-inch (which is named for range of research interests on the ness of many astronomical objects. trol of the observatory, its astronomers dark matter. After Texas assumed con- stellar spectroscopy — piecing together the mers, picked the site for the observatory and McDonald Observatory. The telescope was born from a col- laboration between the University of in the early days, astronomers operate the telescope from a cozy control room. Computers do most of the large atma... But the telescope is showing its age. It sometimes sticks as it tracks an object across the sky (“it has arthritis,” Bash explains), and it has leather bearings that are built to maintain. Upgrading it to accom- modate a fully automated tracking system would be costly.

“We’ve been questioning it a lot lately,” says Frank Bash, who depends on the telescope. “I need much maintenance it requires. Some people want to close it down. Others think it’s still doing good research.”

Bash falls into the latter category, and says it’s not quite time to retire the tele- scope. Over time, it might be dedicated to a specific research project, such as a new seven-planet system. The search, which is already underwa...tion, and it has leather bearings that are built to maintain. Upgrading it to accom- modate a fully automated tracking system would be costly.

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