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Through a Glass Darkly

The race for the world's biggest telescope is heating up in Pasadena. CalTech is one front in the quest, but there's another global contender you may not know about.

By Brenda Rees

Two telescopes larger than any currently in existence are quietly taking shape in Pasadena. One is under way at CalTech, which doubtless wouldn't surprise observers familiar with the city's supernovae of astronomical research—the university and the Jet Propulsion Laboratory. But neither can lay claim to the second project. That telescope's creators labor for the third member of what is literally a stellar triumvirate in Pasadena—the Observatories of the Carnegie Institute of Washington.

The Carnegie Observatories may keep a low profile on home turf, but the place is known around the world as one of the foremost research facilities investigating the cosmos. Its elite corps of astronomers, who have included Edwin Hubble, has been on the front lines of the quest to explore the heavens since 1904. And Carnegie stargazers, whose main offices sit on a residential street off Lake Avenue, are still kicking astronomy research up a notch with the construction of the Giant Magellan Telescope. After its scheduled completion in 2016, scientists hope it will help clarify the origin and evolution of planetary systems by documenting the formation of stars, galaxies and black holes.

Carnegie is spearheading the project with seven universities and research facilities, which include Harvard, MIT and the Smithsonian Institution. With an aperture of 24.5 meters (80 feet), the telescope will produce images 10 times sharper than the Hubble Space Telescope. (The twin 10-meter Keck scopes in Hawaii are currently the world's largest optical telescopes.)

Carnegie's new, $550 million device will be located near its other working telescopes at the Las Campanas Observatory, located high in the Atacama Desert of northern Chile. Carnegie has been managing and operating Las Campanas since 1969. The remote location is prime real estate for cosmic snooping: dark, isolated skies, a dry climate and a very stable atmosphere: It's similar to the environment surrounding the organization's first venture, the Mount Wilson Solar Observatory, before the skies were obscured by the growth of the population—and its annoying city lights.

(Las Campanas became the Carnegie Observatories' principal observation site in 1986, when the operations of the Mount Wilson Observatory were transferred to the Mount Wilson Institute, also in the Carnegie Institute's bailiwick. Some insiders speculate that locals assumed the headquarters migrated south as well, accounting for Carnegie's low profile in its own backyard.)

Whether Carnegie's telescope, also known as the GMT, will be the biggest telescope by the time it goes into operation remains to be seen; other scientific organizations are fast-tracking even larger scopes, including the whopping, 42-meter European Extremely Large Telescope, slated for completion in the next decade as well.

Just last month, CalTech and the University of California, along with the Association of Canadian Universities for Research in Astronomy, received a $200 million commitment toward the development and construction of a device even larger than Carnegie's, the Thirty-Meter Telescope, also scheduled to start operations in 2016.

Meanwhile, the massive undertaking to create the GMT has science circles buzzing. After all, according to Wendy Freedman, director of the Carnegie Observatories and chair of the GMT Board, "telescopes of this size are not ordered off the shelf. They are all literally made by hand. The whole process is pretty amazing."

Indeed, the GMT's first mirror was made from 18 tons of borosilicate glass crushed from Floridian sand; it was finished in 2005 at the University of Arizona's Mirror Laboratory, located beneath the bleachers of the school's football field. The mirror was one of seven designed for the GMT, each 8.4 meters (about 27.5 feet) in diameter. The design is innovative: Six primary mirrors curve around a seventh at the center, like the petals of a flower. The giant mirrors reflect light toward a set of secondary mirrors above, which then redirects the beams down through a hole in the central mirror for data collection at the bottom.

When completed, the GMT mirrors will be transported to Long Beach for the nearly 6,000-mile boat ride to their new Chilean home. "You can't believe the elaborate cases which are being created for these mirrors," says Freedman. "Trucks have to drive very slowly, and we've had to widen the road in places. [The mirrors] will not do us any good even the slightest bit cracked."

The GMT is not the only pending project for the Pasadena-based stargazers. Heading down to Chile in a few months is the newly designed Planet Finding Spectrograph, which measures the orbital jiggle far-off planets make around their suns. "Just in the last 10 years, [astronomers] have made great discoveries about planetary systems elsewhere in the galaxy," says Freedman, noting that the current number of known planets is 268. "I'm sure that number will increase once we start using this instrument."

Pondering the universe, designing instruments and formulating theories are the daily bread of the Pasadena campus. Currently, 18 staff astronomers (including those of emeritus status) work alongside a fluctuating number of postdoctoral fellows and associates. Freedman says scientists working at Carnegie institutions have an unfettered freedom to "pursue creative solutions to problems and questions." Unlike university faculty, staffers don't have extra responsibilities for teaching or publishing articles. As the website notes, "The assurance of generous long-term support permits [its] scientists to pursue long-term projects whose pace is dictated by the pace of discovery itself, rather than by the need to justify the next grant or the next allocation of telescope time. It is this exceptional environment that has enabled the relatively small Carnegie staff to make such disproportionately large contributions to astronomy."

That's just how founder Andrew Carnegie wanted the organization to be. One of the country's wealthiest and most powerful men in the late 19th and early 20th centuries, Carnegie's name endures because of his mammoth philanthropic projects, which included building public libraries. Chartering the Carnegie Institution in Washington, D.C., in 1902, the former steel tycoon hoped to encourage the pursuit of scientific knowledge for its own sake for the benefit of humanity.

Of the institution's 11 original departments and enterprises, only six remain active, one being the observatories that began here in Southern California. In 1904, noted Pasadena booster George Ellery Hale convinced Carnegie to fund an astronomical enterprise, the Mount Wilson Solar Observatory, which, for the first half of the 20th century, was home to the world's largest telescopes and other sophisticated equipment for studying the sun. On the forefront of modern astrophysics, Hale had previously created the spectroheliograph and was responsible for discovering the principles of solar magnetism. He believed that building giant telescopes atop Mount Wilson would further push the limits of the science by providing tangible data.

"Without Hale, who knows if there would be a science tradition here in Pasadena?" muses John Sepikas, professor of astronomy at Pasadena City College and an education affairs official at JPL. "[Hale and Carnegie] both ushered in a golden age of astronomy for Pasadena – and the world, for that matter."

A century ago, work crews trekked back and forth on sometimes precarious dirt roads between Mount Wilson and the Myron-Hunt–designed Carnegie campus. "A lot of my students have grandparents who helped build the telescopes up there," says Sepikas. "Back then, there was a great sense of pride in being associated with the observatory; people were excited to be connected with Mount Wilson."

Great discoveries came from Mount Wilson and Carnegie astronomers, such as Hubble, who proved the notion of the

expanding universe and the increasing speed of that expansion. Indeed, one can imagine him rambling between mountaintop telescope and bucolic campus, carrying some of the 350,000 glass-plate negatives now archived in the campus basement. “Everything was done with mules back then,” muses Freedman. “Now we use frequent flyer miles and email.”

Indeed, the connection between past and present is evident when astronomers walk onto the Pasadena parking lot and look up...and then down. Up is stately Mount Wilson with its venerable observatories and solar towers. Down on the blacktop is an accurate-to-size, white-paint outline of the GMT’s gigantic mirror pattern. The size is daunting.

There are many links to the future at the observatory headquarters; one program seeks to spark interest in science at a young age—the adoption of nearby Longfellow Elementary School. Staff astronomers routinely visit classrooms, provide educational activities and even offer field trips to the campus. Another program opens the Pasadena campus to postgraduate students from Claremont College.

“Getting young people excited and interested in science is so important,” says Freedman. “I truly believe that what we are going to be doing here in the years to come will be some of the most significant research ever. To me, this is the place to be in the future.”