Time to zoom in on the universe

By Scott LaFee
Union-Tribune Staff Writer

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The telescope is just over 400 years old. In terms of human history, that's the blink of an eye.

For most of humanity's existence, reality was mostly what we could see unaided. Then in 1608, a Dutch lens maker named Hans Lippershey created the first practical telescope. It boasted a magnification power of just three, but it was immediately popular, particularly among traders who used the newfangled device to search the horizon for incoming ships and thus beat their competitors to market.

In Italy, a University of Padua professor named Galileo Galilei read descriptions of the telescope and built one for himself the following year. But instead of turning to the sea, Galileo looked to the sky. In doing so, he forever changed our sense of place in space.

“Starting with Galileo realizing that the sun did not revolve around the Earth and that we were not at the center of the universe, we have come to realize how, in one way, insignificant we may be,” said Alison Coil, an assistant professor of astrophysics at the University of California San Diego who is involved in several deep-space telescopic surveys. “The universe is far more vast than we ever imagined.”

Vast indeed. And often very strange. Ever-improved telescopes have revealed a universe fraught with sometimes inexplicable phenomena: the big bang, black holes, brown dwarfs, quasars, pulsars, cosmic rays, exosolar planets, dark matter and dark energy, and the fact that there are more (a lot more) stars and galaxies in the universe than there are grains of sand on Earth.

There's more to come. In this, the International Year of Astronomy, stargazers and universe-watchers are gearing up for many more discoveries using new telescopes. Here's a survey:

In March, NASA is scheduled to launch Kepler, an orbiting telescope whose primary goal will be to look for Earth-like planets in or near the habitable zones of stars. The telescope is named after Johannes Kepler, the 17th-century German astronomer best known for his eponymous laws of planetary motion.

In May, space shuttle astronauts are scheduled to make their final trip to the 19-year-old Hubble Space Telescope, orbiting roughly 350 miles above Earth. They will install a new camera and other instruments, extending the usefulness of a remarkable telescope already credited with precisely measuring the age of the universe, finding evidence of dark energy and snapping thousands of astounding pictures of galaxies far, far away.

If everything goes as planned (hardly a given these days), a successor to the Hubble will be launched in 2013. The James Webb Space Telescope, named after NASA's second administrator, is roughly the size of a tennis court. It will hover far beyond the moon, fixed in space 931,500 miles from Earth, and will use infrared light detectors to see farther and deeper into the universe, piercing cosmic dust clouds to watch the birth of distant stars and solar systems.

Big things are happening on Earth, too. Big, in fact, is the byword.

Currently the largest visible-light telescopes have mirrors no larger than 10 meters, or about 33 feet. The Giant Magellan Telescope, being built in Chile by a consortium of universities and space agencies, will employ a mirror only 8.4 meters (27.6 feet) across. But it will have seven of them. Their combined resolving power is expected to produce images 10 times sharper than those from the Hubble Space Telescope. The tentative completion date is 2018.

On the blackboard are even bigger ground-based telescopes with larger mirrors. The proposed Thirty Meter Telescope (TMT) will have a segmented mirror with a diameter of almost 100 feet. It would be more sensitive than existing ground-based telescopes by a factor of 10 in its natural seeing mode, and by a factor of 100 using advanced adaptive optics that correct for image blur caused by the Earth's atmosphere.

The location of the TMT has yet to be determined, with sites in Chile, Hawaii and Mexico under consideration. It is scheduled to be completed in 2014.

The Thirty Meter Telescope is an American project. The European Extremely Large Telescope (astronomy jargon tends to be descriptive – and a little boastful) would be even larger than the TMT, with a 42-meter, or 138-foot, mirror. Like the Giant Magellan and TMT projects, the European telescope is intended to observe the universe in unprecedented detail, including studying exosolar planets' atmospheres.

Possible locations for the Extremely Large Telescope include South America, the Canary Islands, South Africa, Morocco and Antarctica.

“Bigger telescopes do not simply mean more of the same,” said William F. Welsh, an associate professor of astronomy at San Diego State University. “It isn't just that we can do better. These telescopes will allow us to detect and measure things never seen before.”

Not all future telescopes will be so singular. The proposed Square Kilometer Array would consist of dozens of radio dishes spread out to create a collecting area encompassing 1 million square meters. It would be the largest radio telescope ever, one 50 times more sensitive and 10,000 times faster than present imaging instruments.

Nineteen countries are collaborating on the Square Kilometer Array, which will be built in either South Africa or Australia. Full operation is expected by 2020.

“In certain ways, the discoveries made with the telescope are analogous to those made with the microscope,” said Welsh. “We've become aware that there's much more around us than we ever suspected.

“The microscope revealed the microcosm, showing us the 'infinity in the palm of our hand' and that we are giants in a vast world of microbes. But the telescope revealed the grandeur and splendor of the heavens, and that we are but a small, humble speck in the cosmos.”

Unless, Coil said, an astronomer with a telescope someday proves otherwise.

“We don't know yet if life exists elsewhere on the same scale as life here on Earth, and in that way we may be unique, or at least special in some way.”