A serious search for extraterrestrial life

May 26 2009, By Faye Flam

Things have changed since the original Captain Kirk and Mr. Spock set off to seek out new life and new civilizations. Back in the 1960s, while the Enterprise crew was exploring a galaxy full of exotic life-forms, real astronomers were stuck in a solar system with eight desolate-looking neighbors and no signs of any planets beyond.

Now, finally, astronomers are starting to zero in on Earth-like worlds orbiting other stars. Some of the more recent finds even look potentially habitable.

While technology still hasn't provided anything like warp drive to take us to the stars, it has endowed today's earthlings with tools that were unimaginable in the 1960s -- techniques for doing detective work on objects from quadrillions of miles away.

In the last 13 years, astronomers have used such remote-sending tools to catalog more than 300 planets outside the solar system.

The first such planets were many times bigger than our own, but progressively smaller ones have been turning up. In March, NASA launched a satellite called Kepler, which is seeking subtle changes in starlight that indicate the presence of little specks the size of Earth.

In the future, astronomers envision observing even more subtle changes in starlight to analyze the atmospheres of such planets.

The lineup of ambitious projects was causing plenty of excited chatter
among scientists this month when they met at Baltimore's Space Telescope Sciences Institute for a symposium titled, "The Search for Life in the Universe."

Not only was NASA spending hundreds of millions to comb the galaxy for other worlds and to analyze them, but respectable astronomers, biologists and geologists could now talk seriously about alien life.

Life-detection ideas were thrown around that were, while not easy, at least technologically feasible.
"Why is this interesting?" asked biologist Chris McKay of California's NASA-Ames Research Center. "We have the possibility of a second Genesis. We can have comparative biochemistry," he said, meaning that nature might use alternative ways to construct living things.

Even alien pond scum would change everything about our understanding of life and our place in the universe. We could take it apart and see how it replicated, what it ate, how it evolved.

Scientists have trouble defining life because all living things on Earth use the same building blocks. Is it life if it doesn't involve carbon? What if it doesn't have some equivalent of DNA?
"We use the Justice Potter Stewart definition," said McKay, recalling the famous definition of pornography: We'll know it when we see it.

So many stars ...
In 1966, the year the Star Trek TV series was launched, astronomer Carl Sagan wrote that there were at least $100,000,000,000,000,000,000$ stars in the universe -- so that surely some must have solar systems like ours.

But good planets have been hard to find.

Astronomers call those around other stars extrasolar planets, or just exoplanets. Only two such planets have ever appeared in a Hubble Space Telescope picture.

The rest show themselves only indirectly, through tiny wobbles or other subtle changes detected in their stars.

The wobble idea works on the principle that planets don't actually orbit their suns, as kids learned in school. Instead, a planet and star both orbit a center of gravity. Though the center of gravity is much closer to the star, the mutual forces still make the star circle around a tiny path that could appear as a wobble from Earth.

But the effect is subtle, and several astronomers were burned by false alarms. Finally, in 1995, the first exoplanet was solidly confirmed. From the wobbles, the astronomers could tell the planet was the size of Jupiter and orbited its star closer than Mercury is to the sun. Each "year" on this planet lasts just four days.

More planets soon were found, but all of them were huge, about the size of Jupiter. The problem with Jupiter and planets of comparable size is they are all atmosphere with no solid surface.

But in the 21st century, more refined techniques have picked up a few planets small enough to have rocky or icy surfaces. Called super earths, they range from two to 10 times the size of our planet.

Some were found through the wobble method while others showed up when they passed in front of their stars. Such "transits" create a tiny eclipse that dims the starlight by a fraction of a percent.

This is how the satellite Kepler is supposed to find planets similar to Earth in the next several years, even though an earth would dim the star by less than a hundredth of a percent. The idea was rejected by NASA year after year until agency scientists finally demonstrated in lab tests that, in principle, it could work.

Kepler will stare constantly at just one spot in the sky, near the constellation Cygnus, where it can continue to monitor a group of about 100,000 stars.

Even if everything works, the satellite will detect only 1 in 100 of the Earth-size planets up there, since these tiny eclipses will be visible only if the orbit of a planet is in a plane angled toward us.

A planet like Earth would transit once a year, and astronomers would wait for several such transits before they could tell if it's really there.

After 3 \{ years, astronomers hope to get a cosmic census -- a representative sample of Earth-size planets in our galaxy.

## OPTIMISM ABOUNDS

But is there anything alive up there?
The biologists at the Baltimore meeting were optimistic. Life is tougher than anyone thought. Chemical traces of past life show it goes back at least 3.5 billion years into Earth's 4.6 billion-year existence.

Life may go back further. "This is a key fact," said NASA's McKay. As soon as the planet became remotely habitable, it was taken over by microbes.

The one necessary feature that everyone agreed on was liquid water.

There's plenty of water out there, but for any of it to condense or melt into a liquid, a planet would have to orbit at just the right distance from its star.

A few years ago, James Kasting of Pennsylvania State University helped calculate what astronomers have come to know as the "habitable zone" around other stars. That's a distance that would make conditions somewhat cooler than Venus, and at least as warm as Mars.

A few of the known exoplanets fall in the habitable zone, including one recently announced super earth 12 light-years away. Kepler could find more. But ultimately the scientists are after something bigger: actual alien life.

At the meeting, Harvard-Smithsonian astronomer Lisa Kaltenegger asked the scientists to imagine how we would detect life on Earth if our planet's exact twin were orbiting a star light-years away. "We would see this tiny point of light -- this speckle of light -- but there's a lot of information we can actually get from that," she said.

The key is in the atmospheres, said Penn State's Kasting. Our planet's atmosphere is full of oxygen and methane that can't easily be explained by any nonliving chemical process, he said. If we could detect that, we'd have a good case.

The Hubble's instruments have analyzed the atmospheres around several giant planets as they pass in front of their stars. With its repair, which astronauts completed this month, scientists plan to use it to study more.

It will take more elaborate space telescopes -- or perhaps whole fleets of them -- to analyze atmospheres with planets the size of Earth. All this is on the drawing board.

The gases wouldn't tell us what type of life was out there _ whether it could take the form of intelligent beings, for example. It could be mostly weeds, or pond scum, or slime molds, or something we can't even imagine because we've never seen it.

But even that would go a long way toward explaining what life on this planet is all about, what it's doing here, and how it fits into this vast universe of $100,000,000,000,000,000,000$ stars.
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