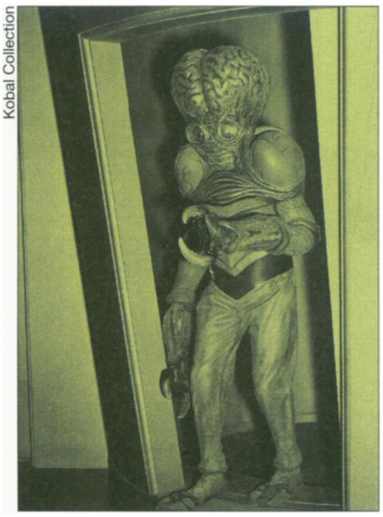
Earths Beyond Earth

By RON COWEN

Twenty years from now, a quartet of space-based telescopes may revolutionize the way people think about the universe and their place within it. From a vantage point just inside the orbit of Jupiter, the four telescopes, known as the Terrestrial Planet Finder, will cast their infrared eyes on the nearest 1,000 stars similar in mass to the sun. The images they record will be combined in such a way as to cancel out the light from each star and amplify the elusive reddish glow of any planets that orbit it.

The result will be a set of pale red dots, one or more of which could be just like Earth.

Because these blobs, which show up in infrared light, have low resolution, astronomers won't be able to discern oceans, clouds, or mountains. Such features give Earth the appearance of a pale blue dot in visible light. Nonetheless, two criteria may indicate whether any of these fuzzy blobs, tens of light-years from our solar system, resembles our planet.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The body must obey the Goldilocks rule: It must reside within a certain distance of its parent star so that water is neither too hot nor too cold to exist as a liquid on the planet's surface. Moreover, its atmosphere must contain three molecules—water, carbon dioxide, and ozone—in abundances deemed necessary for life as we know it.

The same set of infrared telescopes—1.5-meter detectors spaced evenly along a boom longer than a football field—will enable astronomers to determine whether these orbs pass muster as terrestrial twins. Whatever faint light planets emit or reflect, they radiate more in the infrared than in visible light, and the three molecules associated with life have clear signatures in the infrared.

"For the first time in human history, we are pretty confident that we know how to determine whether or not we are alone in the universe," says Harley A. Thronson, senior scientist with NASA's year-old Origins Program, which is devoted to exploring the origins of structure and life in the universe.

"We're the first generation to say, 'Yes, we know how to do it,' and now we're taking the steps to do it."

On Earth, some of the first steps have already been taken. The search for other worlds got a major shot in the arm 18 months ago, when astronomers announced the first indirect detection of a planet orbiting a sunlike star. At last count, researchers have found evidence suggestive of eight giant planets by tracking the motion of stars. Telltale wobbles betray the gravitational tug of an unseen planet.

A spectrograph recently connected to the world's largest visible-light telescope, the 10-meter W.M. Keck atop Mauna Kea in Hawaii, and small, test versions of the telescopes to be launched into space may indirectly detect planets well below the mass of Jupiter. They may even spot planets as small as Uranus, which is about 15 times as massive as Earth.

Over the next decade, large telescopes with mirrors that can flex 100 times a second to correct for the blurring effects of Earth's atmosphere may capture a direct image of a Jupiter-size planet from the ground, according to a 1995 report.

For detecting Earthlike planets, however, there's no place like space. Deep space, that is. The Terrestrial Planet Finder would elude much of the dust from our planetary system, but it would have to take into account dust bathing any other planetary system it studies.

Stretching 100 meters in length, the fully assembled planet finder can't fit inside a launch rocket, so it will have to be put together in space like a giant Tinkertoy. Early in the next decade, scientists will get a chance to hone their skills by operating a smaller suite of telescopes in an orbit closer to Earth, Thronson says. At about the same time, the successor to the Hubble Space Telescope, a single 4- to 8-meter instrument designed to peer at the earliest structures in the universe, should be ready for launch and will provide another opportunity to practice the assembly of large optical devices in Earth orbit.

Complementing these planet-hunting efforts, researchers using giant radio telescopes continue a 40-year-old effort to listen for broadcasts from other worlds. A new network of telescopes should enhance the chances of finding ET.

What about the continuing search for life and its origins in our solar system? Last month, NASA proposed a mission to Europa, seeking to verify hints that this Jovian moon has an ocean beneath its icy crust. In the agency's latest budget plan, a robotic craft would return soil samples from Mars in 2005. Might findings of life-forms or fossils on either body steal the spotlight—and funding—from studies of planets some 30 to 60 light-years distant?

"I think the search for possible life existing or extinct in our solar system is intimately connected to the search for life elsewhere," Thronson asserts.

"Even the star nearest to the sun is very far away, but the impact of what we might find 15 to 20 years from now, beyond the solar system, will be as great as if [that star] were our next-door neighbor. . . . The technology does not now exist, but we can imagine the technology for sending robotic craft to these worlds, and we can imagine the technology for imaging these worlds."

To take a detailed portrait in visible light of a remote, Earthlike planet might require 1,000 telescopes the size of Keck spread out across a thousand kilometers in space, says Thronson. In another 75 years, those seeking pictures of other Earths may find pale blue dots reminiscent of home some 400 trillion kilometers away. □

1951 First commercially built computer debuts

1951 Maize studies show genes can jump among chromosomes

1952 Calves generated by frozen semen

1953 Exposure of Piltdown skull as a forgery

1953 Successful trial of the polio vaccine

1953 DNA's double helix structure discovered

1953 Discovery of REM (rapid eye movement) sleep

1955 Diamonds artificially synthesized

1956 Recognition of global midocean ridge

1957 Launch of Sputnik satellite

1958 Porpoises found to use echolocation