SECTION E

Texas Living

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ARTSDAY

Nonstop news

The cable revolution brings a steady stream of coverage — but is it all fit to air? **12E**

Discoveries

Among stars, a water quest

Scientists try to identify likely locales for life in vast universe

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Science Editor

In politics, it's follow the money.
In Harry Potter, it's follow the spiders.
In the search for life beyond Earth, it's follow the water.

And so on Mars today, two robotic rovers seek signs that the Red Planet was once a wet planet. Rocks are scraped and scrutinized to see if their innards include minerals that formed with the help of H_2O.

For only if liquid water had ever been around is there any hope that "Martian" was once a nonfictional noun.

Life, as scientists understand it, needs water the way hockey needs ice. Without water, chemistry can't get complex enough for life to do all the things it does, like breathing and sex — at least as life is known on Earth. (There's always some chance for the alien equivalent of field hockey.)

Following the water seems to be the best hope for finding evidence that humans cohabit the cosmos with other life forms — to discover whether Earth is the universe's only home for life.

"For the first time in human history," writes astronomer Sara Seager, "we are on the verge of being able to answer this question."

But to actually find that answer, Mars is not world enough. Scientists will have to follow the water far beyond Mars, beyond the solar system, to planets orbiting faraway stars in other hospitable ZIP codes of the Milky Way galaxy.

Fortunately, it seems, there are planets, planets, everywhere — and some may possess plenty of drops of water for life to drink.

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There is no life on Mars now — at least, nothing that would qualify even as a contestant for a reality TV show. Martian water is frozen in the planet's polar ice caps and perhaps elsewhere under the planet's surface. But the Martian landscape advertises a much moister past. Channels seem to have been carved by ancient rivers, and broad depressions look for all the world like dried-up lake beds.

Grayish rust known as hematite, detected from orbit and eyeballed up close by the rover Opportunity, offers further evidence of a watery history. Hematite isn't ironclad proof of water, but other minerals nearby may help confirm the belief that water once flowed on Mars. Details teased out of the minerals by the rover's sensors may tell scientists further tales about the Red Planet's primordial climate — such as whether the weather was ever suitable for life to survive, if not thrive.

If the ancient Martian environment was indeed moist — and if future missions find further clues that life took advantage of it — scientists will have cemented a key piece into the search-for-life puzzle. They will know that Earth isn't unusual, that it's not the only habit-

ESSAY

able planet in history. And if there is more than one, there are probably more than two. Following the water is all about finding where those other habitable planets are hiding.

Merely a decade ago, the existence of planets orbiting stars other than the sun was an open question. But in 1995 astronomers announced unmistakable signs of such an "extrasolar" planet. Since then, many others have been found — nearly 120 by last count — settling forever the question of how special the sun is. When it comes to planets, the sun is not special at all. Lots of stars have planets.

True, the planets discovered so far are nothing like the Earth. Most are big and gaseous; the Earth is small and rocky. And it's the small and rocky (or "terrestrial") planets that astronomers want to find. But with present-day technology, such planets are much too small to see from Earth.

Actually, the big gaseous planets are too small to see, too. Their presence is detected indirectly, by changes in the color of a star's light caused by the tugging of a massive planet's gravity. Detecting a clockwork cycle of such color changes, corresponding to a planet's orbit, reveals planets around stars dozens of light-years away.

Of the distant planets found so far, most are not good candidates for life.

Habitable planets must occupy a goldilocks region of space near their parent star, not too hot or too cold for life to originate and evolve. They must be made of life-friendly materials, with ample water. But many of the known extrasolar planets occupy infernolike orbits very close to their stars. And nearly all are giant gaseous planets without rocky foundations for oceans or lakes.

But the giant planets might have smaller siblings, the way Jupiter and Saturn are merely the biggest of a family that includes the Earth.

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To test whether known extrasolar systems might include habitable planets, scientists are naturally following the water. David Underwood, Barrie Jones and P. Nick Sleep of The Open University in England, for example, have identified "habitability zones" around the 104 stars known to possess at least one planet — defining a habitable zone precisely as the region around a star where liquid water could ex-

See **FUTURE** *Page 3E*

Future missions will test theories on water in space

Continued from Page 1E

ist on a planet's surface.

The British scientists analyzed dozens of hypothetical stars — ranging from half the mass of the sun to half again as massive as the sun, with various amounts of chemical ingredients. Computer simulations determined the water-friendly zone surrounding each "model" star, and known planetary systems were matched to their best fit among the models. Taking the habitable zone around the real star to be the same as in its best match, the scientists calculated whether an "Earth" could survive, given the orbits that the other planets already occupy.

In some systems, a huge planet orbits in or near the habitable zone — bad news for a watery "Earth." It would either smash into the big planet, or be kicked by the planet's gravity into an unstable orbit, possibly leading to a fiery death in the central star, or an icy journey out of the stellar system altogether, the study found. For other known planetary systems, though, such tragedies did not seem likely. Many seem able to support a habitable planet for a long time.

"About half of the 104 systems could have housed an 'Earth' in their habitable zones for at least the past billion years," the scientists reported in a paper posted on the Internet.

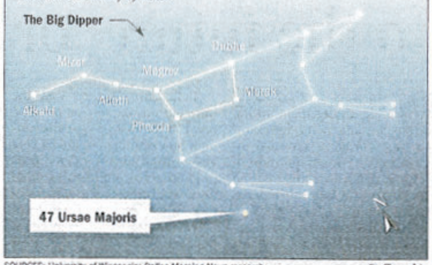
Further hope comes from studies of the planetary system around the star 47 Ursae Majoris (or UMa), about 44 light years from Earth. That star possesses two giant planets at a considerable distance, though not as far as Jupiter and Saturn are from the sun.

47 UMa is about the same mass and temperature as the sun, astrophysicist Manfred Cuntz, of the University of Texas at Arlington, and colleagues in Germany point out in a paper published last year in the journal *Icarus*. They cite several recent studies indicating that not only might a small planet survive in the 47 UMa habitable zone, but that it could be big enough to exhibit the tectonic activity that produces continents. The internal churning of tectonics in action also contributes to cycling substances such as carbon dioxide into the atmosphere, an important part of keeping the planet habitable. Dr. Cuntz and his collaborators found that an "Earth" at 47 UMa might be habitable if the star itself is not too bright.

In a subsequent paper, in the *International Journal of Astrobiology*, Dr. Cuntz and colleagues found that the best chance for a stable and habitable orbit occurs for a small planet almost completely covered with oceans. On planets covered mostly with continents, weathering removes more carbon dioxide from the air, making the planet's surface colder and less likely to be habitable. All rocks and no oceans, then, would make life's chances pretty dim. Another reason to follow the water.

POSSIBLE PLACE FOR AN EARTHLIKE PLANET

47 Ursae Majoris, a star visible near the Big Dipper, is a sunlike star thought to possess two large planets. Studies indicate that an Earthlike planet could survive in a safe orbit with habitable conditions, providing that such a planet was covered mostly by water.



SOURCES: University of Wisconsin; Dallas Morning News research — Staff graphic

Luckily, computer simulations of the planetary birthing process suggest that water worlds would not be rare.

Sean Raymond and Thomas Quinn (of the University of Washington) and Jonathan Lunine (of the University of Arizona) tested 42 versions of terrestrial planet formation in the dusty disk surrounding a young star, varying such features as the mass and orbit of a Jupiterlike planet in the system. (A large planet's presence influences how many water-containing meteorites would crash into an embryonic Earthlike planet.) In the 42 tests, more than 100 planets were formed — 43 in a roughly habitable zone and 11 at a distance from the star very nearly the same as Earth's. Some of those planets turned out dry in the simulations, but others received enough water for multiple oceans, the scientists reported in a paper submitted to *Icarus*.

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Ultimately, of course, the only way to find out if earthlike planets really exist is to look for them. And many elaborate plans are being made to make it so.

One way involves watching stars carefully to see whether their light dims slightly on a cyclic schedule — the dimming caused by a planet passing in front of it. A NASA mission planned for 2007 will monitor thousands of stars for such eclipselike signals.

Even better, of course, would be direct detection of distant Earths, with actual images. That will be harder. Glare from the star obliterates the faint light reflected from a small planet nearby. But astronomers have proposed clever ways to overcome that obstacle.

Telescope mirrors can be arranged, for instance, so that light from the parent star is canceled out by interference, the way colliding water waves disappear if they meet out of synch. Ideas on the drawing board for making use of the starlight cancellation trick, known as null interferometry, include a space-based telescope called FKSI (pronounced "foxy"), under development at NASA's Goddard Space Flight Center in Greenbelt, Md. If approved for funding, FKSI would be the "Volkswagen" precursor paving the way for NASA's "Hummer" of planet searchers, the Terrestrial Planet Finder tentatively scheduled for launch in 2015 or later, says William Danchi, leader of the Goddard FKSI team.

The European Space Agency is also designing Darwin, a multiple-telescope flotilla of spacecraft for launch possibly as early as 2014. And some astronomers believe supersized Earth-based telescopes might be able to join in the hunt.

Success at seeing such a planet, though, would not quite be the same as believing it supported life. Images would have to be analyzed for the telltale colors of specific chemicals, such as oxygen, carbon dioxide and, naturally, water. Large amounts of oxygen in molecular form (two oxygen atoms linked to form an O_2 molecule) would almost surely be a sign of life.

"There seem to be no nonbiological sources that can continually produce large quantities of O_2," Dr. Seager wrote in a paper published last year in *Earth and Planetary Science Letters*. It may be possible to detect patterns of light typical of vegetation, as well.

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Although the odds that future searches will find a water-bearing planet may be good, odds are still odds, never sure things. As with playing the lottery, the best way to win is to buy as many tickets as possible. Alien life's chances are best if there are many possible planets that might possess water.

Calculating those odds requires extending the idea of a water-friendly habitable zone farther out into the reaches of space, to the Milky Way galaxy as a whole. Just as only a small region around any given star would be temperate enough for water-based life, only some parts of the galaxy would contain the right ingredients for a habitable environment.

It's not just a matter of water-friendly temperature. The habitable region must be seeded with heavy elements suitable for forming rocky planets (and providing chemical precursors to life), and it must be far enough away from stellar explosions known as supernovas that would bathe any such planets in deadly radiation. And all these conditions must be maintained for a long enough time for complex life to evolve — perhaps 3 billion years or more.

In a study of these factors published last month in *Science*, Australian astrophysicists conclude that the Milky Way galaxy's habitable zone extends from about 20,000 light years from the center of the galaxy to roughly 30,000 light years away (the Earth, unsurprisingly, sits neatly within that range, about 27,000 light years from the galactic core.) Although that zone probably contains no more than 10 percent of the galaxy's stars, that still translates to roughly 10 billion possible planetary systems.

What's more, the Australian analysis concluded, three-fourths of those stars are older than the sun (which is nearing its 5 billionth birthday), so there would have been plenty of time for complex life to evolve billions of times.

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So if the galaxy teems with populous watery planets, why do budget-strapped Earth-based astronomers have to do all the hard work of seeking them? Why don't the aliens send emissaries to Earth? Or at least an e-mail?

That question was made famous half a century ago by the Italian-American physicist Enrico Fermi. "Where is everybody?" he asked at lunch one day, alluding to a previous conversation about the lack of alien visitors.

Since then, more answers have been suggested than extrasolar planets have been discovered. Alien civilizations may typically discover nuclear energy before space travel and blow themselves up. Aliens planning to send messages to Earth may have had their budget cut. Aliens choose not to bother backward civilizations. Aliens try to communicate but are too advanced for us to understand them. Or not advanced enough.

Or maybe aliens haven't visited because they simply don't exist.

Half a century ago, when Fermi posed the question, that was a logical answer. But today it doesn't wash. The water trail leads to the conclusion that populated planets elsewhere in the galaxy are not merely possible, they are likely.

Mars may be barren today, but elsewhere in the cosmos water must still be flowing. And if astronomers continue to go with the flow, they will most likely learn that if the Earth has no monopoly on water, it has no monopoly on life.

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Resources

- Jet Propulsion Laboratory's PlanetQuest page: http://planetquest.jpl.nasa.gov/index.html
- The Extrasolar Planets Encylopaedia:www.obspm.fr/encycl/encycl.html
- The Astrobiology Web: www.astrobiology.com