Outer Limits

Oct 22, 2007, By Chad Vander Veen

Planet Hunter
Discovering life outside of Earth has long been considered the Holy Grail of science. At the University of Texas at Arlington, Manfred Cuntz, associate professor of physics and co-director of astronomy, hunts for habitable planets. Recently three planets were discovered orbiting the star Gliese 581. The planet Gliese 581c was at first considered to be a possible place to find life, but Cuntz helped explain why Gliese 581d was the more likely candidate.

Cuntz took a few moments to discuss his work and explain how planets could harbor life forms.

What is being done today to locate habitable extrasolar planets?
What we understand as habitability is a planet's principal chance of hosting life, which is measured by a planet's ability to have fluid water on the surface. And that depends on many factors - for instance, the size of the planet, whether that planet has an atmosphere and how thick the atmosphere is. Also, it depends on the distance of the planet from the host star and on the type of the host star - like our sun, which has less luminosity [than others].

But there are many other questions. Which conditions are acceptable for life as we know it? This type of work is being done by biologists who are studying extremeophiles [organisms that thrive in extreme environments, such as in ice or near hydrothermal vents on the sea floor].

How are planets observed?
Most planets are "observed" by their parent stars and studying their gravitational pull on that star. This results in a unique identification of a planet, which is good enough to satisfy the criterion that it is observed.

What's the acceptable range of temperatures on habitable planets? Does it need to be similar to Earth?
People studying habitability generally resort to the concepts of sophisticated forms of life, which require fluid water, which would imply a temperature range of zero to 100 degrees Celsius under an atmospheric pressure of one Earth atmosphere. However, we actually know there are life forms possible, which can tolerate higher [and] lower temperatures, which is actually augmenting the concept of habitability.

What's the most likely form of life to be discovered?
In the early 1990s, the first extrasolar planet was identified. What change allowed this to occur?

It was a technology change - the ability to have ultrasensitive spectra of stellar photospheres [the visible surface of a star]. Planets still are discovered most of the time by the gravitational pull on parent stars. This is measured by the so-called Doppler effect of spectra lines in the spectra of stars. To identify such an effect, in an effort to see the orbit of a planet around a star, you must be able to measure photospheric lines of a star with extreme accuracy. We call it ultrahigh spectroscopy. This change in observational methods made observation of planets around stars possible.

A planet in the habitable zone is in a narrow band of space just the right distance from a star, which allows a higher probability of life occurring. Can you talk about your work with Gliese 581c and Gliese 581d?
The earliest work [among those studying habitability] was not considering the planetary atmosphere in an appropriate way. They were treating planets like the moon, just having surface and no atmosphere. If you do that, you get the wrong temperature range. If you are not considering the atmosphere, you can underestimate the temperature.

[Gliese 581d] is hotter with the atmosphere included. This makes the planet effectively move from the outside edge of the habitable zone into the habitable zone. The result of the appropriate atmosphere discredits 581c as being habitable.

Think of a Mars that has a very thick atmosphere. It moves Mars inside the habitable zone around the sun because it traps heat from the sun and would make Mars habitable.

Venus has a very thick atmosphere, which makes Venus move too close to the sun and traps too much solar heat. In a very simplified picture, if Venus [couldn't] trap as much solar heat, it would be cooler and habitable. Thickness of the atmosphere makes a difference because the thicker the atmosphere, the planet is effectively moved closer to the center star.

A Closer Look
A lab at the University of North Texas (UNT), got some high-powered equipment that'll make the university a big player in microscopic science. The Electron and Ion Microscope Lab is home to three of the most advanced microscopes available - the dual-beam focused ion beam/scanning electron microscope, a local electrode atom probe and an analytical high-resolution transmission electron microscope.

The local electrode atom probe lets researchers see exactly what atoms are made of. The high-resolution transmission electron microscope boasts a resolution of one angstrom, or one 10-billionth of a meter. And the focused ion beam can manipulate microstructures.

These tools will advance nanotechnology research, which many in scientific circles believe is the future of almost every field. And given that only a handful of these sorts of microscopes exist, the UNT is now positioned to be at the forefront of these emerging technologies.

Smashing Adams
For many of us, a nuclear fission reaction means little more than splitting a few atoms. From the days of Oppenheimer and his team of mad scientists to today, most people had a vague idea of what happened between the time an atom split and the inevitable boom that followed. Nuclear fission reactions involve many highly complex individual processes, each of which requires extraordinary equations to describe. Taken as a whole, solving the highly complicated equations that describe a nuclear fission reaction from start to finish was virtually impossible.

At Texas A&M, Professor Marvin Adams wanted to find a way to solve the equations to improve how people use nuclear power. To do this, Adams and his team of researchers got permission to use a supercomputer at the Lawrence Livermore National Laboratory. The computer, called the ASC Purple, part of the Advanced Simulation and Computing Program and the fourth most powerful supercomputer in the world, is helping Adams gain a much clearer understanding of how, exactly, neutrons and other particles behave when a fission reaction takes place. Adams and other researchers hope this sort of computer modeling will help make nuclear power a cleaner alternative energy source.

Cleaning Dirt
The U.S. Air Force is putting a strange-sounding technology to use to clean up contaminated soil at Kelly Air Force Base in Texas. Electric resistive heat (ERH) is an application of electric currents that, when applied to contaminated soil or ground water, acts somewhat like a distillatory - only the end product is a cleaner environment.

ERH is a process in which powerful electric currents are sent 30 feet into the ground. ERH is a fairly straightforward technology. Heating elements are inserted into the ground and electrical current generated. These currents heat the soil and groundwater, producing steam and the vaporization of hazardous chemicals and compounds. Once vaporized, the undesirable materials are drawn to a powerful vacuum, which then sends the contaminants to an underground extraction well where they are treated - thus keeping the harmful materials from being exposed above ground.

ERH is very similar to a process known as soil vapor extraction. Air Force officials, however, have found ERH works more quickly and is more desirable when cleaning up toxic sites.

Auto Bot

Lockheed Martin recently announced that its MULE program reached an important milestone. MULE - short for Multifunction Utility/Logistics and Equipment - is an autonomous combat vehicle in development at Lockheed's Engineering Evaluation Unit (EEU). The MULE navigated a 30-inch step and a 70-inch gap entirely on its own - relying only on its programmed self-awareness.

The MULE is a six-wheeled, unmanned vehicle designed to traverse extreme terrains and provide support for ground troops. MULEs can be configured for various missions, such as a rapid-fire antitank weapon, a payload vehicle and a minesweeper.

Lockheed Martin plans to bring the MULE to the battlefield by 2013. Once deployed, the MULE will go with ground forces over terrain other vehicles can't manage. The 3.5-ton robot can carry weaponry that will give ground soldiers heavier firepower than they could carry alone.

In addition to providing soldiers with high-powered weapons in rugged terrain, the MULE will also function as an evacuation vehicle to quickly carry wounded soldiers from the battlefield.