# MARSBUGS:

**The Electronic Exobiology Newsletter**
Volume 2, Number 2, March 1995

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## HUBBLE FINDS OXYGEN ATMOSPHERE ON JUPITER'S MOON EUROPA

NASA release 95-17

Astronomers using NASA's Hubble Space Telescope (HST) have identified the presence of an extremely tenuous atmosphere of molecular oxygen around Jupiter's second moon, Europa. The planets Mars and Venus are the only two other solar system objects beyond Earth known to have traces of molecular oxygen in their atmospheres.

This detection was made by a team of researchers at the Johns Hopkins University and the Space Telescope Science Institute, both in Baltimore, and is reported in the Feb. 23 issue of the journal "Nature."

"Europa's oxygen atmosphere is so tenuous that its surface pressure is barely one hundred billionth that of the Earth," said Principal Investigator Doyle Hall, of Johns Hopkins. "If all the oxygen on Europa were compressed to the surface pressure of Earth's atmosphere, it would fill only about a dozen Houston Astrodomes. It is truly amazing that the Hubble Space Telescope can detect such a tenuous trace of gas so far away."

Scientists had predicted previously that Europa might have an atmosphere containing gaseous oxygen, but had to wait for Hubble's sensitive instruments for confirmation. The HST researchers caution that the detection should not be misinterpreted as evidence for the presence of life on the small, frigid moon. Located 490 million miles (780 million kilometers) from the Sun, Europa's surface is too cold, measured at -230 degrees Fahrenheit (-145 degrees Celsius), to support life as we know it.

Unlike Earth, where organisms generate and maintain a 21% oxygen atmosphere, Europa's oxygen atmosphere is produced by purely non- biological processes. Europa's icy surface is exposed to sunlight and is impacted by dust and charged particles trapped within Jupiter's intense magnetic field. Combined, these processes cause the frozen water ice on the surface to produce water vapor as well as gaseous fragments of water molecules.

After the gas molecules are produced, they undergo a series of chemical reactions that ultimately form molecular hydrogen and oxygen. The relatively lightweight hydrogen gas escapes into space, while the heavier oxygen molecules accumulate to form an atmosphere which may extend 125 miles (200 kilometers) above the surface. The oxygen gas slowly leaks into space and must be replenished continuously.

Europa is approximately the size of Earth's Moon, but its appearance and composition are markedly different. The

satellite has an unusually smooth and nearly craterless surface of solid water ice. Mysterious dark markings crisscross the surface, giving the moon a "cracked eggshell" appearance. Under the apparently fragmented icy crust, tidal heating by Jupiter might heat the icy material enough to maintain a subsurface ocean of liquid water.

Of the 61 identified moons in the solar system, only three other satellites are known to have atmospheres: Jupiter's volcanically active moon Io (sulfur dioxide), Saturn's largest moon Titan (nitrogen/methane) and Neptune's largest moon Triton (nitrogen/methane).

The definitive detection of Europa's tenuous atmospheric oxygen was made possible by the ultraviolet sensitivity provided by HST's Goddard High Resolution Spectrograph (GHRS) instrument. The GHRS recorded the spectral signature of molecular oxygen (O2) on Europa in ultraviolet light during observations made on June 2, 1994, over a period of six Hubble orbits. Europa was then at a distance of 425 million miles (684 million kilometers) from Earth.

The Hubble observations will be invaluable for scientists who are planning close-up observations of Europa as part of NASA's Galileo mission, which will arrive at Jupiter in December 1995. During its initial entry into the Jovian system on Dec. 7, Galileo will fly by Europa at a distance of less than 22,000 miles (35,000 kilometers). The Hubble Space Telescope is a project of international cooperation between NASA and the European Space Agency.

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LAUNCH OF RUSSIAN FOTON-10 CAPSULE WITH ESA PAYLOAD
ESA press release

A Russian Soyuz launcher carrying the Foton-10 satellite, a retrievable capsule carrying a set of biological experiments in an incubator named Biobox, was successfully launched on 16 February from the Plesetsk cosmodrome (Northern Russia) at 20h40 Moscow time (18h40 Paris time).

This is the fourth time that ESA is present with a major microgravity payload facility on an unmanned Russian satellite. The retrievable Foton-10 capsule, that is scheduled to land in the Russian-Kazakh border region on 3 March, carries the Biobox-2 incubator with experiments on cells responsible for bone mineralization and on small living organism (fruit flies and algae) from research institutes in Belgium, France, the Netherlands, Spain and Russia. These experiments will contribute to a better understanding of the phenomenon of bone mass loss experienced by astronauts in space and will help identify and quantify the influence of absence of gravity on living systems.

The previous missions in this domain with large ESA involvement have been:

- October 1992: Foton-8 capsule carrying ESA's Biopan facility (Biopan-0, with a set of pilot experiments).
- December 1992: Bion-10 mission with Biobox-1 on board. (Biobox contained experiments on cell biology).
- June 1994: Foton-9/ second flight of Biopan (Biopan-1, with experiments on radiation and exobiology).

During the current flight of the Foton-10 capsule, Biobox data will be passed on from the Foton Flight Control Centre in Moscow to ESA's microgravity Laboratory Moslab, in Moscow, from where they will be distributed via a Wide Area Network to the investigators' home institutes. After landing, the entire ESA payload will be dismounted from the capsule and flown back to Moslab within 48 hours for final disassembly and first data analysis.

The Foton 10 payload development and mission management was carried out under the responsibility of ESA's Microgravity Payload Division at ESA's research and technology centre ESTEC in the Netherlands. Biobox was developed under the industrial prime contractorship of Dornier (Germany) while all flight and ground operations in Russia are run for ESA by Kayser Italia (Italy).

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SPACE RADAR STUDIES ARCHEOLOGICAL SITE IN CAMBODIA
NASA Release 95-12

Images from the international Space Radar Laboratory (SRL) may help researchers find previously unknown settlements near the ancient city of Angkor in Cambodia. The radar data was obtained during the October flight of NASA's Space Shuttle Endeavour, processed and sent to the World Monuments Fund (WMF) in January. The group had approached the radar science team about observing the Angkor area after SRL's first flight in April 1994.

"I had read about the radar mission while the April flight was in progress and instantly surmised that it would have applications to the international research efforts at Angkor," said John Stubbs, program director for the fund. "I didn't really know where to start, but I was hopeful NASA would be willing to image the area around Angkor."

Angkor, a vast complex of more than 60 temples dating back to the ninth century A.D., served as the spiritual center for the Khmer people. At its height, the city housed an estimated population of one million people and was supported by a massive system of reservoirs and canals.

The April flight of SRL's complementary radars, the Spaceborne Imaging Radar-C/X-band Synthetic Aperture Radar (X-SAR), first demonstrated their capability to obtain vast amounts of data applicable to ecological, oceanographic, geologic and agricultural studies.

"We realized after the huge success of the first flight that we could be more flexible in adding new sites to the timeline of flight two," said Dr. Diane Evans, the SIR-C project scientist at NASA's Jet Propulsion Laboratory (JPL), Pasadena, CA. "Since our science team was interested in studying as much of the tropical rain forest as possible, Cambodia and the Angkor site seemed to be a great complement to our ecology objectives."

Today, Angkor is hidden beneath a dense rain forest canopy. Its temples have been ravaged by weather, war and looters. Its extensive irrigation system has fallen into disuse.

"The radar's ability to penetrate clouds and vegetation makes it an ideal tool for studying Angkor," Stubbs said. "I can see the canal-and- reservoir system very clearly in the radar imagery, and preliminary analysis reveals what may be evidence of organized settlements of large tracts of land to the north of the present archeological park, which until now, has gone unnoticed."

The SIR-C/X-SAR data will be used by the WMF, the Royal Angkor Foundation and research teams from more than 11

countries to understand how the city grew and then fell into disuse over 800 years.

"The 'temple mountain' monuments at Angkor, such as Angkor Wat and the Bayon, are not unlike some of the pyramidal forms encountered in Central America," Stubbs said. "The sheer size and sophistication of Angkor's great city plan, now enveloped in dense jungle, sets this ancient capital apart as the ultimate jungle ruin."

SIR-C/X-SAR is a joint mission of the United States, German and Italian space agencies. JPL built and manages the SIR-C portion of the mission for NASA's Office of Mission to Planet Earth.

NOTE: SIR-C/X-SAR radar images are available from JPL's public access computer site, via Internet and the World Wide Web, at the address http://www.jpl.nasa.gov, by anonymous file transfer protocol (ftp) at the address jplinfo.jpl.nasa.gov, or by dialup modem to the telephone number 1-818-354-1333.

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NEW TECHNOLOGY USED TO DEVELOP MEDICAL INSTRUMENT
NASA release 95-20

Technology developed by a team from NASA, a major university, and a small business is making it possible to directly and non- invasively measure the stiffness of long bones. NASA is interested in using the technology to test the bones of astronauts, who lose calcium from their weight-bearing bones during space flight.

The instrument, known as the Mechanical Response Tissue Analyzer (MRTA), is a portable device that detects the response of the bone to a brief vibratory stimulus to measure the bending stiffness of the bones. The bones that can be tested are the ulna in the forearm and the tibia in the leg. The instrument was developed by NASA's Ames Research Center, Mountain View, CA, Stanford University, Palo Alto, CA, and Gait Scan Inc., Ridge, NJ.

"The major attraction of this technology is the speed and simplicity with which the measurement gives a complete picture of bone strength," said Sara Arnaud, M.D., of Ames' Life Sciences Division. Arnaud said that a long bone will bend before it breaks, with a stiffer bone requiring more force to break it. Bending stiffness is a mechanical property of bone that reflects both the materials in the bone and its shape. The MRTA is the only instrument that provides a direct and non-invasive measure of bending stiffness in the ulna and tibia, she said.

Among the MRTA's advantages are its safety--because it uses no radiation--and the ease of measurement. A technician places a small probe on the skin surface of the limb to be tested, which rests on a stable support. The patient feels a "buzz" that lasts less than five seconds. The frequencies from the resonating bone are detected at the same site as the stimulus and analyzed by unique software in an attached computer. The result is an accurate measurement of the bending stiffness of the bone. In addition, at an approximate cost of $20,000, the MRTA is fairly inexpensive.

Arnaud noted that while the MRTA is not yet in clinical use, it has been used in several research studies of the forearm bones. She is using the device to measure the strength of the leg's tibia bone among working women at Ames. In other research, the MRTA accurately showed the fragility of bones in patients with osteogenesis imperfecta, a disease marked by brittle bones and increased risk of fractures. Scientists also have used the device to measure the strength of bones in the forearms of women with post-menopausal osteoporosis. Ames' scientists plan to use the MRTA to measure the suspected decrease in bone strength in astronauts following space flight.

Arnaud sees several other potential uses for the MRTA. One promising application is in follow-up testing of patients being treated for osteoporosis. It also may be useful in monitoring the healing of broken bones. The physician could determine whether a healing bone is strong enough to allow the patient to resume using the limb.

The more immediate applications of the MRTA may be in physical fitness, where long bone strength is essential. The lack of radiation exposure and simplicity of measurement make it particularly well-suited to screening studies used to identify substandard levels of fitness in large groups, such as military recruits or students.

"The MRTA doesn't replace the bone density-measuring technology we now have," Arnaud said, "but it provides an excellent non- radiation measure of long bone strength. It will, I am sure, find its place in the resources of physicians treating bone disease."

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NEW ROBOTIC ARM WILL PERFECT DELICATE SURGICAL PROCEDURES
NASA press release

A new robotic arm--steadier than a surgeon's hand--promises to revolutionize the field of microsurgery and allow surgeons to perform very delicate operations of the eye and brain once it is transferred to the marketplace by scientists at NASA's Jet Propulsion Laboratory.

Working with a commercial medical partner, JPL is developing the Robot-Assisted MicroSurgery (RAMS) workstation, which will make possible new types of microsurgery procedures of the brain, eye, ear, nose, throat, face and hand, said Dr. Paul Schenker, who leads the team of JPL developers.

RAMS is being designed with the guidance of the microsurgical community, and a cooperative commercial development agreement has been signed with MicroDexterity Systems, Inc., of Memphis, Tenn. The resulting technology developments will be tested in actual clinical procedures and turned over to the private business sector through the cooperative NASA-industry venture, Schenker said.

Several different directions in medical robotics are being explored worldwide, including imaging-guided biopsies, precision joint replacements, telesurgery in which surgery is performed at a remote location and, most recently, high dexterity operations under microscopic viewing. These are all aspects of the RAMS project under way at JPL.

The primary RAMS control mode is teleoperation, in which the operator's hand motions are transferred by a sophisticated joystick-like hand controller device, and scaled down to dimensions as small as 20 to 30 microns, or 20 millionths to 30 millionths of a meter. RAMS not only refines the physical scale of current microsurgery techniques but also enables more positive outcomes for average surgeons during typical procedures, Schenker said. That is possible because the RAMS system will include control features to enhance manual

positioning and tracking and overcome involuntary jerks and hand tremors that limit most surgeons' motion skills.

The mechanical design and controls will allow relative positioning of surgical tools within 20 microns--or 20 millionths of a meter--while enabling the surgeon to range freely over a continuous work space as large as 20 cubic centimeters, or little more than a cubic inch. Surgeons would thus be able to scale down their hand motions as much as 5 to 10 times and perform new procedures in critical areas such as the inner eye.

The first element of the RAMS workstation, now being tested, is a six degrees-of-freedom surgical robot, or slave, made up of a torso-shoulder-elbow body with a three-axis wrist. This robot manipulator is about 25 centimeters (10 inches) long and 2.5 centimeters (1 inch) in diameter. Each robot joint has a large continuous range of motion and the arm's base will not have to be repositioned frequently during tasks. The torso was designed with 165 degrees of motion while both the shoulder and elbow have a full 360 degrees of motion. The wrist design has 180 degrees of pitch and yaw and 540 degrees of roll. Such large motion ranges greatly reduce the chances of a joint reaching a limit during an operation and interfering with a surgeon's natural hand motion.

The work on the Robot-Assisted MicroSurgery workstation is being performed at the Jet Propulsion Laboratory under contract with NASA's Office of Space Access and Technology.

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LIFE SCIENCES AND SPACE MEDICINE CONFERENCE AND EXHIBITION '95

NASA, in partnership with the American Institute of Aeronautics and Astronautics and in cooperation with the U.S. National Institutes of Health and the U.S. Air Force, is cosponsoring the Life Sciences and Space Medicine Conference and Exhibition '95, to be held April 3-5, 1995, at the Westin Galleria in Houston, Texas. The theme of this conference is "Application of Space Life Sciences: Bringing Space Benefits Down to Earth." This international conference will address a broad range of life sciences and space medicine topics illustrating how knowledge and techniques developed for human space flight can provide beneficial applications on Earth. These topics include environmental control and life support, medical sciences and systems, biological sciences and systems, human factors engineering, technology applications, extravehicular activity and international life sciences cooperation. The conference executive committee includes leaders from the National Aeronautics and Space Administration (NASA), major medical centers, Department of Defense, and the U.S. National Institutes of Health. Discounted rates available until 3/3/95.

For more information, contact AIAA at lifesci@aiaa.org or by calling 202/646-7463.

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