AD ASTRA KANSAS NEWS

To the stars through high-tech / space-tech R & D

Fall 2004 *Vol. 3, No. 2*

First Kansas satellite is ready to soar

Kansas as a leader in the field of design and production of small satellites?

That possiblity may be closer than one thinks. The Kansas Universities Technology Evaluation Satellite Program (KUTESat) will launch its first picosatellite, the Pathfinder, in December of 2004.

The 2.2-pound satellite cube will be launched by rocket into the low earth orbit (a maximum altitude of 1,000 kilometers) on December 20. The launch site for it and about 14 others from the United States, Norway, Japan and South Korea will be the Baikonour Cosmodrome, Russia's equivalent of our Kennedy Space Center.

"To our knowledge this is the first Kansas satellite launched. I would say that as soon as we launch the first one, the space era in Kansas has started," says Marco Villa, program manager of the KUTESat program.

In this first launch of KUTESat's three-stage program, the mini-satellite will carry a digital camera, four dosimeters to measure radiation and communications equipment. Expected to be up for six or seven years, Pathfinder will be operational for one to two years, enough time to serve as a testbed for the avionics and systems to be used in phase two, according to Villa.

Engineers are already working on the conceptual design of phase two, scheduled to fly in 2005. Phase two is an engineering prototype focusing on developing a micro-maneuvering propulsion system allowing six-axis maneuverability.

The final phase, MIST, is scheduled for 2006. In it three picosatellites will be launched together, working in tandem, each with its own duties—imaging (ISS), space environment study (SES), target and relay (TRS).

These are the types of satellites that will be needed for NASA's Jet Propulsion Lab Solar Sail or Mars NetLander missions. One KUTESat goal is to design and build a satellite innovative and reliable enough that NASA would use it on one of its missions.

Solar sails, an advanced propulsion idea currently under research, are thin sails made of composite materials. Solar wind, caused by photons radiating from the sun, pushes the sails. According to Villa, in the Solar Sail mission a picosatellite could be deployed by the main spacecraft and guided, either manually or with precoded commands, to inspect the surface of the solar sail to determine changes. Or it could measure the space environment around the solar sail to detect atmospheric influences that might affect the solar sail. Solar sails exchange energy with solar wind, which could be altered by the presence of a big object.

As for the NetLander mission, many satellites could be dropped in the Martian atmosphere and during their "fall" toward the surface, they could record data, giving a 3-D plot of the atmosphere, says Villa.

With the maximum weight of only a little over two pounds and a cost of about $5,000, they are a bargain to build and launch (about $40,000).

Started in 2002 at the University of Kansas, KUTESat is the first program created at KU to seriously try to establish a space-related field at KU and in Kansas. "Through different projects we want to increase awareness of space related fields and ultimately establish a space center in Lawrence to serve the entire state," says Villa.

In a little over two years the program, headed by Dr. Trevor Sorensen, has involved almost 20 students from KU's aerospace engineering and electrical engineering / computer science departments in the designing, testing and building of the satellite.

In keeping with the objective of broadening this into a multi-university effort, the aerospace engineering department at Wichita State University is expected to join the KUTESat effort in December under the guidance of Professor Roy Myose.

KUTESat is modeled after the CUBESat program. According to its website, CUBESat is a group of over 40 educational and private entities worldwide which are developing picosatellites containing scientific, private and educational payloads. The CUBESat program was developed by California PolyTech and Stanford University. A number of universities nationwide participate in CUBESat.

"What sets KU's program apart (from the others) is that we didn't settle for focusing only on one or two aspects of the satellite, but tried to develop every subsystem in the best possible way. This made the project a little more complex, but for sure very rewarding," says Villa.

"I think we should aim to become a leader in the design and production of small satellites (even much bigger than the CUBESat concept). This will create the possibility to develop companies in different areas to support the effort," says Villa.

Technical and financial support for KUTESat has come from the University of Kansas, the Kansas Space Grant Consortium, NASA Jet Propulsion Lab, Swales Aerospace and Honeywell as well as various companies that have donated components.

Come join our mid-year AD ASTRA INITIATIVE meeting

Nov. 6, 2004
at 2 p.m.
Stoffer Science Hall
Washburn University, Topeka

Topics:
Ad Astra Kansas Day 3 observance
Ad Astra website
Ad Astra foundation

Questions? Call 620-669-8558 or 785-231-1010 ext. 2264

In this issue

MARS HUMAN FACTORS IN NASA's NEW SPACE FLIGHT MISSIONS--Part I

Human Flight to Mars in a Day?

by Randall Chambers Ph.D.

Returning to the Moon, and on to Mars, were included in President Bush's 2004 directive for new manned flight missions for NASA. While serving as a NASA aerospace engineer and a Dept. of Defense (D.O.D.) civilian scientist, I was a project director, engineer/ scientist in some Mercury, Gemini, and Apollo research and training projects. As a chief scientist, and also chief of a Human Factors Unit, we conducted some "manned flight to Mars" simulations to study astronauts' abilities to withstand flight dynamics encountered in sustained space flight. Of special interest were the abilities of humans to sustain the possible flight dynamics of a prolonged flight to Mars, the flight dynamics of which may be a human flying over 35 million miles to Mars.

Human centrifuge flight simulation

Using a computer-controlled gondola at the end of a 50-foot arm of a giant human centrifuge as a dynamic flight simulator in a manned flight to Mars, one volunteer was exposed for 24 hours to sustained reactive acceleration forces at 2 g, twice the sustained acceleration forces of Earth gravity. Subjected to the biodynamic force field of a 2 g 24 hour flight-to-Mars simulation, he endured the required acceleration loads, and demonstrated he could maintain consciousness, visual awareness and comprehension, cognitive capabilities and life support, physiological and psychological functions, and flight control capabilities. Although data analyses focused on only one volunteer subject, this human centrifuge simulation provided design criteria for improving human factors aspects of g-protection and life support systems, flight control interfaces, bioengineering and performance instrumentation, biomedical and psychological monitoring. Additional personnel were tested in a variety of acceleration tolerance evaluations. Also restrained in the gondola's cockpit, they were exposed to combined acceleration force fields as their physiological and pilot performance capabilities were measured along x, y, and z centrifugal force axes for associated tolerance time-lines at different acceleration force levels, including through: 2 g, 3 g, 5 g, 7 g, 8 g, 9 g, 14 g, and 15 g. For the 2 g 24 hour human centrifuge simulation, the technical hypothesis was that the pilot may tolerate continuous acceleration forces of two times Earth gravity by accelerating half way to Mars at 2 g, and decelerating at 2 g the rest of the way, mainlining a total flight time interval of 24-34 hours, flying a continuous 2 g acceleration force approach profile to Mars.

The world's largest human centrifuge, located at the Aviation Medical Acceleration Laboratory at the U.S. Naval Air Development Center, was modified for space flight research, simulation, training, and effects-of-acceleration profiles on astronaut physiology, flight performance, and astronaut safety systems in many space flight projects for NASA and the D.O.D. We have formulated acceleration-force guidelines and standards, encompassing a variety of acceleration G-levels, durations, profiles, and their combinations, primarily ranging through 2 g to 15 g profiles, ranging in peak g durations from 24 hours at 2 g, and to 15g for 5 seconds. In some runs, effects of transverse acceleration dynamics on memory and flight task performance in the cockpit for 4 ½ hours at 2Gx, and other g levels ranging to as high as 9Gx for 2 minutes and 18 seconds. There were marked and somewhat consistent performance decrements as functions of exposure times and increased G levels.

In acceleration physiology, acceleration a is measured as a multiple of g, the standard unit of acceleration due to gravity, and any force F, as a multiple of the standard weight, W, of the body upon which F is acting. In acceleration physiology, the magnitudes of the vectors g and W are employed. The directions of the vectors a and F are independent and the fixed directions of the physical quantities, g and W. A single symbol represents the common ratio formed by normalizing F and a with respect to the standard gravitational values. Thus, physiological G is defined as a ratio of forces, or a ratio of accelerations: G = a/g, or G = F/W. Physiological G = the unit of reactive force causing displacement of the organs and fluids in the human body when the body is accelerated, where l G = force per unit mass due to acceleration of 1 g. The acceleration of Earth gravity is: g = 32.17 ft/sec 2 , or 980.6 cm/sec 2. Linear acceleration modes in g units are simulated on the human centrifuge by the radial acceleration of x, y, and z unit vectors through the human body, and angular acceleration modes about x, y, and z axes of heart motion, as operated by the computer-programmed and controlled combinations of forces from the rotating centrifuge arm and the gimbaled centrifuge gondola at the end of the centrifuge arm.

The human's heart and body may then be evaluated for launch, space flight maneuvers, and re-entry in response to exposures to many acceleration flight profiles and their resulting dynamic loads. Using radial and angular accelerations, effects of acceleration forces expected during launch and lift-off, many space flight maneuvers, reentry, and landing may be simulated, and pilots may be tested and trained dynamically, in their spacecraft configurations. Many flight simulation programs and projects with Mercury, Gemini, and Apollo astronauts were conducted using this facility and its technology. I was project director for many of these joint NASA-NADC-AMAL projects, and directed joint Mercury-Centrifuge simulation, X-20-Centrifuge Simulation, Gemini-Centrifuge, and Apollo Manned Centrifuge projects, research and training.

The manned trip to Mars when it is closest to Earth, about 35 million miles, with 20th century chemical propulsion in this early "sling shot era" of space exploration, involves about 10 minutes of acceleration above 0 g to attain the 25,000 mph (or 1139 g seconds) of earth escape speed and six months of coasting flight at 0 g and a few minutes of deceleration to Mars landing. The expected 21st century propulsion improvements, probably involving nuclear power, can provide a very desirable shortening of this flight time. The shorter flight time would greatly reduce the probability of exposure to a solar radiation storm, a significant danger of a six month coasting flight, and greatly reduce the weight and volume of needed en-route life support. In the planning for a human flight to Mars, there was major concern with the possible six months of coasting flight before arrival to Mars. We hypothesized that if one accelerated in a straight line at 2 g for 12 hours, and then decelerated at 2 g for 12 hours, one may not reach Mars at its near approach of 35 milliion miles from the Earth, but one could determine whether a human could tolerate physiologically long duration continuous 2 G acceleration for 24 hours.

TO BE CONTINUED IN NEXT ISSUE

New staff member joins Ad Astra

Brenda Culbertson, head of the Crane Observatory at Washburn University, Topeka, joins our staff part-time. She will help coordinate Ad Astra efforts in the northeast section of the state, help organize the annual Ad Astra Kansas Day event and research the possibilty of starting an Ad Astra Foundation.

Culbertson, who will continue at Washburn where she has been for the past six years, has degrees in natural science and math, mass media and liberal studies.

Kansans attend 2004 NASA Academies

Kansas was amply represented in this summer's NASA academies.

The NASA Academy is an intensive ten-week summer program for undergraduate and graduate students interested in careers in aerospace-related fields. Students do lab research, attend seminars, meet with NASA scientists and astronauts and visit various NASA centers

Among 19 selected nationally Goddard Space Flight Center's 2004 NASA Academy, June 6-Aug. 13, were:

Jacob Stich of Pittsburg State University, an electronics engineering technology major. His NASA Academy research project was "Forward and Backscattering Measurements of Rainfall using the NASA Microwave Link."

Loral O'Hara, of the University of Kansas. The aerospace engineering major's research project was "Colloidal MEMS Thruster."

KU graduating senior Jennifer Sweeton attended the 2004 NASA Astro-biology Academy at Ames Research Center. She was one of 13 selected nationally for the June 20-Aug 27 session. Using her degree in cognitive psychology, Sweeton's research project was "Adaptation to Overcome Adverse Visual Effects of Small Head Mounted Displays."

Also, the NASA Academy 2004 and Kansas Space Grant affiliate WSU School of Engineering chose WSU freshman Jennifer Marshall of Wichita to represent Kansas in the inaugural program for high school graduating seniors who will be studying science, technology, engineering or math (STEM). The NASA College Freshman Internship Program (CFIP), held at Goddard Space Flight Center, involved a fast-moving weeklong preview of the life of a NASA intern at a NASA field center.

Students who would like advance info concerning upcoming NASA opportunities should sign up at www.tsgc.utexas.edu/stsp/ Sources: NASA Academy website, KSGC

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The following list is part of an ongoing reference directory featuring representative research projects in Kansas. Ad Astra Kansas' goal is to serve as an information hub in Kansas focusing on different areas of high-tech and space research for networking and educational purposes.

ASTRONOMY

"Modeling the Global Atmospheric Properties and Phase Dependent Spectroscopy of Extrasolar Giant Planets," $59,000, T. Barman and D. Alexander, WSU Dept. of Physics and Astronomy. NASA funding awarded summer '04. 316-978-5260

"Studies of Effects of Galactic Gamma-Ray Bursts on the Earth and Earth-like Planets," $7,000, Adrian Melott, KU Dept. of Physics and Astronomy. NASA Goddard Space Flight Center funding 12-03. 785-864-3037 melott@ku.edu

"Cassini Ion Neutral Mass Spectrometer (INMS) Team Member Participation," $30,000, Thomas Cravens, KU Dept. of Physics and Astronomy. University of Michigan funding 4-04. 785-864-4739 cravens@ku.edu

AVIATION

"Aircraft Interior Noise Reduction Studies for Composite Sandwich Panels," $54,000, Mark Ewing, KU Dept. of Aerospace Engineering. Wichita State University funding awarded 4-04. 785-2964 mewing@ukans.edu

"Estimation of Non-Linear Aerodynamic Roll Model for Indentification of Uncommanded Rolling Motions," $43,614, C. Edward Lan, KU Dept. of Aerospace Engineering. NASA Headquarters funding awarded 4-04. 785-864-4267

ENERGY

"State of the Vacuum--Research in Relative Heavy-Ion Nuclear Physics and BRAHMS," $166,500, Michael Murray and Stephen Sanders, KU Dept. of Physics and Astronomy. U.S. DOE funding 4-04. 785-864-7739 mjmurray@ ku.edu

"**Study of the Stability of Particle Motion in Storage Rings,"** $85,000, Jicong Shi, KU Dept. of Physics and Astronomy. U.S. Dept. of Energy funding 12-03 785-864-5273 jshi@ku.edu

INFORMATION TECHNOLOGY

"Design of RFICS's in Peregrine SOS Phase II," William Kuhn, KSU Dept. of Electrical Engineering and Computer Science. NASA funding awarded 2-'04. 785-532-4649 wkuhn@ksu.edu

"High Performance Wireless Communication Systems Using Multiple Antenna Arrays and Efficient Source-Channel Coding Systems," $51,792, S. Jayaweera, WSU Dept. of Electrical and Computer Engineering. NASA EPSCoR /CRINC funding 6-04. 316-978-6320 sudharman.jayaweera @wichita.edu

"Kansas Participation in SeaWind Instrument Activities," $67,800. Richard Moore, KU Dept of Electrical Engineering/Computer Science--ITTC. Funding through Oregon State University. 785-864-3549 rmoore@ukans.edu

"Radar Sounding and Airborne High-Resolution Mapping of Near Surface Layers of Greenland Ice Sheet," "$90,379, S. Prasad Gogineni and David Braaten, KU Dept. of Electrical Engineering and Computer Science. NASA Goddard Space Flight Center funding 4-04. 785-864-8800 gogineni@rsl.ku.edu

MANUFACTURING and ADVANCED MATERIALS

Computational Models for Electrostrictive Graft Elasometer," $49,967, Youqi Wang, KSU Dept. of Mechanical and Nuclear Eng. NASA funding awarded 2-04. 785-532-7161 youqi@ksu.edu

"Design / Build / Test of Acoustic Bandgap (ABG) Materials for Aircraft Cabin Noise Applications," $68,730, Saeed Farokhi, KU Dept. of Aerospace Eng. Raytheon funding awarded 11-03 785-864-2966 sfarokhi@ukans.edu

"High Temperature Adhesives for Application to Aerocapture," $40,000, C. Wang, WSU Dept. of Mechanical Engineering. NASA funding awarded 3-04

Sources: WSU Office of Research Adm., KSU Research and Sponsored Programs and KU Research Awards

Kansas 4-H does aerospace "fairly" well

4-H isn't just about agriculture and animals anymore. The recent Kansas State Fair proves that.

The 2004 4-H rocketry competitions (for ages 10-18) at the state fair drew 260 entries, says Dr. Walter Barker, KSU extension specialist in charge of 4-H aerospace and technology competitions. Also included in the 4-H's aerospace division are astronomy, robotics and remote control competitions.

This year, for the first time at the fair, 4-H members did public outreach concerning their space-tech interests, teaching fairgoers about robotics, astronomy and flight simulation.

Though other states' 4-H programs are also into aerospace, "(I feel) Kansas is ahead of the game because of the involvement in the Space Tech Program, " says Barker.

Space Tech is a four-day experience held in November for 4-Hers at the Kansas Cosmosphere and Space Center. Sponsors include the Cosmosphere, KSU, KU, the FAA and the Kansas Commission on Aerospace Education, This year it will provide hands-on experience in rocketry, robotics, astronomy, global positioning systems (GPS) and geographic information systems (GIS).

A spinoff of the Space Tech Program is that ten Kansas 4-Hers who attend the program will be selected for an all-expense paid trip to the Experimental Aviation Association(EAA) AirVenture event in Oshkosh, Wisc., next summer. This is an outreach project in partnership with the EAA.

"Kansas is the aerospace capital. We want to pass the same experience down to youth so we can keep this status in the world community." says Barker.

Scenes from second annual AD ASTRA KANSAS DAY--

celebrating science and technology in Kansas

April 24, 2004

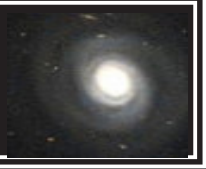
Right: Winner of the Ad Astra Kansas Day poster contest, themed "Super Sleuths--Researching for the Stars," sixth-grader Phillip Eller of Phillipsburg, receives his award from *Kansas astronaut Steve Hawley. Eller also won for his school an outreach presentation from the Kansas Cosmosphere and Space Center. The contest was also sponsored by the Kansas Space Grant Consortium. Two hundred-sixty entries were received. Introductions were made by Ad Astra News managing editor Jeanette Steinert.*

photos by Randall Chambers

After his presentation on the Hubble Space Telescope, Hawley was very accessible to visitors, spending at least thirty minutes answering questions. Here he visits with (l. to r.) Kevin Price, Jane Fortin, Paul Fortin.

Interstellar R&D

Ad Astra Kansas News



This "Interstellar R&D" sixth-time feature in this ***Ad Astra Kansas News*** *sixth issue continues an enterprise to research and gather information on the most important developments preparatory to humanity's greatest adventure — voyaging to the stars. Now, at millennium's turn, is an appropriate time for grand vision and forward thinking, and there are strong signs of a renaissance in interstellar travel thought and activity. This new feature and newsletter, thus, now set forth to develop a national / international / global clearing center and storehouse of knowledge and know-how for travel to the stars: Ad Astra. — Steve Durst, Michelle Gonella*

OBSERVATION

Earth's Astronomy Frontiers and Centers: Development Update

The National Radio Astronomy Observatory, operated for the National Science Foundation and based in Charlottesville VA, continues pioneering interstellar frontiers and making remarkable discoveries. NRAO, currently directed by Dr. Fred Lo, oversees the Green Bank Observatory WV (which this year celebrated its 30th anniversary discovery of the Sagittarius A* black hole signature at our Milky Way Galactic Center), the 27-dish Very Large Array in Socorro NM, the 10-dish Very Long Baseline Array VLBA across the USA, and the American contribution to the future 64-dish Atacama Large Millimeter Array ALMA in Chile.

The VLBA radiowave ability to penetrate surrounding stardust plasma and measure within the dense black hole some 24,000-26,000 light-years from Earth is not the only Hawaii observatory focused on the Galactic Center. The Canada-France-Hawaii Telescope, the 7-nation Gemini North Telescope, the Smithsonian Astrophysical Observatory Submillimeter Array, and among still others, the twin Keck 10-meter telescopes are producing the clearest, highest resolution images and wide-field mosaics of the radio, micro, millimeter and submillimeter, infrared, optical, and ultraviolet waves, and gamma and x-rays in the region near a black hole. Still higher-energy cosmic rays and neutrinos are the focus of astrophysics research in Antarctica, another emerging frontier of 21st Earth-based astronomy. Using the Antarctic ice sheet as a giant continental telescope to study elusive neutrino particles, U of Hawaii physicist Peter Gorman hopes to learn more of the universe's most explosive events.

Besides Hawaii and Antarctica, the Arecibo radio observatory in Puerto Rico and the Cosmic Ray Telescope Array in Delta, Utah, are also pioneering Earth-based astrophysics.

COMMUNICATION

Mysterious Signal Misinterpreted

A recent article in New Scientist magazine states that a new signal, SHGb02+14a, detected through UC Berkeley's Seti@home project, may be from 1,000 light years away. At the time, expectations were raised by NASA's announcement of a new class of non-gaseous planets, and astronomers worldwide were excited by the revelation. However, according to Dan Werthimer, head of the Berkeley project, excitement was misplaced because reporters were unaware of the scope and probabilities associated with this work.

Seti@home data is received from Arecibo radio telescope, which operates constantly, piggybacking onto other observations. There are 15 million signal reports each day which come from Seti@home. A list of candidate signals, based upon persistence, frequency, and location, are then evaluated individually, as were 200 last February. Of that group, only one signal, SHGb02+14a, was again confirmed.

While the persistence of this signal brought some attention, Paul Horowitz, head of Harvard SETI efforts, points out that statistical probability alone suggests at least one of the candidates would reappear. The conjecture that the signal comes from a distance of 1,000 light years was based solely on a lack of known stars of closer proximity within the swath of the beam.

TRANSPORTATION

Advanced Propulsion to Enable Stellar Missions

The future of space exploration will lead out of the solar system and to the stars beyond. To realize missions of such scope, advanced propulsion systems are being developed which will dynamically enhance the cost effectiveness and capabilities of future space vehicles.

NASA is currently touring Starship 2040, a space transportation exhibit featuring full-size control, passenger and engineering compartments, with audio effects to simulate the ambiance of outer space. The revolutionary innovations visitors view are all concepts and technologies currently being studied at NASA centers and partnering institutions across the nation. Advanced propulsion tops that list.

Antimatter propulsion is the ultra high-energy technology which may be needed to travel to the stars, and is currently being investigated at Marshall Space Flight Center. Minimally one hundred times the energy of fission fusion, antimatter propulsion technology would put the Moon at 7.5 minutes away, Mars only a day trip, and other galaxies within our reach.

University of California scientists have teamed with Northrop Grumman Space Technology to develop a way to use sound waves to generate electrical power. The thermoacoustic system is similar to current thermoelectric generators, but twice as efficient and reliable enough for deep space probes. An adaptation of the Stirling engine, heating and cooling helium creates sound waves, just as lightning causes thunder, to drive a single piston.

But other forces appear at the edge of the solar system. Pioneers 10 and 11 are experiencing unexpected drift. A follow-up mission is planned to probe the "Pioneer anomaly." There is some conjecture that both have developed fuel leaks, however others suggest that the laws of physics may change over great distances.

Voyagers 1 and 2 are also experiencing drift. The heliosheath, a bubble-like vestige of solar gravity, may be tugging at the probes. Voyager 1 was believed to have passed through the heliosheath, however since the probe is no longer able to measure the speed of the solar wind, this has not been confirmed and the magnetic field did not increase, as expected based on current theoretical models.

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