AD ASTRA KANSAS NEWS

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

Spring 2005 *Vol. 4, No. 1*

Kansas space future is topic of Ad Astra Kansas Day

Anchored by a 2005 governor's proclamation, the third annual Ad Astra Kansas Day will focus on a Kansas first as well as provide professional development points for teachers.

In a signing ceremony April 4 at the Capitol, Governor Kathleen Sebelius pronounced April 30 to be Ad Astra Kansas Day. This day recognizes the importance of science and technology to Kansas' future. (See the proclamation below.)

Trevor Sorensen

Steven Black

Paul Adams

Terri McManus

Headlining the Ad Astra Kansas Day event to be held April 30 at Washburn University in Topeka is Dr. Trevor Sorensen. Sorensen is the impetus for the KUTESat program at KU, which will send Kansas' first pico satellite into space in May, 2005. He will speak on this milestone achievement and look to plans for the future, both short- and long-term.

Sorensen, originally from Australia, received his B.S., M.S., and Doctorate of Aerospace Engineering degrees from KU. For his doctoral project he worked on Pioneer Venus at NASA Ames. He has worked as a guidance and control engineer on the space shuttle, as flight director assistant at Mission Control and as a software task manager supporting the shuttle mission design and simulation programs. In 1994, he was lunar mission manager for the DOD/NASA Clementine Mission to the Moon. For his contributions to the Clementine, he received the NASA Medal for Exceptional Scientific Achievement. He has since been program manager for the Space Systems R&D contract with the Naval Research lab operating the USAF MSTI-3 satellite; he was principal architect for Honeywell's new global satellite tracking and control system, DataLynx. At Honeywell, he also developed a spacecraft mission operations concept for the Next Generation Space Telescope for the Space Telescope Science Institute at Johns Hopkins University. Currently, he is an associate professor in aerospace engineering at KU, having joined the faculty in 2000. For the last three years he has worked at the Jet Propulsion Laboratory as part of the NASA Summer Faculty Fellowship Program.

Professional development points will be available to teachers who attend this free event, which will also feature Paul Adams, professor of physics at Fort Hays State, NASA solar system educator Terri McManus and science outreach educator Steven Black.

Adams teaches astronomy, science methods and has led teacher workshops in the areas of physical science, biology and earth systems science. Adams is currently working with the education and public outreach efforts of two satellite missions: CALIPSO, a mission to study how aerosols influence climate and AIM, a mission to study noctilucent clouds. He will give an interactive presentation mixed with demonstrations. Explanation of the electromagnetic spectrum will include using handheld spectroscopes. Participants will have access to IR thermometers to allow them to quickly see temperatures of different surfaces. A short discussion about how this might be used in the classroom and how it relates to satellites will follow.

Terri McManus is a science educator currently teaching space and physical science at Williams Science and Fine Arts Elementary Magnet School in Topeka. McManus is a member of the Solar System Educator Program, a national network of edu-

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In this issue

TO THE PEOPLE OF KANSAS, GREETINGS:

WHEREAS, the state of Kansas has begun the 21st century with far-reaching vision, recognizing the importance of science and technology to its future; and

WHEREAS, in 2002, the Kansas legislature appropriated $143 million for the University Research and Development Enhancement Act; and

WHEREAS, current Kansas scientists continue a legacy which includes two Nobel prizewinners and three astronauts, with cutting-edge research in areas ranging from astrophysics to information technology to bioscience to nanotechnology; and

WHEREAS, advances in science and technology often result in new economic opportunities for Kansans in fields unknown to past generations; and

WHEREAS, Kansas' first satellite will be launched in 2005; and

WHEREAS, in this infinite universe which inspired our state motto "Ad Astra Per Aspera" our reach for the stars is just beginning;

NOW THEREFORE, I, KATHLEEN SEBELIUS, GOVERNOR OF THE STATE OF KANSAS, do hereby proclaim April 30, 2005

AD ASTRA KANSAS DAY

and ask all citizens to recognize and encourage scientific achievement within our state, so that Kansas may harvest the bounty of science, technology and space for the good of all humankind.

MARS HUMAN FACTORS IN NASA'S NEW SPACE FLIGHT MISSIONS--Part 2

HUMAN FLIGHT TO MARS IN A DAY?

By Randall M. Chambers Ph. D.,

The Earth's gravitational acceleration of 1 g or 32.2 feet per second squared, cannot now be provided to a test object for very many minutes without rotation. One g is an acceleration or increased speed of 22.0 miles per hour per second. If it were possible, 1 g in a straight line for a year would be about the speed of light. We distinguish the "displacement acceleration by the unit g, and the "physiological effects acceleration " of displacement and gravitational acceleration by the unit G. On the dynamic human centrifuge, with a swinging arm with a gondola at the end with roll and pitch gimbals, with the subject's head (where one primarily detects linear and angular accelerations) at the center of gimbal rotations, mechanical controls of changing arm speed and gimbal angles provide only an approximation of the free flight motions, translated into computer control, the most important physiological effects can be simulated.

In these simulations, partial cockpit was provided within the gondola of the human centrifuge, with pilot seat and restraints, controls and displays, and instruments computer-driven to show the status of the simulated flight while the centrifuge and cockpit "gondola" double-gimbal system rotations provided an approximation of the linear and rotational accelerations for the particular instants during the flight time-lines. Emphasis during pilot training was on pilot familiarization with the instruments and controls under dynamic condition, including simulated failures or malfunctions of system components, and the development of life support systems for withstanding the forces of acceleration. Pilots were "flying" and evaluating some aspects of their flight systems, physiological and performance capabilities, even before the designs there were built, within the limitations of earth bound simulation of free flight.

Planning for a human Mars flight included simulation and research on human physiological tolerance to sustained acceleration forces. One flight volunteer served as an experimental flight test subject being exposed to the proposed Mars flight acceleration physiological dynamics of 2 G for 24 hours in the gondola cockpit at the fifty-foot rotating arm of the human centrifuge, being used as a Mars flight simulator. He volunteered to experience 2 G for 24 hours By accelerating at 2 g for 12 hours, then decelerating at 2 g for 12 hours, he demonstrated that although he would not cover enough to get to Mars on its near approach of 35 million miles from the Earth, he could tolerate long duration 2 G acceleration for 24 hours. He reported that he could have ridden at 2 G for 30 hours. Unfortunately, the engines to provide this acceleration are not yet available. The challenge to the engineers was made to provide short duration manned flights to Mars, such as 2 G for 24 hours.

To provide an acceleration experience of a space ship linearly accelerating at 2 g, we used a human centrifuge with a long arm to minimize the rotation effects. The gondola (or simulated "space ship") at a 50 ft. radius of turn distance along the axis of the centrifuge's rotating arm, which is driven by a direct drive 4000 horsepower electric motor. The roll gimbal of the gondola was rotated to 60 degrees, and the arm was controlled to a constant rotational speed to provide 1.73 G of centrifugal acceleration. With the 1 G of gravitational acceleration perpendicular to the plane of arm rotation, a resultant physiological acceleration of 2 Gz ("eyeballs down") was produced for subject, when standing up on the floor of the gondola. Centrifuge safety precautions were taken, including with continuous multi-lead electrocardiograms continuously viewed by a medical doctor, and with two-way voice communication with the doctor and the centrifuge operator. Most of the time was spent in a reclining chair, with a back angle of about 50 degrees, listening to classical music on a radio. He reported that the experience was in no way uncomfortable, except during the periods of determining the reaching threshold for head motions in this rotating environment. He made calculations, using a slide rule, of speed and distance of simulated travel. In talking, the increased weight of the jaw was also apparent, and lifting the arms or legs clearly required more effort. A motion picture camera viewing the subject in the reclining chair was turned on occasionally by the subject to document various activities.

The electrocardiogram did show occasional ectopic beats or premature ventricular contractions (PVC's), but not of sufficient frequency to be considered by the medical doctors as a basis for stopping the centrifuge. With a sphygmomanometer, the subject took his own blood pressure occasionally during the run. Blood pressure remained in the acceptable "normal" range.

The most striking physiological decrement of the 2 G centrifuge environment was the potential nausea with head rotation, a centrifuge artifact that would not take place in linear flight. When rotating the head, even slowly at constant velocity in roll, pitch , or yaw in a rotating environment, a Coriolis acceleration develops in the vestibular canals, giving a false sense of body rotation. If the head motion is oscillating, the sense of false body rotation is also oscillating, and this quickly becomes nauseated. One can rotate the head in the plane of the centrifuge (or rotating room or rotating space station) rotation without nausea, but one learns to rotate the head out of this plane very slowly to be below the nausea threshold. There may be acclimatization effects. The subject made three experimental trials to determine the nausea threshold during the 2G run, indeed reaching nausea and reaching at a head rotation rate in worst angular direction of about ten degrees per second.

Of particular concern is the altered blood distribution, particularly to the brain. The weight of the blood column along the resultant acceleration vector from the heart to the brain must be more than supported by cardiac blood pressure if blood is to reach the brain to maintain consciousness. Thus in spacecraft or military aircraft, reclining or supine seats are used to reduce the height of the heart to brain blood column along the resultant acceleration vector, and "anti-g" suits which compress the lower parts of the body to reduce blood pooling and maintain blood return to the heart, and pilot straining techniques are used.

The consequence, in this 2 G experiment, of reduced blood flow to the brain over many hours, was uncertain. The volunteer was able to cook and eat, use a slide rule to calculate equivalent speeds, and converse cogently with the medical staff. He was able to sleep for a number of hours. There was little unsteadiness. Medical tests were 'normal,' and there was no apparent physiological decrement for experiencing 2 G for 24 hours.

The implication of this experiment is that humans are ready for continuous 2 g space flight, accelerating half way and decelerating half way, for at least 24 hours, to greatly shorten flights to Mars, for example. As to "acceleration protection" at 2G, having the subjects in reclining chairs or "horizontal" couches will reduce blood pooling, but moderate periods of walking about appear acceptable. The engines for such a 2g flight are not yet available, and may not be for weight and cost and radiation levels. It is necessary to reduce space flight times to distant objects.

This particular project, using acceleration protection at 2 G for 24 hours, accelerating half way and decelerating the other half way, suggests the possibility that slightly higher G's could be sustained in acceleration approach profiles to Mars. Using this human centrifuge as a manned space flight simulator to expose the human volunteers and flight candidates, pilots and astronauts to a large variety of accelerations at higher G levels for much were shorter duration exposure times, the effects of the acceleration dynamics of many aviation and space flight profiles and peak G's have been studied. Flight test personnel were exposed to combined acceleration force fields as their physiological and pilot tolerance time lines at different acceleration force levels, concentrating on those ranging between 2 to 15 G, and flight endurance times of a large variety of approaches ranging from 5 seconds at 15 peak G, and 4 hours and 30 minutes at 2G. Also, we formulated some of the basic principles and guidelines for the design and assessment of space flight training and simulation programs for astronauts and flight crew members in wide varieties of acceleration force environments, in conjunction with NASA-NADC-AMAL astronaut acceleration training and research programs for Mercury-Centrifuge, X-20-Centrifuge, Gemini-Centrifuge,and Apollo Manned Centrifuge research and training projects.

Parts of this paper are being published in the MARS SOCIETY PROCEEDINGS of the 7th INTERNATIONAL CONVENTION OF THE MARS SOCIETY, August 19-22, 2004, by AP0GEE BOOK, in the paper titled:

HUMAN CENTRIFUGE SIMULATION OF MARS FLIGHT DYNAMICS.

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

AVIATION

"Spacecraft System Leak Repair Methods," $41,237, K. Soschinske, H. Lankarani and G. Talia, WSU Dept. of Mechanical Engineering. NASA EPSCoR funding awarded Fall '04. 316-978-6307 hamid.lankarani@wichita.edu

"Thermal Spray Coatings for Composite Structures in Aviation," "$50,000, I. Ahmed, WSU National Institute for Aviation Research (NIAR). ADMRC funding awarded Fall '04. 316-978-6292 ikram.ahmed@wichita.edu

BIOTECHNOLOGY

"Negative Impact of Altered Gravity Models on Male Mammalian Reproductive Capacity," $975,943, Joseph Tash, KU Medical Center Research Institute. NASA funding awarded 3-'04 to 2-'07. jtash@ku.edu

INFORMATION TECHNOLOGY

"Development of a Spatial / Frequency Domain Interferometry Radar System for the Measurement of Sea-Ice Thickness," Prasad Gogineni, KU Dept. of Electrical Engineering and Computer Science. NASA funding awarded 9'04. 785-864-8800 gogineni@rsl.ku.edu

"Gateway to New Research Opportunities: A Low-Energy Wireless Ad-hoc Sensor Networks Test-bed,"$130,000, S. Jayaweera, K. Namuduri and R. Pendse, WSU Dept of Electrical/Computer Eng. and J. Steck, WSU Dept. of Aerospace Eng. NSF/Kansas NSF EPSCoR funding awarded Fall '04. 316-978-6320 sudharman.jayaweera@wichita.edu

"Ice Thickness Measurement Over the Antarctic Peninsula and Selected Outlet Glaciers," Pannirselvam Kanagaratnam, P. Gogineni, KU Dept. of Electrical Eng./Computer Science. NASA Goddard award 9-'04 . 785-864-7742 pannin@ku.edu

"Kansas Universities Technology Evaluation Satellite--the MIST Mission," $20,618, R. Myose, WSU Dept. of Aerospace Engineering. NASA EPSCoR/KUCR funding awarded Fall '04. 316-978-5935 roy.myose@wichita.edu

"Planetary Advance Radio Sounder," Prasad Gogineni, KU Dept. of Electrical Eng./Computer Science. Funding by the University of Massachusetts-Lowell (flow-through from NASA) 9-'04 785-864-8800 gogineni@rsl.ku.edu

MANUFACTURING and ADVANCED MATERIALS

"Methods for the Evaluation of the Fitness of Fiber Reinforced Composite Surfaces for Subsequent Adhesive Bonding," $300,000, W.T.K. Stevenson, etal., WSU NIAR. FAA funding awarded Fall'04 316-978-3120 bill.stevenson@wichita.edu

"Predictive Modeling of Machining Processes Based on Finite Element Analysis," $30,000, V. Madhavan, WSU Dept. of Industrial and Mfg. Engineering. NIST funding awarded Fall '04. 316-978-5913 vis.madhavan@wichita.edu

"Nanostructured Battery Separators for Enhanced Performance and Lifetime-Concept Feasibility Study," $41,237, T.S. Ravi, WSU Dept. of Mechanical Engineering. NASA EPSCoR funding awarded Fall '04. 316-978-6370 ts.ravi@wichita.edu

"Rapid Fabrication of Modular Composite Lay-Up Tools," $49,029, G. Weheba, WSU Dept. of Industrial and Manufacturing Engineering, Aircraft Design and Manufacturing Research Center (ADMRC) award Fall'04. 316-978-5777 gamal.weheba@wichita.edu

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

New NASA website

The NASA Central Operation of Resources for Educators (Core) has a new URL to enter into your bookmarks: http://www.nasa.gov/education/core.

Core is a worldwide distribution center for NASA educational multi-media materials. Educators may purchase exciting NASA materials at minimal charge.

For more information, contact Sue Suhler, program coordinator for KSGC/KNEP, at 785-864-3999.

Cont. "Event"

cators trained by Jet Propulsion Laboratory/NASA and offering training for classroom teachers about JPL missions and providing them with hands-on inquiry-type activities for use with students. She was awarded the "Taking Up Space" Award by Mission Home for her achievement in the advancement of space education and has participated in the NASA Educational Workshop for Elementary School Teachers (0NEWEST) and the Cassini Educator Fellowship programs. Her presentation will begin with a short update on the major findings of current solar system/ JPL NASA missions. Participants will experience inquiry/standards-based, mission-related, classroom activities.

Steven Black, assistant professor and associate chairman of the Department of Physics and Astronomy at Washburn University, instructs physics classes of all levels, including research. Black's ongoing research, in which he includes advanced physics majors, is molecular dynamic simulation of Lennard_Jones Atoms in Four Space Dimensions. Black's presentation will include participatory physics demonstrations using items that can be found in any classroom and will illustrate that physics need not be intimidating to teachers and students.

The Ad Astra Day event is free and open to the public. It is a public service event sponsored by the Ad Astra Kansas Initiative with the cooperation of Washburn University, the Kansas Space Grant Consortium and KTWU, Topeka.

You are invited to

AD ASTRA KANSAS DAY

April 30, 2005
Stoffer Science Hall
Washburn University, Topeka

Agenda

1:00 p.m. Greeting and Introductions

1:15 Trevor Sorensen--"The Kansas University Space Program and Implications to the Future of Space in Kansas"

2:15 Paul Adams--"Satellites and the Infrared Region of the Electromagnetic Spectrum"

3:15 Terri McManus--"Update of the Major Findings of Current Solar System JPL/NASA Missions"

4:15 Steven Black--How to Have Fun with Physics"

5:15 Concluding remarks

Interstellar R&D

Ad Astra Kansas News

This "Interstellar R&D" seventh-time feature in this ***Ad Astra Kansas News*** *seventh 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

Multi-Wavelength Imaging of the Milky Way Galaxy: A Case Study

Reality of the observed universe is relative to the wavelength / frequency on the electro-magnetic spectrum (EMS) in which the observation is made. There is more to our majestic cosmos than meets the eye (visible wavelengths): In addition to the light radiated by stars, galaxies, quasars and other celestial objects, there is the invisible energy of infrared and ultraviolet light, x- and gamma-rays, radio and micro waves.

Interstellar gas, the molecular 'dust' between the stars, was seen by astronomy 50 years ago as a nuisance, blocking visible light-only observation of 'real' objects of interest, the stars. Today the gas between the stars is seen by science and astrophysics as important to studying and understanding the evolution of the galaxy as are the stars themselves.

Imaging the interstellar gas of the Milky Way Galaxy produces different information when using different wavelengths along the EMS (from longest/slowest to shortest/most energetic): Radiowave Continuum 400 MHz — Reveals fast-moving electrons, especially at sites of past supernovae; Microwave Continuum 2.4-2.7 GHz — Warm, ionized gas and high-energy electrons; Far-Infrared 12-100 microns — Dust warmed by starlight, especially in star-forming regions; Mid-Infrared 6.8-10.8 microns — Complex molecules in interstellar clouds, as well as reddish stars; Visible Light 0.4-0.6 micron — Nearby stars and tenuous ionized gas, dark areas are cold and dense; X-Ray 0.25-1.5 kiloelectron-volt — Hot, shocked gas from supernovae; Gamma Ray > 300 megaelectron-volt — High-energy phenomena like pulsars, cosmic ray collisions.

The universe is "as we sense it", notes Larry Kellogg regarding Ronald J. Reynolds's analysis above. "New ideas and new ways of looking at what is around us can be most exciting."

COMMUNICATION

SETI In Japan, Dialing Direct, QE

Japan's first government-backed SETI took place over five days in March 2005. The Hydra constellation was the focus of joint efforts by the Nishi-Harima Astronomical Observatory, using a 2 meter reflector telescope to detect light, and the Mizusawa Astrogeodynamics Observatory, which used a 10 meter radio telescope to detect radio waves.

On the internet, www.TalkToAliens.com offers a $3.99 per minute telephone number that directly routes the user's voice through a 10.5 foot parabolic dish antenna. The "Intergalactic Transmitter" is aimed at the Milky Way and, according to Christopher Rose at Rutgers University, can transmit up to approximately two light years away. The nearest star to our solar system is approximately four light years away.

Interstellar communications are receiving a high-tech boost from a principle called quantum entanglement, or QE. Entangled photons are "inseparable," meaning that when one photon is described, the other is described simultaneously. At NASA Glenn Research Center, two entangled photons were sent on separate paths, one of which passed through a double slit. The image of that slit was detected in both photons, "quantum faxed" to the photon which never passed through the slit.

TRANSPORTATION

Speed Is Of The Essence

Voyagers 1 and 2, launched in 1977, will be Earth's first emissaries to leave the solar system. Traveling at 17,163 km per second, Voyager 1 is 8.7 billion miles from Earth. It appears to be crossing the termination shock of the solar winds and should reach the heliosheath within ten years. Both Voyagers may be operational till 2020. Yet when they enter interstellar space, will they do so without NASA? NASA's 2006 budget does not include the $4 million annual funding to monitor the Voyagers' data.

New technologies and current science have funding appeal. NASA is currently working with the Southwest Research Institute (SwRI) on a new probe called the Interstellar Boundary Explorer (IBEX) which will image the outer boundaries of the solar system. IBEX is expected to launch in 2008 and cost approximately $134 million. But the vast distance to the edge of the solar system demands breakthrough technologies to reach interstellar space before missions become outmoded.

The European Space Agency (ESA) commissioned a study on anti-gravity devices in 2001. While ESA determined to pursue more conventional methods, the possibilities of anti-gravity propulsion remain open. Clovis de Matos of ESA points out, "We do not understand the gravitational interaction at the quantum level." Marc Millis, founder of NASA's Breakthrough Propulsion Physics program, also sees potential in examining "gravitational or inertial manipulation."

Mark Waldron, writing for *Astrobiology Magazine*, suggests quantum entanglement as a viable concept for deep space propulsion. Entangled atoms maintain the same quantum states, no matter how they may be separated. If an entangled atom experiences a change in quantum states, the change will be transferred to the other entangled atoms by "quantum teleportation." This relationship is already being exploited for communications and computer sciences. If applied to propulsion, fuel mass ratios would be obsolete. A small core of entangled atoms could receive energy teleported from their counterparts on Earth. Energy introduced to the Earth-located atoms could be from any source. The energy could then be converted into power to propel the craft and supply electricity for such power-hungry systems as radar.

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