

## KU scientist receives grant to study complexity of universe

LAWRENCE – Everyone looks up at the night sky and asks big questions. What is the structure of the universe, and is there more than one? What natural laws keep the cosmos in order? Where does it all begin, and does it have an end?

One scientist seeking answers to these seemingly infinite questions is Sergei Shandarin, a professor of physics and astronomy at the University of Kansas. For the next two years, his research will be supported by a \$300,000 grant from the private John Templeton Foundation, part of a broader \$5.6 million award to the University of Chicago.

The overall project, New Frontiers in Astronomy & Cosmology, involves 20 scientists from the U.S. and other countries, as well as 21 high school and college student essayists worldwide. Shandarin's research project is titled "The Emergence of Complex Structural Patterns: A Manifestation of Increasing Cosmic Complexity." He is joined by a co-investigator from the University of Groningen in The Netherlands.

The goal of the Templeton Foundation is to "address four big questions that have potential to expand the boundaries and deepen the foundation of scientific inquiry:

- What was the earliest state of the universe?
- Is our universe unique or is it part of a much larger universe?
- What is the origin of the complexity in the universe?
- Are we alone in the universe? Or, are there other life and intelligence beyond the solar system?"

Cont. "Universe" page 3



Photos courtesy of Amelia Hodges



Left: Kinesiology obstacle course designed to add in determining fatigue.

Above: Evaluating space suit radio properties at the Cosmosphere.

## Astronaut health technology research may have uses both in space and here on Earth

By Amelia Hodges

NOTE: "By studying underlying principles of fatigue and developing a wireless biosensor network within a space suit environment, scientists may be able to monitor muscle activity of an astronaut in space or use the same technologies here on earth to monitor progress of patients in rehabilitation facilities."-- KSU website

In October 2011, Kansas State University started working on a NASA EPSCoR project. This project involves the Departments of Kinesiology, Electrical and Computer Engineering (ECE) and the Electronic Design Laboratory (EDL) at K-State, as well as various NASA centers and a Kansas Aerospace company: ICE Corporation.

During the project K-State and its partners will develop and test medical sensors, study and measure wireless propagation inside the space suit, develop a wireless sensor communication network, develop and demonstrate radio hardware, and increase public awareness of NASA's mission. Faculty and student efforts are divided among these five areas into the following overlapping tasks:

Task 1: K-State's Kinesiology department is using off-the-shelf sensors to determine what signals could monitor astronaut fatigue. Knowing the signs of fatigue before it occurs will help astronauts and physicians figure out if the task can be completed safely. New sensors will be developed once we know the best method for monitoring. To further our understanding of current technology and improve our development we are employing undergraduate students to assess commercial sensor design.

Cont. "Health" page 3

### INSIDE

- 2 Meet our Board  
Galaxy Forum shines  
Ad Astra Kansas Day**
- 3 Higgs boson discovery  
Mars rover name  
AAK Engineering Award  
Did you know?**
- 4 Interstellar R&D**

## MEET OUR BOARD MEMBERS



**Kay Neill**—I became involved with Ad Astra Kansas in 2003 when I was President of The Kansas Association of Teachers of Science (KATS). KATS is the largest organization in Kansas of science teachers, and an affiliate of the National Science Teachers Association (NSTA). The purpose of the Kansas Association of Teachers of Science shall be the advancement, stimulation, extension, improvement, and coordination of science teaching in all fields of science at all educational levels. I felt that there was a commonality between the goals

of our two organizations in promoting science in Kansas, and I was excited to lend my help and support to the Ad Astra Kansas Foundation. As a board member I believe that one of the important roles of the foundation is finding ways to support our goal, "That Kansas students will recognize the value and importance of science technology, engineering, and mathematics in building a future for themselves".

**Jeanette Steinert**-- As a lifelong Kansan of German descent, I am pretty stoic. However, the wonders of the universe leave me awestruck. Also, the brain trust of Kansas scientists, past and present, doing cutting-edge, internationally renowned R & D and the contributions they are making (in so many fields) amaze me. And the untapped potential of thousands of youthful minds in our state just waiting to be awakened to STEM, excites me. In the ten years I have been with the Ad Astra Kansas Initiative (now Foundation), the goals have been and continue to be to interest, inform and inspire Kansans about the space sciences. And to encourage a 21st century-vision of our state that moves onward and upward using technology for the benefit of all. After all, our motto is very 21st century.



Above: At the hands-on American Association of Civil Engineers / Kansas DOT booth students did water-related engineering activities.



Photo courtesy of NEKAAL

## AAK GALAXY FORUM SHINES

"Cool!" beamed Silas Steinert when he got his NASA packet with its Voyager poster and other NASA freebies at the Galaxy Forum in September.

The eager McPherson twelve-year old and his twin brother, Simon, were among a mix of adults and students at the fourth annual Galaxy Forum held at the Kansas Cosmosphere on September 22.

Themed "The Quest for Deep Space" this educational forum is one of an ongoing series of international programs seeking to enrich science education by raising awareness of our Milky Way Galaxy and our connection to it.

Topics were a look at our state motto and its relevance in the 21st Century, an outreach presentation inspiring youth to study STEM, and updates on Voyager and the newly launched Radiation Belt Storm Probe.

Power Point presentations for this year and the past two years may be accessed at:

<http://galaxyforum.org/archives/galaxy-forums-2012/#kansas12>

Lesson plans available with many of the presentations.

Photo credit Barbara Davis and Steve Durst

### Presentations:



"Ad Astra: Cool History / Bright Future"



"To the Stars thru STEM"



"History of Space/ Voyager and More"



Photo credit Steve Durst

**Over 350 people attended the third annual Ad Astra Kansas Day Space Celebration held at Washburn University's Stoffer Science Hall on April 21.**

Above: The Washburn University Chemistry Club's "space ice cream" made using liquid nitrogen (temperature of -320 degrees F) was popular with Ad Astra Kansas Day attendees.

Left: Northeast Kansas Amateur Astronomy League (NEKAAL) educator Janelle Burgardt explains the workings of her 8-inch Dobsonian Reflector telescope.

# Higgs boson results exciting

In July, physicists were ecstatic in announcing preliminary results pointing to the discovery of the long-sought Higgs boson particle.

The Higgs boson is a tiny subatomic particle that apparently weighs about 130 times as much as an atom of hydrogen, the lightest gas. The non-scientist might have no idea what's so important about this elementary particle, but Wichita State University physics professor Nick Solomey is excited about the discovery.

Listen to the WSU Newsline podcast interview with Solomey at <http://www.wichita.edu/thisis/wsunews/news/?nid=1873>

## Mars rover name came from Kansas student

When the one-ton robot Curiosity landed in the Gale Crater on Mars in August, it owed something to a teenager from Lenexa--its name.

Three years ago, then 12-year old Clara Ma's entry of Curiosity was selected from nine semi-finalists out of 9,000 entries nationwide to name the rover.

In her winning essay, she said "Curiosity is an everlasting flame that burns in everyone's mind. It makes me get out of bed in the morning and wonder what surprises life will throw at me that day. Curiosity is such a powerful force. Without it, we wouldn't be who we are today."

Ma saw the rover being built, was present in Florida at its launch last November, and with her family at the NASA Jet Propulsion Lab in Pasadena California for its landing in August.

To see a NASA interview with the Shawnee Mission East High School student in August, go at the JPL Education site, go to: <http://www.jpl.nasa.gov/education/videos/playVideo.cfm?videoID=31>

Ma is a student at Shawnee Mission East High School.

According to the NASA website, Curiosity was designed to assess whether Mars was ever habitable, even for the smallest forms like microbes.

The car-sized rover's onboard laboratory will study rocks, soils, and the local geologic setting in order to detect chemical building blocks of life (e.g., forms of carbon) on Mars and will assess what the Martian environment was like in the past.

The \$2.5 billion two-year mission to pave the way for long-term exploration is part of the NASA Mars Exploration Program.

Cont. "Health" from page 1

Task 2: Layers of aluminized Mylar in the space suit make it radio-opaque and traditional radio frequency propagation studies cannot be applied. We are working with two different electromagnetic models in EM Pro software: electromagnetic waveguide and coaxial cable. To verify simulations we wanted to create a more realistic space suit imitating the radio opaqueness. A graduate student in Apparel Textiles and Interior Design is building this mock suit using conductive fabric.

Task 3: To structure the wireless network we first have to determine the data types, data rates and connectivity required. Some of these factors are interdependent with the development of the sensors in task 1 and the radio in task 4. Currently we are working on reducing power consumption with a sleep wake cycle for the sensors. The FPGA is being programmed for data processing.

Right: Part of the K-State research team met with Astronaut Steve Bowen.



**Winners of the Randall Chambers Ad Astra Kansas Award 2012 at the WSU Engineering Open House held last May.**

**"Aerodynamic Characteristics of Box Wing Configurations"**

**L. T. Honse, T. J. Jayaratne, Chris Keeler, Amanda Premer and Brennen Sheldon.**

**Awards selected by a panel of judges, awarded by Vicki Johnson of AAK**



Photo: KSHS website

### DID YOU KNOW?

November 4 is the tenth anniversary of the dedication of Ad Astra, the Kansa warrior atop the Capitol dome.

The 22-ft bronze statue, sculpted by artist Richard Bergen of Salina, was selected to honor Kansas' American Indian heritage and to convey ideas of inspiration and aspiration.

--Source: Kansas State Historical Society

Task 4: The radio being developed is a modification of a micro-transceiver designed under a previous NASA project. K-State's EDL will produce the prototype for testing. We will incorporate energy harvesting and an antenna which can be used for the in-suit propagation studies of task 2. In the end we plan to hand the radio technology off to a local Kansas company for mass production.

Task 5: Finally, over the summer we provided workshops for three programs at K-State: Engineering and Science Summer Institute, EXCITE and GROW. Each program promotes STEM (Science, Technology, Engineering, and Mathematics) to high school or middle school students. We also purchased a replica space suit which is on display in the ECE office. To reach a wider audience we created a twitter account: NASAatKSU and a website: <http://nasa.ece.ksu.edu/>. Feel free to check us out on the web or on campus.

Right: Climbing is part of the obstacle course for the K-State NASA project.



Cont. "Universe" from page 1 Shandarín's project falls under the third category. He plans to explore the origin of the complexity in the universe by quantifying the structural growth of the universe itself.

"Ultimately, all structure in the universe is the result of the gravitational forces whose origin lies in the very first moments of the Big Bang," said Shandarín. "The role of gravity in this molding of the rich and complex patterns found in the universe will be the central focus of this project. Pattern formations of galaxies and stars will be studied in great detail, not only in ordinary three-dimensional space but also in the six-dimensional phase space."

He added that "the project is based on the realization that it is at these large scales that one may hope to unravel the gravitationally propelled mechanisms that are the agents behind the continuing proliferation of complexity in the cosmos."

# Interstellar R&D

## Ad Astra Kansas News

This "Interstellar R&D" feature in this Ad Astra Kansas News twenty-second 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

#### European Southern Observatory: Jewels In The Andes Sparkle at 50

Chile's Atacama Desert hosts Earth's pre-eminent international science and technology organization for astronomy, the European Southern Observatory, supported by 13 European countries, Chile, and Brazil, and observing its 50th anniversary with confidence and excited anticipation of revolutionary cosmic discoveries ahead. ESO has built and operates the planet's largest and most technically advanced telescopes, enabling Chile early in the 21st century to eclipse Hawaii as center of world astronomy.

ESO's three unique world-class observing sites — La Silla, Paranal and Chajnantor — span some 800 km rising north from La Silla on the Atacama Desert (Earth's driest), bordering the 7,000-meter Andes mountain chain. At 2,400 m, La Silla hosted ESO's first telescopes in the 1960s and now operates several 3.6 m optical instruments, including the New Technology Telescope NTT and the world's foremost extrasolar planet detector HARPS — High Accuracy Radial velocity Planet Searcher. At 2,600 m, Paranal is site of ESO's flagship facility VLT — the Very Large Telescope, with four 8.2 m Unit Telescopes and four 1.8 m moveable Auxiliary Telescopes. One of Earth's highest astronomy sites at 5,000 m, the Atacama Large Millimeter/submillimeter Array ALMA at Llano de Chajnantor will consist by 2013 of an array of 66 12 m and 7 m antennas, in a partnership between Europe, East Asia, North America and host Chile. After VLT and ALMA, a fourth ESO site at Cerro Armazones, near Paranal, is destined for Europe's 39 m Extremely Large Telescope ELT, the world's largest by 2020 and expected to revolutionize astronomy as much as Galileo's telescope 400 years ago.

Recent ESO pioneering discoveries include detection of the farthest gamma-ray burst, confirmation of the supermassive black hole at the center of our Galaxy, and the first picture of an extrasolar planet, by the VLT in 2004. There can be no doubt that ESO's revolutionary advances in astronomy, humanity's oldest science, and evolving views towards the majestic Milky Way band of stars will continue to be awe-inspiring to people in the 21st Century as those sights have been to people and cultures of all ages passed.

### COMMUNICATION

#### Neutrino Communication

Communications are key to any type of exploration and even with the small distances we've traveled in space to date, we are plagued by time delays which threaten vital transmissions of code. Interstellar exploration will require an entirely new mode of communication, in an environment where information is crossing light years to reach its target.

The neutrino is a subatomic particle, electrically neutral and with a mass so small that it has never been accurately measured. In fact, neutrinos quite literally pass through normal matter unimpeded. Detecting neutrinos requires a very large mass. An early detector utilized 400,000 liters of perchloroethylene, buried deep underground in a South Dakota gold mine.

Obvious parallels led researchers to examine possibilities for neutrino communications with submerged submarines and then to a groundbreaking experiment done at Fermilab in March of 2012. Scientists from North Carolina State University and the University of Rochester utilized the NuMI beam to fire pulses of neutrinos at MINERvA, a detector weighing 170 tons and located 100 meters beneath the Earth's surface. They sent their message in binary code; it was a single word..."neutrino."

Use of neutrino communications in deep space is obviously decades away and it is important to note that a detector — as we currently know it — would not be able to ride aboard spacecraft due to the huge mass involved. Neutrino communications would, however, be very appropriate for planet-to-planet messaging, no matter what the distance. Also, neutrino communications would safeguard what Star Trek fans have come to know as the "prime directive" of not interfering with the development of budding cultures, since only scientifically advanced beings would even be aware of neutrinos.

#### Published through the Ad Astra Initiative of

Space Age Publishing Company,  
480 California Avenue, Palo Alto, CA 94306  
to promote and publicize Kansas high tech /  
space tech research and development.

Editor and Publisher: Steve Durst  
news@spaceagepub.com  
Managing Editor: Jeanette Steinert  
jeanettesteinert@att.net  
Michelle Gonella, Space Age Publishing Co.  
Web site: www.adastra-ks.org  
Webmaster: Ken Moum

### TRANSPORTATION

#### Plasma Thruster Technology Advances

Travel to the stars, and even to the outer Solar System, will require significant advances in propulsion. The distances that must be crossed are so vast as to make it impossible to carry enough fuel to complete the trip...at least by the standards of current technology.

Ion and Plasma Thrusters have drawn much attention for their potential to bridge the gap between our spacecraft and deep space. In a plasma thruster, fuel is heated electrically and then electric and/or magnetic fields accelerate the charged particles to provide thrust.

An example of this concept was SMART-1, an ion-thruster propelled spacecraft which orbited and explored the Moon during a three-year mission, ending in 2006. The mission utilized Xenon as fuel and carried only 82 kg at launch.

One drawback of Plasma Thruster technology, however, is that the higher the kinetic energy produced, the more quickly corrosion will begin to damage the propulsion system and contaminate sensitive instruments. In response to this, a private propulsion design company, the Elwing Group, is developing an electrodeless plasma thruster.

Developed by Gregory Emsellem and based on research by the French Atomic Energy Commission, the Electrodeless Ionization Magnetized Ponderomotive Acceleration Thruster (E-IMPACT) utilizes ponderomotive force, which is what a charged particle experiences in an oscillating magnetic field.

Electromagnetic waves from radio frequency to gamma rays serve to ionize the fuel. While noble gases...such as Xenon...have been a standard fuel for plasma thrusters, this new technology opens the door to alternative propellants which may be made in situ or more easily transported on missions.

NASA MSFC will be conducting tests on E-IMPACT under a Space Act Agreement, hoping to confirm positive results from previous testing at Electric Propulsion and Plasma Dynamics Laboratory at Princeton University. Following baseline tests with noble gases, a variety of alternative propellants will also be examined.