AD ASTRA KANSAS

AD ASTRA KANSAS FOUNDATION

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Space physics is a magnetic force to KU Alum

Born in Kansas and growing up on the Missouri side of Kansas City, Mona Kessel spent many formative years in Kansas.

From her grandparents' farm and her undergrad years at Baker University in Baldwin City to the MS and PhD in physics she earned at the University of Kansas, "My roots are in Kansas," she said.

"I loved math, especially algebra and word problems. The harder they were the more I enjoyed them. Physics seemed just an extension of that. I did not know about physics as a career until I was in college," said Kessel.

She said attending KU in the early 1980s was a time of incredible opportunity. Her mentor, Dr. Tom Armstrong, was working with Voyager, which was sending back fantastic images of Saturn from 21 million miles away. Halley's Comet occurred in '82.

"[This was all] so exciting I couldn't do anything else but go into space physics," said Kessel.

After graduation four years spent at Mullard Space Science Lab (MSSL) in Surrey, England, was followed by fifteen at Goddard Space Flight Center in Greenbelt, Maryland.

At both MSSL and Goddard, she worked on the Cluster II mission, a European Space Agency (ESA) and NASA study of Earth's magnetosphere and its interaction with solar wind. This area of space around Earth controlled by its magnetic field acts like a bubble around our planet, protecting it from solar radiation.

In 2006 she went to NASA Headquarters. Early on she worked on the Living With a Star program and was program scientist for Cluster II and Geotail. The second mission involved two

Kessel at the Solar Orbiter launch in February 2021; below, on a research trip to Chile in 2017 Photos courtesy Mona Kessel

Cont. pg 3 "KESSEL"

Kansas universities work on NASA AI project

MANHATTAN: Optimizing spacecraft trajectory is a critical aspect of space mission planning analysis.

Researchers from KSU, WSU and KU have been awarded a $750,000 NASA grant for a project, "Artificial Intelligence Assisted Spacecraft Trajectory Optimization and Planning," to do just that.

In recent years, NASA has been interested in applying AI algorithms to improve these analyses.

Spacecraft using solar-electric propulsion pose a challenging problem as optimal trajectory requires the solution of a non-linear, non-convex mathematical problem.

It's even more complicated when the spacecraft is close to a planetary body—where the planet's gravitational pull, the planet's shadow and its gravitationally trapped radiation affect the powering of the electric thrusters by the solar array.

The team is tapped with developing a new, AI optimization tool for the on-ground mission design, and possibly onboard use as well.

The style and design of the proposed software would allow for a steady progression in preciseness by using increasingly rigorous force models at different levels of trajectory optimization.

Cont. pg 3 "AI"

Inside this issue:

We continue to promote science in Kansas...maybe some day this will be an annual day of celebration across the state.

STATE OF KANSAS

PROCLAMATION BY THE GOVERNOR

TO THE PEOPLE OF KANSAS, GREETINGS:

WHEREAS, Kansas has a long history of aeronautics and aerospace innovation; and

WHEREAS, it is in the interest of its citizens for Kansas to be at the forefront of innovation; and

WHEREAS, Kansas' economic future depends on continued growth in aerospace as well as advanced manufacturing, astrophysics, bioscience, energy, health, and other technologies; and

WHEREAS, these accomplishments are dependent on excellence in science, technology, engineering, and mathematics; and

WHEREAS, Kansas is fertile with progressive industries, quality universities, dedicated educators and inquiring young minds ready to spark new ideas and innovations; and

WHEREAS, Kansas' science legacy includes five Nobel Prize winners, five astronauts and scientists involved in far-reaching missions like the Artemis program, Mars rovers, Voyager spacecraft, Hubble and James Webb Telescopes; and

WHEREAS, Kansans have chosen "Ad Astra per Aspera," or "To the Stars through Difficulties," as the state motto.

NOW, THEREFORE, I, Laura Kelly, GOVERNOR OF THE STATE OF KANSAS, do hereby proclaim April 24th, 2021 as

Ad Astra Kansas Day

in Kansas and I urge all citizens to join in this observation.

DONE: At the Capitol in Topeka under the Great Seal of the State this 24th day of April, A.D. 2021

BY THE GOVERNOR: Laura Kelly

Secretary of State

Assistant Secretary of State

Cont. pg 1 "KESSEL

Japanese space agencies, ISAS and JAXA, teamed with NASA to study the magnetotail.

This is a long-tail region of the magnetosphere swept back by the solar wind in the direction away from the Sun.

If Earth were a boat in water, the solar wind flowing around it would be the bow wave. The wake behind would be the magnetotail, which exerts pressure on all the particles swept into it. Geotail measures the flow of energy and its transformation in the magnetotail.

Kessel is now the Research and Analysis lead for the Heliophysics Division at HQ. She manages about 15 different annual competitions and has recently embraced video conferencing. Being organized helps, as does a visual calendar to track progress, whether it be research or a mission--a new project takes 3-5 years of design and development before launching. "I like seeing the big picture. It's one of the best aspects of being at HQ," said Kessel.

"In the 1980s, a professor told me that if we could distill the processes in the magnetosphere, we could come up with a simple concept. [With all the research since then] I think there is a simple concept.

Simply, the magnetosphere is a circulatory system driven by waves sort of like the human body's circulatory system is driven by the heart. Of course, this system has complicating factors, such as the reservoir of particles in the magnetotail, the radiation belts and solar particles," said Kessel.

Cue one of the biggest, newest areas of space science--space weather. When there is a solar storm, usually caused by a coronal mass ejection, solar energy and particles flow into the magnetosphere. This radiation, solar particles, all the extra waves and can "ring the bell", with the resulting energy affecting satellites, power systems, cell phones and more. The aurora borealis is a visual display of this energy transfer.

The Parker Solar Probe (PSP), launched in 2018 has so far made seven passes around the Sun, each getting closer. If the Sun was at one end of a football field and Earth at the other, at closest approach PSP is on the four-yard line closest to the Sun. One of the most interesting things we want to understand is why the outer edge of the Sun's corona is hotter than the Sun's surface. Why is it hotter farther away? How does that happen?

Another mystery to be solved. "That's what makes it so exciting!" said Kessel.

Coming up is a NASA decadel survey asking what's been accomplished? What's next? Kessel is looking forward to it and the input of the next generation. "We like to keep bringing in new, younger people who bring with them youthful curiosity and excitement.

"There's such a cool factor to NASA. Inherent in the privilege of working for NASA is the obligation to give back. The things NASA does is paid for by everybody, so people deserve to hear about as much as they are interested in," said Kessel.

Interested in science? "Do it! Go for it! Even if you don't do it as a career, go as far as you are interested. That training and knowledge will be useful [no matter what you do]," said Kessel.

Cont. from pg 1 "AI"

For example, including things like more detailed and accurate models of gravity fields and planetary atmospheres.

This facilitates the improvement of less exact solutions, while at the same time managing the computational complexity of the underlying problem in an automated manner. This modular architecture allows for application of the software in two different settings, such as preliminary analysis by ground personnel and onboard mission planning. The result is low-level and high-level planning capabilities.

Innovations being considered include using dynamical coordinates in trajectory optimization, a modified state observer to estimate unmodeled acceleration, an AI network for adaptive tuning of planning variables, onboard data driven updates of the neural networks and atmospheric drag models to test aerocapture and atmospheric entry.

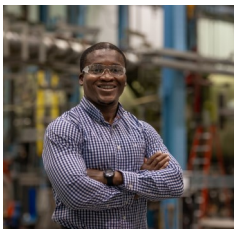
Working with NASA Glenn and NASA Jet Propulsion are scientists from three Kansas universities with the following specialties: Atri Dutta, WSU, astrodynamics and spacecraft trajectory optimization; Arslan Munir, KSU, artificial intelligence and dynamic data driven applications; James Steck, WSU, aerospace engineering and Craig McLaughlin, KU, expertise in orbit determination and atmospheric drag models.

Proposed research will be complemented by educational efforts that focus on student training, engaging K-12 students in astronautic and public outreach events.

Congratulations to two WSU achievers:

Brittany Wojiechowski, a Phd. grad student student in aerospace engineering has been awarded a 2021 National Science Foundation Graduate Research Fellowship, which is worth more than $120,000.

Photos: WSU press release



Prince Yengbe has been awarded the Modern-Day Technology Leader Award by the 2021 Black Engineer of the Year Award (BEYA) STEM Conference.

Benedictine scientist is part of new discovery in interstellar space

Christopher Shingledecker

ATCHISON—Dr. Christopher Shingledecker, assistant professor of Physics and Astronomy at Benedictine College is part of a group of scientists announcing the discovery of numerous new molecules in interstellar space.

Using observational data taken with the Green Bank Telescope (GBT) in West Virginia as part of the GOTHAM (GBT Observations of TMC-1: Hunting Aromatic Molecules) project, the team has discovered a vast, previously unknown reservoir of new aromatic material in the Taurus Molecular Cloud, or TMC-1, in deep space.

This cloud, 140 pc (130ly) from Earth, is a nursery for hundreds of newly formed stars. Observations of TMC-1 made by the GOTHAM team have thus far revealed more than a dozen unexpected molecules.

"This discovery provides the first important clue as to how and where these molecules formed," said Shingledecker. "These molecules are "new" in that we've known they exist on Earth, but they hadn't previously been known to exist in space. We've thought for a while that this general class of molecules, polycyclic aromatic hydrocarbons (PAHs) are prevalent in space, but until our work, we didn't know of any specific ones.

The enormous Green Bank Telescope, with a 100-meter diameter collecting area, is the world's premiere single-dish radio astronomy telescope.

The use of radio astronomy, which enables detection of individual molecules instead of an indistinguishable mass, along with a stacking and matched filter analysis the group developed, allowed the scientists to detect the elusive signals. They identified two specific polycyclic aromatic hydrocarbons (PAHs) in space: the first specific molecules ever detected, even though PAHs are thought to be prevalent in the interstellar medium.

"Here, the surprise is that, of all the regions of space where PAHs could have been found, that we found them in a particularly cold environment where they are perhaps still forming. It's a little like discovering a palm tree growing in Antarctica – as opposed to merely the frozen remnants of an ancient palm tree," said Shingledecker.

One example of a PAH that (most) everyone is familiar with is naphthalene – which is the main ingredient in mothballs. The molecules discovered (cyanonaphthalenes) are naphthalene molecules with a couple extra atoms (a carbon and nitrogen bonded together) chemically tacked on.

The aromatic molecules detected were found floating in the gas of a molecular cloud.

Similar to the palm tree in Antarctica analogy, this discovery raises questions like, "Are these molecules actually forming in the cold molecular cloud we found them in, or are they molecular relics from eons ago that have somehow survived for millions of years?" as well as "What similar molecules might we expect to find now?" said Shingledecker.

"If the molecules are forming where we observed them, the major question is "How complex can molecules in these regions of space get?" and "Can these molecules survive long enough to be incorporated into the planets which these types of clouds usually go on to form?" said Shingledecker.

He said this discovery is a first step to answering these questions, though we are a long way from being able to do so definitively.

The study has been published in the journal, *Science*, and many other publications around the world.

During this project, Shingledecker and Benedictine College teamed with scientists from the Harvard & Smithsonian Center for Astrophysics, Massachusetts Institute of Technology, National Radio Astronomy Observatory, National Aeronautics and Space Administration Goddard Flight Center, University of Virginia, and the Lebedev Physical Institute of the Russian Academy of Sciences.

The GBT has a 2.3-acres concave dish which catches weak radio waves that shower down from space. This means it is super-sensitive to the to the super-faint clouds of hydrogen that hang out between the stars and galaxies. *Photos : Benedictine website*

INTERSTELLAR R & D

Ad Astra Kansas News

This "Interstellar R&D" thirty-ninth feature in the Ad Astra Kansas News continues a 20-year enterprise to research and gather information on important developments preparatory to humanity's greatest adventure—voyaging to the stars. Now, at the 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 feature and newsletter, thus, now set forth to develop a 21st-century national / international /global clearing center and storehouse of knowledge and know-how for travel to the stars: Ad Astra—Galactically, Steve Durst

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230 California Avenue #108
Palo Alto, CA 94306

Editor/Publisher: Steve Durst
news@spaceagepub.com
Managing Ed: Jeanette Steinert
jeanettesteinert@att.net
Webmaster: Ken Moum
Topeka Liaison: Jodi Spindler

We're on the web! and facebook

Observation

Global Placement of Telescopes on the Moon

Earth's Moon – Humankind's first giant leap toward Galaxy Stars – is becoming a new center for 21st Century Astronomy, and a new sphere of interest for an Interstellar University rising from the Ad Astra State.

Astronomy from the Moon, lunar-based telescopes of all wavelengths and all instrument technologies globally placed will enable astrophysical observation and study of the entire Cosmos with unprecedented capabilities.

"The Moon is the ideal site in the Solar System for making astronomical observations and measurements, and it will inevitably become humankind's principal scientific base for astronomy. For this reason alone, the Moon should be given a high priority for human development." *

An Interstellar University originating from Kansas may consider Lunar Observatories with VLBI / Event Horizon Telescopes for Interstellar Observation, Communication and Transportation utilizing zettabyte data transmissions – as may be discussed at the IRG 7th Interstellar Symposium in Tucson AZ, 25-27 September 2021.

Global placement of telescopes, observatories on the Moon

* D. Schrunk, The Moon; B.Sharpe, Graphic / Title

Communication

Interstellar Rosetta Stone

International collaboration on Cosmic Call 1 & 2 in 1999 and 2003 sent a noise-resistant message from Earth to extraterrestrial intelligence including Interstellar Rosetta Stone (IRS), with Cosmic Call 2 totaling 220+ megabytes over 11 hours and 53 minutes.

Canadian scientists Y. Dutil and S. Dumas designed the IRS to include a bilingual glossary of English and Russian. The message had more information about global mathematics and science (building on the 1974 Arecibo Message written by SETI's Frank Drake, also included in Cosmic Call) with several questions on its final page, hoping extraterrestrials would respond and begin communications.

Team Encounter, a Texas startup, funded sending the first IRS message in 1999 from an RT-70 radio telescope in Yevpatoria, Crimea; the second transmission followed in 2003. IRS transmission will reach nine stars in Cancer, Sagittarius, Cygnus, Andromeda, Orion, Cassiopeia, and Ursa Major.

NASA funded Carl Sagan's *Golden Records* in Voyager 1 and 2 and the Arecibo Message; however, NASA and government agencies declined to fund IRS. IRS is the first crowdsourced international, interstellar effort led by Charlie Chafer – currently CEO of Space Services Holdings in Texas. Canadian astrophysicist Yvan Dutil advised Chafer that a radio message would not be comprehensible to extraterrestrials without an introduction explaining our number system, planet makeup, and biology. Dutil teamed with Stephane Dumas, a Canadian physicist, to write the message. Since 2018, several papers on Interstellar Communication Networks were published in the Astronomical Journal outlining benefits of using probes to send and receive interstellar messages on a distributed interstellar network.

Transportation

Low-Cost Interstellar Precursor

In 2017 Breakthrough Initiative proposed launching a fleet of microprobes carried by solar sails weighing about 1 gram each, pushed by radiation pressure from an immense 100 GW laser plant; the laser would provide speed up to 0.15 - 0.2c, allowing microprobes to reach Proxima Centauri in 20 years. This design requires building an immense laser plant on Earth, and directing the microprobe would have to be monitored from Earth with great accuracy at the beginning because there is no way to correct direction later.

A new international proposal for *Low-cost Precursor of an Interstellar Mission* was published in the Journal of Astronomy and Astrophysics, September 2020, by René Heller at Max Planck Institute, Guillem Anglada-Escudé at Inst de Astrofisica de Andalucía, Michael Hippke at Breakthrough Initiatives, and Pierre Kervella at Paris Observatory. The authors propose replacing the Earth-based laser power plant with solar radiation, ready for use and available in unlimited amounts. The prototype would cost about $1 M, with each sail built for $1,000; and $10 M budgeted to launch the interplanetary mission. Participants in the 7th IRG Symposium, September 24-27, 2021, in Tucson AZ, plan to discuss interstellar transportation; their proposals could be the foundation at Transportation Courses, Interstellar University in Kansas.