

Words of Wisdom*From Dr. David Cornelison*

Well, it's about time. Here is the first newsletter in the 3 ½ years since I came to PAMS. I must say it has

been an eventful time, and we have seen and done a lot. As we look to the future, I would like to highlight a few changes and explain how they will position us to grow and improve.

Curricular Changes: In 2010, Missouri enacted a program meant to streamline programs which graduated low numbers. Our department took this opportunity to revamp our degree plans, consolidating into two BS degrees—a BS in Physics and a BSEd in Physics Education. So far, things have gone well, and we are on track to graduate over 10 students for three straight years. If all goes according to plan we may have as many as 16 graduates next year. Although physics is still the smallest science, we have worked to get more students, including partnering with engineering to create a dual degree Electrical Engineering/Physics program. Several students are already enrolled in it.

Research: The biggest change in our research program has been the inclusion of Missouri as part of the federal EPSCoR program, a federal research program to direct funding to states which have typically been underrepresented. The National Science Foundation, NASA and DOE all participate in the program, and Missouri has established a statewide EPSCoR office, based at the University of Missouri. PAMS has already benefitted from the program, with three NASA grants, and an NSF grant receiving funding from EPSCoR. Four of our students and two faculty members worked at NASA Johnson from June through December. The department was helped tremendously in our NASA effort by Charlie Armstrong (p. 11), an alumnus and member of our board of advisors.

Outreach: The department has kept busy with all sorts of outreach, including many public nights at Baker Observatory. In 2012, we also created a new program, called PhysBiz, centered on a traveling van, containing hands-on physical science experiments. The effort is being done in cooperation with Springfield Public Schools and The Discovery Center, the local science museum. Groups of faculty and students are visiting 2nd and 4th grade classes to work with the students on experiments related to their curricular content. In 2012-2013, sixteen visits were made, and a professional development workshop was held for teachers. Our effort is being led by Becky Baker.

Personnel: This year, we are seeing some major changes in departmental staffing. Drs. Manivannan and Thomas both retired in 2013, and Drs. Whitaker and Giedd will be retiring during the summer of 2014. Each of them has brought a level of dedication to the department which will be difficult to replace. We wish them each all the best in their new “careers”. We are also in the process of adding new faces: Kristy Teague as an additional administrative assistant and Nandita Nag started as lab coordinator this semester. A new astronomy faculty member will be added soon, and the department will soon start a new initiative in conjunction with Jordan Valley Innovation Center (JVIC). (*See New Directions on p. 2*).

I hope you enjoy the rest of the newsletter. There are articles from students, faculty, and alumni. We want to hear from you, too! If you have anything you would like us to know, please contact us through any one of our social media sites or stop by Kemper 101.

Announcing the return of *Momentum!*

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New Directions by Dr. David Cornelison

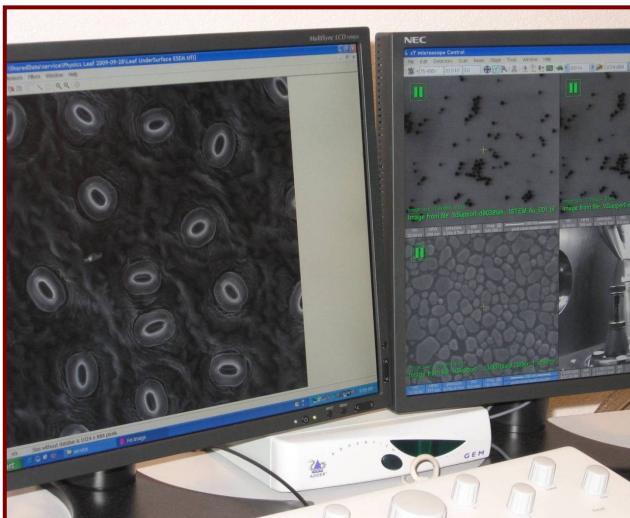
For a number of years, PAMS and CNAS have worked to increase collaboration with JVIC, the MSU research center located in downtown Springfield. The motivation to do so is rooted in our desire to work with the corporate affiliates located there, and to more effectively integrate the extensive JVIC infrastructure with the educational mission of the physical sciences at MSU. With the ability to make new hires that has recently come, the administration at MSU has approved a plan that will place some PAMS faculty on a floor of the JVIC facility and will give them access to the wide array of tools available there. We are now in the process of searching for two new materials physics faculty who will be on a split appointment. One half will be committed to the traditional duties of a faculty member in PAMS, while research duties at JVIC will account for the remainder. The research done at JVIC will incorporate students from MSU. The funds needed for the JVIC-specific duties will be generated by the faculty themselves from external grants.

Currently, the start date for the occupancy of the floor at JVIC is July 1. We are extremely excited by this opportunity and will keep you apprised of new developments as they arise.

A View from the Materials Science Lab

In the Materials Science SEM lab, Dr. Lifeng Dong trains students and faculty in how to scan a sample and obtain nano-level images of its structure.

This electron microscope FESEM (Field Emission Scanning Electron Microscopy) was purchased with a National Science Foundation grant from FEI Co. in late 2009.



A Year of Graduates

Bachelor of Science

Spring 2013

Beaver, Garret
Chung, Junho
Farris, Laurel
Gemar, Heath
Hansen, James
Shrope, Brandon
Summers, Brock

Summer 2013

Miller, Weston

Fall 2013

Anderson, Sean
Renshaw, Elizabeth

Master of Science

Spring 2013

Hossain, Shaikh
Miller, Alexander

Summer 2013

Akkanapragada, Vigna Sai Sandeep
Das, Nayan
Langhoff, Michelle
McCart, Phillip
Zaidi, Syed Ali

Fall 2013

Aboagye-Asare, George
Kirezicyimanzi, Rene



"Congratulations to all!!!"



Faculty Spotlight

Drs. Mike Reed and David Cornelison were recognized at the MSU basketball game on Feb. 2. See their accomplishments and learn about the NASA grant by watching the Maroon Minute video at: blogs.missouristate.edu/physics (Feb. 5).



WHAT WOULD YOU LIKE TO SEE HERE??

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NASA Grant Research News by Dr. Mike Reed

Nearly everyone looks up at a dark sky, sees thousands upon thousands of stars, and wonders if there are other planets with life. How many of those thousands of stars are harboring their own civilizations, with their own stargazers wondering exactly the same thing? It is a question as old as time, and a question that will be answered by this generation.

In the last three years, over 3,000 new planets have been discovered orbiting other stars. It's no longer a question of whether other stars have planets (it's estimated that 90% of them do), but whether any of those planets are Earth-like and have life. We are answering this question right here on our campus.

To determine how many Earth-like planets are out there, we must determine how many solar systems formed like ours did. Many (presumably rocky) planets have already been found in extremely short orbits around their host stars. A year on these planets lasts only a day or two, and so the surfaces are baked to several thousand degrees. It is theorized that atmospheres of these planets will be a blend of their old, cooler atmosphere and the rocks on their surfaces. By determining what these "extrasolar" planets and their atmospheres are made of, we can backtrack and determine how they formed. If the mechanism that formed these planets is similar to the mechanism that formed Earth, the extrasolar planets could potentially harbor their own life.

Drs. Mike Reed and David Cornelison, funded by a three-year NASA grant, will explore the composition of these atmospheres. Reed and Cornelison are collaborating with Dr. Bruce Fegley of Washington University, St. Louis, and Nate Jacobson of NASA's Glenn Research Center.

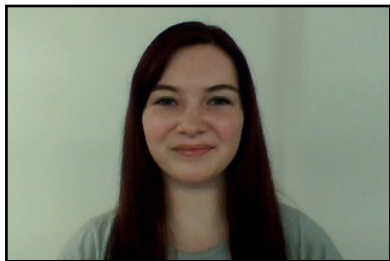
Their study is a blend of theory, lab work, and astronomical observations. With the help of Jacobson, Dr. Cornelison and his team of students are assembling a lab to vaporize rock at high temperatures and measure the optical properties. Dr. Reed's team is observing stars hosting these hot, rocky planets, trying to separate the light of the planet from the star and to determine which rock/gas mixtures exist using the information obtained in Cornelison's lab.

Students form integral parts of these teams. One graduate and two undergraduate students are assembling the high-temperature equipment and vaporizing rocks in Cornelison's lab; this work



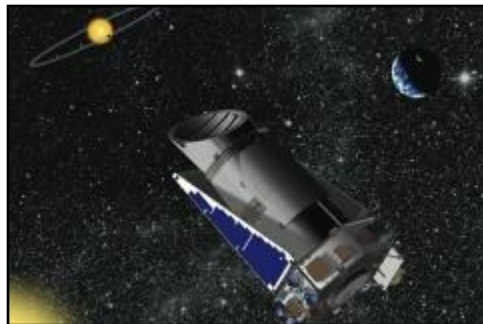
PHOTO CREDIT:
NASA, JPL-Caltech

will form the Master's of Materials Science thesis of Denny Bosch. Two undergraduate students are working with Reed to obtain and analyze data using Baker Observatory's 16-inch telescope. They are looking to determine relationships between planet size, orbital distance from the host star, and reflected light from the planet. The students are the spearhead of our efforts. They are the ones assembling the actual pieces of equipment, in front of the computers, analyzing image after image, spectrum after spectrum, all to disentangle what these planets are made of and how they formed in the first place. Before the grant is completed, over 10 students will have participated as paid researchers. They will have written theses and peer-reviewed papers, given presentations at national and international conferences and worked to answer one of the most fundamental questions of nature. Students form the heart of the solution to the age-old question of whether we have company in the Universe.

"The Kepler Experience" by Heather Foster

Heather Foster is majoring in professional writing and plans to graduate in May 2015. She would like to edit scholarly publications in the field of astronomy, such as journals or textbooks.

For nearly a year now, I have been working with data provided by NASA's Earth-trailing spacecraft, Kepler. Though Kepler is no longer functional, the amount of data it has returned is positively staggering. While in service, Kepler took picture after picture of the same field of stars, turning once a month back toward Earth to stream back the pictures it had taken. Kepler worked almost ceaselessly for four years, only pausing once a month to transmit data to Earth. What to do with these images? The possibilities are nearly endless.



KEPLER SPACECRAFT—PHOTO CREDIT: NASA

My study of these images has been courtesy of grants from NASA and the National Science Foundation. I string pictures of a particular star together in chronological order, then measure how bright the target star appears in each image. The result is a light curve showing the star changing in brightness, following an intricate sine wave-like pattern. This pattern is created by seismic waves within the star. Probing the intricacies of these seismic waves unlocks all sorts of secrets about the star: how it pulsates, the thickness of its layers, even how fast it spins.

I get attached to the stars I study, and each has a name beyond its identifying catalog number. The strange and messy spots in their graphs give them personality. Some stars are easy to read, and in my mind, they are friendly mentors, storytelling for a willing audience. Others have plots to analyze that contain nothing but sloppy, jagged peaks, and they are mischievous tricksters. Time spent on a star feels a little like making a new friend. The stars have been trying to tell us all about them since the beginning of time, and with the advent of the Kepler spacecraft, we are beginning to hear them.

KEPLER TELESCOPE—PHOTO CREDIT: AP.ORG



"Missouri State Experience" by Jacob Swett

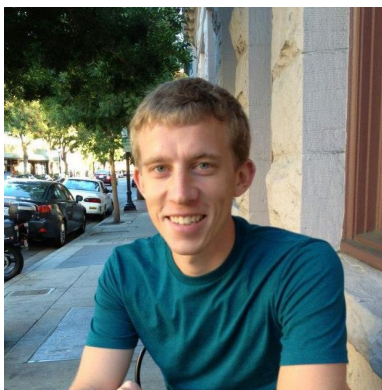
Having graduated from Missouri State a little over a year ago, I've had a chance to reflect on my time there, and as such, I've come to appreciate it more. Working now full-time as a Research Scientist, I look back quizzically on how I arrived where I am today and what happened along the way. I recall entering Missouri State in 2007 and declaring a Physics major with the reassurance that I could always change my major later.

Fortunately, despite a few hesitations and misgivings, I did end up keeping the Physics major, but also decided to add a couple other degrees along the way. Although, my classes at Missouri State certainly made the time worthwhile, it was the extracurricular activities that really made the experience memorable. From the Society of Physics Students, to Student Government, to undergraduate research, I sometimes look back and wonder how I managed to find time to immerse myself in so much. The combination of degrees and extracurricular activities kept me occupied while on campus, but more importantly, they actually did what was often promised to me: *They helped to prepare me for life after college.*

In fact, they helped me prepare more than I had anticipated. Assimilation into my new role certainly had a few hiccups and "learning opportunities" along the way, but by and large, the research I do today is very similar to research I did at Missouri State. Not only do I continue to focus on Materials Science, but much of the research is fundamental, similar to academic research done at a university.

Admittedly, much of the ease of transition is because I had the opportunity to intern with Lockheed Martin as a student, which naturally made the transition easier by helping me already be familiar with the company. More importantly though, the internship prepared me by helping me really see the relevance of my classes. I'll never forget when I had a physics lab that used oscilloscopes, and thinking, "Do people really use these anymore?" And, not entirely paying attention and only to be asked the very next day at work if I knew how to use one! Needless to say, I paid better attention for the rest of the semester.

Jacob Swett is a 2012 PAMS graduate and now works as a Research Scientist in Palo Alto, CA in the Advanced Materials & Nanosystems Directorate of Lockheed Martin's Advanced Technology Center.



While at Missouri State, he majored in Physics, Applied Mathematics, and German with minors in Astronomy and Environmental Physics Technology.

National Science Foundation Grant News

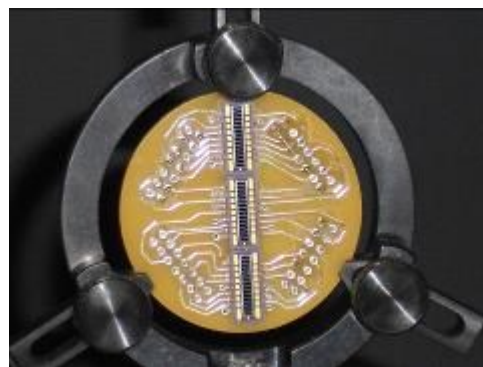
In 2011, Drs. Redd, Younger, and Siegelmann proposed their project to study a super- (that is, beyond) Turing computing machine. Since the machine is also a neural network, it might perform brain-like computations. Contrary to most previous neural network proposals, this project combines theoretical and experimental studies. Drs. Redd and Younger concentrate on developing neural network hardware and Dr. Siegelmann evaluates its computing power.

Starting in December 2012, Dr. Redd is designing and developing analog electronic neurons and synapses. The first neural network built with these components fits on a 1970-era, nine by seven inch, computer wire-wrap board. This network contains three neurons and eleven synapses. It can be configured to take one or two inputs and have one output. The neurons and synapses were designed to be modular and, with few component changes, fit anywhere within a neural network. The modularity will allow mass-producing them on printed circuit boards or in integrated circuit chips. The next step along that line has not yet been decided nor whether it becomes part of this project or is the focus of a follow-on project. Having the neural network learn to behave as various chaos generators may illustrate its computing power. Dr. Younger is simulating this learning within a MATLAB (digital computer) environment. An undergraduate student is working on his PHY 386/486 project making analog circuitry that might be incorporated into future neurons or synapses.

Dr. Younger is developing neural networks using optical computing methods. It is laid out on an optical bench. It has sixty laser diodes over a span of about 1.5 cm (.6 inch) as inputs. A Digital Micromirror Device (a projector at a movie theater uses similar devices) has about a million mirrors that direct the light from the sixty lasers into one of two detectors. The first is a 3000 pixel line camera. The other is an array of forty-eight small solar cells. Since they have been pursuing optical computing research for ten or more years, several undergraduates have done PHY 386/486 projects. Currently, the grant employs two.



Drs. Steven Younger and Emmett Redd (above) are recognized at the MSU basketball game on Jan. 31. See the Maroon Minute video at: blogs.missouristate.edu/physics (Feb. 6).

**Student Project**

48-PIN optical detector diodes mounted on a circuit board by Scott Maasen for a PHY 386/486 project (above).



Dr. Emmett Redd, Dr. Steven Younger (1979 alumnus now at Missouri State's Jordan Valley Innovation Center) and Dr. Hava Siegelmann (University of Massachusetts at Amherst, UMass) are near the midpoint of their three-year National Science Foundation grant. It is titled, "Super-Turing Computation and Brain-Like Intelligence".

"Life After the Bachelors" by Phillip Aron McCart

The best part about my technical training from the graduate program has been the confidence I now have in my ability to tackle a new experimental setup. Whether it is learning a new characterization method or a new synthesis method, I now feel I have a compass to guide my exploration of new experimental setups. The metaphorical compass I speak of is of course an intuition that has been developed while studying physics and applying the theoretical aspects of physics to everyday lab work.

I was fortunate enough to start working with Dr. Mayanovic shortly after he was the principal investigator on an NSF grant to obtain a Raman spectroscope. I was present during the installation and calibration of the Raman spectroscope and all of the initial user training. This singular experience was absolutely invaluable—mainly because I got to see firsthand how Dr. Mayanovic and the other faculty went about becoming proficient with a new piece of characterization equipment. Being present, observing, and doing while a major experiment was still new is something I think every science student should have the opportunity to experience.

During my stay as an EPSCoR graduate intern with NASA's Johnson Space Center, I got the opportunity to experience how science was done in a well-funded non-academic environment. Given the relative size of NASA's budget compared to the PAMS department, there were numerous experiments being done at Johnson Space Center that just can't be done here. In addition to this, there is a vast scientific talent pool that Johnson Space Center has on staff. These two facts combined augmented and complemented my experience back at home incredibly well. Working 40-50 hours a week for 9 weeks with career researchers opened my eyes to what working at a place like Johnson Space Center is like.

Personally speaking, I don't think I would have made it through many other programs. The amount of personal attention provided by the faculty throughout my education in the PAMS department was far more than what I ever expected from the professor-student relationship.

"After completing the graduate program and my summer-long stay with NASA, I feel overwhelmingly optimistic about my future career opportunities."

Whether it was building my confidence up from my lack of math background or being there to catch me when I fall, the personal attention I received from the PAMS faculty kept me together throughout my education. I can't wait to see how the person I've become will handle the future.

"Lessons on Being a Physicist" by Hayley Osman

I am currently a junior pursuing a Bachelor of Science in Physics through the PAMS Department. I was interested in studying physics because I have always been a naturally curious person, but I couldn't bring myself to choose one area of engineering that I could devote the rest of my life to. With physics, the opportunities are endless. I could end up teaching, doing research in a national lab, working in industry, or find myself in a job I haven't even heard of yet. The best part is that it's okay for me to have no idea what I want to do when I grow up.

The summer after my freshmen year, I started to get some real world experience when I moved to Cambridge, Massachusetts to intern in the Gleason Lab at Massachusetts Institute of Technology. Dr. Mitra, my research advisor here at Missouri State, had spent time in this lab doing his Post Doctoral research. I worked there for eight weeks to learn about initiated chemical vapor deposition, a method for producing thin film polymers, so that we could build our own iCVD reactor in Dr. Mitra's lab. Although I was in a chemical engineering lab, I found that physicists are respected throughout the sciences because of our work ethic and determination. I had the opportunity to return to the Gleason Lab for a second summer and started my own project of computationally modeling the iCVD process using the Monte Carlo method.

Here at Missouri State, we are nearing completion on the iCVD reactor and hope to conduct our first deposition later this semester. In August, we also received funding from NASA to continue the project. Throughout my time here, I have presented at two national conferences as well as at the College of Natural and Applied Sciences Undergraduate Research Day.

This year I will also be serving as the Vice President for the Society of Physics Students. We're currently planning our annual trip to Argonne National Laboratory for their Undergraduate Symposium. Many of us will be presenting our research and we hope to bring many students who have yet to choose an area of emphasis. We've even run into a problem never faced in the past...too many students for one van! I've seen this department grow even in the two years I've been here and can't wait to meet the new physicists in training.

As a freshman, I never thought I would be able to put Massachusetts Institute of Technology on my résumé, and as a sophomore I would have laughed at the idea of adding NASA just a year later. But as a junior, I can confidently say that the names of institutions attached to the opportunities I've had pale in comparison to the lessons I've learned working and researching in this field. All this and I'm still an undergraduate. Every year, I get more of an idea about what it's like to be a physicist: it's not about what you know, but how you think about the world around you.

"Every year, I get more of an idea about what it's like to be a physicist: it's not about what you know, but how you think about the world around you."



Fall 2013 NASA Public Observing Night!

It's not often that the average Springfield citizen gets the chance to see more than the brightest stars. Luckily for them, Missouri State University's own Baker Observatory opens its doors to guests from the community twice a year: once in the fall and once in the spring.

On **September 27**, students, adults, and families alike got the chance to escape the light-polluted city and explore the skies in the quiet outskirts of Marshville. Baker Observatory is home to two larger telescopes, 14 and 16 inches in diameter, and a little squadron of smaller, 8-inch scopes.

Guests at the NASA Open House wait patiently in line for a chance to peer through each telescope and view the hottest celestial objects of the night, which this year included the Ring Nebula, the Dumbbell Nebula, and the Andromeda galaxy. NASA interns and Missouri State faculty are happy to answer any questions guests may have, and the questions are many. The event was extremely well-attended and remains an excellent opportunity for the community of Springfield and the surrounding areas to get excited about astronomy year after year.

Upcoming Observation Night: Friday, May 2, 2014

The MSU Baker Observatory will be open for public viewing. We plan to look at Jupiter, Saturn, Mars, double stars, star clusters, nebulas, and galaxies through a variety of telescopes. The event will only be held if the weather is favorable. The rain date will be the following night at the same times. The Observatory is located at **1766 Old Hillcrest Road in Webster County**. A traffic attendant will be at the intersection with Rose Bush Drive to direct parking.



Event Website and Map:

<http://physics.missouristate.edu/NASAObservingNight.htm>

Open to current & future students, family of students, alumni, faculty, staff, community, and visitors.

Admission: Free

Admittance: Open to the public

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A Letter from the Advisory Board by Charlie Armstrong

The PAMS Advisory Board provides advice to the department head in:

- improving public relations for the department,
- making recommendations for development and fundraising,
- assisting with long-range planning, and
- helping to ensure the department responds to and meets the needs of those who might employ its graduates.

The Board is made up of about a dozen individuals consisting of PAMS alumni spanning industry, education, academia, and government along with former or retired faculty. We meet annually, usually in October during Homecoming week.

I think I'm a typical example of who is on our Board: I graduated from MSU in 1979 with a degree in physics and immediately headed to NASA's Johnson Space Center to begin a summer internship. That summer internship began a life-long career at NASA working on everything from Space Shuttle Extravehicular Activity (EVA) operations to Orion Multi-Purpose Crew Vehicle (MPCV) systems engineering. Along the way, I've trained astronauts, written procedures, worked in Mission Control, worked with Russians during joint flights, planned the space station assembly and have kept trying to get the "next thing" after Shuttle off the ground.

Currently, I am working safety integration across the three exploration programs at NASA: the Orion MPCV, the Space Launch System (SLS) and the Ground System Development and Operations (GSDO). Orion is the crewed vehicle that is to take four people to destinations away from low Earth orbit, such as the Moon, asteroids and Mars. It is to be launched aboard the Space Launch System, a launch vehicle larger and more powerful than the Saturn V that took men to the Moon the last time. The Orion on its SLS is to be launched from the Kennedy Space Center which is undergoing an overhaul to become a state-of-the-art 21st-century launch complex as part of the GSDO program.

In July, during the 23rd US EVA from the Inter-

national Space Station, one of the astronauts, Luca Parmitano, experienced a large amount of water in his helmet. The amount of water was enough that it interfered with his seeing and breathing. Due to the potential seriousness of this event, a mishap investigation board has been assembled; and, as a result due to my previous experience in EVA operations, I have been asked to participate in the investigation. This is a kick for me as I sort of get to go back to my roots and get to work on an extremely interesting problem.

I work with graduates from Rice, Purdue, Georgia Tech, University of Texas, Texas A&M, MIT, and others. I've never felt that my preparation was any less than theirs and a lot more affordable, and no one can tell where I went to school until they see the MSU "stuff" around my office, or I wear my Bear-wear. MSU PAMS has a tradition of producing high-quality graduates. The goal of the Board is to help maintain that excellence in any way we can. MSU PAMS is probably the best kept secret in the Midwest. The Board hopes to change that, by getting the word out.

When you have ideas that can help feature what MSU PAMS does, please let anyone on the board know. We will help get your ideas on the ground, improving the programs and broadening the impact of communications you initiate.

**Charles Armstrong**

Missouri State (B.S. Physics, Math '79)
 University of Houston (M.S. Space Physics '93)
 PAMS Advisory Board member
 NASA Exceptional Achievement Medal (2011)
 NASA Spaceflight Awareness (2009)
 NASA Silver Snoopy (2001)