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THE SCOPE

GT Astronomy Club

Faculty Focus 1: Dr. Philip First

By Joanna Wedemeyer

This past week I had the pleasure of interviewing Dr. Philip First of the School of Physics about his research project with NASA concerning protecting Astronauts from radiation. With his being a solid state physicist, I was intrigued to learn how his expertise was being utilized for this project. For this article, I have done my best to compile all the fascinating aspects of this project.

The research project consists of multiple teams in which Dr. Orlando (from the School of Chemistry and Biochemistry) is the principal investigator. According to Dr. First, his group is comprised of Dr. Orlando, Dr. Zhigang Jiang, and himself. The overall project is named R.E.V.E.A.L.S., which stands for "Radiation Effect on Volatiles and Exploration of Asteroids and Lunar Surfaces". As explained by Dr. First,

"It has two parts, one of which is a study of volatile organic compounds on airless bodies, such as the moon and asteroids. The idea is that there is a lot of surface chemistry there that is very important for retaining volatile compounds, like water or other organics. As a consequence, there is good evidence that the amount of water has been underestimated and that there may be much more there that is usable that could be reclaimed from the lunar regolith. That part of the project is Dr. Orlando's main study. Another part of the project has to do with methods and planning for human exploration. That's where I come in; we're hoping to do the basic research that would underlie new types of detectors of radiation. We're hoping to use new materials that have come about in the last fifteen years or so. These are two-dimensional materials, or topological materials. These classes of materials seem to have some interesting properties that could make them useful for detection of radiation, and in particular creating detectors that could be passive so they don't use much power (this is a big deal for Astronauts) and could potentially be organ specific. The medical community is very concerned with organ specific effects...Two dimensional materials are thin and flexible. And so potentially they could be incorporated into a polymer, for instance, that would be part of a space suit, or ideally a space suit liner. Our task is to figure out ways to make these materials and measure properties of them, to make them sensitive to the radiation."

In their research they have a particular focus on neutrons because they are an important *secondary* particles. Cosmic radiation is extremely high in energy and consist of mostly protons, "but every time they go through material...neutrons are always produced". So, there is a good chance of having neutron radiation when on or outside a space station. They are particularly hard to detect, however, so they are hoping to find ways to detect them. The approach they are taking focuses on the electrical properties of the materials, namely the resistance. "There are lots of issues and challenges to be overcome. These topological materials that we're interested in have an interesting mode of electrical conduction which should give us a standard for resistance, so we're hoping that standard could be used to measure the changes in another part of the composite, let's say. In the end, we will be doing sort of a combination of applied and very basic materials studies."

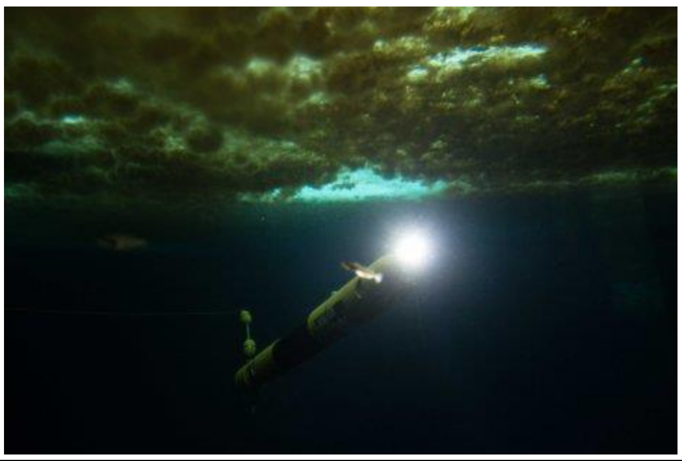
This is Dr. First's very first collaboration with NASA; he's been able to meet other scientists and medical professionals, and Astronaut Steve Davis. "It'll be an interesting experience for me, I'm confident of that."

Faculty Focus 2: Dr. Britney Schmidt

By Joanna Wedemeyer

Recently I interviewed Dr. Britney Schmidt from the School of Earth and Atmospheric Science about her research collaboration with NASA concerning the possibility of life on Europa. The following article presents a summary of all the intriguing facets of her current work.

Dr. Schmidt's research group is interested in seeing if and how other planets support life. Earth is their model, or reference, when analyzing other planets. To quote Dr. Schmidt, "A lot of our work is going to places that have processes like what we think might be going on in these planets and then investigating how those processes operate, and then thinking about how that impacts energy or nutrients or something like that that's available for life. The other way that we do it is we look at these physical processes as analogs for geology or for oceanography...A lot of the work we're doing now is on the interactions between the ocean and permanent ice; we also look at sea ice. So we've been looking at ways that we can measure these processes here on Earth that are understood in some ways but lack a lot of data...Those processes that kind of tell us about the climate here on Earth, on Europa are the same processes that probably built the ice shelf, or the ice shell to begin with...On Europa all of the ice is formed through freezing of its ocean." Dr. Schmidt's team frequents Antarctica where the work they do is to understand the interaction between the ocean and ice. Places that are cold, are permanently without light, and/or relatively low oxygen are also ideal places to study how life lives and interacts with the environment.



Pictured above is Icefin, an underwater exploratory modular vehicle built at Georgia Tech. It is used for arctic research in Dr. Schmidt's project SIMPLE.

Dr. Schmidt's research also extends to spacecrafts. She is an investigator on the Europa Clipper Mission, which she even helped to design when she was a postdoc. The launch is scheduled to launch somewhere between 2022 and 2025. "We'll take somewhere between 3-6 years to get to the Jupiter System, and we'll spend two years pumping its orbit down to be close to Europa, and we'll spend two plus years orbiting Jupiter doing multiple close flybys of Europa...In this way we have a Jupiter orbiting spacecraft doing Europa science." She's also helping with landed missions, missions involving landing spacecraft on the surface of Europa, possibly even breaking through the ice to the ocean, and she's helping doing research on creating the successor to Hubble, Luvoir.

Given the 'rise in SpaceX', I asked Dr. Schmidt if they might start funding Planetary Science missions: "There's no benefit to them. NASA is a discovery and fundamental science organization. SpaceX isn't going to fund what we do cause it doesn't have any practical value for it. But there are things they might fund if they're interested in trying to build vacation homes on Mars or whatever. As an industry they might fund research on the Martian environment, but what we do on Europa won't have any immediate relevance to that. What's great about SpaceX is they are trying to build the capability to take people there because they want to, and in the meantime they're cornering the market on large launch vehicles...they're pushing launch vehicle costs down." Essentially, as she went on to explain, companies like SpaceX are making launch vehicles that are more reliable and cheaper, which is beneficial to NASA because they can buy them from SpaceX or ride along rather than spending time and money trying to build one of their own. "NASA, its job is to do the fundamental research...and the private sector is so companies can go and run with it...they help make space accessible."

As our interview came to a close I asked her what she enjoyed most about the project right now. While Dr. Schmidt enjoys exploring space and figuring out how things work, she also really enjoys interacting with her team and other scientists. "I like the human side of it now, cause science is a human endeavour so the parts where you get to actually participate with people and experience that as a human is kind of cool, right? Why else would you search for life in the Universe other than to know who you are at some level."

Supernovae: The Death of Massive Stars

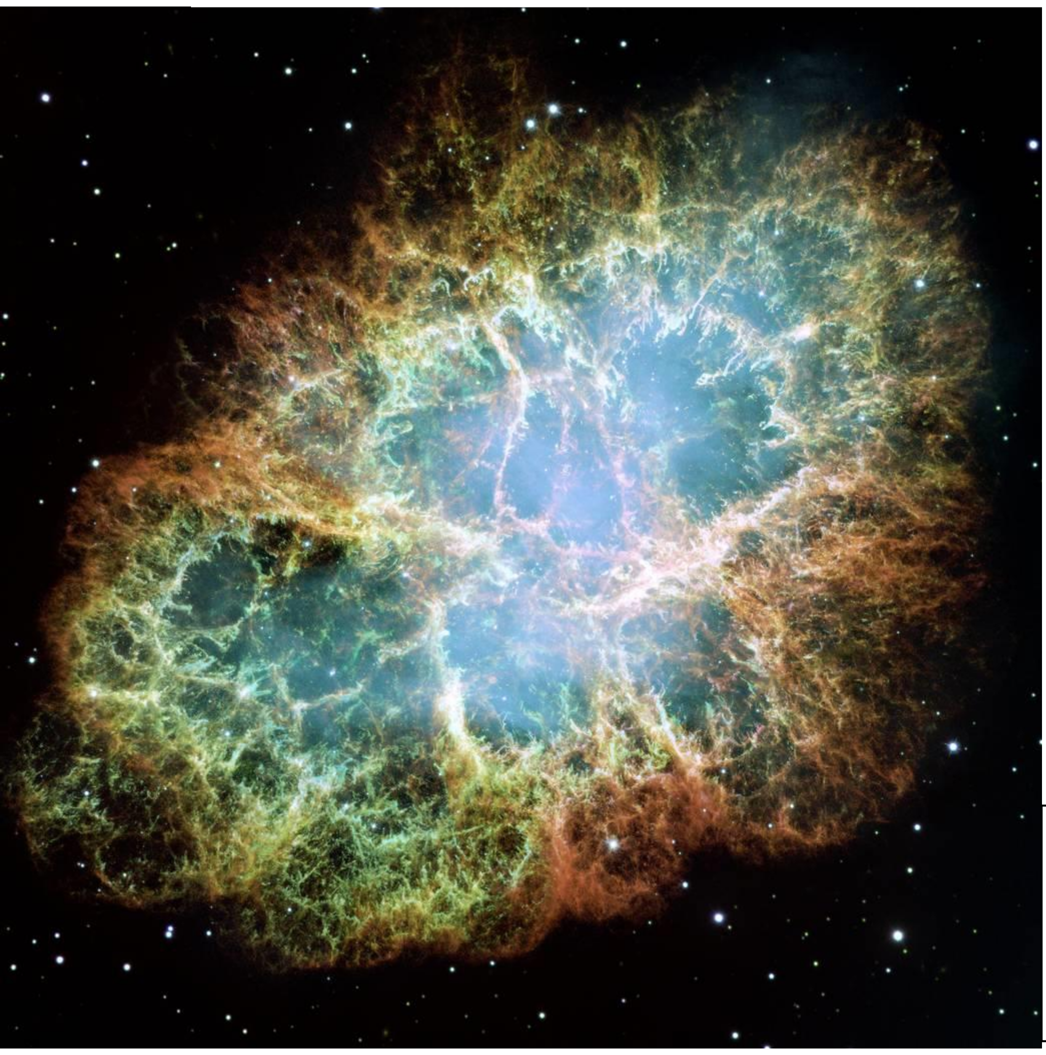
By Will Thompson

Supernovae are commonly known as the violent deaths of massive stars as they are no longer able to undergo nuclear fusion in their cores. However, in addition to marking the deaths of stars, supernovae are also critical to the development of the universe and life as a we understand it. The explosion of massive stars play a critical role in dispersing a variety of elements throughout the cosmos, ensuring that rocky planets form and can develop the necessary conditions for life. Although they are rare, supernovae are among the primary means by which atoms besides just hydrogen and helium are able to spread across space.

There are two primary types of supernovae, Type Ia and Type II. There are also Type Ib and Type Ic supernovae, but they are far less common and won't be discussed here. Type Ia supernovae occur exclusively in binary star systems in which one of the two stars has already stopped the process of nuclear fusion. The remnants of this star, known as a white dwarf, is close enough to the other store that it is able to collect mass from the second star in the system. This means that the high energy mass from the star still actively fusing elements is being transferred to the white dwarf, increasing the mass of the white dwarf. If the white dwarf becomes massive enough, the oxygen and carbon in it's core starts to fuse and the runaway reaction releases so much energy that the star explodes outwards in a supernova. These occur throughout the galaxy with no preference for one region of space over another.

This image of Supernova 1987 A was taken by the Hubble Space Telescope. The supernova is located within the Large Magellanic Cloud, a satellite galaxy of the Milky Way. Image by NASA, ESA, R. Kirshner (Harvard-Smithsonian Center for Astrophysics and Gordon and Betty Moore Foundation), and M. Mutchler and R. Avila (STScI)

In contrast to Type Ia supernovae, Type II supernovae usually occur in the spiral arms in spiral galaxies and don't tend to appear in elliptical galaxies. This is due to the fact that Type II supernovae follow the more traditional perception of a supernova of a massive star over 8 times the mass of the sun collapsing under its own weight and sending a massive shockwave out into space, removing the star's outer layers. Since massive stars undergo nuclear fusion more quickly than regular stars, the stars involved in Type II supernovae are much younger than the stars in Type Ia supernovae. Type II supernovae are primarily found in the spiral arms of spiral galaxies since that is where most younger stars are located. Elliptical galaxies and the centers of spiral galaxies are usually made up of older stars that have either already gone supernova or are too low mass and fuse elements too slowly to ever experience a supernova. The process of a Type II supernova beings when a massive star over 8 solar masses reaches the point in it's life cycle where it's core is under high enough temperatures and pressures to be able to fuse iron in its core. However, the iron core of a star is too dense for the star to be able to fuse any heavier elements, causing the main source of energy in the star to cease. Without the energy released from nuclear fusion, the star's core collapses rapidly under it's own weight. The only thing stopping this collapse are the neutrons in the atoms in the core. Once they become too condensed the rest of the collapsing star bounces off of the neutron star, generating a powerful shockwave that expels all of the star's outer layers across space. As the outer layers of the star expand outwards, a neutron star is left at the core. In some cases, the star is so massive that the neutrons will not be able to resist the force of the collapsing star, causing a black hole to be left in the remnants of the super nova instead of a neutron star. The intense, unstable energies involved in a supernova allows elements heavier than iron to fuse, and the resulting shockwave spreads those heavy elements across space. The disruptions from the shockwave are also theorized to generate new stars as it can create regions of space within nebulas where the gas becomes denser than the



One particularly exceptional supernova that we've observed was seen on February 23, 1987, and has presented a unique puzzle to our understand of supernovae. This supernova, SN 1987A, is unique because, after observing it for the last 30 years, no telescope has detected either a neutron star or black hole left over where the core of the star should be. However, due to a flash of neutrinos detected from the star just before the supernova has lead astronomers to conclude that such an object must exist there. Beyond this anomaly, the shockwave from the supernova has been an excellent object to observe as it is expanding through a ring of gas around the supernova with a diameters of about half of a lightyear. Observing the dynamics of this ring could serve an important indicator of how supernovae can disrupt nearby areas of space and trigger the formation of new stars and planets.

The Crab Nebula (Pictured Left) is the result of a supernova that was observed in 1054 A.D. At the center of the nebula is a neutron star known as the Crab Pulsar, which rotates roughly 30 times every second. Image by NASA, ESA, J. Hester, A. Loll (ASU)

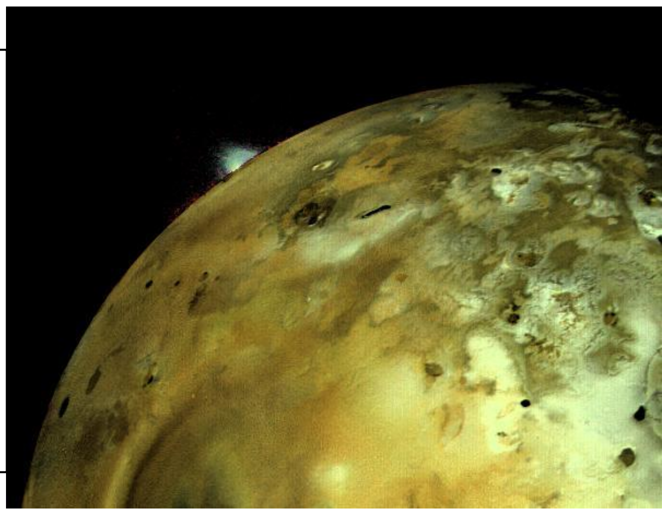
The Pale Blue Dot

By Will Thompson

On February 14, 1990, astronomer Carl Sagan was able to use the Voyager 1 spacecraft to take what has become one of the most famous photos in the history of space travel. The Voyager 1 probe was launched to collect data from the planets Jupiter and Saturn in the outer solar system. Since then Voyager 1 has gone on to become the farthest any manmade object has traveled away from Earth as it is now 13.14 billion miles or 141.36 AU. At this distance it currently around 19.5 hours for a signal to go one way between Earth and Voyager 1. When Voyager 1 was only about half as far away, at 6.4 billion miles, it turned around to take the picture that is known as the *Pale Blue Dot*. The image (as seen on the following page) shows a picture of the Earth as seen from the outer reaches of the solar system. In this picture the Earth is only 0.12 pixels in size and can be seen as a dot in the rightmost beam of light in the image. This beam of light is not actually a sunbeam, but an image artifact produced by the camera on Voyager 1 that makes the scattered light appear to be beams of light across the image.

Voyager 1 is also famous for being the first manmade craft to explore the outer solar system, taking detailed images of Jupiter and Saturn that greatly improved our understanding of the two planets. The proximity of the flyby between Voyager 1 and Jupiter and Saturn allowed for the discovery of many of the moons of these two planets. In addition to discovering numerous new moons, Voyager 1 was the first spacecraft to observe volcanic activity on an object in the solar system besides Earth. The object in question being Jupiter's moon, Io, the most volcanically active astronomical object in the solar system. Although its contribution to our understanding of the solar system demands its own article, the *Pale Blue Dot* stands as one of its most significant images as it, better than anything else, is a humble reminder of the beauty and magnificence of the planet we call home.

Voyager 1's image of Jupiter's moon Io is the first extra terrestrial volcanic activity ever observed by humans. Image by NASA, JPL



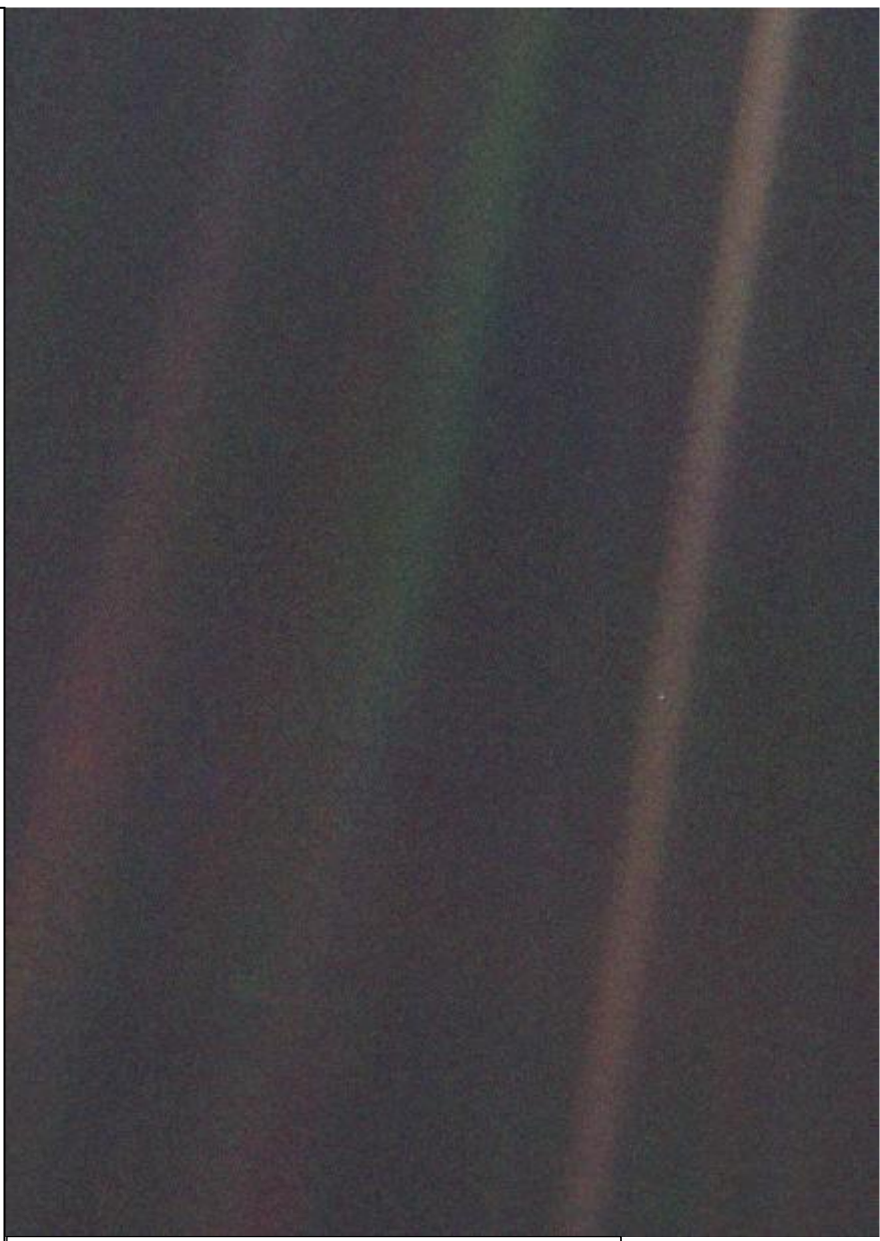
Look again at that dot. That's here. That's home. That's us. On it everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives. The aggregate of our joy and suffering, thousands of confident religions, ideologies, and economic doctrines, every hunter and forager, every hero and coward, every creator and destroyer of civilization, every king and peasant, every young couple in love, every mother and father, hopeful child, inventor and explorer, every teacher of morals, every corrupt politician, every "superstar," every "supreme leader," every saint and sinner in the history of our species lived there--on a mote of dust suspended in a sunbeam.

The Earth is a very small stage in a vast cosmic arena. Think of the rivers of blood spilled by all those generals and emperors so that, in glory and triumph, they could become the momentary masters of a fraction of a dot. Think of the endless cruelties visited by the inhabitants of one corner of this pixel on the scarcely distinguishable inhabitants of some other corner, how frequent their misunderstandings, how eager they are to kill one another, how fervent their hatreds.

Our posturings, our imagined self-importance, the delusion that we have some privileged position in the Universe, are challenged by this point of pale light. Our planet is a lonely speck in the great enveloping cosmic dark. In our obscurity, in all this vastness, there is no hint that help will come from elsewhere to save us from ourselves.

The Earth is the only world known so far to harbor life. There is nowhere else, at least in the near future, to which our species could migrate. Visit, yes. Settle, not yet. Like it or not, for the moment the Earth is where we make our stand.

It has been said that astronomy is a humbling and character-building experience. There is perhaps no better demonstration of the folly of human conceits than this distant image of our tiny world. To me, it underscores our responsibility to deal more kindly with one another, and to preserve and cherish the pale blue dot, the only home we've ever known.



The Pale Blue Dot, taken by Voyager 1 on February 14, 1990

Astronomical Events Calendar

- March 15: Mercury at Greatest Eastern Elongation – Mercury will reach its greatest eastern elongation of 18.4 degrees from the Sun. This will be highest point it can reach in the evening sky.
- March 17: New Moon
- March 20: March Equinox – The March equinox is the first day of spring and marks when there will be a nearly equal amount of day and night across the world.
- March 31: Full Moon and Blue Moon – This will be the second full moon in the month of March, making it a bluemoon.
- April 16:New Moon

Photo of the Month

This photo was taken by Richard Xiong on Georgia Tech's campus. Richard studies electrical engineering at Georgia Tech. This image is of the Soul Nebula, IC 1848. The nebula is approximately 100 light years across and 6,500 light years away. To quote Richard, "the Soul Nebula houses several open clusters of stars, a large radio source known as W%, and huge evacuated bubbles formed by the winds of young and massive stars."

To take this picture Richard used a Sk-Rover 70sa telescope on a IEQ30 mount. The camera was a QHYMs with Optolong SHO filters and an exposure time of 3 hours. Images like these can only be obtained via long exposure starts because the light from this nebula that reaches is so faint that the color can not be clearly seen without collecting the light for an extended period of time.