O R I O N

Newsletter of the Friends of Astronomy Cornell University

Dear Friends,

At the end of June, I will be stepping down as Chair of Astronomy and Ira Wasserman will be taking over. I want to thank you for the support you have provided the Department and me during the past eight years. I am certain that Astronomy at Cornell will continue to prosper under Ira's guidance.

Since the last issue of Orion great progress has been made on the CCAT Project. All major partners, the University of Waterloo (Canada), the UK Astronomy Technology Center, Colorado, Caltech, and Cornell have signed an agreement to work together. A joint planning meeting of the partners is scheduled for July. Another piece of good news is that one of our own, Professor Emeritus Martin Harwit, was awarded the 2007 Bruce Gold Medal of the Astronomical Society of the Pacific for his lifelong contributions to astronomy and, in particular, for his pioneering efforts to establish infrared astronomy from space. Congratulations Martin!

I am looking forward to a restful summer once Ira takes over as Chair on July 1. May your summer also be a happy and healthy one.

-Joe Veverka

The dramatic dust lanes that run across the center of the Centaurus A galaxy are so thick they almost completely obscure its center in visible light. Jean-Charles Cuillandre (CFHT), Hawaiian Starlight, CFHT

Greetings

We have the great pleasure of announcing a spectacular **Friends of Astronomy Symposium** scheduled for **October 12 and 13** on the Cornell Campus. The Fall colors will be at their peak and the Homecoming weekend will have the campus in full activity. We will be celebrating Joe Veverka's years as Department Chair and welcoming Ira Wasserman as our new Chair (see the article about Ira by Ed Salpeter).

In this issue, please note the article by Steve Beckwith '73 Applied and Engineering Physics, Professor of Astronomy at Cornell from 1978 to 1991, and Director of the Space Telescope Science Institute from 1998 to 2006. His article discusses the deepest space photograph ever taken, which possibly sees the edge of the visible universe. Take a moment and explore the magnificent web site that he suggests.

We are very proud of the contributions the Friends of Astronomy have been making to

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Summer 2007

Contents

Editor
Patricia Fernández de Castro
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The Dusty Universe

Jason Marshall is finishing his Ph.D. at Cornell this summer.
In the fall he will head back to his native California for a postdoc at Caltech/JPL.

"I study dust for a living," I mumbled in a vain effort to convince my skeptical future in-laws that I really was a good catch. Life would have been easier if I had been a dentist! In-laws respect dentistry. It's a fine field with a strong future. We all have teeth, after all. But dust? My inquisitors mused, "I suppose studying dust could be... profitable. Are you working on robotic vacuum cleaners?" It was not looking good for me. "Not exactly," I replied, shooting down their last hopes that their daughter was marrying wisely. "I actually study dust in distant galaxies." Silence assailed my ears. I had apparently inoculated the room with a bizarre combination of intrigue and dread. "Oh, that's... interesting. But... why?" were their next words after the air-pressure in the room had returned to normal. It's easy to quickly toss out this type of query as ignorant, but in fact, it's probably the best question of all.

To begin with, the universe is a very dusty place. Actually, this is a bit disingenuous since most of it is vacuum. All the matter in an Earth-sized volume in a random spot between typical galaxies contains about as many hydrogen atoms as are present in a quarter teaspoon of water. So I should have started by saying that the universe is a very empty place. Emptiness isn't very interesting, however, so I'll ignore the void and start by asking, just how dusty is the universe? Well, if you took a box and filled it with the typical mixture of gas and dust found in interstellar space, the gas in the box would outweigh the dust by about 124 to 1. In other words, if the box weighed as much as $31 in quarters, the dust would weigh only as much as a single quarter. That is not a lot of dust, but it's enough to have a profound effect on the universe.

But before we get to these profundities, you may be wondering if this dust is similar to the stuff gathering on top of your refrigerator. The answer is yes... and no. Household "dust" is made up of things like pollen, mold, pet hair, decomposing insects, mite excrement, human skin, and of course dirt. Most of these earthly goodies don't appear in astronomical dust, but a few of the things found in normal dirt do. Typical dirt contains silicates, which are minerals composed mainly of oxygen and silicon. It turns out that silicates are abundant throughout the universe and make up around 50% of all astronomical dust grains. The other 50% or so is carbonaceous grains composed mostly of carbon and hydrogen, some of which are fairly similar to particles found in soot and car exhaust. The origin of astronomical dust is not very well understood, but it's believed that silicate and carbonaceous grains form in the cool atmospheres of giant stars.

Composite infrared image of M81. In red, the prominent dusty spiral arms where massive stars are actively being formed. (NASA/JPL-Caltech/UA & CfA, NOAO/AURA/NSF).

Until recently, dust was much more of a nuisance to astronomers than anything else. Although there's a lot less dust than gas, dust is so efficient at absorbing visible light that many stars and galaxies are completely obscured by it. This obscuration is called "extinction" by astronomers and has been the origin of much frustration and confusion. In the late 18th century, the British astronomer and composer William Herschel attempted to ascertain our position in the cosmos by dividing the sky into regions and counting the number of stars in each. After completing his survey, he reasoned that the region with the highest concentration of stars must be in the direction towards the center of the cosmos. Seeing no such concentration, Herschel concluded that we must be located at the center! This was assumed to be true until the discovery of extinction by the American astronomer Robert Trumpler in the 1930s. Just as someone near the edge of a sandstorm might erroneously conclude they are in the middle of it since they can't see the actual edge, an earth-bound observer might also conclude they are at the center of the cosmos since extinction by dust completely obscures the center of the galaxy.

Thus, dust has complicated the process of discovery in astronomy for centuries. However, the past several decades have witnessed dramatic improvements in infrared observatories that have led to a renaissance in studies of all things dusty. Since dust absorbs infrared light very weakly compared to optical and ultraviolet photons, some sources that are completely obscured at shorter wavelengths can be seen when observed in the infrared. Additionally, obscuring dust heats up to temperatures near room temperature by the absorption of photons, and subsequently emits radiation of its own in the infrared. A particularly powerful new facility has been presented to the astronomical world with the Spitzer Space Telescope mission, including the InfraRed Spectrograph (IRS) built at Cornell by Prof. Jim Houck and collaborators. The IRS allows us not only to peer into the heart of enshrouded sources, but also to spectroscopically measure the strength of spectral lines from various atoms and to discern the chemical composition, temperature, and mass of dust within these sources.

Under the guidance of Prof. Terry Herter and collaborators on the Cornell IRS team and others elsewhere, I have spent the last several years using the IRS to study dusty

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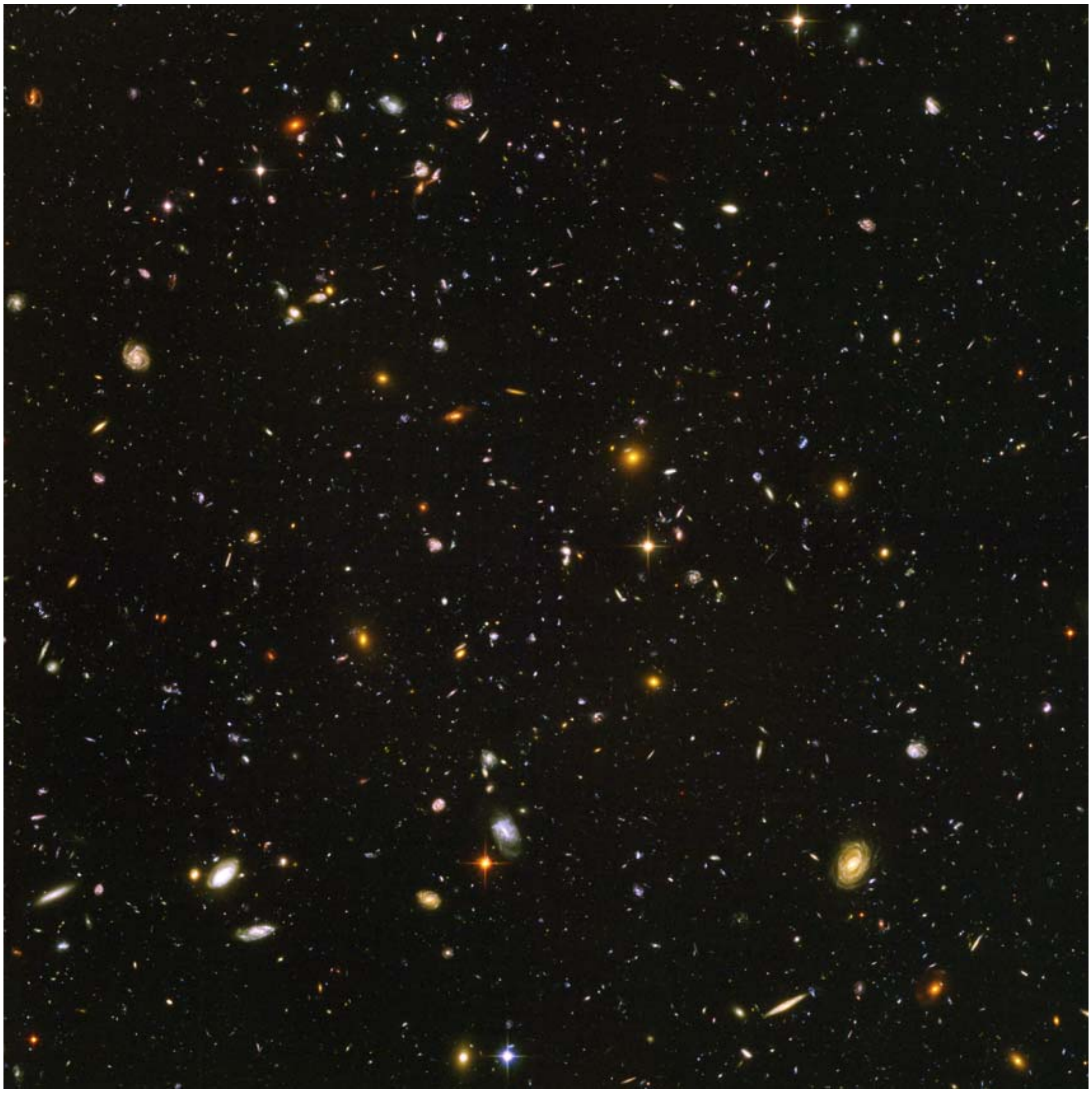
The First Stars

Steve Beckwith, AEP'73 and former director of the Space Telescope Science Institute, has taken the deepest space photograph ever.

From the instant of the Big Bang, the expansion of the universe began to alter the character of its contents. The separation of the fundamental forces, the creation of elementary particles, and the synthesis of the protons, neutrons, and electrons that constitute ordinary matter all happened within the first three minutes. The subsequent changes took place at a more leisurely pace. The recombination era producing hydrogen and releasing the cosmic microwave background took the next 400,000 years. A long dark period followed lasting hundreds of millions of years until the creation of stars and galaxies lit up space and ionized the remaining gas.

Once stars were born, they drove an important transition in the history of the cosmos. Just prior to that era, the universe was dark, neutral, and relatively smooth. After galaxies, the universe was filled with starlight, its gas was ionized, and it developed lumps on all scales from dust grains to filaments of galaxies stretching hundreds of millions of light years across. That is the universe we live in today.

The history of astronomy has been a steady increase in the power of our telescopes to look farther and farther out, and consequently farther back in time. But before the Hubble Space Telescope, the most distant stars and galaxies that could be seen looked pretty much like the stars and galaxies we see nearby. The Hubble Space Telescope changed that view. With the Advanced Camera for Surveys, installed in the last servicing mission in 2002, Hubble had just enough power to see back to the time when the first galaxies were being assembled from the detritus of the Big Bang.



With that goal in mind, a group of us at the Space Telescope Science Institute set out to take the deepest exposure of the universe in the history of astronomy. We dedicated 400 orbits of the telescope to a one million second exposure over two periods each lasting 40 days (and 40 nights) starting in September, 2003 and ending in January, 2004. This exposure is called the Hubble Ultra Deep Field (HUDF). Within it, we can look back almost 13 billion years to a time when the universe was a very different place than it is today.

Figures 1 to 3 show some of the rich detail that emerges

Figure 1: The Hubble Ultra Deep Field is 3 minutes of arc on each side, about one tenth the diameter of the full moon. The faintest galaxies in this image are 31st magnitude, 10 billion times fainter than the faintest objects that can be seen by the unaided eye.

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Detecting the Big Bang: A New Experience for Undergraudates in the Experimental Astronomy Lab Course

Jim Cordes' research interests include neutron stars, pulsars, and the interstellar medium.

The Department of Astronomy's lab course for undergraduates (A410, Experimental Astronomy) teaches students hands-on techniques in both optical and radio astronomy. Telescopes available to the students are the optical Hartung-Boothroyd Observatory on Mount Pleasant and the 3.8m radio telescope on the roof of the Space Sciences Building, The Josephine Lawrence Hopkins Foundation Teaching Radio Telescope. To enhance the lab course, we are continually upgrading the instrumentation of the radio telescope. Currently, the receiver and data-acquisition systems are being upgraded with support from the College of Arts and Sciences and from the Hopkins Foundation. A very generous additional grant from the Hopkins Foundation will enable us to add a very exciting new laboratory module, detecting the cosmic microwave background radiation.

Currently we understand the universe's evolution and structure to be in accord with the "ΛCDM" paradigm (Cold Dark Matter with a Cosmological Constant). The structure we see today as clusters of galaxies was imprinted in the tiny fraction of a second after the big bang during the inflation era. As the universe expanded, it cooled from its initial, very hot state, all the while radiating as a "black body" at continuously lower temperatures. Today we see this as the Cosmic Microwave Background (CMB) with a temperature of 2.7 Kelvin. When the universe was about 400,000 years old the temperature was about 10,000 K, cool enough for hydrogen atoms to form and for the radiation to become free of interaction with matter. The structure seen in the CMB radiation today was imprinted at this time of freedom; we are basically seeing a snapshot of the universe as it was then.

The CMB is thus very fundamental to our basic understanding of the universe and its evolution. Measuring the CMB is therefore a tantalizing addition to our lab-course repertoire. Students can go home and say to their friends and family, "I measured the big bang last semester!"

Considerable work is needed to "add" the big bang to our course. The new module requires fabrication of a new antenna and receiver system, including a cryogenically cooled system and the ability to point the antenna at hot and cold radio sources for purpose of calibration. The antenna will be a conventional horn antenna operating at about 12 GHz frequency (approximately 120 times the frequency of the FM band). It will be on a hand-steerable mount so that measurements can be made at different angles through the atmosphere to remove atmospheric radiation. By making the appropriate series of measurements, with simple calculations students can estimate the present-day temperature of the CMB. Of course, they and we know what the correct answer is. But by making their own attempt, they will learn techniques in radiometry and they will surely appreciate the work now being done to look for *variations* in the CMB temperature across the sky that are less than one millionth of the mean temperature of 2.7 Kelvin.

We are very enthusiastic about developing this lab module and we thank the Hopkins Foundation for providing the financial support.

-Jim Cordes

Nancy and Lee Corbin during the inauguration of the Department's teaching telescope in June 2004.

Ira Wasserman the Next Department Chair

Ira Wasserman will take over the chairmanship of the Astronomy Department in July. He is certainly no stranger to Cornell, since he came here as a research associate in 1978, straight after receiving his Ph.D. in theoretical astrophysics from Harvard. His thesis had to do with primordial magnetic fields and with galaxy formation. These are still research topics of interest to him and his profession, but he has branched out into many areas since then. These areas go from esoteric and speculative topics, such as cosmic strings and branes for the early universe, via the general theory of neutron star structure and evolution to explicit analysis of observations, e.g., of radio pulsars.

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A Brief History of the Fuertes Observatory

Philip Nicholson is professor of Astronomy and Supervisor of the Fuertes Observatory.

Many Cornell alumni have fond memories of their first encounter with the mysteries of the night sky at Fuertes Observatory, located since 1917 on a grassy knoll overlooking the north shore of Beebe Lake. Most people are surprised to learn that it is in fact the fourth or fifth astronomical observatory on the Cornell campus. The first, albeit rather primitive, wooden observatory building was built between 1876 and 1882 and was located on the Arts Quad where now stands the north end of Goldwin Smith Hall. The main impetus for its construction came from Prof. Estevan Antonio Fuertes, the Dean and first professor of Civil Engineering at Cornell and a devotee of practical, laboratory-based learning.

A view of the old Veterinary College (left) and the 1903 Fuertes Astronomical Observatory and Geodetic Laboratory (right), circa 1904. The photograph may have been taken from the Sage Hall tower. Ives Hall (ILR School) now stands where the Vet College was until 1959, while the observatory was removed to make way for Barton Hall in 1915.

Born in Puerto Rico, educated in fine arts in Barcelona and in engineering at Rensselaer Polytechnic Institute in Troy, NY, Prof. Fuertes was a successful civil engineer who had worked in Puerto Rico, on the Croton aqueduct for New York City, and on early Panama canal surveys. He was lured to Cornell in 1873 by Andrew Dickson White's vision of a new university where practical training would coexist with traditional academic learning.

Prof. Estevan Fuertes (1838-1903), known affectionately as "the Mogue" for his resemblance to the Indian Mogul emperor whose likeness appeared on cigarette packs of the era

Demolished in 1892 to make way for the Dairy Building, the observatory was rebuilt by 1896 on or near what is now the site of Day Hall, but apparently it remained a rather ramshackle wooden structure which was deemed a "standing reproach to the campus." Trustee General Alfred C. Barnes offered to provide a more suitable building to house the observatory and its geodetic equipment. Contemporary postcards show a handsome brick building, 80 feet by 20 feet and topped with three domes, which was completed in September 1903. Named for Prof. Fuertes, who died in 1903, it was situated across East Avenue on an eminence to the south of the old Veterinary College, on what is now the site of Barton Hall. Unfortunately, this fine facility was demolished in 1914 or 1915 to make way for the new drill hall.

Soon thereafter plans were laid for a new Fuertes Observatory, to be located on the Hasbrouck poultry farm to the north of Beebe Lake. Of concrete block and stucco construction, 87 by 18 feet with a 24-foot diameter steel dome, this building was completed in the fall of 1917 at a total cost of $20,000. Initially a 5-inch equatorial telescope from the old observatory was installed in the dome, but in 1919 Prof. Irving P. Church, head of the Civil Engineering department and another afficionado of practical astronomy, procured two 12-inch glass blanks declared surplus by the Yerkes Observatory in Chicago. The two-element lens was ground and polished by the firm of Brashear & Co and delivered to Cornell in 1920. The present 12-inch telescope, built by the Warner and Swasey Company of Cleveland, Ohio, was installed in October 1922 and officially dedicated on June 15, 1923 as the "Irving Porter Church Memorial Telescope." In 1964 the Irving Porter Church professorship in engineering was endowed in Prof. Church's honor; the present occupant of this chair is our own Professor of Astronomy Joseph A. Burns.

Introductory laboratory classes in astronomy continue to be taught at Fuertes, as they have been for over 80 years. For at least 40 years, and perhaps much longer, the Cornell Astronomical Society has operated Friday

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A Brief History of the Fuertes Observatory

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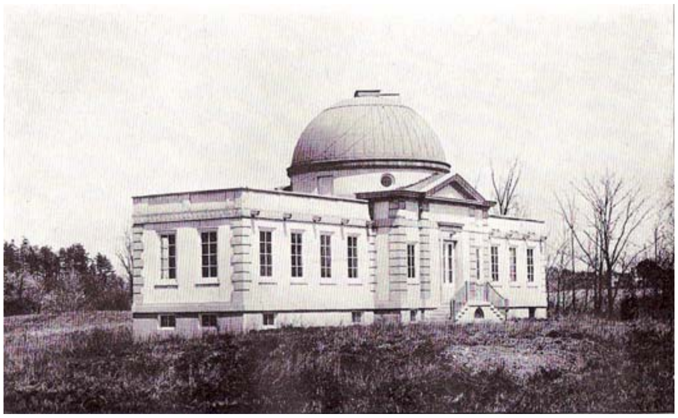

The new Fuertes Observatory in 1924, soon after its dedication.

Night open houses at the Observatory, inspiring generations of eager star-gazers of all ages. However, the campus itself has grown immensely over this period, and what must once have been a remote site with dark skies is now hemmed in by the residential and dining facilities of North Campus, while the southern sky is regularly spoilt by the lights of Schoellkopf stadium. As a result, it is now impossible to see the Milky Way from the rooftop deck at Fuertes, or even most of the fainter naked-eye stars. Only the moon, planets and the brightest stars remain visible to the unaided eye.

In the future, the Astronomy Department envisages constructing a new facility for upper-level observing labs at a dark site, perhaps on Mt. Pleasant adjacent to our existing Hartung-Boothroyd Observatory, or perhaps in the Cornell Plantations as part of a proposed Gateway Center off NYS Route 366. But its convenience for undergraduates, appeal to alumni and long history all argue for maintaining Fuertes as a functioning observatory well into the forseeable future.

-Philip David Nicholson,
with Jennifer Bailard ('09)
and Shianne Beer ('08)

The First Stars

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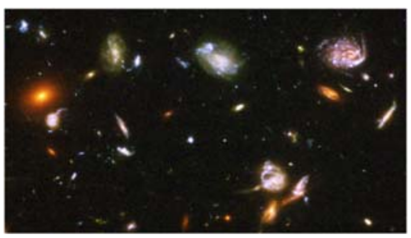

Figure 2: This is a section of the Hubble Ultra Deep Field approximately 40" across showing the rich detail of foreground and background galaxies. The HUDF contains more than 10,000 galaxies within its small field, implying more than 100 billion galaxies over the whole sky to the equivalent depth.

from this remarkable image. To appreciate the detail for yourself, you can browse through it on the internet using the UDF SkyWalker, written by our colleagues Knud Janke and Sebastián Sánchez at the Astronomical Institute of Potsdam: <http://www.aip.de/groups/galaxies/sw/udf/index.php#>.

The SkyWalker lets you scan across the image in high resolution, revealing a mixture of ordinary spiral and elliptical galaxies in the foreground, whose light was emitted when the universe was already about half its present age, and small, chaotic blobs that are clusters of stars and galaxies when the universe was less than 20% of its age today (Figure 2). You will see areas dominated by galaxies in collision and buildup, such as in Figure 3, some containing small, red amorphous structures that are the most distant galaxies ever seen. These red galaxies emitted their light before the universe had made that phase transition into the state we commonly see in less powerful telescopes.

Astronomers are planning one more advance beyond the Hubble Space Telescope to search for any stars that might have developed earlier. The James Webb Space Telescope is designed to look back more than 13.5 billion years to within 200 million years after the Big Bang. What it will find is a subject of great speculation within the ranks of professional astronomers, but it will most certainly end the era in which new telescopes are built to look farther out. We believe we have seen the edge, the era where the creation of the first stars would forever change the nature of the universe, and that achievement will forever change the nature of astronomy.

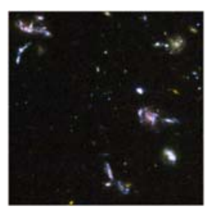

Figure 3: This 20"x20" section of the HUDF shows a series of galaxies being built up by the accumulation of smaller pieces in collisions. The galaxies we see today were built up in the same manner over billions of years.

-Steven Beckwith

A Rocky Spring Break

Ryan Anderson is studying the surface composition of Mars and what it implies about the history of the planet.

In the wee hours of the morning of March 17, when most reasonable Cornellians were at home sleeping through the snowstorm that was blanketing New York, a Jeep careened past us as we made our way along the snowy road to the Rochester airport. Its license plate said "Mars Rox", and a yellow bumper sticker cried "Save Pluto!" Driving the Jeep was Jim Bell, our professor for Astronomy/EAS 577 – Planetary Surface Processes. We were on our way to study a planet of volcanoes, canyons, ancient dunes and impact craters, and none of us were going to let a little snow stop us.

The planet, of course, is Earth. Thanks in part to a generous donation from FoA Ed Hewitt'54, BME '55, we spent spring break in northern Arizona studying the surface processes and geology of our own planet and comparing them to those that act on other planets in the solar system.

On our first day, we drove north in a convoy of minivans to Flagstaff, stopping along the way to climb the spectacular red rocks at Sedona. Once we got to the top, we took the opportunity to discuss the geology of the layers exposed by millennia of erosion while we enjoyed the awesome view.

On Monday, we met up with USGS geologist Ivo Lucchitta who guided us as we visited the Grand Canyon. He explained every layer, fault, and outcrop that we saw, and reinforced in our minds the vastness of geologic time. As we ate lunch at the rim, almost as breathtaking as the view was the thought that the Grand Canyon is insignificant compared to Valles Marineris on Mars.

The next day, we made a pilgrimage to Lowell Observatory, where we saw the historic telescopes used by Lowell to study Mars and by Tombaugh to discover Pluto. We then visited Red Mountain, a cinder cone volcano that has been carved open to expose its internal structure. We chipped at the cemented cinders, studied the minerals and rocks from the volcano and tried to understand what happened to the volcano to create the huge "amphitheater" in its side.

The class poses for a photo after climbing to the rim of SP crater, a cinder cone volcano in northern Arizona. The remains of several older volcanoes are visible in the background.

A highlight of the trip was our visit to Meteor Crater, the best-preserved impact crater on the planet. We hiked around the rim of the crater, climbing giant boulders that were heaved up to the rim by the explosion. In thirty mile-per-hour winds, we learned about the geologic and human history of the crater and studied the rocks that were created (and destroyed) by the impact. We finished the day with a hike through Lava River Cave, a mile-long subterranean tunnel formed by flowing lava from a nearby eruption. The floor of the cave was frozen lava, with ripples and pressure ridges indicating the direction of the final flow through the tube.

Thursday, we visited SP Flow, a relatively young volcano with an extensive lava flow emerging from one side. We climbed up the 820-ft mountain of loose volcanic rocks, studying them along the way. At the top we had a view of the lava flow, the volcano's crater, and a dozen nearby volcanoes.

Grand Canyon geologist Ivo Lucchitta shares his expertise with us at the canyon's south rim.

Finally, we visited Walnut Canyon. The canyon is a well known archaeological site, but we were visiting for a different reason. All along the canyon, erosion has exposed rock that shows characteristic slanting layers known as cross-bedding. These layers are formed when ancient sand dunes solidify and turn to rock, preserving the slopes of the dunes.

As we stood breathless at the rim of volcanoes, craters and canyons, it was impossible not to see the Earth as a planet, one of many, subject to the same forces that shape all the others. Our trip to Arizona gave context to features that we had only seen in pictures, and reinforced the excitement of piecing together the ancient history of a planet based on the processes that shape its surface.

-Ryan Anderson

The Dusty Universe *(cont.)*

galaxies. As two galaxies merge, large quantities of the gas and dust in each progenitor are driven towards the merged nascent nucleus. Since gas is the fuel from which new stars are created, these very dense concentrations in the hearts of dusty galaxies give rise to massive bursts of star-formation called starbursts. Additionally, most galaxies harbor supermassive black holes (typically one-million to one-billion times as massive as the Sun) at their centers. Much of the gas and dust funneled into the nucleus of a merged galaxy may therefore accrete onto its supermassive black hole, giving rise to what is called an active galactic nucleus (AGN), which is the same process that powers quasars. Complicating matters in many of these galaxies is the obscuration of the optical light from newly formed stars and supermassive black holes by the mixture of dust and fueling gas, which makes it difficult to figure out what is going on at the heart of dusty galaxies.

The major question in this field has therefore been: is the majority of the power emitted by dusty galaxies fueled by starbursts or by AGNs? To ascertain the dominant power source behind dusty galaxies, I've written software that analyzes the spectra obtained with the IRS (see Figure 1). The goal is to figure out which dust components are present in the observed spectra of pure starburst galaxies and AGNs and which of these components are also present in the spectra of the dusty galaxies. If the unclassified dusty galaxy has properties similar to those of a pure starburst galaxy, then we can be fairly confident it is powered by star-formation. Similarly, if the dusty galaxy has properties similar to AGNs, then we can infer that it is powered mostly by accretion onto a supermassive black hole. In the end, all I'm really doing is putting together a big jigsaw puzzle. The dust components are the puzzle pieces and the border is given by the IRS spectra. My job is to figure out where all the pieces go and, hopefully, what the final picture of these very dusty parts of the universe looks like.

At least that was what I was preparing to say to pacify my in-laws. But, luckily, it turned out I wasn't the only person in the room who thought the universe is worth studying for its own sake. My wife's grandfather thankfully agreed with me that "why" is a pretty darn good question, and "just because" is a perfectly respectable response. I would not invent a fancy vacuum cleaner, but he and I both thought my job was genuinely interesting and, in retrospect, I know that I'm pretty lucky for that. I'm not sure I would have found the same to be true of teeth.

-Jason Marshall

Greetings *(cont.)*

the Department. Recently Ed Hewitt assisted Jim Bell's undergraduate class to go on a study trip in the Arizona desert to study geoastronomy during the week of spring break, and Lee and Nancy Corbin arranged a grant from the Hopkins Foundation for us to upgrade our teaching radio telescope. Thanks! The Department is very fortunate to have your support.

We are also happy to let you know that the Editor of this Orion Newsletter, Patricia Fernández de Castro, successfully defended her Ph.D. thesis in History, with 'Distinction,' on May 25, 2007, at the University of Chicago. Congratulations Dr. Patricia!

We are hoping to see you at the October Symposium. Please respond as early as you can.

Best Wishes,

Yervant

TO UPDATE YOUR E-MAIL

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Ira Wasserman *(cont.)*

Ira's research is broad not only in covering many topics, but in showing versatility within each topic and in his broad range of collaborators—physicists and observers, professors, post-docs, graduate students and undergrads. For instance, on branes, dark matter, dark energy and the early universe he goes from esoteric collisions of two branes producing expansions of the universe to hard-boiled warnings on what observational data can and cannot do for determining cosmological and other constants. His neutron star calculations include how instabilities can give an upper limit to the rotation rate of a neutron star, etc. His versatility also rubs off onto some of his ex-graduate students—e.g., K. Schenk took a job in neurobiology at UCSF.

As befits a Chairman, Ira has been as energetic in educational efforts as in his own research. He has been the Director of Graduate Studies in Astronomy and related fields for a number of years and has been instrumental in various types of planning committees. He has involved an amazing number of undergrads in actual research, but also contributed pedagogy to courses on special plus general relativity for undergraduates who have had only a freshman physics course.

As you know, Ira has been a frequent contributor to this Orion Newsletter and surely he will continue to do so.

We wish Ira well in his new endeavor!

-Ed Saltpeter

Friends of Astronomy Symposium
The Universe Near and Far

Friday, October 12, 2007

2:00 - 4:30 pm	Registration and informal gathering
6:30 pm	Reception and dinner (Statler)
	Dinner Speech (S. Beckwith)

Saturday, October 13, 2007

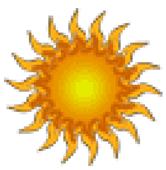
9:00 am	Welcoming Remarks (I. Wasserman)
9:15	Science Results from the Mars Rovers (S. Squyres)
9:45	Planets Around Other Stars (J. Lloyd)
10:15	Coffee Break
10:45	The Cassini Mission to Saturn (J. Burns)
11:15	Pulsars and Gravity (J. Cordes)
11:45	Cosmology and Astrophysics Debate: The Pivotal Topics (Moderator: Y. Terzian, Panelists: R. Bean, D. Lai, E. Flanagan, H. Tye)
12:30 pm	Lunch
1:30	Student Research Presentations
2:30	Mapping the Universe at Arecibo (R. Giovanelli)
3:00	Science with the Spitzer Space Telescope (J. Houck)
3:30	Coffee Break
4:00	The State of the Department (Faculty)
4:30	Open Discussion
6:30	Reception and dinner (Statler)
	Dinner Speech (I. Wasserman)

Books in Science and the Universe

The Varieties of Scientific Experience: A Personal View of the Search for God, by the late Carl Sagan, edited by his widow Ann Druyan. The Penguin Press 2006.

December 20, 2006 was the 10th anniversary of Carl Sagan's death. He spent about three decades as a faculty member in the department of Astronomy at Cornell and was perhaps the greatest science communicator of his era. His famous PBS Television "Cosmos" series and the book of the same name were the highlights of his public career. In 1985 he was invited to present the Gifford Lectures in Glasgow, Scotland, and this book represents the lectures he gave there. In them he discusses his views of science and religion in relation to the vast universe. One of the chapters is about life in the universe and the religious implications of finding other intelligent beings on other planets. Do they have the same God as we? Another chapter, which is titled "The God Hypothesis," is a critical analysis of religious beliefs and the discoveries of modern science. It is clear that if God were synonymous with the laws of physics he would have been happy.

-Yervant Terzian



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Thanks to the Friends!

Derek Schaeffer and Brian Ken received, respectively, the Cranson W. and Edna B. Shelley Award for Undergraduate and Graduate Research in Astronomy. Sabrina Stierwalt was awarded the Eleanor Norton York Prize in Astronomy.

Saul Teukolsky's Birthday Symposium

The Departments of Astronomy and Physics celebrated Saul Teukolsky's 60th birthday with a symposium on Relativity and Astrophysics on June 2, 2007.

In the picture, Saul with Kip Thorne, his graduate advisor at Caltech.

Yervant's Critical Thinking Corner

Prince Carl wants to marry Princess Sophia, but her father asks Carl first to solve a puzzle. There are three boxes, one made of gold, one of silver and one of lead. Inside one there is a treasure. If Carl can figure out which box has the treasure, he can marry Sophia.

The boxes have some instructions.The gold box says 'The treasure is in this box.' The silver box says 'The treasure is not in this box,' and the lead box says, 'The treasure is not in the gold box.'

Now the King gives Carl a hint; 'One of the statements, and only one, is true.' Where is the treasure?

The statement on the gold box cannot be true, because if it is, then the statement on the silver box must also be true, and that cannot be since only one statement is true. Therefore, the statement on the lead box is the only one that can be true, and that says that the treasure is not in the gold box. Since the statement on the gold box is false and since the one on the silver box, which says, 'The treasure is not in this box,' is also false, the treasure is in the silver box.