Star Dust

National Capital Astronomers, Inc. Phone: 301/565-3709

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Mars!

by Doug Hamilton

The next meeting of the National Capital Astronomers will be held Saturday, January 3, at 7:30 P.M. in the Lipsett Auditorium of the Clinical Center (Building 10) at the National Institutes of Health (NIH). Our speaker, Doug Hamilton, will be talking about Mars.

Abstract

Mars has captivated the human imagination from the earliest times right up until today's age of modern spacecraft exploration. Of all the planets in the Solar System, Mars is by far the most amenable to eventual human exploration and colonization. But Mars has some secrets that future inhabitants will need to know about. This talk will focus on some fascinating and little known facts about our nearest neighbor, including the mysterious origins and eventual fate of Mars' two small moonlets, Phobos and Deimos, recent results from the ongoing Mars Pathfinder and Mars Global Surveyor missions, and the possibility of — and evidence for — past or present life on the red planet.

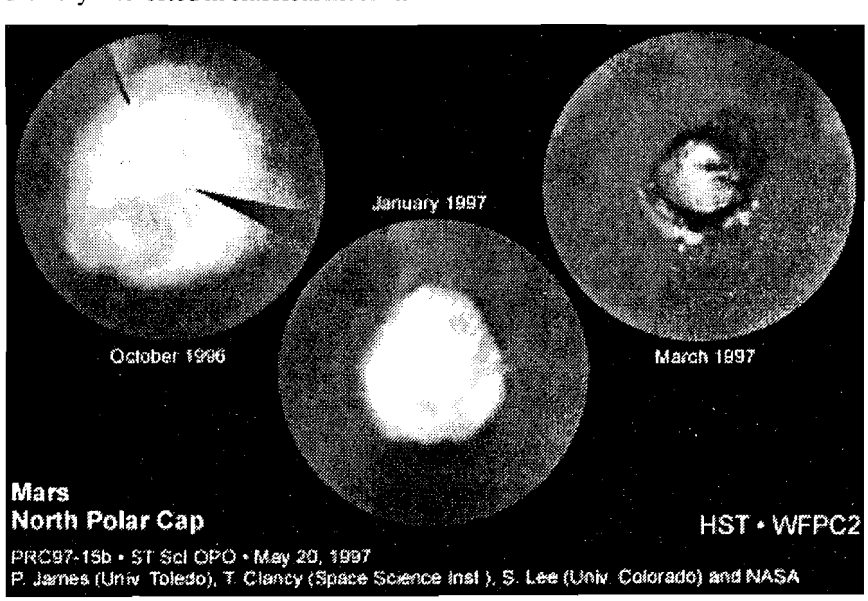
Biography

Dr. Hamilton attended Stanford University where in 1988 he earned a B.S. in Physics with Distinction and Honor.. He earned his M.S. (1990) and Ph.D. (1994) in Applied Physics at Cornell University, Ithica, New York. Dr. Hamilton received numerous academic honors and awards, notably the Dean's Award for Excellence in Teaching in 1997.

Dr. Hamilton has worked for the department of astronomy at Cornell University and at the Max Planck Institute in Heidelburg, Germany where he was a post-doctoral research scientist. He is currently an assistant professor in the department of astronomy at the University of Maryland at College park.

His primary areas of interest are in planetary science including planetary rings, satellites, asteroids, comets, the origin of the solar system and of planetary systems, and dust dynamics. He is also very interested in classical mechanics including celestial mechanics, orbital evolution, resonances, and teaching methods as well as the electrodynamics of charged particle motion.

Dr. Hamilton's professional activities include being a Co-Investigator on the Galileo Dust Detection System Team. He is also a reviewer for the *Astronomical Journal*, the *Geophysical Research Letters*, *Icarus*, the *Journal of Geophysical Research*, *Nature*, *Planetary and Space Science*, the A.S.P. Conference Series, the *Encylopedia of the Solar System*, NASA, the Planetary Data System, and the University of Arizona Press. Dr. Hamilton has written many publications and is a sought after speaker throughout the DC metro area. ○



Hubble Space Telescope Images of Mars: These images displaying the North Polar Cap were taken during one rotation after Mars' 1997 oppostion.

Calendar of Monthly Events

The Public is Welcome!

NCA Home Page: http://myhouse.com/NCA/home.htm

Saturday, January 3, 5:30 PM-Dinner with the speaker and other NCA members at the Thai place Restaurant, 4828 Cordell Avenue, Bethesda, MD. *See* map and directions on back page.

Saturday, January 3, 7:30 PM-NCA meeting, will feature Larry R. Nittler, Department of Terrestrial Magnetism, Carnegie Institution, speaking on "Stars in the Laboratory: Presolar Grains in Meteorites." For directions, *see* map and directions on back page.

Mondays, January 5, 12, 19, an 26, 7:30 PM-Public nights at U.S. Naval Observatory (USNO), in Northwest Washington, D.C. (off Massachusetts Avenue). Includes orientation on USNO's mission, viewing of operating atomic clocks, and glimpses through the finest optical telescopes in the Washington-Baltimore region. Held regardless of cloud cover. Information: USNO Public Affairs Office, 202/762-1438. Home page: http://www.usno.navy.mil.

Tuesdays, January 6, 13, 20, and 27, 7:30 PM-Telescope making classes at Chevy Chase Community Center, Connecticut Avenue and McKinley Street, NW. Information: Jerry Schnall, 202/362-8872.

Fridays, January 2, 9, 16, 23, and 30, 7:30 PM-Telescope making classes at American University, McKinley Hall Basement. Information: Jerry Schnall, 202/362-8872.

Fridays, January 2, 9, 16, 23, and 30, 8:30 PM-Open nights with NCA's Celestron-14 telescope at Ridgeview Observatory; near Alexandria, Virginia; 6007 Ridgeview Drive (off Franconia Road between Telegraph Road and Rose Hill Drive). Information: Bob Bolster, 703/960-9126. Call before 6:00 PM.

During questionable weather, call the IOTA Hotline (Phone: 301/474-4945) for NCA meeting status. The absence of a cancellation notice on the Hotline means the meeting will take place.

See page 6 for more Washington area astronomical events. Other events too numerous to list in *Star Dust* are listed in the publications *Sky & Telescope*, the *Astronomical Calendar 1997*, the *Observer's Handbook 1997*, in numerous software packages, and other links available on the NCA Home Page (*see* above for address). NCA members can purchase all these (and much more) at a discount. To join NCA, use membership application on page 7.

Microscopic Astronomy — A New Way to Study the Universe

Review by Nancy Byrd

At the December 7th meeting of the National Capital Astronomers, Larry R. Nittler of Carnegie Institute of Washington, Department of Terrestrial Magnetism spoke to us on "Presolar Grains in Meteorites." Dr. Nittler began his talk by suggesting that the study of such grains constitutes a new branch of astronomy, one that uses the electron microscope. We can get information about things that are "very, very large," like stars, by studying things that are "very, very small, tiny grains that are only 3 micrometers across and weight about 10^{-15} kg."

This is the reasoning: Given the age of the universe (by almost any reckoning) and of our galaxy, there has been time enough for several generations of stars to have formed and exhausted their hydrogen, becoming things like supernovae which produce dust. Moreover, this occurred before the solar system formed, yielding a big molecular cloud to the Milky Way which mixed, and a portion of which collapsed under its own gravity to form the solar system. Most of the early solar system dust became very hot, vaporized, and homogenized. This process erased most presolar system history of our neighborhood. But we now are confident that there are meteorites on Earth which contains presolar dust grains.

Dr. Nittler called our attention to a rock sample that he had brought with him. It was a piece of the famous Allende meteorite which fell in Mexico in 1969. The Allende Meteorite is a type of rock known as a carbonaceous chondrite. It has been dated as about 4.6 billion years old, the age of the solar system and older than any rocks found on Earth. This rock, maintains Dr. Nittler, has actual pieces of stardust in it, which can be isolated from the surrounding rock. using some rather Draconian chemical procedures. But how

can we know that these separated dust grains are actually presolar star stuff?

Earlier this century, we measured the abundances of elements in various meteorites, measured the elemental abundances spectrally in the Sun and other bodies that we could not sample directly. We found a good correspondence between measurements of the abundances in certain meteorites and spectrally inferred abundances for the Sun. From these observations, we have estimated solar system abundances. Dr. Nittler then showed us the well-known plot of solar system abundances as a function of increasing atomic number. From these data scientists constructed models of nucleosynthesis in stars which explain the data with remarkable agreement. However, for many years, there was little other data to confirm or deny that those nucleosynthesis processes actually took place. Moreover, this estimate of the abundances of elements in the solar system reflects a mixture of matter from many stars. The dust grains which Dr. Nittler and his colleagues study are much more likely to be from only one star.

Stars, which form in different locations, at different rates, incorporating different materials will vary. A way of studying individual classes of stars is to use the isotopes of the matter contained within them. [An element is defined by the number of protons in its nucleus. An isotope of an element is defined by the number of neutrons in its nucleus as well as the number of protons.] Given the mixing of matter that happens during formation of the solar system, it is not surprising that the isotopic ratio of $^{12}C/^{13}C$ is similar for most solar system carbon. Likewise, the ratios of the different isotopes of oxygen are also quite similar throughout the solar system. But when you look at the isotopic ratios found in the meteorite dust grains from Dr. Nittler's laboratory, you see that the numbers vary by several orders of magnitude from what is ordinarily seen in the solar system. These large variations from normal values serve as criteria for calling the dust grains presolar.

The Allende Meteorite is a carbonaceous chondrite of type CV3; with clumps of calcium-aluminum inclusions or CAIs (high temperature silicates and oxides), ≠chondrules, carbonaceous material and volatiles in a matrix of fine grained, iron rich olivine. The meteorite fell in Allende, Chihuahua, Mexico in 1969. Over two tons of meteoritic material have been recovered. Photo courtesy of New England Mateoritical Services.

These dust grains were discovered in the laboratory in 1987, although people had been looking for them since the mid sixties. What are these dust grains made of? Diamonds were the first grains discovered but are hard to study, because they are so small, only 2 nanometers in diameter. Other observed grains are on the order of micrometers (υm) which can be studied in today's laboratories. These grains, Dr. Nittler noted, are "sturdy stuff." For instance, silicon carbide (SiC), aluminum oxide (Al_2O_3), graphite with concentric layers, like an onion have been observed. These minerals are those which survived laboratory separation procedure; there are probably other types of presolar grains which we haven't found a way to find, because "they dissolve away in all those chemicals." He notes that these grains are also quite rare in meteorites, on the order of parts per million. "We find the needle in the haystack by burning down the haystack." Dr. Nittler studies the grains using a technique known as secondary ion mass spectrometry. This device uses a high energy ion beam to "blast" away atoms from the sample, where they can be separated by mass and detected. The instrument is also a microscope; you can get CCD images from them and use image processing techniques to isolate the isotopically anomalous grains.

What can these grains tell us? They can tell us their history. The formed in stars; but these stars formed in a galaxy. The galactic neighborhood from which the star formed contributed certain elements to the star. During its life, other elements were synthesized inside the star; mixing took place in the star, and in the latter stages much matter was ejected into the interstellar medium. When it had cooled sufficiently, it could clump together to form dust grains. The dust grains existed for a while in interstellar dust clouds. These dust grains became swepted up in the formation of the solar system and were incorporated into asteroids, pieces of which reached us as meteorites. These dust grains record that history.

The dust grains can tell us about supernovae and the events leading up to supernovae. Since supernovae have been known to produce copious amounts of dust (we observed this in Supernova 1987a), we expect to find grains that have been produced in a supernova. Dr. Nittler illustrated by showing a calcium ratio plot for a single graphite relative to the ratios in the Sun. The grain is anomalously rich in ^{44}Ca (140 times the ratio in the Sun), but matches solar values for the other calcium isotopes. This isotope is the decay product of radioactive titanium 44 (^{44}Ti), known only to form in supernovae. ^{44}Ti has a half-life of 50 years. Now massive stars, just before becoming supernovae, are believed to have an onion-shell structure, with the layers being different elements. The presence of a relatively large amount of titanium 44 in a carbon rich grain is evidence for significant mixing of nonadjacent layers in these giant stars. This is much more detailed information than we could get using normal astronomical methods.

We can get evidence about galactic evolution. "The Big Bang, " says Dr. Nittler, "can account for the creation of

GRAINS, Continued on page 4

Don't throw this newsletter away. If you're finished with it, pass it on to someone else to read or recycle it. It's right for astronomy and the environment.

GRAINS, Continued from page 3

the light elements, including all of the hydrogen and some of the helium." The first stars to form would be made almost entirely of hydrogen and helium. But these first stars, we believe, were massive and created the heavier elements by nucleosynthesis during their later evolution. These heavier elements were ejected into the interstellar medium as dust by the subsequent supernovae. When the next generation of stars formed from this dust, it had some heavier elements in its starting mix. Thus the galaxy becomes more metal rich (with more elements with numbers of protons greater that 2) over time. The Sun has a metallicity (percent of elements heavier than helium) of 2%. Moreover, the isotopic ratios probably change with time. Dr. Nittler presented a chart of silicon isotopic ratios in a grain compared with those of the Sun, which suggest such evolution.

Dr. Nittler concluded by showing a transmission electron microscope photograph of a slice of a graphite grain (5 microns in size) taken by Thomas Bernatowicz of Washington University. The grain has an iron carbide grain in the middle if it. The iron carbide formed first and the graphite grew around it. This sample tells us about chemical evolution within a star. Microscopic astronomy has come of age! ❍

"Roving and Revolving Over the Red Planet" by James Zimbleman

Review by Andrew Seacord, III

Dr. James Zimbleman, from the National Air and Space Museum, presented this talk to NCA on November 1, 1997, summarizing the results of the Mars Pathfinder and Mars Global Surveyor missions at the November NCA meeting. He divided his presentation into three parts: The history of Mars exploration prior to the Pathfinder mission, current Pathfinder and Global Surveyor results, and future missions to the red planet.

Prior to the first spacecraft encounter with Mars, the Mariner 4 fly-by on July 15, 1965 all observations were earth-based telescopic. Interpretations of visual markings on the Martian disk lead to speculations that canals exist on the Martian surface and that they were possibly created by an intelligent civilization. This idea seemed to be corroborated by seasonal variations of larger surface features, supposedly caused by vegetation irrigated by water flowing in these canals. Mariner 4 shattered this picture with 22 images of the Martian surface showing it to be a cold, dry, barren wasteland with craters. Mariner 9, launched on May 30, 1971, arrived on Mars at the height of a large dust storm. One prominent feature which the Mariner and, later, Viking orbiter spacecraft showed is a large canyon system, Valles Marineris (the Mariner Valley) over 2,000 miles long which has depths of up to five miles deep. This feature seems to have been created by stretching and pulling the surface.

In 1975, the Viking missions were launched, each of which consisted of an orbiter and a lander. The Viking I lander touched down on the Martian surface in 1976 near the Martian equator. Later that year, the Viking II lander touched down on the opposite side of the red planet but much farther north. However, the coordinates of the Viking II site are not well known to this day. The Pathfinder landing site is about 500 miles from the Viking I site. The Viking lander images sent back to Earth showed a dusty surface strewn with pitted rocks, some which appear to be of volcanic origin. Spacecraft analyses of Martian soil samples did not unquestionably rule out life on the surface, but the possibility of the existence of life seemed remote. Orbiter images show evidence that a large amount of water once flowed on the surface of Mars. Some surface features seem to have been caused by subsurface water flow and drainage (sapping) of meltwater. Also from these missions, it can be concluded that volcanism was active until fairly late in Martian history.

Another chapter of pre-Pathfinder history is not yet finished. The subject of this chapter is the collection of the 12 Martian meteorites which have isotopic abundances and trapped gasses that match those in the Viking analysis. One of these meteorites is now famous ALH 84001 which has globules within carbonate veins. It has been conjectured that these globules are the fossilized remains of microscopic organism which once lived on Mars. Whether or not this is true has not been decided; the jury is still out.

The Mars Pathfinder mission, as well as the Viking missions before it, were all engineering missions, not science missions. Their goals were to evaluate the technology of robotic exploration of Mars. The landing sites were chosen on the basis of spacecraft safety, not on the scientific value of what was expected. The Viking sites were chosen because of the supposed flat terrain. One goal of the Pathfinder mission was to evaluate the feasibility of landing a spacecraft encapsulated in a cluster of inflated balloons which serve as a cushion. The first analysis of the spacecraft accelerometer data, and the subsequent operation of the spacecraft on the surface, indicate that the method was successful. Another major goal of Pathfinder was the evaluation of its rover, Sojouner. Of major importance are its wheel carriage, alpha-proton spectrometer, and the electrical system which includes the solar panel and battery. The battery failed after several weeks of operation, well beyond the design lifetime. The lessons learned from the Pathfinder mission will be incorporated in future missions to Mars.

So, what science has Pathfinder given us so far? We know from the tracks left in the Martian soil by Sojourner that the soil has a layer of fine-grained particles. Sojourner investigated soil samples. A whitish region was found which is not understood. Another result of the mission is that silicon dioxide seems to be more abundant than expected. This suggests that the Martian crust was once molten like the Earth's crust. And, therefore, Mars and Earth had similar early histories. The rocks surrounding the Pathfinder lander are basalts, indicating a volcanic origin. The chemical signatures from them closely match those of the twelve

Asteroidal Appulses, 1998 January — Early February

Date	Day	EST	Star	Mag	Asteroid	dmag	dur. s	ap. in.	Location
Jan 5	Mon	21:31	SAO 56001	9.9	Julia	1.2	17	5	Virginia
Jan 16	Fri	23:04	ZC 833	7.1	Nininger	8.8	4	1	n. Florida
Jan 17	Sat	3:50	T-11d 2155	10.5	Iduna	2.5	9	6	Florida
Jan 26	Mon	17:54	T+34d 0214	10.9	Julia	0.8	12	8	Maine
Jan 26	Mon	22:13	SAO 99095	8.8	Nausikaa	2.6	9	3	New York
Feb 4	Wed	18:14	SAO 98393	9.0	Misa	3.7	8	6	Pennsylvania

"Mag" is the magntude of the occulted star. "dmag" is the drop in brightness of the merged star nd asteroid if the star disappears behind the asteroid. "dur." is the expected duration of a central occultation in seconds. "ap. in." is the mimimum aperature that I believe is needed to detect the occultation. All events can be observed visually. The location is only approximate, and for each of these events, there is a chance that an occultation will be visible from your location. For some events, astrometric updates will refine the paths three weeks to three hours before the events.

No grazing occultation expeditions are planned during January and early February. Phone the IOTA occultation line, 301-474-4945, for updates and details; also, meeting places and maps for grazing occultations are often given on IOTA's Web site at http://www.annomalies.com/iota/splash.htm

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Martian meteorites. Sojouner's analysis of the neighborhood soil indicated that this soil is very similar to that at the Viking lander sites.

In 1997 September, the next member of our armada arrived at Mars, the Martian Global Surveyor. Its main engine inserted the spacecraft in a highly elliptical orbit around the red planet. The mission plan was to use aerobraking to remove orbital energy , causing the orbit to become circular. Aerobraking results from drag from the atmosphere on the solar panels. Once the orbit is circular, mapping of the Martian surface will begin. Mapping was to begin in 1998 March. The Global Surveyor is the first spacecraft to use aerobraking for orbit control.

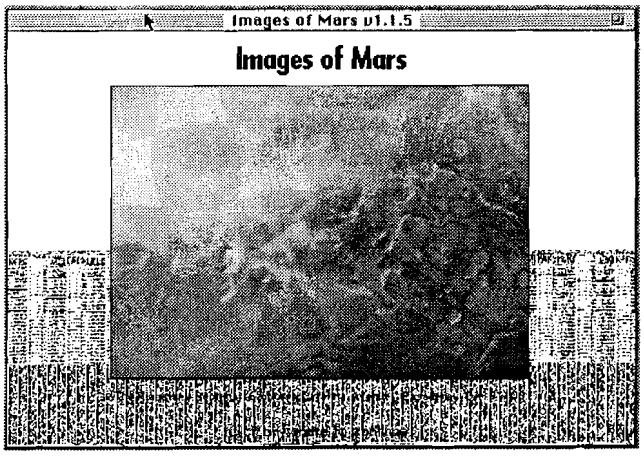
During a passage closest to Mars (periapse), telemetry from the spacecraft indicated that the atmosphere drag on the solar panels was not nominal. Analysis showed that one of the solar panels is not positioned properly. It is thought that one of the panel braces is cracked or partially broken. The planned rate of aerobraking would further damage the brace. Therefore, it was decided to decrease the rate of aerobraking, delaying the start of surface mapping until 1999 March.

In spite of this difficulty, however, the Global Surveyor has sent back some useful images of surface features. One image is of a channel in which sand has cascaded to the floor. Sand dunes forming a ripple pattern lie along the channel floor. The Surveyor has also shown that the Martian northern plains are very flat except for some craters. It appears that some of these flat areas could have been the floors of oceans that once existed on Mars.

Following the results of the Mars Global Surveyor, Dr. Zimbleman briefly mentioned plans for Mars lander missions in 2001, 2003, and 2005. The 2001 and 2003 landing sites are now being discussed. The 2005 mission will have a lander with a rover. The rover will collect rock samples and place them in the part of the lander vehicle which will return to Earth.

Following Dr. Zimbleman's formal presentation and question-answer session, the audience had an opportunity to use 3-D glasses to view a panoramic photograph taken by Pathfinder. ❍

Images of Mars, the object of centures of intense curiosity and careful scrutiny, is now the subkect of an Electronic PictureBook authored by The Planetary Society. *Images of Mars* contains a brief by descriptive captions that describe the planet as revealed by Vikings I and II. As the current international movement to return to Mars grows, students will find this an informative introduction to the planet and its beautiful, but hostile, terrain.



The *Images of Mars Electronic PictureBook* is a HyperCard® stack designed to run on a color Macintosh computer with at least 2.5 megabytes of Ram, System 7.0, and HyperCrad 2.1®. (When I viewed the stack, I needed to turn 32 bit addressing off from my IICi. the images appeared clear. The color was amazing for this level. Sorry, this does not include images from Pathfinder or Global Surveyor, yet. HyperCard, however, is designed where you can add your own stacks—ed.)

National Capital Area Astronomical Events

Free Lectures at the Einstein Planetarium and Other Daily Events
National Air & Space Museum

202/357-1550, 202/357-1686, or 202/357-1505 (TTY)
Home page: http://www.nasm.edu

Other Area Astronomical Events

Other Planetariums, Observatories, and Science Centers in the Area

Montgomery College Planetarium — "Astrolabs" Takoma Park, MD. January 24, 7:00 PM. (*See* their web site at http://myhouse.com/mc/planet.htm.)

U.S. Naval Observatory Colloquia — "Future Astronomical Missions beyond the Great Observations", speaker: Dr. Pete Stockman. January 23, U.S. Naval Observatory, Building 52, Room 300. Colloquia beings at 10:30 AM.

Scientific Colloquia, Goddard Space Flight Center — All colloquia will be held in the Building 3 Auditorium at 3:30 PM. "Young Galaxies", speaker: Charles Steidel, California Institute of Technology. January 9.

"Dance of the Continents", speaker: Paul Hoffman, Harvard University. January 16.

"Atmospheric Science in Extreme Environments: Arctic Bogs to Ozone Holes", speaker: Steven Wofsy, Harvard University. January 23.

"The Rebellion against Science", speaker: Paul Gross, Harvard University. January 30.

Campus Observatory Open House University of Maryland — "Nemesis—The Sun's Companion", speaker: Dr. Roger Bell. January 5, 8:00 PM.

"NEAR's Flyby of Asteroid 253 Mathilde", speaker: Dr. Lucy McFadden. January 20, 8:00 PM.

Capital Science Lectures Carnegie Institution — "Exploring the Giant Planets with the Hubble Space Telescope", speaker: Heidi B. Hammel, Department of Earth Atmospheric and Planetary Sciences, MIT. January 20, 6:30 PM.

AAS Washington DC Meeting — "Astronomy for a Day", a free workshop for astronomers and educators, January 8. You can register on site or email at aased@aas.org or call 312-294-0340..

Check your local web sites for any other events that may be happening in the area.

Meteor Showers

Quadrantids —Visible between December 28 and Janaury 7. Meteors tend to be bluish and possess an average magnitude of about 2.8. Numbers rage from 45 to 200 per hour. Called Quadrantids because of its emanation from a now obsolete constellation called Quadrans Muralis (the Mural Quadrant) between Hercules, Bootes, and Draco.

American Astronomical Society Meeting

January 6-10, 1998

The 191st Meeting of the American Astronomical Society (AAS) will be held in Washington, DC at the Washington Hilton and Towers.

Dr. Robert A. Eisenstein, the recently appointed Assistant Director of Mathematical and Physical Sciences at the National Science Foundation will speak on Thursday, 8 January at 11:40 am

The Honorable Vernon J. Ehlers, R-ML will be speaking on "The Perspective of Congress" during the Public Policy Session on Thursday, 2:00-3:30 pm. He joins John Bahcall and Charles Townes on the Public Policy Panel.

Registration Fees:	
Junior/Emeritus AAS Member	$ 55
AAS Member	$225
Nonmember	$275
Spouse/Guest	$ 25
One Day, AAS Member	$120
One Day, Nonmember	$150

All registration fees should be submitted to and made payable to:

AAS Conference — ICM
c/o International Conference Management
4709 Montgomery Lane 1st Floor
Bethesda, MD 20814

(Registration available on site.)

Newsletter Deadline for February *Star Dust*, January 15, 1997

Send Submissions to Alisa & Gary Joaquin, at 4910 Schuyler Dr, Annandale, VA, 22003-5144. Leave a message on voice mail 703/750-1636. Text files or graphic files in .GIF or .TIFF may be sent via E-Mail to ajglj@erols.com or fax submissions to 703/658-2233. **No submissions will be accepted after the 20th.** There will be no exceptions. We need a reasonable amount of time to design, edit, and review this newsletter. We would appreciate everyone's help in this matter by getting everything in on time. Thank you.

National Capital Astronomers, Inc.

SERVING SCIENCE & SOCIETY SINCE 1937

NCA is a non-profit, membership supported, volunteer run, public-service corporation dedicated to advancing space technology, astronomy, and related sciences through information, participation, and inspiration, via research, lectures, presentations, publications, expeditions, tours, public interpretation, and education. NCA is the astronomy affiliate of the Washington Academy of Sciences. All are welcome to join NCA. For information: 703/841-4765.

SERVICES & ACTIVITIES:

Monthly Meetings feature presentations of current work by researchers at the horizons of their fields. All are welcome; there is no charge. *See* monthly *Star Dust* for time and location.

NCA Volunteers serve as skilled observers frequently deploying to many parts of the National Capital region, and beyond, on campaigns and expeditions collecting vital scientific data for astronomy and related sciences. They also serve locally by assisting with scientific conferences, judging science fairs, and interpreting astronomy and related subjects during public programs.

Discussion Groups exchange information, ideas, and questions on preselected topics, moderated by an NCA member or guest expert.

Publications received by members include the monthly newsletter of NCA, *Star Dust*, and an optional discount subscription to *Sky & Telescope* magazine.

NCA Information Service answers a wide variety of inquiries about space technology, astronomy, and related subjects from the public, the media, and other organizations.

Consumer Clinics on selection, use, and care of binoculars and telescopes, provide myth-breaking information, guidance, and demonstrations for those contemplating acquiring their first astronomical instrument.

Dark-Sky Protection Efforts educate society at large about the serious environmental threat of light pollution, plus seek ways and means of light pollution avoidance and abatement. NCA is an organizational member of the International Dark-Sky Association (IDA), and the National Capital region's IDA representative.

Classes teach about subjects ranging from basic astronomy to hand-making a fine astronomical telescope. NCA's instructors also train educators in how to better teach astronomy and related subjects.

Tours travel to dark-sky sites, observatories, laboratories, museums, and other points of interest around the National Capital region, the Nation, and the World.

Discounts are available to members on many publications, products, and services, including *Sky & Telescope* magazine.

Public Sky Viewing Programs are offered jointly with the National Park Service, the Smithsonian Institution, the U.S. Naval Observatory, and others.

NCA Juniors Program fosters children's and young adults' interest in space technology, astronomy, and related sciences through discounted memberships, mentorship from dedicated members, and NCA's annual Science Fair Awards.

Fine Quality Telescopes up to 36-cm (14-inch) aperture are available free for member's use. NCA also has access to several relatively dark-sky sites in Maryland, Virginia, and West Virginia.

YES! I'D LIKE TO JOIN THE NATIONAL CAPITAL ASTRONOMERS

Enclosed is my payment for the following membership category:

[ ] Regular
- [ ] *Sky & Telescope* and *Star Dust*. ($54 per year)
- [ ] Star Dust only ($27 per year)

[ ] Junior (Only open to those under age 18) Date of birth: _____
Junior members pay a reduced rate.
- [ ] *Sky & Telescope* and *Star Dust*. ($42 per year)
- [ ] Star Dust only ($15 per year)

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If family membership, list names of additional participating immediate family members in same household, with birthdates of all those under 18 years old: _____

Note: If you already subscribe to ***Sky & Telescope***, please attach a recent mailing label. You may renew this subscription through NCA for $27 when it expires.

Make check payable to: **National Capital Astronomers, Inc.**, and send with this form to:

NCA c/o Jeffrey B. Norman, 5410 Connecticut Avenue, NW, Apt. #717, Washington, D.C. 20015-2837.

The following information is optional. Please indicate briefly any special interests, skills, education, experience, or other resources which you might contribute to NCA. **Thank you, and welcome to NCA!**

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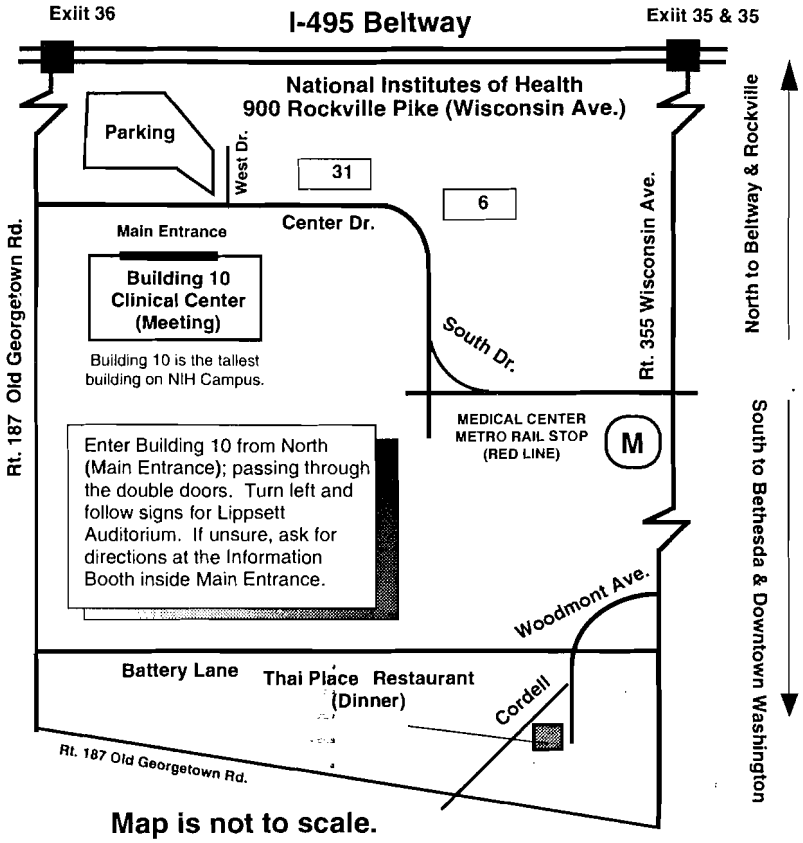
Getting to the NCA Monthly Meeting

Metrorail Riders - From Medical Center Metro Station: Walk down the hill, pass the bus stops and turn right at the anchor onto Center Drive. Continue uphill to Building 10, the tallest building on campus (walking time about 10 minutes). Also, the J2 bus line connects the Bethesda (7:16 PM) and NIH (7:23 PM) Metro stops with Building 10 (7:25 PM).

To Thai Place Resaurant- Take Wisconsin Avenue toward Bethesda and head right onto Woodmont Follow Woodmont to Cordell Avenue (2 blocks south of Battery). The Thai Place Restaurant is on the corner of Cordell Avenue and Woodmont (4828 Cordell Avenue). There should be adequate parking on the street outside the restaurant. Seats are not guaranteed after 5:00 PM.



Star Dust **is published ten times yearly (September through June) by the National Capital Astronomers, Inc. (NCA), a nonprofit, astronomical organization serving the entire National Capital region, and beyond. NCA is the astronomy affiliate of the Washington Academy of Sciences and the National Capital region's representative of the International Dark-Sky Association. NCA's Phone Number 03/841-4765. President: Harold Williams, 301/565-3709. Deadline for *Star Dust* is the 15th of the preceding month. Editors: Alisa & Gary Joaquin, 4910 Schuyler Dr., Annandale, VA 22003, 703/750-1636, E-mail: ajglj@erols.com. Editoral Advisor: Nancy Byrd**

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