Star Dust

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Water on the Terrestrial Planets and the Moon

by Nancy Byrd

At the Saturday, November 7, 1998 meeting of National Capital Astronomers (NCA), Dr. William J. Webster, Jr. of the Laboratory for Terrestrial Physics at NASA's Goddard Space Flight Center in Greenbelt, will address members on the subject of "Water on the Terrestrial Planets and the Moon." The meeting will be held in the Lippsett Auditorium in Building 10 of National Institutes of Health in Bethesda.

Dr. Webster submits the following abstract for the talk: Beyond the asteroid belt, water is common. In fact, the most common solid surface out there is water ice of varying levels of purity. The gas giant planets all contain substantial fractions of water in their atmospheres and their rings are mostly water ice particles. The consensus understanding of the formation of the solar system twenty years ago regarded this as entirely expected. The average temperature of the protosolar nebula was expected to allow volatiles like water to accumulate only in the outer solar system. The terrestrial planets were expected to be depleted in volatiles because of their proximity to the heat source that became the sun. As late as ten years ago, it was thought that only the Earth had a significant amount of water; both initially present and retained over time. Terrestrial planets might have contained significant water at the time of their formation. However, the heat released by the formation of a planetary core, together with the effects of the massive bombardment by leftover planetesimals going on at the same time, was expected to evaporate, dissociate, and drive off virtually all of the primordial water. Earth escaped this complete dehydration, it was reasoned, because of a combination of its location in the solar system, atmospheric pressure, high levels of volcanic activity, and, eventually, the modification of the chemistry of the atmosphere due to the origin of life. All other terrestrial bodies (Mercury, the Moon, Venus, and Mars), were expected to have anhydrous mineralogy. Earth was, therefore, a special case. This was a well thought out and entirely self-consistent theory. Initial results from planetary exploration completely supported the theory. However, we now know that this theory is completely wrong. Water, either in liquid or solid form, is present on all the terrestrial planets including the Moon and Mercury(!) in varying abundances and from varying sources. The evidence for water ice on Mars became especially clear with the recent Mars Pathfinder mission. Clean and unambiguous evidence of a past flood at the landing site has given extra credence to work suggesting that Mars was wet and warm in the geologic past. Venus' atmospheric chemistry strongly suggests that Venus had a deep primordial ocean which was lost due to the runaway green house effect. Both the Moon and Mercury retain significant deposits of ice near their poles presumably deposited by icy meteoroid impacts over the last two billion years. The ice has remained in place due to the shadowing of much of their polar regions by crater rims. These results are the key to the opening up of the inner solar system for human exploration and eventual economic exploitation. ❍

Gamma Ray Tour of the Universe

Presented by David Thompson
Reviewed by Andrew W. Seacord, II

The October NCA meeting featured Dr. David Thompson, who began his lecture with a brief presentation of the history of the Compton Gamma Ray Observatory (GRD). It was launched on 1991 April 5 by the shuttle Atlantis. The observatory, which has an Earth ground weight of 35,000 pounds, is the heaviest scientific payload which has been launched by the shuttle. The observatory - which has four gamma ray telescopes: EGRET, COMPTEL, OSSE, and BATSE - has produced excellent data and, at this time, is expected to collect data for at least two more years. The only problem of the mission occurred during the deployment of the high gain antenna. During the launch, the antenna became

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Calendar of Monthly Events

The Public is Welcome!

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

Mondays, November 2, 9, 16, 23, and 30, 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.

Tuesday, November 3, 7:30 PM - Telescope making classes at Chevy Chase Community Center, Connecticut Avenue and McKinley Street, NW. Classes from November 10th throught April will be cancelled due to construction and will resume in May. Information: Jerry Schnall, 202/362-8872.

Fridays, November 6, 13, 20, and 27, 7:30 PM - Telescope making classes at American University, McKinley Hall Basement. Information: Jerry Schnali, 202/362-8872.

Saturday, November 7, 5:30 PM-Dinner with the speaker, and NCA members at the Athenian Plaka- at 7833 Woodmont, Bethesda, MD. *See* map and directions on back page.

Saturday, November 7, 7:30 PM-NCA meeting, will feature Dr. William J. Webster, Jr., speaking on "Water on the Terrestrial Planets and The Moon,." For directions, *see* map and directions on back page.

Friday, November 13, 20, and 27, 8:30 PM - Open nights with NCA's Celestron C–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.

Saturday, November 14, 7:30 PM - Exploring the Sky. Sessions are held at Rock Creek Park, in the field south of the intersection of Military and Glover Roads, near the Nature Center. Free to the public. Information: 202/426-6829.

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 1998*, the *Observer's Handbook 1998*. NCA members can purchase all these (and much more) at a discount. Information can also be found in numerous software packages, and links available on the NCA Home Page (*see* above for address). To join NCA, use the membership application on page 7.

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stuck and did not deploy. Astronauts unstuck and deployed it during an emergency space walk.

The emphasis of Dr. Thompson's lecture was a response to the question: "What have we learned?" Probably the most important lesson learned was that no single portion of the electromagnetic spectrum is sufficient to answer these questions toward which the research is directed. Multi-wavelength observations are required. Dr. Thompson reiterated this observation throughout discussions of gamma rays, pulsars, blazars, gamma ray bursters, and "mysteries for the future".

Why gamma rays? Gamma radiation is the highest energy electromagnetic radiation. Celestial sources of gamma rays must, therefore, be inherently powerful. Observations of a source at gamma ray wavelengths may give a very different picture of the source than those made at other wavelengths. Dr. Thompson provided an interesting example of this. The quiet sun (that is, no solar activity) is not a gamma ray source. Since the moon has no magnetic field to shield it from high energy cosmic rays, these high-energy particles slam into the lunar surface and produce secondary gamma radiation. Consequently, the moon is a much brighter gamma ray source than is the sun.

Dr. Thompson showed us a panoramic picture of the gamma ray sky in which the galactic plane is very bright. Gamma radiation is produced when high energy cosmic rays collide with the interstellar gas. An interesting feature of the gamma ray sky is that the central bulge is prominent above the galactic plane, but is not seen below it. The reason for this is still a mystery.

The next topic of the lecture was pulsars which are rotating neutron stars and constitute the brightest gamma ray sources. The neutron star is created during a type II supernova. The core of the original star, having an original mass from 1.4 to 2 or 3 solar masses, becomes the neutron star and the stellar envelope is blasted away from the core and forms a supernova remnant (SNR). [The neutron star, itself, has a diameter of about 16 kilometers.] It possesses a strong

dipole magnetic field, with a strength in the order of 10^{12} gauss, that focuses jets of charged particles, including relativistic electrons, along the star's magnetic poles. The relativistic electrons spiral around the magnetic field lines, generating synchrotron radiation in opposing beams from the magnetic poles. For the light house model of pulsars, the axis of the dipole magnetic field is offset from the rotation axis. As the neutron star rotates, the beams sweep across space. If the star is oriented such that a beam sweeps across the Earth, the radiation is received as a series of pulses, hence the name pulsar. Each pulse is associated with one rotation of the neutron star. The pulse rate is very regular but decreases slowly. The rate at which the pulse rate decreases depends on the magnetic field strength.

Some pulsars, such as the Crab, Vela, and GEMINGA pulsars are well-known. GEMINGA has a pulse (rotation) period of 237 milliseconds. Its pulses are very bright with gamma radiation but only "seen" in X-rays and visible light. The Crab pulsar is at the center of the Crab Nebula, an SNR. The Crab has a double pulse - it "blinks" twice at each rotation - which is aligned at all wavelengths across the electromagnetic spectrum.

The consistency between these pulse structures would imply a single pulse generating mechanism. However, another pulsar, B1055-52, shows a different relationship with pulses across the electromagnetic spectrum. The radio pulsar shows a double pulse for each rotation (like the Crab) but the double pulse is not seen at all other wavelengths. Also, the pulses are not aligned across other wavelengths. The simple lighthouse model is inadequate for the explanation of the observed pulse structure of B1055-52. Another departure from the lighthouse model is that, the radiation is mainly in the gamma region with little radiation at longer wavelengths. The multi-wavelength pulse structure seems to suggest that some of the radiation being observed is thermal radiation from the neutron star's 100,000 K surface. This example serves to emphasize the importance of multi-wavelength observations.

The next topic was active galaxies. Since the activity in active galaxies is produced in the nuclei of these galaxies, they are usually referred to as an Active Galactic Nuclei, or AGN. One of these is the radio galaxy 3C219 [number 219 in the Third Cambridge Catalog of Radio Sources]. The optical image of 3C219 is a compact blue object. Jets are seen radiating from the blue object at radio wavelengths.

Another AGN is the quasar 0528+34 which has a red shift of 2, giving it a distance of 6×10^9 light years. An interesting fact about this object is that its radiation is variable and its observed intensity can be as strong as that of the Crab pulsar which is located at a distance of only 6500 light years.

The question is "How is such enormous power generated"? Several scientists, including Meg Urry of the Space Telescope Institute, have proposed a unified model. (See Urry and Padovani, 1995, Publications of the Astronomical Society of the Pacific, Vol. 107, page 803.) According to the unified model, a black hole with a mass of between 10^6 and 10^9 solar masses exists at the center of the AGN. The black hole is surrounded by an accretion disc which is hot and emits soft x-rays. The accretion disc is surrounded by a rapidly rotating torus of a material that blocks soft x-rays generated by the accretion disc. A jet of high-energy electrons emanates from the core in opposing directions perpendicular to the accretion disc and torus.

The intrinsic power of the AGN and its orientation with respect to Earth determines the characteristics of the source we observe. If the AGN is oriented so that the observer looks down the jet, he or she sees a rapidly variable gamma ray source called a blazar. The first blazar detected in gamma rays is 3C279, which is also a radio galaxy. The variability is due to the jet in which a series of blobs of ionized gas, traveling close to the speed of light, emerge from the AGN core. The effects of small fluctuations are magnified. Gamma ray emission accompanies the emergence of a new blob from the AGN core. When two photons react to produce an electron-positron pair, high-energy gamma rays are absorbed. However, since jets are not isotropic and the blobs are moving at relativistic velocities, the gamma rays escape.

Along with the variable gamma emission is continuous radiation which has two components. One component is synchrotron radiation, which has a peak intensity in the infrared or red part of the optical spectrum. The other component has a peak intensity in the gamma ray region and is, apparently, produced by inverse Compton scattering by which an electron traveling close to the speed of light bumps a low-energy photon in to the gamma region.

The blobs in the jet of 3C279 appear to be superluminal; that is, they appear to be traveling faster than the speed of light. This is actually a geometrical effect caused by the blobs traveling close to the speed of light in a direction very close to, but not exactly, along the line of sight.

A flare of that same blazar, 3C279, occurred in January 1996 and was recorded over portions of the entire electromagnetic spectrum. The gamma and x-ray "light" curves had the same pattern. The ultraviolet and radio observations encountered problems so portions of the light curve during the gamma and x-ray flare were absent. There was a rise in the optical light curve but no variation in the radio intensity. There was, however, an unexplained dip in the visible and UV curves prior to the gamma flare. The lesson learned here is the necessity of observing these objects over as much of the electromagnetic spectrum as possible.

Next, Dr. Thompson discussed another class of gamma ray sources, gamma ray bursters, GRBs. They are characterized by a cluster of rapid gamma ray bursts superimposed on an increase of background gamma ray emission. These are onetime events; that is, they do not repeat. The Burst And Transient Source Experiment (BATSE) telescope on the Compton GRO has observed many of them. The GRBs are not concentrated in the galactic plane, but are scattered isotropically over the celestial sphere. Their distances are not known. It is difficult to develop a model for them when it is not known whether they are local or at great (i.e. cosmological) distances.

The first clue toward understanding the GRBs - particularly in terms of their distances - comes from the bursts themselves. The bursters produce a cluster of high energy (greater than 30 Mev) bursts over a low energy (100 Kev to 1

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Proposed Changes to the NCA Constitution

by Jeff Norman

The offices and trustees of NCA have decided to support the following three proposals to conform the NCA Constitution to current practice:

1) Create a Board of Directors consisting of the five officers and the four trustees to be the governing body of NCA;

2) Change the name of the "sergeant-at-arms" to "audio-visual engineer"; and

3) Permit the officers and trustees to make whatever changes are necessary in the language of the Constitution to implement (1) and (2).

Under the current NCA Constitution, we have a governing body of five trustees which never meets and five officers who theoretically have no power to make major decisions. (The President is both an officer and a trustee.) In recent years, the officers and trustees have been meeting jointly once a year to plan the following year's activities and make decisions.

The purpose of this change is to bring the governing structure of NCA in line with that of almost every other small nonprofit organization. We have only 169 dues-paying members. It is impractical for such a small organization to have a separate set of trustees. I have done volunteer work for several other small nonprofit organizations, all of which are larger than NCA. In each case, the officers and trustees (usually called "at-large members" in most organizations) form a single governing body.

At our November 7, 1998 meeting, NCA members will be given a ballot to vote on these proposals as a package. The officers and trustees of NCA recommend a yes vote. ○

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Mev) burst. The high energy cluster continues long after the low energy burst decays to zero. The Italian-Dutch telescope, BeppoSAX, having both gamma and x-ray telescopes, has been used to search for an after glow. With this telescope, researchers have observed x-ray bursts, including decay, with better resolution and positional accuracy than is possible with the Compton GRO. BeppoSAX has provided observation of the optical, x-ray, and gamma afterglow of a GRB. The detection of the optical afterglow has provided a visual identification and, using other telescopes including the Hubble telescope, a determination of the red shift (3.4) of the source. This source, therefore, is located at a cosmological distance far beyond our galaxy.

With these data, we can estimate the total energy of each burst to be in the order of 10^{54} ergs, far more energy than would be released from a Type II supernova. So, what are these objects, hypernovae? Collisions between a black hole and a neutron star? It is now time to involve the theoreticians. Dr. Thompson noted, however, that this identification would not have been possible without multi-wavelength observations. Even though the research of these objects was triggered by the observation of gamma rays, we use all parts of the electromagnetic spectrum together to develop a model for them.

The last class of gamma ray burst source that Dr. Thompson discussed is called a Soft Gamma Repeater (SGR). They produce multiple bursts from a single source. Their burst signature shows a sharp increase, or burst, with periodic pulses superimposed on the burst decay. The initial burst delivers enough energy to heat up the Earth's nightside ionosphere to the extent that it can affect radio communication. SGR 1900+14, which has recently done this, is a variety of pulsar with a 5- second period, called a magnetar. Ordinary pulsars do not produce a burst of radiation, particularly gamma rays. SGR 1900+14 is associated with a supernova remnant located about 1,840 ly from the Earth. Magnetars exhibit a much larger decrease of pulse rate which indicates a much stronger magnetic field than non-SGR pulsars are expected to have. It is estimated that SGR pulsars must have a magnetic field strength in the order of 10^{15} gauss, making it the strongest magnetic field known. The power of the GSRs comes from the magnetic field. Presently, we know of only three magnetars and do not understand the production of such a strong magnetic field.

Have we solved all of the mysteries of the universe? No. Dr. Thompson concluded with a presentation about the future of gamma ray astronomy, including work in progress and a new gamma telescope being planned. The third EGRET (Energetic Gamma Ray Experiment Telescope) catalog is being compiled. He showed us a map of the celestial sphere with known gamma sources plotted on it. Over one half of the sources in the catalog have not yet been identified, mainly because there are no collaborative data at other wavelengths. This emphasizes the necessity of multi- wavelength observations.

We are now looking ahead toward the next generation of gamma ray telescope and planning the Gamma ray Large Area Space Telescope (GLAST) with a target launch date sometime in 2004. It will be significantly larger, have better resolution, and cover a broader energy range than the Compton GRO EGRET telescope. Particle physicists at SLAC and CERN are helping to design the new detectors.

We thank Dr. David Thompson for an excellent lecture and are looking forward to an update of gamma ray sources, particularly when the analysis of GLAST data becomes available. ○

Newsletter Deadline for December *Star Dust*, November 15, 1998

Send Submissions to Alisa & Gary Joaquin, at ajglj@erols.com or fax submissions to 703/658-2233. **Text must be in ASCII and graphics submitted must be in TIFF, GIF, or JPEG.** Thank you.

Planned Grazing Occultation Expeditions

DATE	Day	EST	Star	Mag	%	alt	CA	Location
Nov 12	Thu	2:10	SAO 099153	7.6	37-	17	7N	Chester, VA (Richmond expedition?)
Nov 12	Thu	4:54	rho Leonis	3.8	37-	46	-1S	York, PA
Nov 13	Fri	5:00	sigma Leo	4.1	27-	37	1N	Grantville, PA (e. of Harrisburg)
Nov 22	Sun	18:54	SAO 187385	8.3	12+	8	1S	Frederick & Westminster, MD
Nov 26	Thu	22:41	ZC 3310	6.4	50+	11	1S	Mattawoman, MD & Quantico, VA
Nov 27	Fri	17:21	chi Aqr	4.9	60+	40	2S	Assateague Is. & Pokomoke City, MD

Notes:
Nov. 12, SAO 099153: Possible Richmond exped., no expedition from DC area.
Nov. 12, rho Leonis: The star is a possible close double.
Nov. 26: After Thanksgiving Dinner. The main DC expedition will probably try it near Mattawoman; the path also goes over Dunkirk, MD.
Nov. 27: Assateague is preferred, with Sun alt. -8 deg. A Richmond-Norfolk effort might try it about halfway between those two cities, where the Sun alt. will be -6 deg., still all right.

Asteroidal Appulses

DATE	Day	EDT/EST	Star	Mag	Asteroid	dmag	dur. sec.	ap. in.	Location
Nov 2	Mon	0:24	T+17d 03090	9.8	Vanadis	3.9	6	8	Pennsylvania
Nov 12	Thu	20:25	PPM 736551	10.0	Adeona	3.9	7	8	n.w. Ohio
Nov 19	Thu	20:03	PPM 709785	9.8	Herculina	1.7	30	8	Arkansas
Nov 20	Fri	19:53	SAO 094447	8.4	Eugenia	3.6	18	4	Pennsylvania

Notes:
Nov. 19: Herculina may have a 40-km satellite, based on observations of an occultation of Herculina seen in 1978, so it is worthwhile to observe even in the Mid-Atlantic States region.
Nov. 20: Eugenia's diameter is expected to be over 200 km; so this is the best possibility for the Mid-Atlantic States this year. The altitude is 14 deg. in azimuth 83 deg. (east).

Total Lunar Occultations

The better total lunar occultations are listed below; they can be accurately timed by aiming a camcorder into a low-power eyepiece of your telescope and recording WWV with the audio:

DATE	Day	EST	Star	Mag	%	alt	CA	Notes
Nov 5	Thu	19:18	D Aldebaran	0.8	95-	6	-30N	Rising, azimuth 79 deg.(E)
Nov 5	Thu	19:56	R Aldebaran	0.8	94-	13	65N	*** can video directly ***
Nov 5	Thu	22:00	R Ceres	7.5	94-	36	43N	Hard; will last 3 seconds
Nov 12	Thu	1:56	R CX Leonis	6.0	37-	15	31S	possible close double
Nov 13	Fri	5:15	R sigma Leo	4.1	27-	41	25N	*can video directly*; graze
Nov 22	Sun	17:47	D BB Sgr	6.6	12+	18	41S	Sun-11d; Cepheid, min. 7.3
Nov 26	Thu	22:33	D ZC 3310	6.4	51+	12	12S	possible close double; graze
Nov 27	Fri	17:07	D chi Aqr	4.9	60+	37	20S	Sun alt. -4 deg.; graze
Nov 30	Mon	0:32	D 89 Psc	5.3	83+	29	66N	

"D" following the time denotes a disappearance, while "R" indicates that the event is a reappearance. As noted above, 2 events are good enough to videorecord with 12x or greater camcorders directly, no telescope needed.
Three of the events, with "graze" in the notes, have graze expeditions planned as listed above. Good luck with your observations.

Phone the IOTA occultation line, 301-474-4945, for updates and details, or check IOTA's Web site at http://www.sky.net/~robinson/iotandx.htm. For asteroidal occultations, finder charts can be found at http://members.home.net/dega/astchart.htm.

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

Arlington Planetarium, Arlington, VA — "Stars Tonight", Nov. 2, 7:30 PM.

Campus Observatory, Depart. of Astronomy, University of Maryland, College Park — "Life in the Universe", Speaker, Dr. Virginia Trimble, Nov. 5, 8:00 PM.

"Gas Between the Stars: What Gets it Hot and What Keeps it Cool?", Speaker, Dr. Mark Wolfire, Nov. 20, 8:00 PM.

Capital Science Lectures, Carnegie Institution of Washington — All lectures are on Tuesday evenings starting at 6:30 PM at the Carnegie Building, 1530 P Street, NW, Washington, DC

"Return to the Center of the Universe," Speaker Dr. Alan Dressler, The Observatories, Carnegie Institute, Nov. 17.

Maryland Space Grant Observatory — Open House every Friday evening (weather permitting), Bloomberg Center of Physics and Astronomy, Johns Hopkins University, Baltimore, MD. Information: 401/516-6525 or check their web site at www.pha.jhu.edu/facilities/observatory/telescope.html.

Montgomery College's Planetarium, Takoma Park — "Total Solar Eclipses", Nov. 21, 7:00 PM.

Space Telescope Science Institute (STScI)— Free lectures held the first Tuesday of each month at 8:00PM in the STScI Auditorium at Johns Hopkins University. Following the lecture visit the Maryland Space Grant Observatory. Free parking is available.

"Ultrared and Dusty Galaxies at High Redshifts," Speaker Amy Barger, University of Hawaii, Nov. 4.

"Microlensing at the Edge," Speaker Andrew Gould, Ohio State University, Nov. 18.

US Naval Observatory Colloquia — All Colloquia will take place in Bldg. 52, Room 300, with coffee and cookies at 10:00, talk at 10:30, and lunch at 12:00

"Programs and Status of the IAA", speaker Dr. Zinovy Malkin, Nov. 9.

Virginia Living Museum Planetarium, Newport News, VA — "Our Endangered Skies & More Than Meets The Eye," Sept. 19- Nov. 15. See their website for more events and programs at http://users.visi.net/~stargazr/html.

IAS Microwave Forground Workshop — Nov. 14-15, Princeton, NJ

Meteor Showers

Full Moon

1998 November 4

Major Activity

Radiant	Duration	Maximum
Leonids (LEO)	November 14-20	1998 Nov. 17 19:45 UT (Possible Meteor Storm) 1999 Nov. 18 01:50 UT (Possible Meteor Storm)

Minor Activity

Radiant	Duration	Maximum
Andromedids	September 5-December 6	Nov. 14/15
Alpha Monocerotids	November 13-December 2	Nov. 21
Apha Pegasids	October 29?-November 17?	Nov. 1-12
Northern Taurids	October 12-December 2	Nov. 4-7
Sourther Taurids	September 17-November 27	Oct.30-Nov. 7

Daylight Activity

None

Get Ready for Your Eclipse

presented by Jim Roy
Einstein Planetarium
6:00 PM, November 28, 1998

Eclipses are probably the most conspicuous astronomical events you can see. Normally a total solar eclipse is the most spectacular of Earthbound shows. This presentation will cover several of them, with the emphasis on the upcoming August 11, 1999 total solar eclipse through Europe. You will also learn about annular eclipses, eclipses of the Moon by the Earth, and a bit about transits (crossings) and eclipses elsewhere in the Solar System. For instance, Mars with its fast moving mini-moons can have several transits each day at its equator, and Jupitor has dandy solar eclipses caused by its large inner moons. Here on Earth, we will see Mercury cross the Sun on November 15, 1999 amd May 7, 20003, while there will be a much rarer transit of Venus on June 8, 2004. These will be visible outside the U.S. unfortunately.

Jim Roy, a veteran astrophotographer, has witnessed and photographed 3 solar eclipses (July 11, 1991, February 26, 1998, the annular of May 10, 1994), and two lunar eclipses. He has been a Planetarium volunteer since 1988. ○

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.

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: _____
- [ ] *Sky & Telescope* and *Star Dust.* ($42 per year)
- [ ] Star Dust only ($15 per year)

_____ _____ (____) _____ _____

First name(s) | Last name | Telephone | E-mail

_____ _____ _____ _____ _____-_____

Street or Box | Apartment | City | State | Zip Code + 4

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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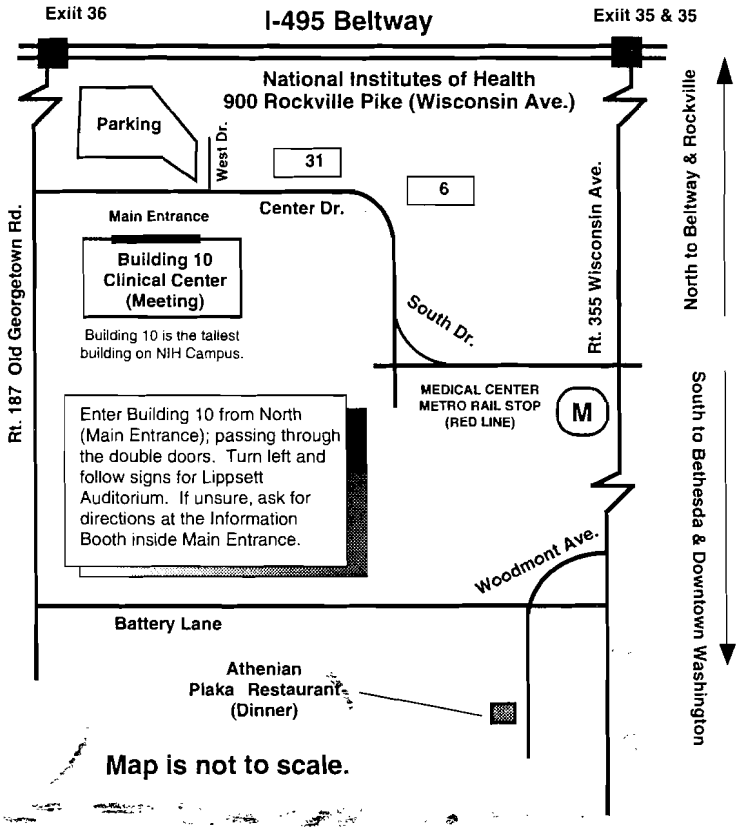
Getting to the NCA Monthly Meeting

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 Athenian Plaka- Take Wisconsin Avenue toward Bethesda and head right onto Woodmont. The address is 7833 Woodmont. There should be adequate parking on the street outside the restaurant. Seats are not guaranteed after 5:30 PM.



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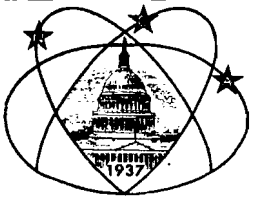

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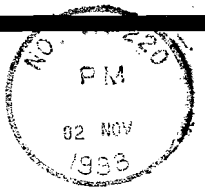

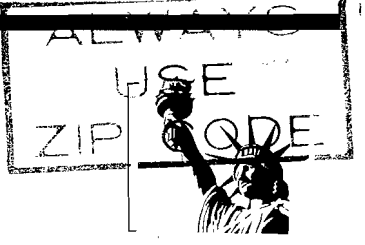

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