Star Dust

National Capital Astronomers, Inc. http://capitalastronomers.org

Volume 64, Number 3 November 2005 ISSN 0898-7548

November Speaker: Lucy-Ann McFadden, "First Results from the Deep Impact Mission"

Submitted by Walt Faust

Lucy-Ann McFadden, Associate Research Scientist, Astronomy Department, University of Maryland, College Park, MD will present the talk "First Results from the Deep Impact Mission" at the November 12 meeting of the National Capital Astronomers ,7:30 P.M., at the University of Maryland Observatory, in College Park, MD.

Abstract

On July 4, 2005 Comet Tempel 1 and Deep Impact's impactor spacecraft were in the same place at the same time. The ensuing impact produced a stunning release of dust, icy grains, and gas that was observed by the flyby spacecraft and ground- and space-based observatories world wide. From the motion of the dust, the strength of the comet nucleus is about 65 Pascals and the density is about 600 kg m^{-3}. These and additional results will be presented. We can discuss the implications for the starting material of the early Solar System.

Curriculum Vita

Dr. McFadden earned her B.A. degree in natural sciences from Hampshire College, her M.S. degree in Earth and planetary science from the Massachusetts Institute of Technology, and her Ph.D. degree in geology and geophysics from the University of Hawaii. She has been associated with the University of Maryland in various capacities since finishing her doctoral degree.

Review of Talk by Professor Theodore Alan Jacobson: "The Expansion of the Universe"

by Walt Faust and Jack Gaffey

Professor Theodore Alan Jacobson, Department of Physics, University of Maryland, College Park, presented the talk "The Expansion of the Universe" at the October 1 meeting of the National Capital Astronomers at the University of Maryland Astronomy Observatory.

Professor Jacobson began with a chronology of Albert Einstein's application of his theories of relativity to cosmology.

1905: Einstein's Special Theory of Relativity, (SR)

Light moves at a unique velocity *c*, relative to any/all material objects. *c* poses a speed limit for the relative motion of two objects. There is no special reference frame "at rest" in space [true still, in General Relativity, (GR)]. The four dimensions x, y, z, and t have an aspect of symmetry. As in Newton's view, space is rigid, independent of its contents.

1915: Einstein's General Theory

The geometry of space is dynamic, warped by its contents of mass-energy density and pressure. Time stands apart from x, y, and z.

1917: Einstein Applied General Relativity to Cosmology

Expansion of the universe is described by a variable scaling factor *a(t)*, applied to distances between objects. Whereas for Newton, the universe was infinite, uniform, and static— in GR, static mass distributions are not consistent with Einstein's original field equation. For a uniform mass distribution, *a(t)* is a decreasing function; the universe collapses! This led Einstein to introduce the cosmological constant Λ [units of length^{-2}]. Functioning as an anti-gravity, it was introduced to balance gravity, so to produce the then-favored static universe. Such a constant was the only way to achieve this without violating the spirit of GR. Einstein did not realize that the balance so achieved is unstable; small density perturbations make it collapse or expand. Others subsequently recognized this instability. Historical note: This was the first juncture where theory dictated a non-Euclidean topology of space.

1922: Solutions to Einstein's Equation

Alexander Friedmann (St. Petersburg) showed that there were solutions to Einstein's equation even with the constant Λ, in which space expands or contracts. Einstein disbelieved Friedmann, and wrote a short note stating that he was wrong. Einstein supposed that the mass density was a constant, to preserve the balance. Friedmann correctly chose a constant total mass, the mass-energy density times a^3.

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NCA Events This Month

The Public is Welcome!

NCA Home Page: http://capitalastronomers.org

NCA Mirror- and Telescope-making Classes: Fridays, Nov. 4, 11, 18, and 25, 6:30 to 9:30 P.M. at the Chevy Chase Community Center, at the northeast corner of the intersection of McKinley Street and Connecticut Avenue, N.W. Contact instructor Guy Brandenburg at 202-635-1860 or email him at gfbrandenburg @yahoo.com.

Observing with NCA's 14-inch telescope: See schedule and information at right.

Exploring the Sky: Saturday, November 5, with NCA's 14-inch and other telescopes in Rock Creek Park, D.C. See Page 5.

Open house talks and observing at the University of Maryland Observatory in College Park on the 5th and 20th of every month at 9 P.M. The talks are non-technical. There is telescope viewing afterward if the sky is clear.

Dinner with NCA members and speaker: Saturday, November 12 at 5:30 P.M., preceding the meeting, at the Garden Restaurant in the University of Maryland University College Inn and Conference Center. See map and directions on Page 6.

If you are planning to come to the dinner before the meeting, please tell Benson J. Simon, telephone: 301-776-6721, e-mail st88@ioip.com, so that we can make reservations for the right number of people.

Upcoming NCA Meetings
November 12: Lucy McFadden, University of Maryland, Astronomy Department. Planetary Group "First Results from the Deep Impact Mission"

December 10: Robert W. Farquhar, The Johns Hopkins University, Applied Physics Laboratory, Space Department, "The Lagrange Points"

More NCA meetings: January 14; February 11; March 11; April 8; May. 13; June 10.

In the News

Reported by Dr. Nancy Grace Roman

Sylvia Has Two Partners

[from a NASA news release]
Like tiny planets in a miniature solar system, two chunks of rock have been found orbiting an asteroid known as Sylvia. The discovery is the first observation of a triple-asteroid system and may give clues to the nature of the process that spawned the planets some 4.6 billion years ago.

Asteroids are thought to be leftovers from the formation of the solar system. Measuring 380 by 260 by 230 kilometers, Sylvia (discovered in 1866) is the ninth largest asteroid. Over the past decade, some twenty asteroids have been found to be accompanied by one satellite. Planetary scientists assume that these small moons are the results of collisions in the asteroid belt: Rocky debris from a collision re-accumulates into a so-called rubble pile asteroid, sometimes with a smaller object in a stable orbit around it.

In 2001, astronomers spotted the first satellite—a rock eighteen kilometers in diameter that orbits the asteroid every 3.65 days. But it took the powerful 8.2-meter Very Large Telescope of the European Southern Observatory in Chile and a special camera designed to compensate for atmospheric turbulence to spot Sylvia's second partner. The new moonlet, discovered by planetary scientist Franck Marchis of the University of California, Berkeley, and colleagues, is just seven kilometers across and orbits Sylvia every thirty-three hours.

From the observed orbits of the two satellites, the team deduced that Sylvia's density is just twenty percent higher than that of water, suggesting that the asteroid is very porous. This is in excellent agreement with the collision theory, which predicts that many asteroids are loose aggregates of smaller fragments. Future measurements may shed light on the physical properties of the satellites themselves.

Observing with the NCA C-14

Mike McNeal

Day, Date and Time	Prime Objects
Sat., Nov. 5, 7:30 P.M.	Rock Creek Park: *Exploring the Sky*
Open — call to set up a time.	Mars

In Mike McNeal's backyard, 5410 Grove St, Chevy Chase, MD, (Friendship Heights Metro).

Please make reservations by 10 p.m. the Friday before.

Call Mike at 301-907-9449 or email him at mcnealmi@verizon.net.

The deadline for the December Star Dust is November 23. Please send your material to Elliott Fein by that date to ensure inclusion. Send submissions to Elliott Fein at elliott.fein@erols.com.

Articles submitted may be edited to fit the space available.

Do You Want to Get *Star Dust* Electronically?

Any member wishing to receive *Star Dust,* the newsletter of the National Capital Astronomers, via e-mail as a PDF file attachment, instead of hardcopy via U.S. Mail, should contact Nancy Grace Roman, the NCA Secretary, at nancy.roman6@verizon.net or 301-656-6092 (home).

Happenings at the NCA Telescope-Making Class

Guy Brandenburg

Visits by John Dobson, Tunisian Students; Commercial Mirrors Tested and Found Lacking; Two Dozen 10-inch Diameter, 8-foot-long Telescope Tubes Available

Over the past month, it's been rather busy at the NCA Telescope-Making workshop at the Chevy Chase Community Center on Friday nights.

On Friday, September 30, we were treated to a visit by the well-known 90-year old John Dobson, inventor of the eponymous Dobsonian alt-azimuth mount. We happened to be pouring a pitch lap that evening for a 6-inch mirror. Dobson didn't approve of using a masking tape dam around the tool, which is one of the methods we use most frequently; he advocated waiting until the pitch was almost cool again and pouring it from the center out, so that it matches the curvature of the glass better. (That requires excellent temperature control and timing, which Jerry Schnall and I find to be rather difficult.) He did approve of the wet stick method that we were using, however. He also said that in his workshops, students almost never did any mirrors smaller than 8 inches, and that he always had them use under-sized tools, because he felt that prevented turned-down edge when polishing. He also saw no need to use plastic mesh for microfaceting the large pitch facets. (However, Jerry and I still find that to be a useful technique.)

Dobson also said that he never bothered to learn how to do any of the bench test methods for examining the figure of mirrors, such as the Foucault knife-edge test, the Ronchi test, the Couder masks, or any of the other ones. He told us that he relies strictly on the star test because he had read somewhere that it was the most sensitive one. Thus, when testing a mirror, he has to put it into a partly-completed telescope. However, since stars have a bad habit of not staying in one place at night, he said that he generally uses the reflections from telephone pole insulators, perhaps a block or two away, because they don't move. His method of testing mirrors was to look at the image of the little distant artificial star inside and outside of focus. When you are inside focus, the bright regions in the image are places where the light is reflected from the high spots, relative to a paraboloid; those will need to be polished down. When you are outside of focus, the bright regions are places where light is reflected from the low spots; those regions need to be left alone, and the rest of the mirror needs to get polished down.

I didn't get a chance to discuss his theories on the evolution of the universe with him, though I understand that he did talk about it with others. I did get him to sign my copy of his book on building telescopes.

The week before that (September 23) we got a visit from two attractive and friendly young Tunisian university-level astronomy enthusiasts who had managed to hook up with NASA and the U.S. State Department. They were accompanied by a cameraman, a State Department guide, and a teacher from a university in Tunis. Along with one of our students, who is originally from Morocco and has recently completed an excellent 8-inch mirror, we ended up having many-sided conversations in English, French, and Arabic about astronomy, mathematics, and more, which was great fun. They got to look at our techniques and methods for making telescopes, and perhaps will create a telescope-making workshop back home. Just a few days later (October 3), they had plans to observe an annular solar eclipse in Libya along with a NASA astronaut. A film is being made of their adventures, and perhaps we'll get to see a copy.

Several local amateur astronomers recently brought in their commercial mirrors, sold under the name of Meade, Celestron, and others, to be examined by us. Through Surplus Shed, we also purchased several 5- and 6-inch finished mirrors produced by A. Jaegers that were polished, but not aluminized. The Meade and Celestron mirrors, as well as the vast majority of the Jaegers mirrors, had very serious zonal defects (i. e., rings polished into the face of the mirror), or were rough, had turned edges, or were seriously undercorrected, or were overcorrected, or exhibited an exceedingly strange combination of all of the above defects at once, resembling a Zulu shield! However, one of the 6-inch f/10 Jaegers mirrors was actually an excellent sphere. At that focal ratio, a sphere will work fine. Unfortunately, that mirror has a very large chip on one side. One of the 5-inch Jaegers/Surplus Shed mirrors also turned out to be excellent, better than 1/10 wave when we did a quantitative knife-edge test with a Couder mask and data reduction software. However, the other mirrors were ones that none of our students would accept as finished.

Over the Columbus Day holiday, Steve LaPrade and I traveled up to a closed-down textile factory in Milton, PA, and took delivery of over two dozen cardboard tubes that will be excellent for making telescope tubes for 8-inch mirrors. Steve constructed a frame that fit into the bed of his truck so that we could hold all of them, and donated the gas and wear and tear on his truck, as well. We have the tubes stored in our workshop at the CCCC, and they are free to anybody who wants to make a telescope with one of them! They are 8 feet long, have an interior diameter of 10 inches, and the cardboard is ¼ inch thick. They are not too heavy, and when they are painted inside and out and strengthened at each end with some sort of a metal or plywood ring, are plenty strong for a nice, inexpensive tube.

On the way up, Steve and I stopped by an optical manufacturing shop just north of Baltimore, at the invitation of one of its managers, so we could take a look at their methods of grinding, polishing, and figuring mirrors and other optical items. (I was asked not to identify the company.) They had all sorts of milling machines that made short work of the rough grinding of the general shape of the mirrors, some of which were very large (4 feet across or more) and very exotic (lots of them were made out of Cer-Vit or Zerodur), and paid for mostly by defense contractors. They had planetary turntables that polished flats against a rotating lap. They had lots of motorized turntables to polish or fine grind mirrors. They had interferometers to judge which parts of a mirror were high or low in comparison with a reference mirror. They even had an area where they melted pitch for various specifications; there were probably more than 20 different named varieties of pitch. We also saw how they got a rough polish on one of their mirrors: they made a metal tool to fit its curvature, then glued some carpet to the tool! I also got a brief introduction to a test known as the wire test, which might be useful when testing really fast mirrors (below f/5).

Review of Talk by Professor Theodore Alan Jacobson

(Continued from page 1)

1914 to 1921: Vesto M. Slipher

Vesto M. Slipher (Lowell Observatory) studied redshifts of nebulae, defined as $z = \Delta\lambda/\lambda \cong v / c$ if the recession velocity $v << c$. He found z's up to 0.006, implying $v = 0.006$, $c = 1{,}800$ km/sec. Applied to Earth's age [then taken ~10^9 y], this yielded a distance D of 6 million ly. Even this weak minimum distance placed nebulae far beyond our Milky Way [diameter ~ 80,000 ly]. Our galaxy doesn't delimit the universe.

1924: Edwin Hubble

Edwin Hubble (Mt. Wilson Observatory) used Cepheid variables, established as "standard candles" by Henrietta Swan Leavitt, to identify nebulae as other galaxies at great distances. [Cepheids are bright, radially pulsating stars whose period and mean magnitude are attributed to self-propagating, periodic ionization and recombination of He.]

In more recent work, Type 1a Supernovae afford standard candles observable at even greater distances. [A white dwarf accretes matter from a companion star. When the mass exceeds the Chandrasekhar limit, 1.4 solar masses, the white dwarf explodes.]

In 1929, Hubble noticed a prevailing redshift varying linearly with distance. He stated then his law regarding the recession velocity: $v = H D$, where H is the Hubble constant and D is the distance. This describes a general flow, apart from particular motions. Thus $D = v/H = v\, t_H$, where the "Hubble Time" $t_H = 1/H$ is taken as the age of the universe. His initial estimate was $H = 450$ *km/sec/megaparsec*, or $t_H = 2 \times 10^9$ *years*. Currently accepted is $H = 72$ *km/sec/Mpc*, or $t_H = 13.7 \times 10^9$ *y.*

The Dilation of Space

This is described by a scaling factor $a(t)$. Einstein considered what deformations of space could occur with the passage of vast spans of time. In virtue of translational and rotational symmetry [no special place, nor direction], the only time-dependence which could be expressed in the 3-space itself lay in a scaling factor $a(t)$ of the distances. Space is expanding, in fact; objects are thereby becoming farther spread out. This is modeled by the inflation of a balloon bearing coins of fixed size.

Einstein wrote, for the distance between two entities A and B in a distant epoch t , the product $D(t) = a(t)\ (x_B - x_A)$. Optionally, by choice of units, let the current [$t = t_0$] distance between any two entities A and B be $x_B - x_A$; i.e., $a(t_0) \equiv 1$. Note that the quantity $x_B - x_A$ is independent of the time. The scaling factor applies to two neighboring galaxies whose separation is sufficient that they are not gravitationally bound. In a second important case, A and B are two successive crests of a light wave [$x_B - x_A = \lambda$]. The ratio of the separation of A and B at some cosmologically remote time t_2 to that at another t_1 , now respecting GR's spatial dilation, is $R = a(t_2) / a(t_1)$. We suppose $t_2 > t_1$, $a(t_2) > a(t_1)$, an expanding universe. The λ observed at t_2 exceeds that emitted at t_1 by the factor R , an effect of the cosmological redshift.

A greater number of meter-sticks [or coins] can be inserted between A and B at time t_2 than at t_1 . Such physical objects do not partake in the expansion of space, because they are held together by internal forces.

By the time a light ray from A reaches a *remote B*, it will have traveled a distance greater than the initial $a(t_1)\ (x_B - x_A)$. On the expanding balloon, an inchworm crawling at fixed speed c upon the local surface is further transported by the expansion. Progress of the light ray obeys $a(t)\, dx = c\, dt$.

Time in GR, in contrast to SR, does not have a symmetrical relationship with x, y, and z. A Mercator map projection of Earth offers an analogy: The latitude [like time] does not get scaled, but the true distance scale of longitude [like distance] varies as the cosine of the latitude.

The Scaling Factor Implies Hubble's Law

The distance from A to a *remote B* is again $D(t) = a(t)\ (x_B - x_A)$. The recession velocity $v(t) = dD(t) / dt$. Within a given epoch t , $H(t) = v(t) / D(t) = \{da(t)/dt\} / a(t)$ has the same value for all object-pairs [observer and observed] not bound gravitationally or by other forces; $(x_B - x_A)$ cancels out.

The relationship as displayed conforms to Hubble's law, as derived from his observations. However, it does not account for the transit time of the light; the recession velocity and redshift are established cumulatively over times earlier than the observer's t . If the scaling factor a varies significantly, observations will depart from this law. Yet we recognize $H(t)$ as a logarithmic derivative, which varies slowly.

Looking Far Back in Time, T = 2,700 K

The Cosmic Microwave Background (CMB), predicted by the Belgian priest Georges Lemaitre, was observed in 1965 by Penzias and Wilson (Bell Labs). Initially the universe was extremely hot. Even H atoms were not bound; protons and electrons formed an optically dense plasma. With telescopes, we see back only to that epoch. The universe expanded and cooled, eventually {age ~ 300,000 years} falling below T = 2,700 K ~ 0.24 eV, where the high-energy tail can't ionize H. The protons and electrons combined into H atoms, and the universe became transparent. Today the CMB temperature is 2.7 K, implying a redshift factor $z = \Delta\lambda/\lambda = 1000$, relative to that epoch. [Wien's Displacement Law: The frequency-peak of brightness is proportional to T.]

At T = 1,000,000 eV, Neutron-Proton freezeout occurred. The initial plasma of quarks and gluons consolidated into neutrons and protons, interconverting by inverse beta decay and beta decay. The abundance ratio is exp { $- \Delta m\, c^2 / k$T }, where Δm is the mass difference [$m_n = 940$ MeV, $m_p = 938$ MeV; fewer n's] and k is Boltzmann's constant. With cooling, the neutron deficiency increased. By about T = 10^6 eV, the density had decreased enough that the rate of neutron creation fell to near zero. Though neutrons continued beta-decay [isolated neutron lifetime ~889 s], their proportion fell only ~15% during nucleosynthesis, as the neutrons and protons were "cooked" into helium nuclei. There was freezeout of the neutron/proton ratio ~ 1/7.

14 protons and 2 neutrons yield 12 hydrogen nuclei and 1 He nucleus [alpha particle]. This theory gives 75% H and 25% He, agreeing with the known abundances. The theory is also correct for heavier nuclei: 10^{-5} deuterium; 10^{-5} He^3; 10^{-10} Li^7.

T = ~ 10^6 eV = 1.16×10^{10} K; dividing by 2.7 K, we find that this corresponds to $\Delta\lambda/\lambda = z = 4.3 \times 10^9$, hence $a(t)$ has increased by that factor.

Acceleration of the Scaling Factor *a(t)*

It is believed that the universe has always been expanding. That is, $a(t)$, the scaling factor, has always had a "velocity" $da(t) / dt > 0$. [The quotes reflect that $a(t)$ has no dimension.] The rate of change in

(Continued on page 5)

Other National Capital Area Meetings

Northern Virginia Astronomy Club
Sunday, November 13, 7:00 p.m. "Mars Glider", Dr. Mike Summers, GMU Department of Physics.

The Atmospheric Regional-Scale Environmental Survey (ARES) is a proposed Mars Scout Mission that would be the first airplane to fly over another planet. It has three primary science themes: Crustal Magnetism, Atmospheric Chemistry, and Mineralogy and Geology. The science issues will be addressed with a suite of instruments, including magnetometers, visible and IR cameras, and a mass spectrometer. As a near-surface aerial platform, ARES will survey Mars at a spatial resolution several orders of magnitude better than is possible from orbit, while covering vastly more surface terrain that possible with rovers. Although ARES is not primarily an astrobiology mission, all of the science themes relate to understanding the past and current biological potential of the planet Mars.

General membership meetings are open to the public, and are held at Enterprise Hall, room 80, on the campus of George Mason University (directions) in Fairfax, Virginia. The meeting hall is in the basement floor of the building. It is best to park in parking lot B and walk up the hill to the rear of Enterprise Hall (see note above).

Meetings start at 7:00 PM, on the second Sunday of every month. If you come earlier you can do a little socializing. The first part of the meeting is club business, during which the officers make reports about their activities and areas of responsibility. The next part of the meeting usually includes:

- Show and Tell, where members share gadgets, books, techniques, etc.
- The Observing Report, describing the astronomical events for the next month.
- Q&A, where beginning astronomers are encouraged to ask questions to be answered by more experienced members.
- The Sky Tour, describing what's where in the sky for the next month.

The final part of the meeting is a program, usually by one of the members, but sometimes by "outside experts". We've had presenters from all aspects of Astronomy.

There's a good deal of socializing before and after meetings, allowing members to put faces with the voices they've heard in the dark.

Please note: GMU has two parking lots designated as B. One of them has closed temporarily. Please continue further around Patriot Circle to the 2nd lot B or park in the Patriot center lot and walk to Enterprise Hall. Handicapped parking remains the same.

For more information: see http://www.novac.com

Review of Talk by Professor Theodore Alan Jacobson

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this velocity is described by the 2nd time derivative according to Einstein's equation:

$$d^2a(t) / dt^2 = - (4\pi / 3) (G / c^2) a(t) (\rho + 3 P)$$

where G is the gravitational constant, ρ the density of mass + energy, and P the pressure. The effect of mass and energy, a positive ρ, is to decelerate the expansion. [Einstein, seeking a steady state, sought an opposing term to cancel this. Thus he introduced Λ, his "Cosmological Constant"; see earlier]. Note that a negative pressure P would oppose ρ.

How shall we understand such negative pressure? In thermodynamics, one considers a gas at pressure P, enclosed within a cylinder and piston. Let the piston be withdrawn slightly, to produce an increase of volume dV. The gas, in doing work on the piston, loses internal energy U; i.e., $dU = - P\, dV$, [$P > 0$, $dV > 0$]. Let there instead be no gas, but a *positive vacuum energy increment dU* arising spontaneously upon a change dV of volume. This corresponds to a negative pressure $P = - dU / dV$.

The early universe was so hot and dense that the mass-energy ρ dominated the pressure term $3P$, and gravity slowed down the expansion. That is, since $\rho + 3P > 0$, it followed that $d^2a(t) / dt^2 < 0$. The expansion caused ρ to decrease. After some 5 billion years, $\rho + 3P$ became negative; hence $d^2a(t) / dt^2$ became positive. We entered the present epoch of accelerating expansion; hereafter, ρ continues to decrease.

This theory arose from simple considerations by Einstein. It explains a host of data: e.g., Hubble's law; the CMB; and the early stages of nuclear synthesis. But it is striking that within our current knowledge, no "vacuum energy" has been identified, to play the role of the pressure P. Physicists know well zero-point fluctuation energies of all fields and of all particle types. These are not too small to serve, but many orders of magnitude too large! New physics is needed to resolve this problem. Stay tuned!

Exploring the Sky
by Joe Morris

2005 Schedule, Remaining

Date	Time	Notes
11/5	7:00 P.M	Pleiades; possible Taurids meteor shower

Exploring the Sky is an informal program that for nearly fifty years has offered monthly opportunities for anyone in the Washington area to see the stars and planets through telescopes from a location within the District of Columbia.

Sessions are held in Rock Creek Park once each month on a Saturday night from April through November, starting shortly after sunset. We meet in the field just south of the intersection of Military and Glover Roads NW, near the Nature Center. A parking lot is located immediately next to the field.

Beginners (including children) and experienced stargazers are all welcome—and it's free! A presentation of the National Park Service and National Capital Astronomers.

Questions? Call the Nature Center at (202) 895-6070 or check the Internet sites: http://www.nps.gov/rocr/planetarium http://www.capitalastronomers.org

Getting to the NCA Monthly Meeting and the Dinner Before the Meeting

Jeff Guerber

NCA meetings are now held at 7:30 p.m. at the University of Maryland Observatory, in College Park on Metzerott Rd. between University Blvd. (MD-193) and Adelphi Rd. To get there from the Capital Beltway (I-495), either take US Rt. 1 south about a mile, turning right onto MD-193 West, then at the first light turn right onto Metzerott; or, take New Hampshire Ave. (MD-650) south, turn left at the second light onto Adelphi Rd., two more lights, turn left onto Metzerott, and proceed about a mile to the observatory. The observatory is on the south side of Metzerott Rd., directly opposite the UM System Administration building; you can park there if the observatory lot is full, but be careful crossing Metzerott Rd.

At 5:30 p.m., before the meeting, please join us for dinner at the Garden Restaurant in the UMD University College Inn and Conference Center, 3501 University Blvd. East at Adelphi Rd. From the Beltway, either take New Hampshire Ave. south, turn left onto Adelphi, and at the third light (passing Metzerott) turn left onto University then immediately right into the garage; or, take US-1 south, turn right onto University Blvd. west, and take it to the intersection with Adelphi Rd. Park either in the garage (costs), or in Lot 1 nearby (free). To get to the Observatory, exit to the right onto University Blvd. (MD-193) east, and at the second light turn left onto Metzerott Rd.

Getting to the NCA Meeting
Star=Observatory R=Restaurant P=Parking

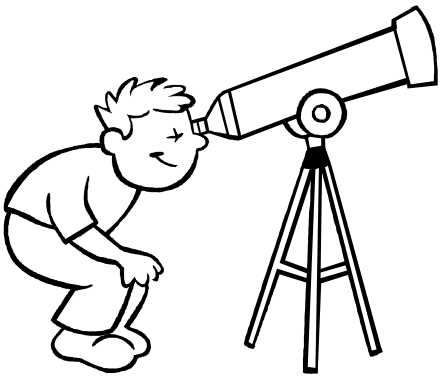
Observing after the Meeting

Elizabeth Warner

Following the meeting, members and guests are welcome to tour through the Observatory. Weather permitting, several of the telescopes will also be set up for viewing.

Are You Coming to Dinner?

If you are planning to come to the dinner before the meeting, please tell Benson J. Simon, telephone: 301-776-6721, e-mail st88@ioip.com, so that we can make reservations for the right number of people.



Do You Need a Ride?

Please contact Jay Miller, 240-401-8693, if you need a ride from the metro to dinner or to the meeting at the observatory. (Please try to let him know in advance by email at rigel1@starpower.net.)

Support the IDA

Join the International Dark-Sky Association

3225 N. First Avenue Tucson, AZ 85719-2103

www.darksky.org

Star Dust is published ten times yearly, September through June, by the National Capital Astronomers, Inc. (NCA).
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SERVING SCIENCE & SOCIETY SINCE 1937

NCA is a nonprofit, membership-supported, volunteer-run, public-service corporation dedicated to advancing astronomy, space technology, 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. NCA is an IRS Section 501(c)(3) tax-deductible organization. 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 in a number of capacities. Many members serve as teachers, clinicians, and science fair judges. Some members observe total or graze occultations of stars occulted by the Moon or asteroids.

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

Consumer Clinics: Some members serve as clinicians and provide advice for the selection, use, and care of binoculars and telescopes and their accessories. One such clinic is the semiannual event held at the Smithsonian Institution National Air and Space Museum.

Fighting Light Pollution: NCA is concerned about light pollution and is interested in the technology for reducing or eliminating it. To that purpose, NCA is an Organization Member of the International Dark Sky Association (IDA).

Classes: Some NCA members are available for educational programs for schools and other organizations. The instruction settings include star parties, classroom instruction, and school-teacher training programs that provide techniques for teaching astronomy. NCA sponsors a telescope-making class, which is described in the *Star Dust* "Calendar of Monthly Events."

Tours: On several occasions, NCA has sponsored tours of astronomical interest, mainly to observatories (such as the National Radio Astronomy Observatory) and to the solar eclipses of 1998 and 1999.

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, and others. Contact: Joe Morris, joemorris@erols.com or (703) 620-0996.

Members-Only Viewing Programs periodically, at a dark-sky site.

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

Fine Quality Telescope, 14-inch aperture, see "Calendar of Monthly Events."

Yes, I'd like to join NATIONAL CAPITAL ASTRONOMERS!

Name: _____ Date: ____/____/_____
Street address: _____ ZIP Code:_____
Telephone: ____-____-_____ E-mail: _____
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Present or Former Occupation (or, If Student, Field of Study): _____
Academic Degrees: _____ Field(s) of Specialization: _____
Employer or Educational Institution: _____

MEMBERSHIP CATEGORIES AND ANNUAL DUES RATES

All members receive Star Dust*, the monthly newsletter announcing NCA activities. As an added optional benefit to extend your knowledge of astronomy you may also choose* Sky and Telescope *magazine at the discounted rate of $33.*

Student Membership: ……..… $15 ……..with *Sky and Telescope*....$48
Standard Individual or Family Membership: ……. $27 ……...…..with *Sky and Telescope*....$60

You are welcome to make contributions in any amount in addition to the dues shown above.
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Please mail this form with your check payable to National Capital Astronomers, to:
Mr. Jeffrey Norman, NCA Treasurer; 5410 Connecticut Avenue, NW #717; Washington, D.C. 20015

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If undeliverable, return to
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4620 N. Park Ave., #306W
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FIRST CLASS
DATED MATERIAL

The November NCA Meeting is on the 2nd Saturday of November!

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