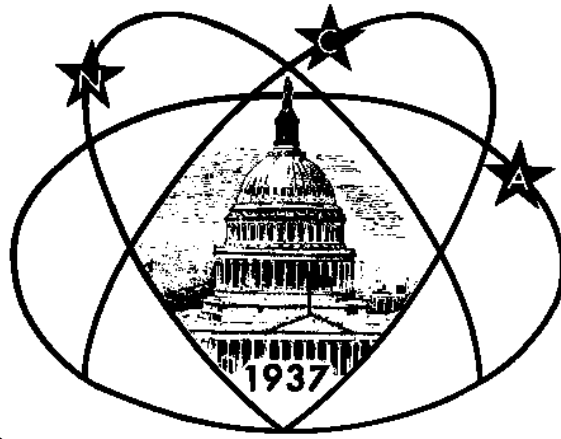


Star



Dust

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Maurice Shapiro on Cosmic Rays

submitted by Gary Joaquin

Dr. Maurice Shapiro will present the featured talk for the January 6 meeting of National Capital Astronomers, "Messengers from Outer Space — The Adventures of Cosmic Rays in the Galaxy". His talk is dedicated to the memory of Robert H. McCracken. The meeting will be held in the Lipsett Amphitheater in Building 10 (Clinical Center) of the National Institutes of Health in Bethesda at 7:30 P.M. Dr. Shapiro has provided us with a synopsis of his talk and a brief biography.

Synopsis

When Victor Hess made his manned balloon flights in Austria early in the 20th century, he discovered a penetrating radiation coming from the sky. (The "rays" turned out later to be mainly particles.) Little could he imagine that his discovery with a simple instrument, an electrometer, would lead to two important scientific disciplines: elementary particle physics and cosmic ray astrophysics.

The nature of the high energy particles bombarding the earth was not elucidated

until 1947, when it was found that, in addition to the main components, hydrogen and helium, the atomic nuclei of the elements up to iron (and later up to uranium!) were arriving at the top of the atmosphere. That the most abundant of the primary cosmic rays were protons (the nuclei of hydrogen) was established only in 1941, 30 years after Hess' discovery!

For some years, cosmic ray particles with energies of the order of billions of electron volts (GeV) worked as "nature's accelera-

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Tales of a Journey

Review of Dr. Sean Solomon's Lecture on the MESSENGER Mission to Mercury

by Nancy Byrd

At the December 2000 meeting of National Capital Astronomers, Dr. Sean Solomon told NCA about "a journey" and gave an interesting overview of the planned "MESSENGER Mission to Mercury." Dr. Solomon is the Principal Investigator for the MESSENGER Mission and the Director of the Department of Terrestrial Magnetism, Carnegie Institute of Washington. He told NCA why scientists want to do the mission and gave a summary of what is currently known about the innermost planet of our Solar System.

Mercury, a Planet of Surprises

Dr. Solomon began by showing us how Mercury is a planet of extremes. When one corrects for the effects of internal pressure, Mercury is the densest planet in the Solar System. It has the highest diurnal variation in temperature, a variation of 600 Kelvin. Data suggest that geologi-

cal processes, at least on the surface, ended first among the terrestrial planets. It is the only planet in spin orbit resonance and the only Solar System body in 3:2 spin orbit resonance. It is the smallest planet, about 2/3 the diameter of Mars, yet it has a global magnetic field and a magnetosphere most like that of Earth when compared to other planets in the solar system. Mars no longer has a global magnetic field; Venus also does not have a global magnetic field.

What Mariner 10 Taught Us

The Mariner 10 spacecraft is the only spacecraft to visit Mercury. In 1974-75, it flew by three times at approximately 180 days apart. This timing, coupled with Mercury's spin orbit resonance, meant that the spacecraft always imaged the same side of the planet. Thus, Mariner 10 imaged only 45% of the planet's surface. Nevertheless, these images showed tanta-

lizing geological features cutting its heavily cratered, superficially moonlike surface, such as numerous thrust faults which showed no preferred orientation. The images and other measurements made by the Mariner craft revolutionized what was known about this planet and pointed to major questions to be answered on a return trip. This mission also discovered Mercury's surprising magnetic field and documented the time variable nature of Mercury's magnetosphere. The mission also discovered H, He and O in Mercury's tenuous atmosphere (termed "exosphere" because of its rarified nature). Surface pressure on Mercury is about 1 part in 10^{15} that of Earth pressure at sea level.

Earth-based Observations

Earth-based observations have been minimal but have produced a few important

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NCA Events This Month

The Public is Welcome!

NCA Home Page: <http://capitalastronomers.org>

Fridays, January 5, 12, 19, and 26 from 7:00 - 10:00 P.M. - Telescope-making and mirror-grinding classes at American University, McKinley Hall, Basement (Room 9), Nebraska and Massachusetts Avenues, N.W. Call or email Guy Brandenburg to confirm: 202-635-1860 or gbranden@earthlink.net.

Fridays, 8:30 P.M. January 5, 12, 19, 26 at 8:30 P.M. - Open nights with NCA's 14-inch telescope at Ridgeview Observatory near Alexandria, Virginia; 6007 Ridge View Drive (off Franconia Road between Telegraph Road and Rose Hill Drive). Call Bob Bolster, (703) 960-9126 before 6:00 P.M.

Saturday, January 6 at 5:30 P.M. Dinner with the speaker and NCA members at the North China Restaurant 7814 Old Georgetown Road Bethesda, MD See the map and directions on Page 8.

Saturday, January 6 at 7:30 P.M. - NCA meeting, at the Lipsett Auditorium in Building 10 at NIH, will feature Dr. Maurice Shapiro talking to NCA about "Messengers from Outer Space — The Adventures of Cosmic Rays in the Galaxy"

See Page 4 for more National Capital area astronomical doings. To join NCA, use the membership application on Page 9.

Review of Sean Solomon Talk

(Continued from page 1)

results. In 1985, Potter and Morgan discovered sodium in Mercury's exosphere and in the following year, potassium. This year (2000), calcium has been reported. Mariner 10 detected none of these elements. In 1965, Gordon Pettengill and R.B. Dyce determined that Mercury has a 3:2 spin orbit resonance, not synchronous rotation, as was previously believed. This implies that every point on Mercury's equator spends some time in the Sun. But because of the high eccentricity of its orbit, the amount of insolation varies widely from place to place at Mercury's equator. Moreover, the inclination of its axis is so low that there are likely to be places on Mercury that have never seen the Sun. In fact, Slade et al. (1992) and Harmon and Slade (1992) report the discovery of polar deposits by astronomers from Arecibo and Goldstone using radar. The polarized radar signals from these deposits are diagnostic. The only other surfaces that have returned such signals are the polar ices of Mars and the surfaces of the icy moons of Jupiter. Dr. Solomon showed us a north polar image showing circular radar bright spots. Because Mariner 10 also imaged much of this area, we can see that the bright circular spots correspond to topographic depressions (craters) in the area of overlap of the two images. Such depressions, if in perma-

nent darkness, would have a temperature of about 90 Kelvin. It now appears that Mercury, a planet with a perihelion equatorial temperature as high as 700K may have permanent water ice!

The MESSENGER Mission

NASA has a program called Discovery that invites applications for proposer-initiated space craft projects. In this program, the proposer chooses what is to be done and where to do it, and makes a proposal constrained by microscheduling, launch vehicle, and total mission costs. The two main criteria for selection are scientific excellence and technical feasibility. The MESSENGER mission was selected as a Discovery mission in July 1999.

MESSENGER, Mercury Surface, Space Environment, Geochemistry, and Ranging mission will be the product of a consortium headed by the Principal Investigator, Dr. Solomon. The project will be managed by The Johns Hopkins University Applied Physics Laboratory (JHU/APL). JHU/APL will design and build the MESSENGER spacecraft, in collaboration with GenCorp Aerojet (propulsion system) and Composite Optics, Inc. (integrated structure). Instruments and instrument subsystems in the science pay-

(Continued on page 3)

Maurice Shapiro

(Continued from page 1)

tor." The advent of multi-GeV accelerators took over the task of exploring the physics of elementary particles, and many cosmic ray (CR) researchers switched to CR astrophysics. One of their striking discoveries was that of the very highest energy CR, whose origin remains a mystery. Although typical CR energies are comparable to those attainable with man-made machines, the highest CR energies are a billion times greater. A project designed to detect enough of these very rare particles requires an area of the size of Delaware.

Biography

Dr. Shapiro is best known for his investigations of the galactic cosmic rays -- their primary composition, propagation, source composition, and "age." He has also made contributions to nuclear physics and elementary-particle physics. In 1949 he founded the Laboratory for Cosmic-Ray Physics at the Naval Research Lab (NRL) in Washington, and continued to lead it until 1982. From 1953 to 1965 he was also the director of the Nuclear Physics Division at NRL. During World War II Dr. Shapiro was a group leader in the Los Alamos Laboratory of the Manhattan Project.

In 1970 he organized the Division of Astrophysics of the American Physical Society, and served as its chairman in 1971-2. Dr. Shapiro has been the founding Director of the International School of Cosmic-ray Astrophysics since 1977 at the Majorana Center in Erice, Italy. Some 700 young scientists from 28 countries have benefited from this School.

Dr. Shapiro is the past president of the Washington Philosophical Society, the Association of Los Alamos Scientists, the Association of Oak Ridge Engineers and Scientists, and the High-Energy Astrophysics Division of the American Astronomical Society. His awards include the Navy's Distinguished Service Award, a Guggenheim Fellowship, the A. von Humboldt Senior U.S. Scientist Award, the University of Chicago's Professional Achievement Award, and the Distinguished Career in Science Award of the Washington Academy of Sciences. He has been visiting professor at the University of Iowa, Northwestern University, the University of Bonn, the Weizmann Institute in Israel, and the Institute of Mathematical Sciences in Madras. He currently serves as visiting professor at the University of Maryland.

Review of Sean Solomon Talk

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load are being supplied by JHU/APL, the NASA/Goddard Space Flight Center, the University of Colorado, and the University of Michigan. The Science Team includes co-investigators from: the Carnegie Institution, JHU/APL, the University of Colorado, the University of Arizona, Southwest Research Institute, NASA/GSFC, the University of Michigan, Washington University, the University of California, Brown University, Northwestern University, and MIT.

The Current Phase of the Project

The project is currently in what NASA calls Phase B, the detailed design phase. In about six months' time (June 2001) NASA will conduct a major review and make the decision on whether or not to proceed with the mission. If the decision is yes, they will proceed to Phase C/D, fabrication, assembly, and test (July 2001 to March 2004). The launch date is March 2004. The mission will include five years of cruising, two planetary flybys of Venus (June 2004 to March 2006), two planetary flybys of Mercury (July 2007 to April 2008), insertion into Mercury orbit, and study of Mercury from orbit (April 2009 to April 2010).

Questions to be Addressed

In the mission proposal, the proposers said that MESSENGER would address the following six questions: What planet-forming processes led to the high metal/silicate ratio in Mercury? What is the geological history of Mercury? What are the nature and origin of Mercury's magnetic field? What are the structure and state of Mercury's core? What are the radar-reflective materials at Mercury's poles? What are the important volatile species and their sources and sinks on and near Mercury?

The first question bears on the evolution of the Solar System. George Wetherill of Carnegie Institution, one of the foremost experts on the evolution of the terrestrial planets, has done computer simulations of planet formation. One such scenario results in a planet about the same mass, distance from the Sun and bulk composition as Mercury (Wetherill, 1988). However, in this scenario the planet suffered impacts, which caused it to move around the inner solar system. The implication of this scenario is that Mercury need not have formed in its present orbital position.

There are three competing ideas as to how Mercury got its high metal/silicate ratio. Idea #1, due to Weidenschilling in 1978, postulates that in the early Solar nebula, particles would begin to accrete in the Mercury orbital neighborhood; those with a lower metal/silicate ratio would have less mass and therefore would be more subject to aerodynamic drag and would fall into the sun. Idea #2, by Cameron (1985) and Fegly and Cameron (1987) postulates that, at some point in the history of Mercury, the Sun was particularly active and vaporized the silicate outer crust, leaving a metal-enriched Mercury. A prediction of this theory is that Mercury would be enriched in refractory minerals (minerals with high boiling points) and there would be a depletion of alkali metals and FeO. Idea #3 by George Wetherill (1988) postulates that Mercury suffered a giant impact after differentiation (a gravitational sorting process wherein the denser materials sink to the center of the planet and the less dense float). The impact selectively removed silicates. Benz et al. (1988) posit that the impact preferentially removed mantle material, leading to a depletion of Calcium-Aluminum silicates, without the enhancement of refractories. Thus, study of the composition of the crust may well help to understand the evolution of Mercury and the inner Solar System.

Geology of Mercury

Mariner 10 returned images of many unique geological features about which we have many ideas and questions, but no mission to the neighborhood of Mercury has happened in 25 years. What is the meaning of these geological features? What is the surface composition of Mercury?

Earth-based surface reflectance in the visible and the near infrared show no strong absorption features. Overall, the spectra are similar to that of the lunar highlands. McCord and Clark in 1976 reported a shallow absorption feature at $.85 \mu\text{m}$, possibly of Fe^{2+} in pyroxene, but this finding remains controversial.

Jeanloz et al. (1995), based on microwave and mid IR observations, suggest that Mercury's surface contains considerably less FeO and TiO_2 than most lunar highland samples. They postulate a basalt-free, feldspar-rich crust without effusive volcanism.

Mariner 10 returned pictures of Mercury showing heavily cratered terrain and smoother terrain with few craters. A tantalizing feature, seen all over Mercury and without any preferred orientation is the lobate scarps. Where these scarps crosscut craters, the craters appeared foreshortened, suggesting thrust faulting. Did Mercury shrink? Was this due to cooling? No other planet shows such evidence of shrinking. The question of what the smooth terrain is, remains. Is it volcanic? We need higher resolution images to answer this. Can we distinguish geologic units on the basis of chemistry and mineralogy? The work of Robinson and Lucey (1997) indicates that we can. Finally, do we have samples of Mercury in our meteorite collections? We can recognize Mars rocks and Moon rocks. We do not have sufficient information about what distinguishes a Mercury rock from any other rock to answer this question. The big question is the following: Is the part of Mercury that Mariner 10 saw similar to the rest of the planet or will we have to revise many of our notions of Mercury? Our experience with Mars taught us to be wary of information gleaned in flybys. None of the apparently water sculpted features, nor the large volcanoes of Mars were seen in the Mars flybys. An Arecibo radar image (Harmon 1997) suggests a large (400km) shield volcano on Mercury.

Mercury's Magnetic Field

Mariner 10 discovered Mercury's magnetic field, a big surprise. The field is Earth-like in a number of respects: both planets have dipole magnetic fields, and the magnetic poles appear to be approximately lined up with the axes of rotation. Earth's magnetic poles wander around the rotational axis with a period of about 10,000 years. But Mercury fills a much greater percentage volume of its magnetosphere than does Earth. The Solar wind is much greater than greets the Earth and Mercury has no ionosphere to interact with that Solar wind.

There are a number of competing theories as to what is the nature of Mercury's internal magnetic field: hydromagnetic dynamo, thermoelectric currents, or magnetic remanence. Each of these would produce different geometries of magnetosphere. We do not yet have models which yield testable predictions for distinguishing between the theories. To date, our knowledge of

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Other National Capital Area Meetings, etc.

U.S. Naval Observatory (USNO)

conducts a free 90-minute tour of its facilities every Monday night at 8:30 p.m., except on Federal holidays. The tour includes presentations about the Master Clock, observations through telescopes (weather permitting), a video presentation on the mission and history of the Observatory, and discussions with staff astronomers. Call the USNO Public Affairs Office, 202/762-1438 before going down. Source: <http://www.usno.navy.mil>

Department of Terrestrial Magnetism (DTM) Carnegie Institute of Washington Seminars are held on Wednesdays at 11:00 a.m. in the Main Building, 5241 Broad Branch Road, N.W., Washington, D.C.

January 3, Derek L. Schutt, Department of Terrestrial Magnetism, "Upper Mantle Structure Around the Yellowstone Hot-spot".

January 24, Derek C. Richardson, Department of Astronomy, University of Maryland, "Adventures with Rubble Piles: The Evolution of Fragile Planetesimals".

January 31, Mark A. Richards, DTM Visiting Investigator, Department of Geology and Geophysics, University of California, Berkeley, "Why Earth has Plate Tectonics and Why Venus Does Not".

DTM is located on 32nd Street one block south of its intersection with Military Road. Proceed south on 32nd Street one block to Jocelyn Street, turn left on Jocelyn, and right into the parking lot. Coffee and tea will be served at 10:45 a.m. Please call to confirm that there have been no cancellations. Tel. 202-478-8830. Source: <http://www.ciw.edu/DTM-seminars.html>

Goddard Scientific Colloquium

Construction in Building 3 has been postponed. The Scientific Colloquium will be held at 3:30 p.m. on Fridays in the Building 3 auditorium until the work is re-scheduled.

January 12 Ken Neelson, Jet Propulsion Laboratory, "Extremophiles".

January 19 Donald Gurnett, University of Iowa, "Magnetospheric Radio and Plasma Waves Throughout the Solar System".

If you plan to attend and do not have a NASA badge, please contact Carol Krueger, at (301) 286-6878, at least 24 hours beforehand. Source: leawww.gsfc.nasa.gov/users/djt/colloq/

Montgomery College's Planetarium

Fenton St. in Takoma Park, MD.
Saturday, January 27 at 7:00 P.M.

"Astrolabes" Source: <http://www.mc.cc.md.us/Departments/planet/>

Northern Virginia Astronomy Club (NOVAC) meets 6:00 p.m. at Lecture Hall 1 on the Fairfax campus of George Mason University. 703 803-3153.

January 14 Dr. Eric Smith, "The Next Generation Space Telescope". NGST is planned as a powerful space telescope that will replace the highly successful Hubble Space Telescope when it retires near the end of this decade. Scheduled for launch in 2009, NGST will feature lightweight optics approximately 8 meters in aperture (HST is 2.4 meters), and will carry cameras and spectrographs sensitive to infrared radiation. Over the telescope's 5-10 year lifetime astronomers hope to observe the farthest reaches of the universe. Dr. Smith is the Deputy Project Scientist for NGST at Goddard Space Flight Center. Source: <http://novac.com>

University of Maryland Observatory on Metzert Road. Open house on 5 and 20 of each month includes a 20- to 30-minute slide presentation in the lecture hall, followed by telescope viewing.

January 5 at 8:00 p.m. Film: "Mysteries of the Universe: Science Odyssey".

January 20 at 8:00 p.m. Dr. Peter Teuben, "Galaxy: The Universe in Numbers (Monty Python)".

February 5 at 7:15 p.m. & 8:00 p.m. Dr. Dana Hurley Crider, Goddard Spaceflight Center, "What Happened to the Water on Mars".

Info: (301) 405-3001 Source: <http://www.astro.umd.edu/openhouse/>

University of Maryland College Park Astronomy Department Colloquia — None currently scheduled. Source: <http://www.astro.umd.edu/colloquia/>

Greenbelt Astronomy Club The Greenbelt Astronomy Club meets on the last Thursday of each month (except holidays) at 7:30 p.m. at the Howard B. Owens Science Center, 9601 Greenbelt Road, Lanham, MD 20706. For more information on upcoming events, call (301) 277-4041 or e-mail at grnblastro@learn.com. (Call the Science Center at 301-918-8750 or (301) 441-4605 to confirm meeting dates). Next meeting: January 25. Club meetings are open to the general public. Source: leawww.gsfc.nasa.gov/docs/outreach/gac/GAC.html

NASA/GSFC LEP Seminar Laboratory for Extraterrestrial Physics Brown Bag Seminar. The Laboratory for Extraterrestrial Physics (LEP) at NASA's Goddard Space Flight Center

conducts weekly science seminars Fridays at noon in Room 8 in Building 2 at Goddard.

January 5, Mike Carlowicz, Raytheon ITSS at NASA/GSFC, "National Sun Earth Day 2001".

January 12, Masha Kuznetsova, "Incorporating Collisionless Magnetic Reconnection Effects into MHD Models".

January 19, Ed Sittler, "Pickup Ions at Dione and Enceladus".

January 26, Bill Burke, TBD

February 2, Tom Moore, "Low Energy Neutral Atoms as Seen from IMAGE".

Source: http://lepjas.gsfc.nasa.gov/~seminar/lep_seminar.html

Goddard Engineering Colloquia

All colloquia are held at 3:30 p.m. on Mondays in the Building 3 Auditorium, unless otherwise indicated below.

No information available at press time.

Note: Individuals not badged for entry into Goddard should obtain the current procedure by contacting Main Gate security at 301-286-7211. Source: <http://ecolloq.gsfc.nasa.gov/sched.html>

Space Telescope Science Institute (STScI) Free public Lectures at the Space Telescope Science Institute.

Lectures are at 8 p.m. the first Tuesday of every month in the STScI auditorium, on the campus of Johns Hopkins University. Free parking is available. For directions, call 410-338-4700.

January 2, Dr. Chris Fassnacht, "Riding the Cosmic Flow: How Fast are We Going?"

February 6, Megan Donahue, "Chandra Observations of Clusters of Galaxies".

The Johns Hopkins University's Bloomberg Telescope is open to the public every Friday evening, weather permitting. For more information, contact the observatory at (410)-516-6275 or via email at altan@pha.jhu.edu. Source: http://hubble.stsci.edu/about_us/open-night.shtm

Deadline for February Star Dust: January 15



Please send submissions to Elliott Fein at elliott.fein@erols.com.

Text must be in ASCII, MS Word, or WordPerfect. Graphics in BMP are best.

Thanks.

Other National Capital Area Meetings, etc.

Laboratory for Astronomy and Solar Physics (LASP) — Seminars are on Thursday at 3:30 PM in GSFC Bldg. 21, Room 183.

January 18, Wei Zheng, Johns Hopkins University, "PRIME for NGST".

January 25, Roland van der Marel, STScI, "The Mass and Velocity Distribution of Galaxy Clusters".

February 1, David Wilner, Harvard-Smithsonian CFA, "The Dark Side of Star Formation: Probing High Redshift Galaxies with the Sub-millimeter Array".

Coffee, Tea, and Cookies served before the seminar. For additional information contact Eli Dwek at 301-286-6209 (edwek@stars.gsfc.nasa.gov) or Jon Gardner at 301-286-3938 (gardner@harmony.gsfc.nasa.gov). Source: http://stars.gsfc.nasa.gov/www/lasp_colloq/index.html

National Air & Space Museum – Free lectures at the Einstein Planetarium and other daily events. 202-357-2700. No info at press time. Home page: <http://www.nasm.edu>.

Laboratory for High Energy Astrophysics (LHEA) Tuesday Seminar Series — NASA GSFC Building 2, Ground Floor Conference Room, 3:30 P.M. No information available at press time. Source: <http://lheawww.gsfc.nasa.gov/docs/lhea/TuesSeminar/Seminar.html>

LASP Stellar & Extra-Galactic Astronomy Lunch — Talks are Wednesdays at 12:00 Noon in Room 242 of Building 21, except as noted.

January 17, Johannes Staguhn, GSFC/RITSS, "High Resolution Observations with Millimeter Interferometry".

January 24, Nicholas Phillips, GSFC/RITSS, "Neural Networks as a Tool for Parameter Estimation".

January 31, Jason Rhodes, GSFC/NRC, "Cosmic Shear with HST Images".

Tuesday, February 6, Eli Dwek, GSFC, "On Chemical Evolution with Dust".

Source: <http://hires.gsfc.nasa.gov/~gardner/seal/>

Washington Area Astronomers Meeting

The next Washington Area Astronomers Meeting will be held on **Thursday, February 22** at NASA's Goddard Space Flight Center, Greenbelt, MD. The meeting will be held in Building 26, room 205.

To get on the mailing list, contact George Kaplan at the U.S. Naval Observatory, gkaplan@usno.navy.mil, (202) 762-1562 Source: http://aa.usno.navy.mil/waa/mtg_info.htm

Baltimore Astronomical Society

Meetings are held the second Tuesday of each month at 7:30 p.m. at the Maryland

Science Center, 601 Light Street, Baltimore, MD. For these meetings *only*, you may park in the Science Center Lot on Key Highway. Come in the Members' Entrance, and sign in at the Guard Desk. Hotline: 410-545-5919. Source: <http://www.baltastro.org/>

Maryland Science Center, 601 Light Street, Baltimore, MD

Planetarium programs: no information available for January.

Crosby Ramsey Memorial Observatory: Stargazing Thursdays

See the Moon, planets, and stars through our historic, and now computer controlled, Alvan Clark & Sons 8" refracting telescope. The observatory is open to the public every Thursday from 5:30 to 10:00 P.M., weather permitting. Admission is free. Phone 410-545-2999 after 5:00 P.M. on Thursdays to

find out if the observatory will be open that night. The observatory is on the roof of the Maryland Science Center. On Thursdays, enter on the southern side of the building — the side that faces Key Highway. (The northern doors, facing the Inner Harbor, will not be open.) The observatory is open to the outdoors, so please dress appropriately.

Sungazing Sundays: Safely look at the Sun and its features — such as sunspots and prominences — through a special set of filters on our telescope. The observatory is open to museum visitors every Sunday from 11:00 A.M. to 4:00 P.M., weather permitting. Admission is included with Science Center admission. Phone 410-545-2999 after 10:30 A.M. on Sundays to find out if the observatory will be open that day. Source: <http://www.mdsci.org/>.

Support the IDA

Join the International Dark-Sky
Association

3225 N. First Avenue Tucson, AZ
85719-2103

www.darksky.org

Review of Sean Solomon Talk

(Continued from page 3)

Mercury's magnetosphere is poorly constrained; moreover, until we can measure the field from orbit, we cannot separate Mercury's internal field from the external field. Currently, the most popular idea is that Mercury's internal magnetic field is due to a hydromagnetic dynamo, like that of Earth. Hopefully, data taken in Mercury orbit will answer the question.

Dr. Solomon displayed a nice cartoon of the magnetic field of Mercury as it is currently understood. He pointed out that the drawing failed to convey the dynamic nature of the field. It is quite variable, because of Mercury's small size and proximity to the Sun.

Libration of Mercury and Mercury's Core

Because of the high eccentricity of Mercury's orbit, 0.2, the highest in the Solar System next to Pluto, Mercury varies in distance from the Sun from 0.3 to 0.45 AU. Because of that variation, the effect of solar tides varies during a Mercury year, causing a libration of longitude, or variation in the planet's spin rate. "It is small, but it is measurable." Dr. Solomon then told us that as a consequence of spin-orbit resonance, there is a relation linking the amplitude of physical libration, the obliquity of the planet, and the gravity field of the planet. From this relation, one can recover the moment of inertia of the solid outer part of a planet. If there is a fluid outer core, that moment of inertia will be a factor of 2 greater than if it is entirely solid. From careful altimeter measurements from orbit and geometrical calculations, calculation of the gravity field, and the above relations, we can determine how much of the core is liquid and how much is frozen. (Such techniques could provide useful information about the ocean content of Europa as well.)

The Polar Deposits

Current observations are consistent with the presence of water ice. But could the radar brightness be due to elemental sulphur? If ice, how much would be cold-trapped in Mercury craters? MESSENGER's gamma ray and neutron spectrometer will detect water ice. The ultraviolet spectrometer will detect sulphur.

The Volatiles

Finally the MESSENGER mission will address the question of the volatiles discovered in Mercury's exosphere. For this task, the ultraviolet spectrometer and the energetic spectrometer measurements will be compared to the x-ray and gamma-ray spectrometers to discriminate between different placement mechanisms such as photo sputtering, ion sputtering, impact vaporization, etc.

We wish Dr. Solomon and his colleagues success in this excellently conceived project, and we thank Dr. Solomon for his very interesting talk.

Star Dust Is Now Available Electronically

(Correction)

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 ngroman@erols.com, or via telephone at 301-656-6092 (home)

Meteor Showers

January Radiants

Full Moon: January 9

Major Activity

Radiant	Duration	Maximum
Quadrantids (QUA)	December 28-January 7	January 3 11:36 UT

Minor Activity

Radiant	Duration	Maximum
Zeta Aurigids	December 11-January 21	December 31/January 1
January Bootids	January 9-18	January 16-18
Delta Cancrids (DCA)	December 14-February 14	January 17
Canes Venaticids	January 13-30	January 24/25
Eta Carinids	January 14-27	January 21/22
Eta Craterids	January 11-22	January 16/17
January Draconids	January 10-24	January 13-16
Rho Geminids	December 28-January 28	January 8/9
Alpha Hydrids	January 15-30	January 20/21
Alpha Leonids	January 13-February 13	January 24-31
Gamma Velids	January 1-17	January 5-8

Daylight Activity

None

Source: <http://comets.amsmeteors.org/meteors>

Mid-Atlantic Occultations and Expeditions January 2001 to Early February 2001

by David Dunham

Asteroidal Occultations

DATE	Day	EST	Star	Mag	Asteroid	dmag	Dur	Ap. s in.	Location
Jan 7	Sun	23:04	TYC24671659	11.1	Tatjana	3.3	6	8	DC area
Jan 17	Wed	1:46	TYC13390878	11.1	Deborah	3.3	5	8	Georgia
Jan 23	Tue	3:52	TYC29731090	9.7	Talhybius	6.4	3	6	Georgia
Jan 26	Fri	22:58	TYC24511980	11.7	Etheridgea	2.7	7	8	DC area
Jan 27	Sat	18:47	SAO 129257	8.4	Troilus	8.2	4	2	Ohio
Feb 1	Thu	6:34	TAC-6o 7853	11.0	Melpomene	1.1	10	8	NC; Sun -8 deg.

Notes:

Jan. 27: Troilus is a Trojan asteroid.

Feb. 1: Melpomene may have a distant large satellite, from a 1978 occ'n

Lunar Grazing Occultations

DATE	Day	EST	Star	Mag	% alt	CA	Location
Jan 1	Mon	18:31	ZC 0018	5.8	40+	46	12S Duck, NC
Jan 5	Fri	0:12	85 Ceti	6.3	72+	26	-1N Mason-Dixon Line
Jan 18	Thu	7:21	30 Librae	6.5	31-	37	12S Lexington, VA; Sun -3 deg.
Feb 3	Sat	22:17	ZC 0760	6.6	76+	57	2S Westminster & Bel Air, MD
Feb 3	Sat	23:40	106 Tauri	5.3	76+	43	1N Harrisburg, PA

Total Lunar Occultations

DATE	Day	EST	Star	Mag	% alt	CA	Notes
Jan 1	Mon	18:08	D ZC 0018	5.8	40+	45	45S Sp. K1; graze, Duck, NC
Jan 4	Thu	23:18	D ZC 0398	6.5	72+	36	65N Sp. K0
Jan 5	Fri	0:03	D 85 Ceti	6.3	72+	28	19N Close dbl.; graze n. MD
Jan 6	Sat	16:49	D delta1 Tau	3.8	88+	27	88N Sun alt. +1 deg.
Jan 6	Sat	17:26	D delta2 Tau	4.8	88+	34	44S Sun -5 deg.; Hyades
Jan 6	Sat	18:13	D delta3 Tau	4.3	89+	43	60N dbl., 7.5 mag., 1.6" n.
Jan 6	Sat	19:21	D ZC 0663	6.9	89+	56	31N Sp. A0
Jan 7	Sun	0:50	D SZ Tauri	6.5	90+	44	56S Sp. F5
Jan 7	Sun	23:42	D zeta Tauri	3.0	96+	67	84S Sp. B4
Jan 8	Mon	0:58	R zeta Tauri	3.0	96+	54	-87S
Jan 12	Fri	22:08	D ZC 1578	6.9	84-	15	79S Sp. K0; maybe double
Jan 17	Wed	4:07	R ZC 2072	6.6	40-	28	89N Sp. K0
Jan 30	Tue	20:32	D SAO 109952	7.4	34+	30	80S Sp. K0
Jan 31	Wed	19:24	D SAO 110464	6.8	44+	52	71S Sp. K0
Feb 1	Thu	19:21	D SAO 93301	7.2	54+	61	63N Sp. G5
Feb 1	Thu	20:52	D ZC 0464	6.1	55+	49	77N Sp. K0; maybe double
Feb 2	Fri	22:42	D ZC 0610	5.9	66+	41	26N dbl., mag. 9.3 4.4", PA 326
Feb 3	Sat	0:34	D ZC 0620	6.1	67+	21	83S Sp. K0
Feb 3	Sat	23:27	D 106 Tauri	5.3	77+	45	23N Sp. A5; maybe double

D following the time denotes a disappearance, while **R** indicates that the event is a reappearance. When a power (x; actually, zoom factor) is given in the Notes, the event can probably be recorded directly with a camcorder of that power with no telescope needed. The times are for Greenbelt, MD, and will be good to within ± 1 min. for other locations in the Washington-Baltimore metropolitan areas unless the cusp angle (CA) is less than 30 deg., in which case, it might be as much as 5 minutes different for other locations across the region. **Mag** is the star's magnitude. **%** is the percent of the Moon's visible disk that is sunlit, followed by a + indicating that the Moon is waxing and - showing that it is waning. So **0** is new moon, **50+** is first quarter, **100+** or - is full moon, and **50-** is last quarter. The Moon is crescent if **%** is less than 50 and is gibbous if it is more than 50. **Cusp Angle** is described more fully at <http://www.lunar-occultations.com/iota>. **Sp.** is spectral type-color, **O,B**,blue; **A,F**,white; **G**,yellow; **K**,orange; **M,N,S,C** red

Phone the IOTA occultation line, 301-474-4945, for weather go/cancel decisions, and other updates, or check IOTA's Web site at <http://www.lunar-occultations.com/iota> for finder charts and path updates.

David Dunham, 2000 Dec. 17

Phone home 301-474-4722; office 240-228-5609; car 301-526-5590.

Getting to the NCA Monthly Meeting

Saturday, January 6

5:30 P.M. - Dinner with the speaker and NCA members at the

North China Restaurant
7814 Old Georgetown Road (near Cordell)
Bethesda, MD
301-656-7922

7:30 P.M. - NCA Meeting at Lipsett Auditorium in Building 10 at NIH. Guest speaker: Dr. Maurice Shapiro; title of talk: "Messengers from Outer Space — The Adventures of Cosmic Rays in the Galaxy"

Directions to the Meeting Place

From Rockville Pike (Wisconsin Ave., Rt. 355)

To get to the parking lot at the South entrance (this will be the entrance for the next three years or so until they finish the new wing) from Rockville Pike, enter NIH at the Metro Entrance: South Drive (traffic light). Go straight ahead. At the third stop sign you will be at the parking lot, but you will have to make a left turn then a right to get to the entrance to the lot. Make a right turn into the lot. Building 10 is just north of the parking lot. Enter the building and follow the signs to the Lipsett Auditorium.

From Old Georgetown Rd., enter at Lincoln Drive (traffic light nearest to Suburban Hospital). Go straight ahead. The second stop sign is at a T. Bear left and the lot will be on the right.

Make a right turn into the lot.

Metrorail Riders - From Medical Center Metro Station: Walk down the hill, past the bus stops. Continue straight past the anchor. At the second stop sign after the anchor, bear right up the incline into the entrance of Building 10, the tallest building on campus (walking time less than 10 minutes).

Taking the J2 or J3 buses from Silver Spring, get off at the Metro stop and follow the directions given for motorists from that point. If coming from Montgomery Mall, get off at the first stop in NIH, before the Clinical Center. There are signs near the ramp for the garage directing you into the side entrance. Walk straight through the building to the Lipsett amphitheater.

Directions to the Restaurant

Dinner before the meeting will be at 5:30 P.M. at the
North China Restaurant
7814 Old Georgetown Road (near Cordell)
Bethesda, MD
301-656-7922

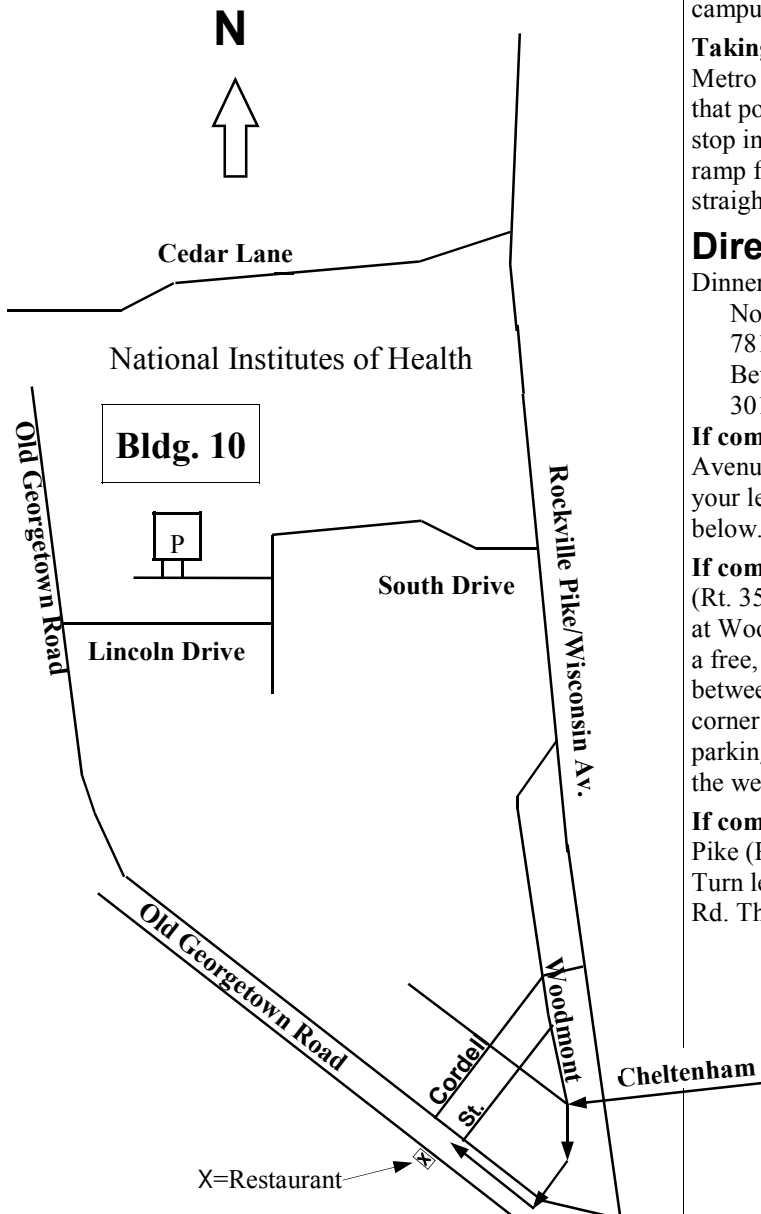
If coming from the District, when going north on Wisconsin Avenue, ignore all signs until you pass Old Georgetown Road on your left. Once past Old Georgetown Rd., follow the directions below.

If coming from south of Bethesda, go north on Wisconsin Ave. (Rt. 355), turn left onto Cheltenham Dr. (traffic light). Turn left at Woodmont Ave. Turn right onto Old Georgetown Rd. There is a free, public parking garage very close to Old Georgetown Road between Cordell and St. Elmo. The restaurant is almost on the corner of Cordell and Old Georgetown Road. Best to get to the parking garage by 5:30 because it becomes full soon thereafter if the weather is good.

If coming from north of Bethesda, go south on the Rockville Pike (Rt. 355). Turn right onto Cheltenham Dr. (traffic light). Turn left at Woodmont Ave. Turn right onto Old Georgetown Rd. The restaurant is a few doors from the corner of Cordell.

After dinner,

Go Northwest on Old Georgetown Rd.
Enter NIH at Lincoln Drive (traffic light nearest to Suburban Hospital). Go straight ahead.
The second stop sign is at a T.
Bear left and the lot will be on the right.
Make a right turn into the lot.



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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. 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. Most of these NCA members are also members of the International Occultation Timing Association (IOTA).

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). Some NCA members are also individual members of IDA.

Classes: Some NCA members are available for educational programs for schools and other organizations. The instruction settings include star parties, classroom instruction, and schoolteacher 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. Contact: Sue Bassett wb3enm@amsat.org

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 the NATIONAL CAPITAL ASTRONOMERS

Date:

Name(s): _____

Address: _____

Telephone: _____ E-mail: _____

Other family members who should receive a membership card: _____

Dues:

___ \$57 With *Star Dust* and a discount subscription to *Sky & Telescope*.

___ \$27 With *Star Dust* ONLY.

___ \$45 Junior membership with *Star Dust* and a discount subscription to *Sky & Telescope*.

___ \$15 Junior membership with *Star Dust* ONLY.

___ \$100 Contributing member (with *Sky & Telescope*) (\$43 tax-deductible).

___ \$150 Sustaining member (with *Sky & Telescope*) (\$93 tax-deductible).

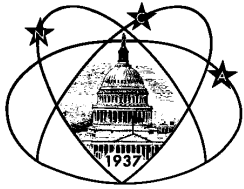
Junior members only: Date of Birth: _____ Only members under the age of 18 may join as juniors.

Tax deductible contribution: _____ Thank You.

_____ I prefer to receive *Star Dust* by e-mail.

Please send this form, with your check payable to National Capital Astronomers, Inc., to:

Mr. Jeffrey Norman, NCA Treasurer, 5410 Connecticut Ave NW #717, Washington DC 20015-2837



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If undeliverable, return to
NCA c/o Nancy Roman
4620 N. Park Ave., #306W
Chevy Chase, MD 20815-4551

**FIRST CLASS
DATED MATERIAL**

Urgent

Director for Juniors' Program Wanted

NCA is looking for a volunteer to take over the juniors' program. This person would serve as an astronomical contact point for juniors, and would match up an interested junior with an astronomical mentor. Leith Holloway, who has chaired it for many years is retiring from the job. If you are interested, please email or call Nancy Byrd, nancy@pangean.com. or 703-978-3440.

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