# Star Dust

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

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## April Speakers: Michael J. Mumma ,"The Organic Origins Observatory" and Ian Jordan, "Star Visors: The External Occultation Technique for Observing Exoplanets"

***Submitted by Jeff Guerber***

Dr. Michael J. Mumma and Mr. Ian Jordan will present the talks at the April 2 meeting of the National Capital Astronomers. The meeting will be held at 7:30 P.M. in the University of Maryland Astronomy Observatory on Metzerott Road in College Park, MD. Dr. Mumma will speak about "The Organic Origins Observatory (OOO)." Ian. Jordan will speak about Umbral Missions Blocking Radiating Astronomical Sources (UMBRAS).

**Abstract of OOO Talk**

The central quest in Astrobiology and Planetary Science is to understand the origin, evolution, and distribution of life. These issues are closely linked to the origin and evolution of organic chemicals and water in comets, planets, proto-planetary disks, and exoplanets. The proposed Organic Origins Observatory (OOO) is a meter-class radiatively-cooled telescope featuring a cross-dispersed echelle grating spectrometer. OOO would be placed at the L2 Lagrange point and would be the first space observatory to offer very high-dispersion infrared spectroscopy. OOO will assess chemical evolution in proto-planetary disks, will evaluate the role of exogenous delivery to exoplanets, and will test whether comets delivered Earth's oceans and pre-biotic organics.

***the evolution of organic chemicals***

**Bio of Dr. Mumma**

Dr. Michael J. Mumma has research inter-

*(Continued on page 2)*

## Review of talk by Dr. Randy Kimble, "Robotic Repair of the HST?"

***Reviewed by Jay H. Miller***

The speaker at the March 12 meeting of the National Capital Astronomers at the University of Maryland Astronomy Observatory was Dr. Randy Kimble. Dr. Kimble had originally planned on speaking to us last fall, but had to postpone his talk. In the meantime events have changed the Hubble's future. There is no money in the President's FY06 budget for a repair mission. Thus the title of the talk now ends in a question mark.

The talk was divided into two parts. The first dealt with the motivation for servicing the Hubble Space Telescope (HST) and the second dealt with the execution of the task. Originally the goals were to extend the lifetime of the telescope by replacing critical systems, install new instruments to enhance its capabilities, and to prepare for its safe disposal when its observing life-time was over by bringing it back in the shuttle and putting it in the Smithsonian. The first two were part of the planned fourth servicing mission, SM4.

***the motivation for servicing HST***

Unfortunately, the loss of Columbia two years ago has changed everything. In January 2004, SM4 was cancelled; in August 2004 NASA was authorized to work toward the robotic servicing and de-orbit mission in connection with NASA's "Vision for Exploration"; in December, the National Academy of Sciences endorsed a shuttle servicing mission, but in February 2005 the President's FY06 budget included funds only for de-orbiting.

There is now no intent to bring the Hubble

*(Continued on page 3)*

# NCA Events This Month

## The Public is Welcome!

**NCA Home Page: http://capitalastronomers.orgt**

**NCA Mirror- and Telescope-making Classes:** Fridays, April 1, 8, 15, and 22, 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:** Sunday, April 3, and Saturdays, April 9, 16, and 23, in Mike McNeal's backyard, 5410 Grove St, Chevy Chase, MD, (Friendship Heights Metro). Please make reservations by 10 p.m. the Friday before. See more information o this page. Call Mike at 301-907-9449 or email him at mcnealmi@verizon.net to let him know you are coming.

**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.

**NCA meeting:** Saturday, April 2 at 7:30 P.M. at the University of Mary-land Astronomy Observatory on Metzerott Road in College Park, MD. There is observing through the observatory's telescopes at the end of the meeting if the sky is clear.

**Dinner with NCA members and speakers:** Saturday, April 2 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**
2005: April 2, May 7, and June 4

# Observing with the NCA C-14

## *Mike McNeal*

| All at 8:45 p.m. | Prime Objects |
|---|---|
| April 3 | Saturn |
| April 9 | M44, Saturn |
| April 16 | NGC2403, Moon |
| April 23 | NGC2903 |

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 to let him know you are coming.

# April Speakers, *continued*

*(Continued from page 1)*
ests in atomic and molecular structure, planetary and cometary physics and chemistry, and the formation, evolution, and characterization of planetary systems. He pioneered the application of high dispersion infrared spectroscopy to comets, resulting in the first detections of cometary water, methane, ethane, and other chemicals. With the near-infrared cross-dispersed echelle spectrometer at Keck-2, he now detects up to ten parent volatile species simultaneously along with numerous other components in comets. Dr. Mumma is the author or co-author of more than 170 refereed scientific papers. He is an elected Fellow of the American Physical Society. He twice received NASA's Medal for Exceptional Scientific Achievement, and in 1999 the International Astronomical Union named Asteroid 8340 "Michael J. Mumma" in his honor. He is a Senior Scientist in the Solar System Exploration Division, and Director of the Goddard Center for Astrobiology, NASA Astrobiology Institute.

**Abstract of "Star Visors" Talk**
In 1962, Lyman Spitzer and Bob Danielson first published an analysis of the efficacy of interposing an external screen to block light from a star so that a planet in orbit could be observed. The renaissance of space astronomy and technological advances has brought the external occultation technique to the verge of realization. Ian Jordan will describe how star visors

## *direct imaging of exosolar planets*

may be used in conjunction with other techniques to achieve the goal of direct imaging and study of exosolar planets. He also will discuss some of the history and results of the UMBRAS (Umbral Missions Blocking Radiating Astronomical Sources) collaboration, including recent ground demonstrations performed with the aid of GSFC and the Westminster Astronomical Society.

**Bio of Ian Jordan**
Ian Jordan has been an integrated science planner and program coordinator for Computer Sciences Corporation on the HST project at Space Telescope Science Institute for eight years. He completed requirements for an M.Sc. in Applied Physics from the Johns Hopkins University in 2004. Previously, Jordan was an astronomer for seven years at the U.S. Naval Observatory's Washington, D.C. and New Zealand transit-circle stations, and then a Planetary Data System archive specialist at the University of Maryland's Astronomy Department. He is a member of the AAS, RASC, RASNZ, and a senior member of the AIAA, with half a dozen first-authorship publications. The focus of his research has been investigation of vehicle and mission design, testing, and operations analysis as applied to external occulters.

# Exploring the Sky
## *by Joe Morris*

### *2005 Schedule*

| Date | Time | Notes |
|---|---|---|
| 4/9 | 8:30 P.M. | Orion; Taurus; Leo; Pleiades |
| 5/14 | 9:00 P.M. | Moon and Saturn near Gemini; Beehive cluster |
| 6/11 | 9:00 P.M. | The Big Dipper and the Summer Triangle |
| 7/16 | 9:00 P.M. | 10-day-old Moon; Jupiter in the western sky |
| 8/27 | 8:30 P.M. | Pegasus and Andromeda rising; Hercules |
| 9/24 | 8:00 P.M. | Rock Creek Park Day; Andromeda Galaxy |
| 10/8 | 7:30 P.M. | Draconid meteor shower peak 10/8 |
| 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.

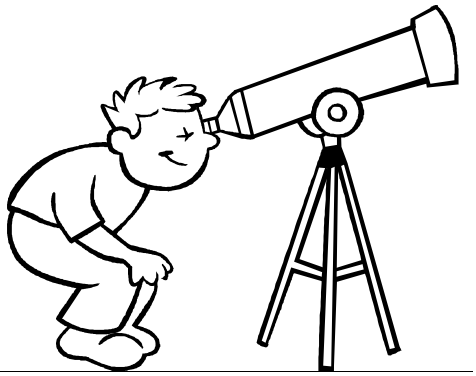
Beginners (including children) and experienced stargazers are all welcome—and it's free!

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

A presentation of the National Park Service and National Capital Astronomers.

# 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 hard-copy via U.S. Mail, should contact Nancy Grace Roman, the NCA Secretary, at
nancy.roman6@verizon.net
or 301-656-6092 (home).



# Review of Talk on Robotic Repair, *continued*

*(Continued from page 1)*

back to Earth in the shuttle. While it would be nice to have it in the Smithsonian, the added weight of the HST is considered to be too great for a safe re-entry of the shuttle. Therefore, a controlled powered re-entry of the telescope is planned. An uncontrolled de-orbit has a 1 in 250 chance of human casualties, much worse than the 1 in 10,000 international standards. NASA wants the telescope to burn up over the Pacific Ocean. This will require the attachment of a propulsion unit because the HST has no such unit.

Before one can think about adding more capabilities, its subsystems must be upgraded, since they have deteriorated over time and will continue to do so. First to fail would be the gyros which will probably cease functioning within about two to three years. Three gyros are needed and four are presently working. People have been working on a two-gyro option and recent tests have been successful. There may also be the possibility of operating on only one gyro. HST could also be put into a safe mode to await further servicing if all gyros fail. Next are the batteries. They are projected to remain viable until at least 2009 or 2010 with prudent on-orbit management. Last is the Fine Guidance Sensor (FGS). Currently only one of the three is pristine and it would be nice to have at least one more. If the gyros, batteries and FGS are serviced, then HST would remain useful for at least five more years.

Two new scientific instruments planned for installation in HST are the Cosmic Origins Spectrograph (COS) and the Wide Field Camera 3 (WFC3). Dr. Kimble told us about the latter first, because he is involved with it. The WFC3 is to go into the WFPC2 bay. The new wide-field camera covers wavelengths from 200nm to 1700nm and has a wider field of view than its UV- and IR-sensitive predecessors. It will complement the Advanced Camera for Surveys (ACS) and NICMOS, the current infrared camera, by having greater speed at UV and IR wavelengths. At the UV end, it is well suited for studying star formation and chemical enrichment in galaxies. At the IR end, it would look at the accelerating universe, high-redshift galaxy forma-

*(Continued on page 5)*

*The deadline for the May Star Dust is April 15.*
*Please send your material to Elliott Fein by that date to ensure inclusion.*

*Send submissions to Elliott Fein at elliott.fein@erols.com.*

*Text must be in ASCII, MS Word (97 or earlier), or WordPerfect.*

*Articles submitted may be edited to fit the space available.*

# Mid-Atlantic Occultations and Expeditions

***by David Dunham***

## Asteroidal Occultations

| Date | Day | EDT | Star | Mag | Asteroid | dmag | dur. s | Ap. in. | Location |
|---|---|---|---|---|---|---|---|---|---|
| Apr 3 | Sun | 3:39 | TYC49570428 | 10.4 | Semele | 3.5 | 8 | 5 | Conn.,New York |
| Apr 3 | Sun | 23:26 | TYC34690391 | 10.9 | 2005 AB | 4.9 | 2 | 6 | nOH,nPA,sNY,MA |
| Apr 11 | Mon | 23:03 | SAO 100088 | 8.1 | Stobbe | 6.7 | 2 | 2 | Mass.,New York |
| Apr 14 | Thu | 5:12 | SAO 211669 | 8.6 | Hale | 8.6 | 2 | 2 | wVA,NC; Sun-7d |
| Apr 26 | Tue | 2:17 | TYC68380752 | 10.9 | Panopaea | 1.3 | 23 | 7 | New York, NJ |
| Apr 28 | Thu | 23:06 | SAO 183474 | 8.3 | Dembowska | 2.3 | 11 | 2 | Quebec,P.E.I. |
| May 1 | Sun | 1:26 | 2UC28389950 | 11.8 | Eugenia | 0.4 | 25 | 8 | n. New England |
| May 1 | Sun | 3:05 | TYC68090488 | 10.4 | 2001 KH76 | 12.8 | 8 | 5 | TNO; Americas? |
| May 3 | Tue | 22:19 | 2UC39835289 | 11.9 | 2001 XQ254 | 11.1 | 5 | 8 | TNO;N.America? |

TNO: Trans-Neptunian Object; valuable, but prediction very uncertain.

## Grazing Occultations

| DATE | Day | EDT | Star | Mag | % | alt | CA | Location |
|---|---|---|---|---|---|---|---|---|
| Apr 11 | Mon | 21:08 | SAO 76243 | 8.1 | 11+ | 20 | 7N | Westminster & Timonium, MD |
| Apr 13 | Wed | 21:00 | SAO 77346 | 9.7 | 26+ | 44 | 9N | Westminster & Baltimore, MD |
| Apr 13 | Wed | 21:12 | SAO 77351 | 9.2 | 26+ | 41 | 9N | York & Oxford, PA; Newark, DE |
| Apr 14 | Thu | 20:21 | SAO 78478 | 9.3 | 35+ | 60 | 9N | Potomac & Dunkirk,MD; USNO,DC |
| Apr 16 | Sat | 0:55 | SAO 79530 | 8.2 | 45+ | 19 | 10N | Slnsgrv,Narvon,KnS,PA;Mlvl,NJ |

## Total Lunar Occultations

| DATE | Day | EDT | Ph | Star | Mag | % | alt | CA | Sp. | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| Apr 3 | Sun | 6:14 | R | ZC 2976 | 7.0 | 34- | 16 | 28S | K2 | Sun -7; graze, n.N.Car. |
| Apr 11 | Mon | 21:01 | D | SAO 76243 | 8.1 | 11+ | 21 | 21N | A2 | Graze,nMD;dbl,mg=8.8,.5" |
| Apr 12 | Tue | 21:46 | D | ZC 717 | 7.7 | 18+ | 24 | 62S | A0 | Dbl.,mg1=mg2=8.3,sep .1" |
| Apr 13 | Wed | 20:54 | D | SAO 77346 | 9.7 | 26+ | 44 | 19N | K0 | Graze, n.cen. MD |
| Apr 13 | Wed | 21:03 | D | SAO 77351 | 9.2 | 26+ | 42 | 25N | K5 | Graze,s.cen.PA,neMD,nDE |
| Apr 13 | Wed | 21:29 | D | SAO 77383 | 8.2 | 26+ | 37 | 86N | F5 | |
| Apr 13 | Wed | 22:11 | D | SAO 77415 | 8.3 | 26+ | 30 | 83N | B9 | Dbl.,mg1=mg2=9.0,sep .1" |
| Apr 13 | Wed | 23:16 | D | ZC 868 | 7.5 | 27+ | 18 | 79N | A0 | Dbl,mg2 10,sep 8.6",PA254 |
| Apr 14 | Thu | 20:19 | D | SAO 78496 | 7.5 | 35+ | 61 | 66S | K0 | Sun alt. -7 deg. |
| Apr 14 | Thu | 20:30 | D | SAO 78480 | 7.5 | 35+ | 58 | 5S | K5 | Sun-10;Dbl.,=mg.8.3,sep.1 |
| Apr 14 | Thu | 21:10 | D | 49 Aurigae | 5.3 | 35+ | 51 | 89N | A0 | Star is ZC 1008 |
| Apr 14 | Thu | 23:10 | D | SAO 78580 | 7.3 | 36+ | 28 | 85S | A2 | Dbl.,mg2 10 sep.29",PA132 |
| Apr 16 | Sat | 23:43 | D | SAO 80165 | 7.5 | 55+ | 39 | 51S | F2 | |
| Apr 19 | Tue | 1:55 | D | ZC 1479 | 6.4 | 74+ | 27 | 48N | F2 | |
| Apr 19 | Tue | 3:13 | D | ZC 1485 | 7.1 | 74+ | 12 | 63S | G0 | |
| Apr 20 | Wed | 0:46 | D | 53 Leonis | 5.3 | 82+ | 44 | 48S | A2 | Star is ZC 1576 |
| Apr 21 | Thu | 23:14 | D | 13 Vir | 5.9 | 94+ | 50 | 87S | A5 | Star is ZC 1770 |
| Apr 27 | Wed | 0:08 | R | ZC 2404 | 6.7 | 90- | 9 | 40N | G2 | Azimuth 136 deg. |
| Apr 30 | Sat | 4:04 | R | ZC 2930 | 7.2 | 60- | 16 | 39S | A0 | |
| May 1 | Sun | 5:38 | R | ZC 3087 | 7.8 | 48- | 23 | 32N | A9 | Sun alt. -6 deg. |
| May 2 | Mon | 4:07 | R | ZC 3227 | 6.3 | 38- | 7 | 30S | K0 | Azimuth 119 deg. |

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

# Review of Talk on Robotic Repair, *continued*

*(Continued from page 3)*

tion, sources of cosmic re-ionization, dust-enshrouded star formation and water and ices in the solar system. An added advantage of the WFC3 is that it is easy to install, sliding in on a couple of rails and the gyros can be attached to it so that one installation serves two functions.

The Cosmic Origins Spectrograph would be used to measure various physical conditions such as density, temperature and pressure. It enhances ultraviolet spectroscopy, which can't be done from the ground, by factors of 10-20 times in sensitivity and as much as 100 in observing time and replaces an instrument, STIS, which no longer functions. COS operates from 1150 to 3200 Å. It will improve our knowledge of the cosmos by using absorption line spectroscopy to look at how the background light from distant quasars is absorbed by the interstellar medium. COS is essentially ready to go. Both COS and WFC3 contain corrective optics so the one on HST is not needed and will be removed.

The instrument to handle the upgrading and the repairs is the Hubble Recovery Vehicle (HRV). It will consist of a de-orbit module and an ejection module (EM); it will dock onto the HST. The EM will contain parts not needed after servicing HST along with storage facilities for the replacement parts. It will be discarded after it is no longer needed because its mass would hinder the functioning of HST. Since it is a substantial piece of equipment, the HRV will require either an Atlas 5 or a Delta 4 Heavy for launching.

The Robotic System (RS) will perform the manipulative functions and consist of a Grappler Arm (GA) which will capture Hubble and hold and move the Dextrous Robot (DR) around for functioning. The DR will actually perform the servicing. The system will also include tools for servicing and interfacing the DR to HST hardware. The Grappler Arm's predecessors have been used on the Shuttle, ISS and will be used on Orbital Express. The DR has already been built and consists of two eleven foot, seven-degree-of-freedom arms. Fortunately, HST was built to be serviced by astronauts in heavy gloves, so fine dexterity is not needed. There are about 40 tiny cameras scattered around so people on the ground can see what is going on. The DR can be operated directly, in a scripted mode with commands generated from the ground, or in a manual mode. There are sensors which can tell when something is hanging or binding so that adjustments can be made. Importantly,

***The Cosmic Origins Spectrograph would be used to measure various physical conditions***

since no humans are involved in space, it is not limited by short term EVAs and can take as long as necessary; it can stop to allow humans on the ground to think about how to solve problems; and it can retry tasks when needed. However, because it doesn't have the dexterity of a human, some objectives have been eliminated.

Key installation tasks with the DR have been demonstrated on the ground. Dr. Kimble showed some of the tools necessary for servicing and an animation and ground test video of some of the tasks. The batteries can operate the DR for about 8-10 hours a day before they need recharging. It is interesting that while one arm does the tasks, the other can serve as a brace for stabilization when necessary. COS will go into the bay presently occupied by COSTAR which contains the original corrective optics. Full robotic servicing could take as much as 50 days. Everything can be done slowly and carefully.

The key operations have been tested on the ground. Still, the NAS has reservations on whether everything can be ready by the planned December 2007 launch date. Also, the thought is that astronauts would be better able to handle any unforeseen problems. Because robotic servicing is not in the present plans, NASA is to do an

*(Continued on page 6)*

## Meteor Showers
## April Radiants

**Full Moon: April 24**

**Major Activity**

| Radiant | Duration | Maximum |
|---|---|---|
| **Lyrids (LYR)** | April 16-25 | April 22@ 06:30 UT |

**Minor Activity**

| Radiant | Duration | Maximum |
|---|---|---|
| **Tau Draconids** | March 13-April 17 | March 31-April 2 |
| **Librids** | March 11-May 5 | April 17/18 |
| **Delta Pavonids** | March 21-April 8 | April 5/6 |
| **Pi Puppids (PPU)** | April 18-25 | April 23/24 |
| **April Ursids** | March 18-May 9 | April 19/20 |
| **Alpha Virginids** | March 10-May 6 | April 7-18 |
| **April Virginids** | April 1-16 | April 7/8 |
| **Gamma Virginids** | April 5-21 | April 14/15 |

**Daylight Activity**

| Radiant | Duration | Maximum |
|---|---|---|
| **April Piscids** | April 8-29 | Apr. 20/21 |

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

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

***Jeff Guerber***

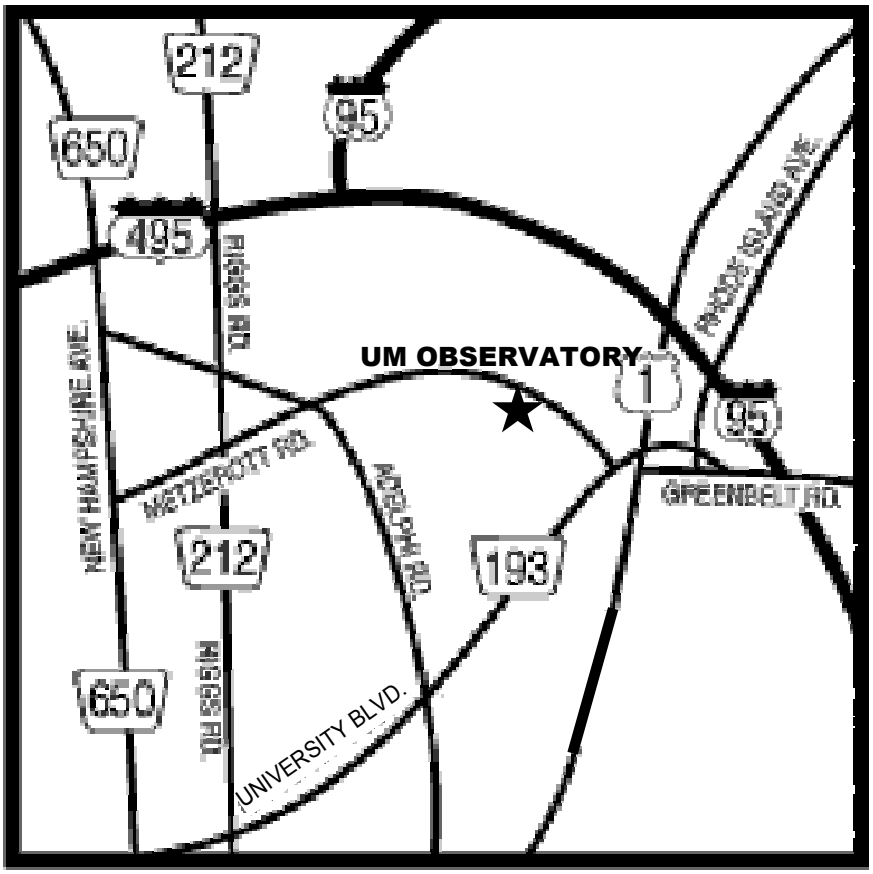
NCA meetings are now held at 7:30 p.m. at the University of Maryland Observatory, in College Park on Metzerott Rd. between University Blvd. (MD-193) and Adelphi Rd. To get there from the Capital Beltway (I-495), either take US Rt. 1 south about a mile, turning right onto MD-193 West, then at the first 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.

# Review, *continued*

*(Continued from page 5)*

"inventory Preliminary Design Review" the week of March 21 so that they don't lose any of the knowledge gained; they will also do a concept review for the de-orbit-only mission. The cost of the full robotic servicing mission is about $1.4 billion. De-orbiting alone would cost about $700 million, or half the cost of the robotic servicing mission.




**Getting to the NCA Meeting**

# 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.)

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Observing - Michael McNeal, mcnealmi@verizon.net; Telescope Making - Guy Brandenburg; *Star Dust* Editor - Elliott Fein

**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 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: _____
Would you prefer to get *Star Dust* by e-mail? ____
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**

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