Star Dust

National Capital Astronomers, Inc. Phone: 301/320-3621

Volume 54, Number 2 October, 1995 ISSN 0898-7548

Near-Earth Asteroid Rendezvous (NEAR) Mission

by Harold Williams

The next meeting of the National Capital Astronomers will be held, Saturday October 7 at 7:30 P.M. in the Lipsett Auditorium of the Clinical Center (Building 10) at the National Institutes of Health (NIH). David Dunham, a long time member of NCA and senior staff member of Johns Hopkins University, Applied Physics Laboratory, S3G Group, will speak on the "Near-Earth Asteroid Rendezvous (NEAR) Mission." His primary responsibility currently is trajectory design for the mission which will be launched in February 1996. When this mission is successful Dave will have been its navigator.

The NEAR mission will be the first of NASA's new Discovery programs in its new "faster, cheaper, better" philosophy of planetary mission operation. The total spacecraft development cost of $115 million is well under the $150 million cost cap for a Discovery mission, and the development phase took only 27 months. NEAR will orbit 433 Eros for nine months quite closely imaging it and analyzing its spectra. 433 Eros is a large, near-Earth asteroid roughly 40 kilometers long. It is an S class asteroid which dominates the population of the Inner Asteroid Belt. The albedos and colors as determined by spectrographic observations of S types imply a composition of iron- and magnesium-bearing silicates (pyroxene and olivine) mixed with metallic nickel and iron. *Galileo's* flyby observations of the two S-type asteroids, Gaspra and Ida did not accurately determine the relative abundance of the three key mineral present in such surfaces: olivine, pyroxene and nickel-iron metal. A precise abundance of the key elements (iron, silicon, magnesium and so on) in association with mineral identification would help settle the debate over whether S asteroids are undifferentiated bodies related to ordinary chondrite meteorites or if they are geochemically processed bodies akin to stony-irons. A gamma-ray/X-ray spectrometer should help answer this question. The payload will consist of a high-resolution camera, a near-infrared spectrometer, a gamma-ray/X-ray spectrometer, a magnetometer, a laser altimeter, and radio science package.

Since *Galileo* revealed Ida's moon, Dactyl, which is around 700 meters across, the NEAR cameras should reveal natural satellites and debris bigger than about 5 meters. In an aside David Dunham and the International Occultation Timing Association (IOTA) were the first to show the theoretically unpopular fact that asteroids had companions. This they did by ground-based observing of asteroid occultations some years ago.

Many wonderful and still undreamed of discoveries await such a close inspection of an asteroid as will be possible with NEAR's orbit around 433 Eros. As an added bonus on its approach to Eros it will flyby quite close to 253 Mathilde, a C-class main belt asteroid. This will give us a fleeting glimpse of the first C-class asteroid ever. C-class asteroids appear to be made up of minerals rich in water like some carbonaceous meteorites. Mathilde is quite large, 61 kilometers long compared to smaller Gaspra (16 kilometers) and Ida (33 kilometers). Mathilde also has a long rotation period of around 17 days.

David Dunham wrote the first computer program to predict grazing occultations while still an undergraduate. He received his B.A. from the University of California, Berkley's astronomy department and his Ph.D. from Yale University astronomy department with a dissertation titled, "The Motions of the Satellites of Uranus." David is a celestial mechanician with a deep and abiding interest in all types of occultations of anything with anything else (Solar eclipses included). David is one of the founders of the IOTA and its president since 1975. He is a member of many scientific societies; and has received NASA group achievement award for the trajectory design for the 3rd International Sun-Earth explorer, to redirect the spacecraft to achieve the first encounter with a comet (Comet Giacobini-Zinner in 1985) and a Computer Sciences Co-

See NEAR, on page 4

Calendar of Monthly Events

The Public is Welcome!

Mondays, October 2, 16, 23, and 30, 8:30 PM-Public nights at the U.S. Naval Observatory (USNO), in Northwest Washington, D.C. (off Massachusetts Avenue). Includes orientation on USNO's mission, viewing of operating atomic clocks, and glimpses through the finest optical telescopes in the National Capital region. Information: USNO Public Affairs Office, 202/653-1541.

Wednesday, October 4-October "Sky Watch" column appears in *The Washington Post* "Style" section. It lists many other events for that month.

Saturday October 7, 5:30 PM-Dinner with the speaker at the Athenian Plaka Restaurant, 7833 Woodmont, Bethesda, before the monthly meeting. Reservations are for 5:30 PM sharp. See the map on the back page of this issue for directions.

Saturday, October 7, 7:30 PM-The October NCA meeting will feature David Dunham speaking on "Near-Earth Asteroid Rendezvous (NEAR) Mission." Meeting will take place at the National Institutes of Health in the Lipsett Auditorium, Room 1c114 in the Clinical Center (Building 10). *See* back page for directions.

Fridays, October 6, 13, and 20, 8:30 PM-Open nights with NCA's Celestron-14 telescope at Ridgeview Observatory; near Alexandria, Virginia; 6007 Ridgeview Drive (off Franconia Road between Telegraph Road and Rose Hill Drive). Information: Bob Bolster, 703/960-9126.

Saturday, October 14, Night-Waning gibbous Moon provides this month's *third longest* Saturday night "deep night" period. See October 21st listing.

Saturday, October 21, 8:00 PM-"Exploring the Sky", in Rock Creek Park at Military and Glover roads, NW. Information: Joe Morris, 703/620-0996; Rock Creek Nature Center, 202/426/6829. *See* March 1995 issue, page 4.

Saturday October 21, Night-Waning crescent Moon provides this month's *longest* Saturday night "deep night" period (i.e., continuous time interval with neither daylight, twilight, nor Moonlight), with Moonless skies practically all night long. Several relatively dark-sky sites are available for NCA members' use in Maryland, Virginia, and West Virginia. Information: Daniel Costanzo, 703/841-4765. *See* page 6.

Friday, October 27, 8:30 PM-CCD imaging workshop: Capturing M31 with the C-14 from suburbia. Ridgeview Observatory (*See* October 6). Information: Bob Bolster, 703/960-9126.

Saturday, October 28, Night-Waxing crescent Moon provides this month's *second longest* Saturday night "deep night" period, although period doesn't begin until after Moon sets early Saturday night. *See* October 21st listing.

Wednesday, November 1, 7:30 PM-November "Sky Watch" column appears in *The Washington Post* "Style" section. It lists many events for that month.

Saturday, November 4, 10:30 AM to 4:00 PM-NCA presents "Binoculars! Telescopes! Astronomy!" *Free consumer advice*. The Smithsonian Institution, National Air and Space Museum, Milestones of Flight Gallery. *See* page 7.

Saturday, November 4, 7:30 PM-The November NCA meeting will feature Jeff Goldstein speaking on "The Winds of Other Worlds."

Coming Soon-Carnegie Institution of Washington Capital Science Lectures. Coming in January, Irwin Shapiro and in March, Anneila I. Sargent. See this space for more details.

NOTE-Other events too numerous to mention here are listed in the publications *Sky & Telescope*, the *Astronomical Calendar 1995*, the *Observer's Handbook 1995*, and in numerous software packages. NCA members can purchase all of these at a discount. To join NCA, use the membership application on page 9.

Charge-Coupled Device (CCD) Astronomy Panel Discussion

Reviewed by Harold Williams and Daniel Costanzo

On Saturday September 9, 1995 at the National Institutes of Health (NIH) in the Lipsett Auditorium our panel discussion was opened by NCA member **Bob Bolster's** excellent presentation on why CCD cameras are superior to more traditional photographic cameras. These remarks coming from a person who I regard as an obvious master of astrophotography was particularly impressive to me. The higher efficiency of the CCD with dim illumination and the larger linear response over the brightness versus exposure graph he showed us revealed how this works with no "toe" or "shoulder" like film has in its exposure curve. Plus, the data is already in digital form, thus avoiding the need for raster scanning the film doing an analogue-to-digital conversion. Bob's CCD camera is an ST-6 built by Santa Barbara Instrument Group, and using a TC-241 CCD detector, employing a six-by-eight millimeter CCD chip. He had the device on the table up front, plus hardcopy printouts for comparison with other cameras, and hardcopy images, for perusal by the audience after the discussion. All of his hard copy printouts had higher resolution than any of the 35 millimeter slides he was able to show us during the talk. CCDs suffer from the disadvantage that the chip, being smaller than a piece of film, means that there is a "smaller piece of sky to work with." Plus it is hard and tedious to find an object, identify it, and focus on it; but this is also true with film. I got the distinct idea finding, focusing, and guiding equipment with a well thought out flip-mirror viewer might make the difference between an exciting adventure and a tediously expensive pain.

Requirements for CCD imaging were carefully detailed by Bob like an equatorial mount with a good drive and slow motion controls. Some important things to consider when selecting the CCD chip are field of view, chip size, object size (i.e., angular size), telescope focal length; and need to match pixel size and telescope resolution. CCDs don't have as great a spatial (angular) resolution compared to film. For deep-sky work, a 2 arc second pixel sky coverage is recommended for his telescope at Hopewell Observatory. For planetary work, a 0.5 arc second pixel sky coverage is recommended for his telescope. His telescope has about a 25 micron pixel size. He also showed us a nomogram out of Sky publishing's new *CCD Astronomy* magazine which do some of these calculation for you. For long exposures, a cooled camera (chip) is needed. This reduces both thermal noise and electronic noise. Some people use water cooling, meaning they have all these water lines running from their telescopes, and require a nearby source of water. Others use thermo-electrical cooling. Sixteen-bit digitizing (tells you how many gray levels, i.e. brightness levels) is recommended. A sixteen-bit CCD chip provides 65,536 brightness levels. Twelve-bit chips (4,096 brightness levels) is the minimum he recommends. Eight-bit chips (256 brightness levels) are not recommended. They provide much too few brightness levels for a decent dynamical range. Parallel data transfer from the chip to the computer is also needed, Bob's camera has a serial transfer; and he revealed how frustratingly slow this transfer can become, especially since it is unnecessary now to have to settle for serial transfer. When selecting the computer, a portable microcomputer is best, based on a 386 or better microprocessor chip, with a large hard disk drive (each image takes as much as eighteen kilobytes on the hard disk). He uses a 486-based laptop microcomputer.

To take a picture and process it three images must be taken and stored on your computer: a raw image (a picture of a real object in focus), a dark frame (shutter closed), and a flat frame (uniformly illuminated). The process of reduction then uses the three pictures thusly: subtract the dark frame from the raw image (this corrects for noise), then divide by the flat frame (this corrects for sensitivity of pixels, vignettes, and removes dust shadows in the optical system). The image is then enhanced, and sharpened, and "warm" and "cold" pixels (picture elements) are removed. This leads to a high contrast result available for softcopy or hardcopy output. CCDs give data in histogram and tabular format, from unexposed pixels, to fully saturated pixels, along with the percentage of pixels exposed at a certain brightness level. Bob showed us images of the Moon, Jupiter, Jupiter with Comet Shoemaker-Levy 9 impact sites, all take with a 36 centimeter (14 inch) Celestron-14 Schmidt-Cassegrain telescope (SCT). He also showed images of the Horsehead Nebula, taken with his 30 centimeter (12 inch) Wright reflecting telescope. In a one minute exposure with the Wright, the CCD showed more detail in and around the Horsehead than a one-half hour photographic exposure of the same area through the same instrument. He also showed a CCD image of Comet d'Arrest taken last month.

Star images are disappointing in CCDs, i.e., they are not as sharp as they are on photographs taken with the same instrument. Because of pixelation, they are often not round. But CCD images of stars are still quite useful for scientific purposes even if they are aesthetically a little peculiar. CCDs allows you to do photometry and astrometry right off the image, without need for transfer to film. Astrometry is made easier by using the finely ruled CCD grid. Bob assisted David Dunham last July by using the Celestron-14 to perform astrometry in preparation for the occultation of a star that month by the asteroid 387 Aquitania. He telephoned his astrometric results to David Dunham to decide whether the path had to be shifted for observers of the then pending occultation. Bob highly recommended, "if you're getting into this business," subscribing to the periodical *CCD Astronomy*, published by Sky Publishing Corporation, and acquiring the book on CCD astronomy by Richard Berry (Reference: *Choosing and Using a CCD Camera*, by Richard Berry, 1992, Willmann-Bell, Inc., Richmond, Virginia).

Peter Chen spoke next on Charge Injected Devices (CIDs). Peter Chen is

See PANEL, on page 4

NEAR, from Page 1

operation Technical Excellence Award 1990 for trajectory design for the International Solar-Terrestrial Physics Program. He has published many papers, and helped send many spacecraft safely on their voyagers of discovery through the void. Without his calculations many discoveries made by others using the spacecrafts would have been impossible. He is one of the three NCA members that I know about who have an asteroid named in their honor by the International Astronomical Union (IAU). Asteroid 3123 is named Dunham. As a self test you might ask your self who the other asteroids named after NCA members are?

PANEL, from page 3

employed by the Computer Science Corporation (CSC) in the Laboratory for Astronomy and Solar Physics at Goddard Space Flight Center (GSFC), working especially in ultraviolet sensors on the Shuttle-borne Astro missions. He combines astronomical research with instrument design. He got his Ph.D. from the University of Texas at Austin where he started doing occultation work. Peter Chen recommended occultations timings as an exciting and fun thing to do. It requires small portable telescopes used in a time critical way. Because of the brightness of the moon versus the dim occulting star, lunar occultations of stars are particularly well suited for the adaptability of CIDs versus CCDs. After seeing and hearing Peter Chen's description of how CIDs worked, I realized that my discussion of CCDs in last month's *Star Dust* actually described CID operation. I thought each charge bin was independently addressable. That only happens in CIDs. CCDs actually get the information out by shifting the charges in a phased read out of the bins. That makes CCDs much more fragile to radiation damage and much less adaptable in reading them out. It also explains why CCDs are more common since the silicon chip wiring equivalent on CIDs is much more complex. Not having to shift the charges out in a phased read out, but instead to be able to independently get at each charging photometer pixel also explains why CIDs do not bloom with bright sources. This was demonstrated by Peter shining a pocket laser pointer on the CID taking his picture in the auditorium and displayed on a monitor. This same independent read-out ability of CIDs also explains why they can be read out in milliseconds, can be non-destructively read out (unlike a CCD), and are much more resistant to radiation damage. In fact, for the hard radiation environment of the Moon, which has no appreciable magnetic field and therefore no magnetosphere to deflect the incoming Solar wind of charged particles, CCD detectors in telescopes on the Moon will not function for very long unless you can bury them a couple of meters underground. Since this is impractical, CIDs seem to be the only means to implement robotic telescopes on the Moon.

One Apollo Moon landing mission missed being fried by major Solar flares by only a few days. If such a flare had occurred, the astronauts on the Moon would have had only a half-hour's warning to dig a hole in the Lunar soil and bury themselves in it. This very scenario is fictionalized in novelist James Michener's thoroughly forgettable, not to mention inaccurate, book (and television movie) "Space." Like human beings, CCDs can also be blasted and killed by Solar flares. (The HST is always under Earth's protective magnetosphere, meaning its CCD detectors are protected from Solar flare blasts.) About once every four months, Solar flares would blast a CCD located on the Moon, killing it.

Charles Worley spoke next about using CCD detectors to do speckle interferometry. Charles is with the U.S. Naval Observatory (USNO). He's been observing double stars since the 1950s. He initially started this work at Lick Observatory, and for many decades, he visually observed double stars to calculate orbits and create a double star catalog. That catalog is now called The Washington Double Star (WDS) Catalog. He also created another catalog of double stars containing every documented double star observation going back to the 1820s. More recently, he has been delving into CCD-based speckle interferometry of double star systems at the USNO. Charles began by saying that "I started my astronomical career at the

Saturn Article Corrections

The article "Hubble Observes a New Saturn Storm," appearing in the 1995 May issue (page 5) of *Star Dust*, neglected to give dimensions in International System (SI) Units along with Imperial System (IS) Unit dimensions. Below are the SI Unit dimensions, followed by IS Unit dimensions in parentheses:

The east-west extent of the storm near Saturn's Equator, imaged in 1994 by the Hubble Space Telescope (HST), was 13,000 kilometers (7,900 miles), equal to Earth's diameter.

HST captured an image of this storm on 1994 December 1, when Saturn was 1,450 million kilometers (904 million miles) from Earth. From analysis of Voyager spacecraft images taken in 1980-1981, Saturn's strongest eastern winds were clocked at 1,600 kilometers per hour (1,000 miles per hour).

This same article also noted a blue fringe on the right limb of Saturn in the "true-color" HST image printed with this article. Unfortunately, *Star Dust* only prints pictures in black-and-white. However, a beautiful color print of this very same HST image is printed on the cover of the February issue of *Sky & Telescope*, and again on pages 6 and 23 of that issue. (This fine periodical is available, at a discount, with NCA membership.)

Saturn is presently visible at convenient pre-Midnight hours. As noted in the article "Attention Saturn Watchers!," in the May issue of *Star Dust* (page 3), Saturn has been undergoing a rare sequence of events this year where the rings appear edge-on, and briefly disappear, as viewed from Earth. For details, see *Sky & Telescope*'s May issue, pages 65-66, 68-72, and 92-95. As NCA members, you have free access to several high quality telescopes capable of showing these events in fine detail. Please take advantage of the great privilege these instruments, and Saturn, make available to you. Forty-three years is a long time to wait for another look at these events.

Lick Observatory more than forty years ago." He then added that using the USNO's 30 centimeter (12 inch) and 66 centimeter (26 inch) refractors he has to date made some thirty-six thousand double star measurements. He used the Lick Observatory's telescopes to make another five thousand, and he used the Cerro Tololo Observatory's telescopes to make five thousand more. That means, to date, he has made some forty-six thousand double star measurements, the majority of them being done through visual observation at the telescope eyepiece. He has long realized that after he was gone from the scene, people couldn't be expected to continue making these kinds of painstaking quantitative measurements using visual techniques. So, in 1990, the USNO acquired a speckle interferometer in an attempt to automate and improve this data capture process. It was installed on the 66 centimeter (26 inch) refractor, and over six thousand speckle measurements of double stars have been completed with it to date, using this instrument.

"Speckle interferometry" was defined by a French astronomer about twenty-five years ago. It involves capturing a very large number of very short exposures of an astronomical object, and reconstructing the image of the object by putting the speckles back together using a computer. Using magnification, he turns the USNO telescope into an f/270 instrument. The USNO speckle interferometer attached to it uses a CCD as the detector and records the data on videotape. However, like all observational astronomy, the quality of what you get depends on the seeing. His work is aided by the superlative seeing available from the USNO. "The seeing can be extremely good here, as good as any place in the World," Charles said. That allows "World-class observing" to be done from the USNO. And he knows what "World-class observing" is, as he has observed all around the World. In general, seeing from the USNO is good early in the night, and then deteriorates as the night wears on, all the way through dawn. With all the concrete and asphalt being heated up during the day, one would think that seeing would be worse early in the evening and improve later at night. Worley didn't know why the opposite was true. He just knew this is what happens, and it has been proven by speckle observations.

Using the speckle interferometer, he can separate double stars between 0.01 to 0.02 arc seconds apart. Using vector auto-correlation, Worley and his group are getting good results. The computer measures the separation and position angle for them, versus the traditional way where the observer had to painstakingly measure these data visually at the telescope. The USNO is the second largest "speckle group" in the World, as far as production of double star measurements; and that's despite the bad transparency and light pollution plaguing the Washington, D.C., which would curtail other kinds of astronomical observation. He showed a videotape showing images made of double stars using the USNO speckle interferometer.

Results from using very long focus refractors, like those available in Washington, D.C. at the USNO, show time and again the truth of the statement that very useful observational astronomy can still be done from the heart of Washington. Long focal length telescopes are not so sensitive to reduced transparency and light pollution as shorter focal length telescopes are. This all goes to show, Worley said, that there are actually people doing astronomy, observational astronomy, here in Washington... Don't give up doing astronomy in Washington.

David Dunham (NCA member and speaker next month) spoke on high speed occultation imaging with CCD detectors. Commercial CCD products currently don't integrate fast enough to do occultations, despite what advertisements say. Some advertisements have been quite misleading in this regard by showing inaccurate images of occultations. Dave has talked with them about that. In reality, CCDs have something like a ten second long integration time. And the shortest CCD integration time current commercial devices can be expected to provide is about a second or so. Occultation imaging requires a time resolution significantly higher than this.

The European component of the International Occultation Timing Association (IOTA) is currently trying to get around this problem by developing their own CCD system, custom designed for better timing accuracy than current video occultation imaging systems can now provide. They are working with some astronomers in the Czech Republic to get these devices produced at low cost. But this is all still in the developmental stage. Meanwhile, Dave, using CCD video cameras (derived from bank surveillance cameras), has been able to get a 0.03 second (1/30th second) time resolution out of the thirty frames per second standard video rate. This is a time resolution much better than available via visual timing (a few tenths of a second), without the reaction time inherent in visual timing. And its better than photometers as it has a larger field of view (on the order of 20").

Using an image intensifier with a CCD detector, Dave can reach down to apparent magnitude 11 to 12 with a 20 centimeter (8 inch) Celestron-8 SCT, and get good timings of occultations. With guide star catalog errors of 0.5 " and the asteroid being 0.1" in diameter, a path error of something like five path widths can occur, which is not good. But using the new PPM star catalog, the nominal predictions of asteroidal occultations have been getting quite good, getting only, at most, a path width away from the nominal predicted path. He also had some success with "last minute astrometry" alerting individuals around the World, via Internet, to do CCD astrometry of the asteroid as it approaches the star, it will occult, have

See CCDs, on page 6

Newsletter Deadline for November *Star Dust* OCTOBER 15, 1995

Send Submissions to Gary & Alisa Joaquin, at 7821 Winona Ct., Annandale, VA, 22003, Leave a message on voice mail 703/750-1636 or send an ASCII file via E-Mail at 71561.1747 @compuserve.com or fax to 703/658-2233. Submissions must be on time or they may not get in.

A Note From the Editors:

Our new E-mail address is as follows: **AGJOAQ@ix.netcom.com**. Before sending submissions, try using the new address with a simple test file first. Documents can be sent in Word Perfect format or in Microsoft Word.

DO NOT BE LATE!!!

CCDs, from page 5

these people do the astrometry, and then get the results of this astrometry sent to him, again via Internet, so he can make last minute refinements of the predicted path on the ground.

The Galileo spacecraft found a moon orbiting the asteroid Ida, confirming beyond any doubt that asteroids can have moons. So observations before and after any asteroidal occultation are needed to catch any similar moons orbiting other asteroids. Dave encouraged all to please take part in his occultation expeditions, and "we do want people out there observing [asteroidal occultations]." Dave's current portable occultation expedition equipment consists of a battery operated videotape recorder, a 10 centimeter (4 inch) monitor (its also possible to use a camcorder viewfinder instead), a WWV time cube, a Celestron-8 SCT, a CCD video camera with an image intensifier, an adapter to put the camera on the telescope, and a mixer (a way to record an audio signal onto videotape). Dave is recording an analog signal. The camera does have a sort of pixel system. But video is analog.

Typically in documenting occultations with CCD equipment, you want to know if the star is on or off. You don't really care about the brightness level. So measuring brightness level using a CCD system in occultations is not that important.

David Skillman spoke next on using his computerized telescope for variable star CCD photometry. David Skillman builds spacecraft at Goddard Space Flight Center (GSFC) and volunteers his own equipment and free time to collecting variable star observations for needy astronomers. He said, "The best place for a telescope is at your fingertips." So his is only thirty meters (a hundred feet) from his house in Laurel, MD where he has a fully automated 66 centimeter (26 inch) reflecting telescope, set up in a 2 x 2 meter (7 x 7 foot) observatory, and rigged so he observes indoors with a computer. "I do quite a bit of observing with professors who are quite good at getting papers out," David boasted. He has published in the *Journal of the Astronomical Society of the Pacific*, among other places with his affiliation listed as his Laurel, MD observatory. There's a lot you can do from the Washington area. With his equipment, David has imaged 20th magnitude objects even though his sky is utterly blasted by light pollution. He can also get down to 17th magnitude in a one minute exposure, with photometric accuracy. Wayne Warren pointed out that at 17th magnitude, there's a whole lot of objects to look at.

Wayne Warren, President of NCA, spoke on double star imaging via CCD detectors. Wayne described the system he built for occultation work, and how he tested it on double stars. Someone in the Astronomical League (AL) put together a list of a hundred "spectacular double stars" that could be observed from the Lower 48 States with small telescopes. The AL gave out a "merit badge" to those observing them. In order to get the "merit badge" a log sheet and drawing of what you saw had to be filled out for each double star observed. Ever the good Boy Scout, Wayne, using his CCD setup, was recording images of each of these doubles on videotape, along with his audio narration of his observing log for each star. He was going to send the videotape (containing all one hundred double stars) to the AL. This also was a great test run for occultation preparation. It taught such things as not forgetting your videotape when going out the door.

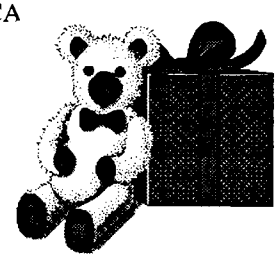
He showed a videotape containing numerous double stars captured with the CCD camera attached to his Celestron-8 SCT, and made at "the NASA Optical Site." The seeing is really rather poor out there. Plus "its lonely out there" as well. Besides his voice, the audio tape also played night insects chirping in the background. Wayne added that McAllister & Company have ruined forever "the Double Double" (Epsilon Lyrae) by finding a fifth component, meaning it's now called "a double triple." Symmetry always seems to be broken or at least cracked a little if you look hard enough. As usual, we are indebted to NIH and NCA member Jay Miller for arranging to meet at NIH, where he works.

Attention Dark-Sky Watchers!

October's traditionally clear skies, relatively long nights, lack of bugs, and comfortable nighttime temperatures, provide some of the best opportunities for experiencing the Universe under relatively dark skies. You won't get another chance like this until April. This October is blessed with three Saturday nights where, for all practical purposes, Moonless skies prevail during the convenient hours between dusk and Midnight: **October 14, 21, and 28**. And here's a tip for experiencing "the Winter constellations" without facing viciously cold Winter night temperatures: observe them after Midnight in October's predawn hours. You might lose some sleep, but it is a lot warmer outside. In fact, October's nighttime lows frequently are warmer than January's and February's daytime highs. This October is blessed with two Saturday and Sunday mornings where, for all practical purposes, Moonless skies prevail between Midnight and Dawn: **October 21, 22, 28, and 29**. NCA members have access to several relatively dark-sky sites in Maryland, Virginia, and West Virginia. For more details, see the "Calendar of Monthly Events" on page 2.

Attention Astronomical Shoppers!

NCA membership makes a great Holiday or birthday gift. It lets that special someone in your life enjoy *Star Dust* and *Sky & Telescope* magazine for an entire year. Renewing an NCA gift membership means these publications can be enjoyed year after year. For further gift shopping savings, NCA membership gets you a significant discount on all Sky Publishing Corporation publications and products. NCA experts are also ready to give free and unbiased consumer advise on buying binoculars, telescopes, etc. So think of NCA when you're doing astronomical gift shopping. For more details, see the membership application page at the end of this issue.



Binoculars! Telescopes! Astronomy!

Free Consumer Advice

Holiday season thoughts of astronomy? Consumer beware! "Bargains" on binoculars and telescopes are just as risky as other "great deals." Learn to wisely choose, use, and care for astronomical instruments from NCA. Our experts are available on Saturday, November 4, **any time** between 10:30 a.m. and 4:00 p.m., with myth-breaking information, guidance, and demonstrations.

Saturday, November 4

National Air & Space Museum

Milestones of Flight Gallery

This free program is a joint gift of NCA and the Smithsonian Institution, National Air and Space Museum (NASM). NCA volunteers are still needed! NASM can provide volunteers with free parking. Information: Daniel Costanzo (NCA), 703/841-4765; Cheryl Bauer (NASM), 202/357-1529.

The 10:30 a.m. starting time means this program begins as soon as the NASM Monthly Sky Lecture ends. So if you arrive at NASM by 9:30 a.m. you can also attend the lecture in the Albert Einstein Planetarium, and this program afterward in the Milestones of Flight Gallery.

NCA member Daniel J. Costanzo. Photo by Chris Costanzo/Corcoran School of Art

National Capital Astronomers, Inc. (NCA)

Serving Science & Society Since 1937

Computer Readable NCA Directory

This article is being repeated for members' convenience,

Any NCA member who prefers to have a computer-readable version of the NCA database, instead of a hard copy of the directory, may now order this by enclosing a NEW 3.5 inch MS-DOS formatted disk with his or her renewal form and check. (Postage for mailing a disk is 55 cents.)

This disk will be returned to the NCA member with a tab-delimited ASCII file (about 21,000 bytes) that can be imported into his or her system for use as reference. Unfortunately I cannot produce a Mac version of the NCA database. A computer-readable directory may be preferable for members who have computers because this file can be electronically searched, and it cannot be lost as easily as a hard copy.

I can also provide a README file and a simple search program (an .EXE file or QBASIC program) for members who do not already have software for searching. The NCA database can be scrolled by using the "type b: filename¦more" command. The user can import the database into just about any favorite text editor, spread sheet, or database software. For more information, please call me at 301/564-6061.

Leith Holloway, NCA Secretary

Biographies Wanted

Last year the editorial staff of *Star Dust* started producing an article introducing members of NCA. We would like to continue this feature. To know who-is-who helps members get to know each other. If you would like to submit an article, please call Alisa and Gary Joaquin, Editors of *Star Dust*. *See* page 5 in the box for the E-Mail address information and instructions.

Important Information Numbers

Smithsonian Sky Watchers' Report: Non-technical information recording on astronomical events, objects, and phenomena in the Washington, D.C. region's sky. Updated weekly. 202/357-2000

***Sky & Telescope* "Skyline"**: Moderately technical information recording on latest in space technology, astronomy, and related sciences. Updated weekly, or sooner if necessary. 617/497-4168

McDonald Observatory "Star Date": Non-technical information on space technology, astronomy, and related subjects. Broadcast weeknights, around 8:00 PM, by listener-supported public radio station WAMU-FM 88.5.

Accurate Time Services (via phone line): Eastern Time (in 24 hour mode) and Universal Time given via the U.S. Naval Observatory and the National Institute of Standards and Technology. Excellent for synchronizing clocks and watches. (Voice Recordings) 202/653-1800, 900/410-TIME, and 303/499-7111; (Modem Time Service) 202/653-0351

"Space Weather" Indices: Highly technical, but quite useful voice recording on Solar activity and its effect on Planet Earth, given via the National Oceanic and Atmospheric Administration. Updated every three hours. 303/497-3235 (anytime) or WWV at 2.5, 5, 10, 15, and 20 MHz (at 18 minutes after every hour)

Local Weather, Sunrise/Sunset, and UV Index: Recording of latest weather forecast out to five days, plus Sunrise/Sunset times, and forecasted Solar ultraviolet radiation index. Covers Washington, DC and vicinity. 703/260-0307

NCA Artificial Satellite Prediction Service: Free customized prediction of viewing opportunities. Satellites frequently are clearly visible to unaided eyes or binoculars, even from heavily light polluted areas. Contact Walter I. Nissen, Jr., (voice phone) 216/243-4980, (e-mail) dk058@cleveland.freenet.edu

NCA Jupiter Galilean Moon Prediction Service: Free customized prediction of viewing opportunities for Jupiter's four Galilean moons. They are clearly visible in small telescopes and binoculars, even from heavily light-polluted areas. Contact John Lohman (voicephone) 703/820-4194 at least one week prior to anticipated viewing.

Occultation Line: Highly technical, but quite useful voice recording with latest updates on occultations and grazings of stars by the Moon, planets, and asteroids; from the International Occultation Timing Association. Many of these events are visible with the unaided eye, binoculars, and small telescopes. 301/474-4945

Other Free Public Science & Technology Lectures: National Air and Space Museum (NASM): 202/357-1552 (ask to receive NASM bimonthly calendar by mail); University of Maryland (Astronomy Department): 301/405-3001; Goddard Space Flight Center (Goddard Visitor Center): 301/286-8981; Carnegie Institution of Washington: 202/328-6988 or 202/265-2752

Science & Technology Public Radio Programs: Quality, informative, and educational radio programs featuring space technology, astronomy, and related sciences are presented at irregular intervals on WAMU-FM 88.5. For program listing, call WAMU Public Radio Listener Talk Show Hotline: 202/885-1200 and Press 3.

"Star Hustler": Completely non-technical, frequently outrageous, but always informative presentations on astronomical events, objects, and phenomena. Broadcast every night, just before sign-off (generally shortly before 1:00 AM) on Maryland Public Television (MPT) stations. Check your local TV guide for your local MPT Channel. Updated weekly. (MPT can also be picked up in the District and Virginia.

National Capital Astronomers, Inc.

SERVING SCIENCE & SOCIETY SINCE 1937

NCA is a non-profit, membership supported, volunteer run, public-service corporation dedicated to advancing space technology, astronomy, and related sciences through information, participation, and inspiration, via research, lectures, presentations, publications, expeditions, tours, public interpretation, and education. NCA is the astronomy affiliate of the Washington Academy of Sciences. All are welcome to join NCA. For information: 301/320-3621 or 703/841-4765.

SERVICES & ACTIVITIES:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Enclosed is my payment for the following membership category:

[ ] Regular
- [ ] *Sky & Telescope* and *Star Dust*. ($48 per year)
- [ ] Star Dust only ($24 per year)

[ ] Junior (Only open to those under age 18) Date of birth: _____
Junior members pay a reduced rate.
- [ ] *Sky & Telescope* and *Star Dust*. ($34 per year)
- [ ] Star Dust only ($10 per year)

_____ _____ _____ (____) _____
First name Middle Last name Telephone

_____ _____ _____ _____ _____-_____
Street or Box Apartment City State Zip

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

Note: If you already subscribe to ***Sky & Telescope***, please attach a recent mailing label. You may renew this subscription through NCA for $24 when it expires.

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

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

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

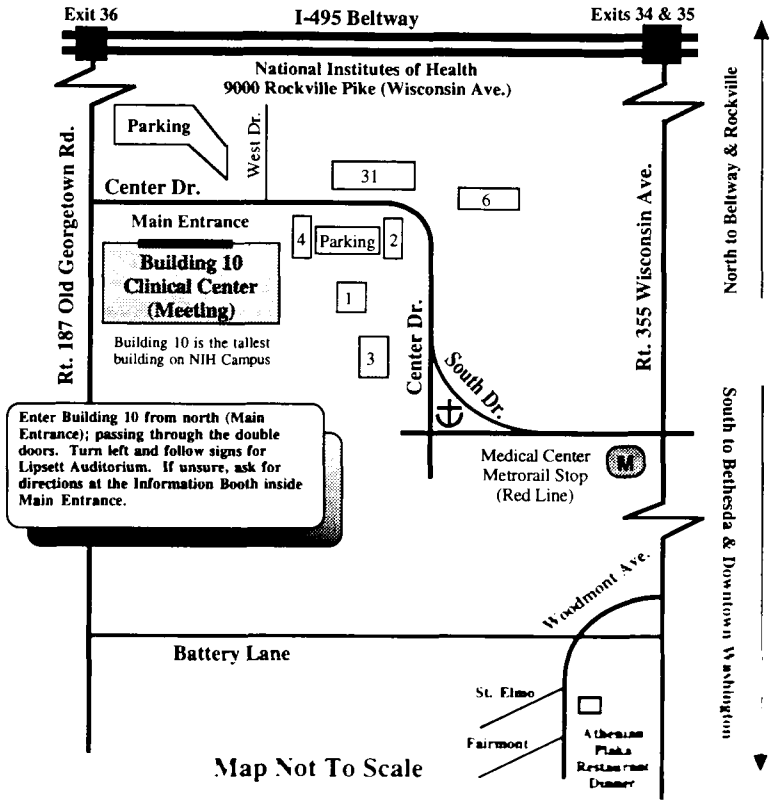
_____

_____

Getting to the NCA Monthly Meeting

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

Athenian Plaka Restaurant - Take Wisconsin Avenue toward Bethesda and bear right onto Woodmont (or take the next right onto Battery Lane). Follow Woodmont to St, Elmo (3 blocks south of Battery) and look for the restaurant on your left (between St. Elmo and Fairmont, address 7833 Woodmont). Parking may be found on Woodmont and in a local parking lot (restaurant claims free parking). Cars may be ticketed, even on weekends. Seats are not guaranteed after 5:30.



Star Dust **is published ten times yearly (September through June) by the National Capital Astronomers, Inc. (NCA), a non-profit, astronomical organization serving the entire National Capital region, and beyond. NCA is the astronomy affiliate of the Washington Academy of Sciences and the National Capital region's representative of the International Dark-Sky Association. Phone Numbers: 301/320-3621 or 703/841-4765. President, Wayne H. Warren, Jr., 301/474-0814. Deadline for *Star Dust* is the 15th of the preceding month. Editors Alisa & Gary Joaquin, 7821 Winona Ct., Annandale, VA 22003, 703/750-1636, E-mail-*see* deadline box for new address. Daniel J. Costanzo, Editorial Advisor. *Star Dust* © 1995 may be reproduced with credit to National Capital Astronomers, Inc.**

National Capital Astronomers, Inc.
If Undeliverable, Return to
NCA c/o Leith Holloway, Apt. #M-10
10500 Rockville Pike
Rockville, MD 20852-3331

FIRST CLASS

Exp. 7/96
Leith Holloway
10500 ROCKVILLE PIKE APT M10
ROCKVILLE MD 20852-3331