Star Dust

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Cold Temperature Actuators for NGST

Submitted by Nancy Byrd

The next meeting of National Capital Astronomers will be held this Saturday, November 6, 1999 in Lipsett Auditorium in Building 10 at National Institutes of Health at 7:30 PM. At this meeting, Dr. John Vranish of NASA, GSFC will present a talk entitled, "Cold Temperature Actuators for NGST." Dr. Vranish brings us a different perspective from our usual astronomer-speaker. He designs the systems the astronomers use. Dr. Vranish is an electrical engineer who creates "simple, innovative and competitive edge systems and strategic components." This is no idle boast. He holds 30 U.S. patents ranging from electronics to mechanics and from systems to strategic components. He was named, three times, as GSFC Inventor of the Year, and has received seven cash Space Act awards. He was a 1997 IR 100 Award winner (given for the 100 best inventions in the world, as selected by R & D Magazine). His achievements are legion. If NASA achieves the goal of "faster, cheaper, better", it will be, in no small measure, due to his efforts.

In his talk, Dr. Vranish will discuss long stroke, cold temperature actuators for the Next Generation Space Telescope (NGST). Says Dr. Vranish, "These actuators are particularly challenging in that they have a relatively long stroke (up to 6 mm), must locate with great precision (25nm >), must hold position with power off and must operate in the thermal-vacuum conditions of space (30° K). And, of course, they must be very light weight, compact, rugged and reliable. In space, there is no opportunity to fix things that do not work. All of the above, suggest that proven technology (specifically electromagnetics) should be used. But, at the same time, NASA is looking to make significant technical break troughs and to make things lighter, faster, cheaper and better. So how, then, does one both use proven electromagnetic technology in a low-risk manner and, at the same time, make a significant technical breakthrough? It is done using a combination of innovation, imagination, determination, pragmatism and lots and lots of mistakes. It is done using a meticulous step by step method and verifying and learning from each step as we go."

In this talk, our speaker will discuss two of his actuator approaches (Precision Screw Slides and Locking Lorentz Slides). These are currently being funded by NASA, are being prototyped and will be competed against each other. Dr. Vranish will describe the technical strategy and systems concept behind each, and then the hardware and electronics/controls design details. He will point out key mistakes made along the way as well as the successes. Hardware and test results to date will be presented and some hardware components will be made available for the audience to experiment with. The presentation will conclude with the presenter soliciting feedback from the audience." It is all part of the effort," he says, " to continuously 'improve the breed'." ○

Limits on The Age of The Universe

An Essay on the author's NCA Lecture of October 2, 1999

by John Graham

In his recent book "What Remains to be Discovered" John Maddox reminded us that we easily forget how recent are the roots of present knowledge of the age of the universe. At the end of the 19th century, astronomers didn't worry much about it at all since most evidence suggested that the age of the universe was large, large beyond comprehension. The stars had always been there and people did not know what to make of galaxies. The situation is different now. In 1999 we recognize that change, cy-

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Calendar of Monthly Events

The Public is Welcome!

NCA Home Page: http://capitalastronomers.org

Mondays, November 1, 8, 15, and 22, 7:30 PM - Public nights at U.S. Naval Observatory (USNO), in Northwest Washington, D.C. (off Massachusetts Avenue). Includes orientation on USNO's mission, viewing of operating atomic clocks, and glimpses through the finest optical telescopes in the Washington-Baltimore region. Held regardless of cloud cover. Information: USNO Public Affairs Office, 202/762-1438. Home page: http://www.usno.navy.mil.

Fridays, November 5, 12, 19, and 26, 7:30 PM - Telescope making classes at American University, McKinley Hall Basement. Information: Guy Brandenburg, 202/635-1860.

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

Saturday, November 6, 5:30 PM - Dinner with the speaker, and NCA members at North China Restaurant, 7814 Old Georgetown Rd, Bethesda, MD. *See* map and directions on back page.

Saturday, November 6, 7:30 PM - NCA meeting, at Lipsett Auditorium in Building 10 at NIH, will feature Dr. John Vranish, speaking on "Cold Temperature Actuators for NGST" *See* map and directions on back page.

Saturday, November 13, 7:00 PM - Exploring the Sky at Rock Creek Park in the field south of the intersection of Military and Glover Roads near the Nature Center. Information: 202/426-6829. Note the time change.

See page 8 for more Washington area astronomical events. Other events too numerous to list in *Star Dust* are listed in the publications, *Sky & Telescope*, the *Astronomical Calendar 1999*, the *Observer's Handbook 1999*. NCA members can purchase all these (and much more) at a discount. Information can also be found in numerous software packages, and links available on the NCA Home Page (*see* above for address). To join NCA, use the membership application on page 9.

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cling, expiration and rebirth on all time scales are characteristic of an evolving universe which was once very different and apparently began a finite and measurable time ago. Here I want to describe 3 ways that we can constrain this age: (1) the universal expansion, (2) the ages of the oldest stars, and (3) age limits from nucleo-cosmochronology.

I) THE UNIVERSAL EXPANSION

The expansion of the universe is observed as a redshift in the spectra of galaxies. Interpreted as a Doppler velocity, the velocity is roughly proportional to the distance of the galaxy with the constant of proportionality, the Hubble constant, H_o. But it is more complicated than that. Doppler shifts are the result of the relative motion of bodies moving through space. Here on the universal scale, we are dealing with the expansion of space itself. Expansion redshifts do not depend on relative velocity but on the increase in distance between the light emitting galaxy and the observer during the time of propagation. Space, just as much as matter and energy, is an intrinsic component of the universe with its own properties. Distances to remote galaxies are so large that we are looking
back to a time when the space between galaxies was much smaller. We are compelled to accept that the universe was once many times denser, and going back still further, that there was an epoch when it all began.

Although the expansion has now been recognized for most of the 20th century, it has been hard to pin down because of the immense distances involved and the coarseness of our distance indicators. Hubble's first estimate of the expansion parameter in his 1929 paper was about 10 times too large and led to an age of the universe (extrapolating back to zero size) of 2 billion years, much too short for several reasons. Even recently, H_o was uncertain by a factor 2. When major programs for the Hubble Space Telescope (HST) were being selected, a high priority was given to improving the situation. There are several reasons why this needed to be done. Determining the age of the universe is one but others involve the early history of the universe when chemical element synthesis took place. The redshift is our only distance indicator for the most distant objects and determining the distance scale is critical for understanding the most energetic events that we see in far off galaxies.

It is important to determine distances which reach beyond the local

velocity perturbations to where the expansion dominates. But first we need a firm foundation of known distances to nearby galaxies. Prior to the HST, there were just not enough accurate distances to nearby galaxies available, and thus their determination was the fundamental aim of the HST Key Project.

At the time that the HST program was planned, Cepheid variable stars were considered the best distance indicators. Cepheids are stars which find themselves temporarily in a state where they become unstable. The instability is damped but a natural pulsation results whose period is closely related to the mass and in turn the intrinsic luminosity of the star. If you know the intrinsic luminosity and can measure the apparent luminosity, you can work out the distance. We know them in our own Milky Way system; we can recognize them as far out as the Virgo cluster of galaxies (16 Mpc - 50 million light years). Their main deficiency is that they cannot be seen quite far enough to span local velocity perturbations and we have to do this by resorting to secondary distance indicators. As has recently been demonstrated, supernovae are very good for this and extend far into the observable universe but they too have their problems and must be calibrated locally.

The HST Key Project Team is a large one and one which has undergone evolution itself over the last 15 years. The core of our program has been to use the HST to determine Cepheid distance to 18 galaxies. We have added to our sample data for 7 other galaxies which were observed by other groups and whose observations are now in the HST archives. The distance scale is anchored to that set by Cepheids in the Large Magellanic Cloud, a satellite galaxy of our own whose distance is well known.

Newsletter Deadline for December *Star Dust*, November 15, 1999

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

For each galaxy on our list, the project has involved getting periods and apparent brightnesses for 10 - 30 Cepheid variables by obtaining images of each galaxy spread over about 50 days. By choosing optimal spacing, we can limit the number of epochs in the 50 day time base to 10 - 12.

Why HST? First, it's not cloudy up there and we can get the data when we want it. Second, the high spatial resolution enables us to separate the Cepheids from the large number of normal stars in a galaxy. Third, the background light is low and we don't have to worry about a moonlit sky every two weeks. When we have the observations, the basic steps in the analysis are as follows:

1) We measure the brightness of every star on every one of the frames. Then we use the computer to tell us which of the stars are variable.

2) Then we find periods for the variation and isolate the Cepheids. Light curves are determined.

3) Then we construct period-luminosity relations and compare them with the ones in the Large Magellanic Cloud.

Four final papers have just been submitted which use the Cepheids results to calibrate secondary indicators to come out with a Hubble constant of 71 +- 7 km/sec/Mpc. To determine the corresponding age of the universe we now have to use a theoretical model for the expanding universe.

In formulating General Relativity, Einstein showed that mass/energy and space/time were intimately related. Gravity could be understood as a curvature of space/time. As J.A. Wheeler neatly put it, space/time grips mass telling it how to move — mass grips space/time telling it how to curve. Space/time itself is an active participant in the universe and itself transmits curvature from near to far. Einstein showed that a static universe could be constructed from 4 dimensional space time with a positive scaling factor R. Later following the observation of an expanding universe, Friedmann and Lemaitre showed that many models, some expanding, some contracting, some stationary, were possible and that it was a matter of choosing the right one. The simplest Friedmann expanding universe is one with flat space and a scaling factor which varies with time. This model gives an age of 9.4 billion years for H_o = 71. But we cannot see quite far enough to know if this is the correct model to use.

Perhaps the most exciting advance has come from the detection of very distant supernovae. They are so distant that we can see them as they were at only a fraction of the age of the universe. Supernovae have one great advantage over Cepheids. They are very bright. Supernovae type I, the most promising, are in effect thermonuclear runaways when a whole star is self-destructing. For a short time they can be as bright as a whole galaxy and thus can be seen to the edge on the observable universe. It is only recently that large format detectors used with large telescopes have pushed this advantage to the fullest.

Complex image analysis with high computing power make it possible to discover and follow up new examples almost as they happen. They can be seen sufficiently far away that different cosmological models can be distinguished. Two teams are currently working at breakneck speed on this. Using a preliminary calibration to obtain distances, one finds that the cosmological deceleration was slower at the time of the supernova explosions than is indicated by the simple model. Allowance for this effect leads to a Hubble constant of 65 and an age of the universe of 14.2 billion years. In our Cepheid distance scale work, we have made an independent calibration of the supernova luminosities and find excellent agreement with the above value. Although 10% lower than the Key Project value, the lower Hubble constant accounts for only about 1/3 of the age difference emphasizing how much the final value depends on the assumed geometry of the expanding universe.

II) AGES OF THE OLDEST STARS

The second method for assessing the age of the universe is to determine the ages of the oldest stars. This provides a useful lower limit. Stellar ages have had a curious history in the last 100 years. This has mostly been linked with our under-

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standing as to how stars shine and how their energy source is maintained. Last century, Helmholz and Kelvin proposed that the energy source was gravitational contraction. The problem was that the time came out much too short. For the sun, only 20 million years, unacceptable then and now from a geological point of view.

At the beginning of the present century, the contraction theory was in the curious position of being both generally accepted and generally ignored (a little like dark matter at present). Then with the recognition that energy could be made available by the burning of hydrogen to helium, astrophysicists realized that if the sun was made largely of hydrogen, there was an enormous energy source available. Some suggested that if the required high temperatures could be provided, an upper limit of 10 thousand billion years was likely. Immense ages of stars continued to be proposed right through the 1920s. Jeans gave a probable age for a solar mass star of 10 thousand billion years as late as 1929, the year when Hubble plotted his famous diagram. After that, with Hubble ages of only a few billion years, these large numbers were heard of no more.

The catch was that nuclear generation in stars only goes on in a small core. The high temperatures required ensure that it spreads very little. As well, the products of nuclear burning (e.g., helium) are not mixed with the rest of the star but stay in the core and are eventually material for nucleosythesis themselves. Physics of stellar structure is basically simple and it is straightforward to calculate the relation between stellar mass, brightness and temperature and how these change as the hydrogen in the core is burned up. By now, it has become quite easy to understand why an age of only 5 billion years for the sun is not only reasonable but necessary.

Age dating of stars and star clusters has now become somewhat routine. Stellar ages cover a wide range. The most massive stars burn their nuclear fuel so rapidly that they last only a few million years. The least luminous ones use up their hydrogen so slowly that they can be as old as the whole galaxy. Thus, the question "What is the age of the oldest stars?" puts a firm lower bound on the age of the universe. Globular clusters provide the best data just because of the sheer number of stars in each of them. They attain their great ages by their essential stability. Theoretical evolutionary tracks are easily fitted when there are so many stars which can be presumed to have the same age. The main uncertainties have been in the absolute calibration of the stellar brightnesses. Many new geometrical distances for nearby stars have been provided by the Hipparcos satellite. These can be matched to similar stars in the globular clusters. Partly as a result of the new data, new globular cluster ages have been evaluated and mean values of 11.5 billion years with a one side 95% confidence lower limit of 9.5 billion years. To compare these with the Hubble expansion ages, 2 billion years need to be added to take into account the time lapse from the Big Bang until when galaxies formed. Do all galaxies form at the same time? On local evidence, I'd say the answer is almost invariably yes. Every nearby galaxy which we examine in sufficient detail shows a population of oldest stars which compare very closely with those we see in our own Milky Way.

There is a second limit, again based on very old stars, which can be placed on the age of our galaxy. This comes from the observed luminosities of white dwarf stars, stars composed of remnant dense cores which no longer shine by nuclear reaction but can only cool. They cool slowly enough that the oldest can be recovered in deep surveys. One such survey was made up of stars selected as companions of brighter stars which provide good sample statistics. They are nearby and the assumption is made that they belong to the galactic disk. Assuming it formed 1 billion years after the globular cluster, this would imply a total age for the universe of 12.5 billion years. This lower limit seems a firm one.

III) NUCLEO-COSMOCHRONOLOGY

The basic idea of this method was outlined in a paper by Rutherford (again in 1929 - it was a good year!) and applied to meteorite analysis. If one can estimate the age of radioactive isotopes and if one knows their nucleosynthetic history, one can use the relative isotope abundances to put a lower bound on the age of star formation and of the age of the universe since the heavy elements of this type can only be made in stars. There is some reason to limit consideration to isotopes which can only be formed in supernovae because the modeling is more straightforward. If one assumes only a single burst of element formation, the age comes out at only 7 billion years. But such a simple picture is excluded by the presence of short-lived isotopes in the primitive solar system meteorites and the history of star formation and nucleosynthesis becomes a significant (and uncertain) consideration.

Using, for want of better, a model of uniform nucleosynthesis up until the birth of the solar system, an age of about 13 billion years is indicated. Again to compare with the expansion age 2 billion years have to be added onto this to take into account the time needed for the galaxy to form. Other cosmochemists have done the same calculation for oxygen isotopes in ancient meteorites. They get ages of about 2 billion years greater. While the measuring uncertainties are small, systematic errors arise because of our lack of knowledge of the star forming history which was probably far from uniform.

IV) CONCLUDING REMARKS

Putting all these ages together, it is remarkable that the numbers derived in such very different ways are in as close agreement as they are and that an age close to 13 billion years is looking increasingly likely. Disagreements by a factor 2 or 3 are common in contemporary astrophysics and here it is a lot less than that! Let us look more closely at the two Hubble expansion values. The big advantage of the distant supernova method is that it allows us to constrain the geometry of the expanding universe. The basic Hubble constant measurement is almost the same in the two investigations and the difference is largely due to the expansion model itself. But the model required by the faint supernova method has rather profound implications. First it requires a hyperbolic, open (and unbounded) universe but more significantly it needs a positive cosmological constant.

The cosmological constant is the famous number which Einstein intro-

duced into his original universe, one closed in four-dimensional space/time in order to keep it from collapsing on itself. It has the effect of a positive pressure or negative gravity. Then Hubble found that the universe was expanding anyway and the term became unnecessary. But it is back again with some justification from the concept of the vacuum energy density produced by the ongoing production and destruction of virtual particles in a vacuum. The existence and physics of the vacuum energy states is well established experimentally but a strict quantum mechanical interpretation requires an impossible high density and cosmological constant. Up until now, it seemed better to assume the constant zero, but much as we would like it, it doesn't seem to be going away.

Another worry has been whether or not we are observing a typical part of the universe. Frankly, we don't know. We do know from the evenness of the 3-degree background radiation that, when the universe was about a million years old and ceased to be opaque it was very homogeneous, but between then and now, when we see only a very small fraction of the universe, we do not really know what happened. It is a general rule that the more we look at anything, the more structure we seem to see.

A basic limitation is that we depend on electromagnetic radiation almost entirely for what we know. We can only believe in what we perceive. The huge broadening of knowledge of the cosmos which has come from the detection of radio, X- and gamma-rays in the last 50 years gives a feel for this principle. Perhaps the next step will be the detection of gravitational waves, and here we can expect to break completely the present boundaries and look back right to the very beginning of the expanding universe. ○

Small Group of NCA Radio Astronomers Get-Together Proposed

Avi Dey, an NCA member who lives in Vienna, VA is interested in having a small group get-together perhaps at a Vienna Coffee House of NCA members who are interested in exploring Radio Astronomy.

Besides learning more about the subject, he is proposing consideration of doing some small group projects among interested NCA Members (and family when appropriate). There is a possibility that such a small group may be able to do an educational display and a demonstration at the International Children's Festival next year in Vienna. The local Northern Virginia coordinator for AARL , the not-for-profit organization for ham radio may be a good discussion leader for this first get together. AARL has quite a bit of practical knowledge about this subject which we can perhaps tap for mutual benefit.

Anyone who has some knowledge in this area or is interested in learning more by small group discussion and doing small group projects are requested to contact Avi by phone at his office: 202-434-4705 or home: 703-242-0312. His email address is avidey@CapAccess.org.

International Space Business Assembly

Cosponsored by the American Astronomical Society and Daimler-Chrysler Aerospace

"Where the World will get down to the Business of Space"

November 2-4, 1999

Reagan International Trade Center

Washington, DC

Preliminary Schedule: Tuesday — Opening Ceremonies The Honorable Madeleine Albright U.S. Secretary of State

Wednesday — Three topics on the Global Space Industry and the International Space Station.

Wednesday evening — Space and Science Diplomats Reception

Thursday — Topics on marketing and how the space industry may learn from non-space luminaries.

Thursday evening — The President's Dinner and Closing Ceremonies

For information call: 719/576-8000

Mid-Atlantic Occultations and Expeditions, November 1999

Total Lunar Occultations and Mercury Transit

DATE	Day	EST	Star	Mag	%	alt o	CA	Notes
Nov 03	Wed	04:01	R ZC 1625	5.8	21-	22	76N	
Nov 04	Thu	05:09	R ZC 1741	7.1	13-	23	65N	
Nov 12	Fri	19:21	D 33 Sgr	5.7	19+	10	76N	ZC 2746
Nov 15	Mon	16:11	1st contact, Mercury transit, alt. 7 deg. in s.w.					
Nov 15	Mon	16:22	2nd contact, Mercury transit, alt. 5 deg. in s.w.					
Nov 15	Mon	16:40	Mercury edge 6.0" (deepest) from Sun's edge, alt. 2 deg.					
Nov 16	Tue	20:15	D 45 Aqr	6.0	56+	34	64N	Sp. K0; ZC 3275
Nov 19	Fri	17:57	D ZC 0106	6.6	85+	31	41N	Sun alt. -11 deg.
Nov 20	Sat	02:06	D 26 Ceti	6.1	87+	14	84S	ZC 0150; azimuth 260 deg.
Nov 21	Sun	19:38	D mu Ceti	4.3	97+	39	76N	ZC 0405; close double
Nov 24	Wed	06:30	R 104 Tauri	4.9	98-	18	73S	ZC 0764; close double
Nov 24	Wed	20:50	R ZC 0888	6.0	95-	25	76N	Close double?
Nov 24	Wed	21:53	R 57 Orionis	5.9	95-	36	53S	ZC 0895; spectroscopic binary
Nov 25	Thu	01:17	D chi2 Ori	4.6	94-	69	-87S	Bright side, prob. can't see
Nov 25	Thu	02:33	R chi2 Ori	4.6	94-	69	63S	Close double
Nov 25	Thu	23:07	D ZC 1077	4.0	88-	38	-42N	Bright side, prob. can't see
Nov 26	Fri	00:02	R zeta Gem	4.0	87-	49	69N	Close dbl; R n.side, M.Crisium
Nov 30	Tue	04:42	R ZC 1603	7.2	45-	51	88N	
Dec 01	Wed	02:44	R ZC 1709	6.6	35-	20	80N	
Dec 04	Sat	05:19	R ZC 2035	7.2	11-	15	72S	Close double
Jan 02	Sun	05:52	R gamma Lib	3.9	15-	21	90S	12x camcorders; 2000

D following the time denotes a disappearance, while R indicates that the event is a reappearance. The times are for Greenbelt, MD, and will be good to within +/-1 min. for other locations in the Washington-Baltimore metropolitan areas.
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.

Planned Grazing Occultation Expeditions

DATE	Day	EST	Star	Mag	%	alt o	CA	Location
Nov 06	Sat	05:37	SAO 139480	8.1	3-	8	11N	Onancock, VA
Nov 30	Tue	05:12	SAO 118637	8.1	46-	54	3S	York, PA & Newark, DE
Dec 02	Thu	06:18	SAO 138923	8.0	26-	43	5S	Lewisbury, PA & Newark, DE
Jan 02	Sun	05:10	gamma Lib	3.9	16-	19	8S	Long Key, FL (year 2000)
Jan 09	Sun	17:54	delta Cap	2.9	9+	20	5S	Hancock, MD & Allentown, PA

Don't throw this newsletter away. If you're finished with it, pass it on to someone else to read or recycle it. It's right for astronomy and the environment.

Asteroidal Occultations and Appulses, and Saturn Occultation

Those with good finder scopes and/or setting circles who can find deep sky objects or variable stars are especially encouraged to monitor close approaches, called appulses, that are listed below, since an occultation is possible in Maryland or adjacent states.

Asteroidal Appulses and Saturn Occultation

DATE	Day	EST	Star	Mag	Asteroid	dmag	dur. s	ap. in.	Occultation Location
Nov 04	Thu	17:25	S02 11304	11.4	Adelheid	3.5	4	8	N. Virginia
Dec 02	Thu	23:30	SAO 093040	9.2	Saturn	2000	8	all	N. America*
Jan 03	Mon	03:11	14 Mon	6.4	Cheruskia	6.0	8	1	central Florida

* Graze in south polar area. Very difficult; see p. 108 of February, *Sky & Telescope*.

Phone the IOTA occultation line, 301-474-4945, for updates and details, or check IOTA's Web site at http://www.lunar-occultations.com/iota which now has an asteroidal occultation section with finder charts. Good luck with your observations.

David Dunham

Still Looking for New Editor of *Star Dust*

Alisa Joaquin, editor of *StarDust*, will be taking some much needed leave time. The reason being, she and Gary Joaquin, her husband, are expecting their first child, a daughter, in March. She does not know if she will be able to continue her duties as editor for some time.

In the mean time, she would like someone to take over as newsletter editor starting in January, 2000. The person must have experience with PageMaker 6.0 or higher. Experience can come from either Mac or PC. Other duties include, searching the web for images, and calendar information of astronomical events happening in the Washington-Baltimore area to be included in the newsletter.

It would be helpful if the person who is interested would contact Alisa Joaquin at 703/750-1636 and arrange to meet with her to discuss in full the newsletter production and what it entails. To arrange for an appointment, you may either call her at the above telephone number or email her at ajglj@erols.come.

Alisa Joaquin, Editor

National Capital Area Astronomical Events

Free Lectures at the Einstein Planetarium and Other Daily Events
National Air & Space Museum

202/357-1550, 202/357-1686, or 202/357-1505 (TTY)
Home page: http://www.nasm.edu

Other Area Astronomical Events

Carnegie Events Capital Science Lectures — "Landmark Images From the Hubble Space Telescope: Magic and Meaning," speaker, Sandra M. Faber (Lick Observatory, University of California, Santa Cruz), Nov. 16, 7:00 PM.

Carnegie Events-Dept. of Terrestrial Magnetism — All seminars are held on Wednesdays (unless indicated otherwise) at 11:00 a.m., in the seminar room of the man building. Coffee and teas served at 10:45 a.m.

"Circumstellar Disks: From Protostars to Planetary Systems," speaker, Ray Jayawardhana (Harvard-Smithsonian Center for Astrophysics, Nov. 10.

"Re-Os Isotopic Evidence for Early Differentiation of the Martian Mantle," speaker, Alan Brandon (Department of Geology, University of Maryland), Nov. 17.

Laboratory for Astronomy and Solar Physics — All seminars are on Thursday at 3:00 PM in Building 21, Room 183A.

"Nailing Down Cosmological Parameters with CMB and Galaxy Surveys," speaker, Max Tegmark, Princeton. Nov. 4.

"The Lick, Keck, and Anglo-Australian Planet Surveys," speaker, Paul Butler, Carnegie DTM. Nov. 18.

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

Montgomery College's Planetarium, Takoma Park — "Total Solar Eclipses" Nov. 20, 7:00 PM.

University of Maryland College Park Astronomy Department Colloquia — All colloquia are held on Wednesdays at 4:00 PM. Location will vary.

"An Impact Origin of the Earth/Moon System," speaker, Dr. Robin Canup (Southwest Research Institute), Nov. 3. Colloquia held at CSS 2400.

"Hubble Vision," speaker, Dr. Doug Hamilton, Nov. 5, 8:00 PM.. This particular colloquia is also an open house at the Observatory, Metzerott Rd., College Park, MD.

Meteor Showers

Full Moon

November 4 & 23

Major Activity

Radiant	Duration	Maximum
Leonids	Nov. 14-20	Nov. 17* at 19:45 UT Nov. 18* at 02:08 UT (*possible storms)

Minor Activity

Andromedids	Sept. 25-Dec. 6	Nov. 14/15
Alpha Monocerotids	Nov. 13-Dec. 2	Nov. 21
Alpha Pegasids	Oct. 29?-Nov. 17?	Nov. 1-12
Northern Taurids	Oct. 12-Dec. 2	Nov. 4-7
Southern Taurids	Sept. 17-Nov. 27	Oct. 30-Nov. 7

Daylight Activity

None

Washington Area Astronomers Meeting

Naval Research Laboratory, Washington, DC

November 4, 1999

Registration is $15.00

Topics Include:

Astronomy Highlights at NRL

The Composition of a Split Comet

Opening a New Window on the Universe: High Resolution, Low Frequency Radio Astronomy with LOFAR

An X-Ray Examination of the Black Hole in the Active Galaxy NGC 3516

Signatures of Exo-Solar Planets in Dusty Circumstellar Disks

Recent Results on Brown Dwarfs

Registration begins at 8:30 AM. Sessions being at 9:00 AM.

For more details see the website at: http://aa.usno.navy.mil/waa/

To get on mailing list, contact Mary Ann Phillips at University of Maryland, maryann@astro.und.edu or 301/405-1550

National Capital Astronomers, Inc.

SERVING SCIENCE & SOCIETY SINCE 1937

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

SERVICES & ACTIVITIES:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Enclosed is my payment for the following membership category:

[ ] Regular
- [ ] *Sky & Telescope* and *Star Dust*. ($57 per year)
- [ ] Star Dust only ($27 per year)

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

Note: If you already subscribe to ***Sky & Telescope***, please attach a recent mailing label. You may renew this subscription through NCA for $27 when it expires.

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

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

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

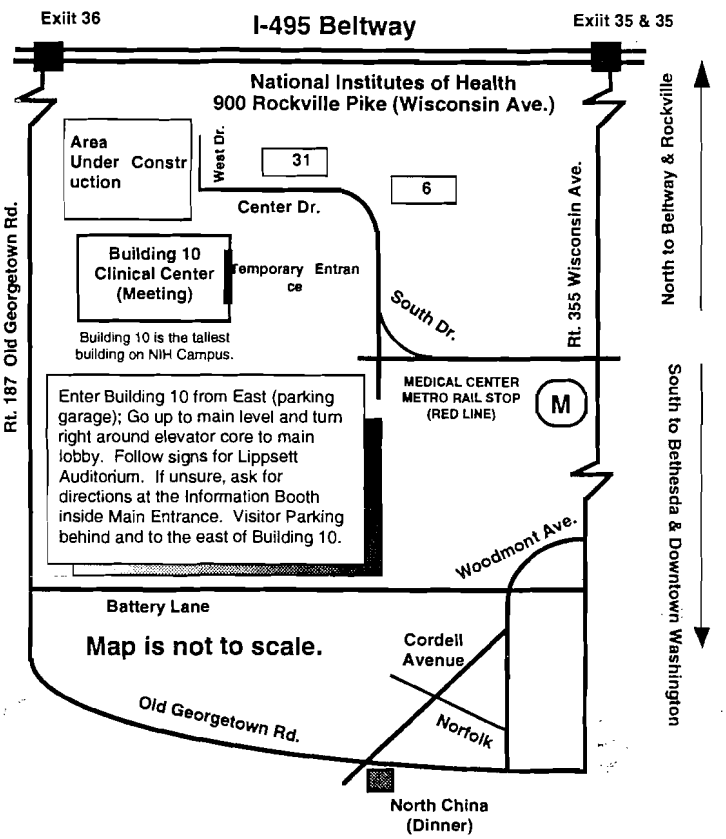
_____

_____

Getting to the NCA Monthly Meeting

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

To North China Restaurant - Take Wisconsin Avenue toward Bethesda and bear right onto Woodmont (or take right onto Battery Lane and left on Woodmont). Follow Woodmont to Old Georgetown Road and make a right. The restaurant is a few blocks on the left (7814 Old Georgetown Road). There is parking around the corner on a side street. Seats are not guaranteed after 5:30.



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