Star Dust

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The Deep Impact Mission

An Upcoming Talk by Michael A'Hearn

Submitted by Nancy Byrd

At the Saturday, January 8, 2000 meeting of National Capital Astronomers (NCA), Dr.Michael A'Hearn will talk to NCA and friends about the Deep Impact mission which will study comet 9P/Tempel 1. The meeting will take place at the Lipsett Auditorium in the Clinical Center (building 10) of the National Institutes of Health at 7:30PM. Dr. A'Hearn, a long-time member of NCA, is Professor of Astronomy at the University of Maryland and a recognised authority on comets. He submits the following abstract of his talk:

"The Deep Impact mission was recently chosen by NASA to be the 8th Discovery Program mission. This mission will be the first to explore the interior of a cometary nucleus. The mission will deliver a 500 kg cylindrical impactor into the nucleus of comet 9P/Tempel 1 at 10.2 km/s. For a baseline model of a cometary nucleus, this should excavate a crater 28m deep and 120m in diameter. However, our uncertainty about the properties of cometary nuclei is so large that these numbers are very uncertain and a major goal is to use the properties of the crater, including its depth and diameter, to determine the structural properties of the cometary nucleus. A flyby spacecraft will view the impact and the resultant crater with optical cameras and near-infrared spectrometers. Earth-based observatories will also play a key role in obtaining data at all wavelengths and with techniques that are not possible on the flyby spacecraft. This talk will provide a more detailed overview of the mission and its scientific goals."

We happily welcome Dr. A'Hearn back as a speaker and look forward to hearing more about this fascinating mission. ❍

New Views of Protoplanetary Disks

A Talk Given by Dr. C. A. Grady on December 4, 1999

Reviewed by Dr. Andrew W. Seacord, II

This talk represents some early results of research which Dr. Grady and her colleagues have conducted on the morphology of Protoplanetary disks around early stars, usually A-type stars. The study of these disks, which are made up of gas and dust, has taken on a greater importance since the discovery of planets orbiting stars similar to our Sun. Twenty-eight such planets are now known to exist.

Examples of young stars which are known to have circumstellar disks are Beta-Pictoris (age of 30 million years (Myr)), Vega and Formalhaut (both between 200 and 300 million years (Myr) old) and HD 141569 (only 10 Myr old). Although planets in them cannot be observed directly, there is in direct evidence in some disks which suggest the presence of planets or proto-planets. One bit of evidence is a gap, or void, in the disk which has been cleared out by an accreting protoplanet.

There is still much we do not know about these circumstellar disks and the formation of planets in them. We do not know how soon, we can detect the presence of planets in the life of the young central star. We do not know the spatial distribution of protoplanets, their size distribution, their relation to activity, such as accretions and outflows, in the disk, and how planetary formation affects this activity. Finally, we do not know the implications for the diversity of planetary systems and the prospects of forming planetary systems with architectures similar to that of our solar system.

So, how do we observe circumstellar material around intermediate mass stars? If we choose stars that are more luminous than the Sun, there are more photons to

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Calendar of Monthly Events

The Public is Welcome!

NCA Home Page: http://capitalastronomers.org

Mondays, January 3, 10, 17, 24, and 31, 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, January 7, 14, 21 and 28, 7:30 PM - Telescope making classes at American University, McKinley Hall Basement. Information: Guy Brandenburg, 202/635-1860.

Fridays, January 7, 14, and 28, 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, January 8, 5:30 PM - Dinner with the speaker, and NCA members at Thai Place, 4828 Cordell Ave., Bethesda, MD. *See* map and directions on back page.

Saturday, January 8, 7:30 PM - NCA meeting, at Lipsett Auditorium in Building 10 at NIH, will feature Dr. Michael A'Hearn, speaking on "The Deep Impact Mission" *See* map and directions on back page.

See page 6 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 7.

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detect from light scattered by the dust grains. For these stars, the gas and dust disks will be larger and, thus, more massive; hence, more material to scatter the star light and, being larger, the disks will be more visible. Actually, the first circumstellar disks to be detected were those around A stars, for example, Beta-Pic.

Since the known extrasolar planets around solar-type stars are hot gas giants, we want to know how they are formed in circumstellar disks. Dr. Gardy presented two competing theories. One is that these planets were formed by gradual agglomeration of planetesimals to form a rocky, 10 to 15 earth-mass core. This core rapidly captures gases in the disk to form a large atmosphere envelope. Models of this process suggest that the formation time for a Jupiter-like planet is in the order of 10 Myr. Formation of the planets beyond Saturn would take 100 Myr. The infrared (IR) excess of young stars, which is caused by thermal emission of dust around the star soon disappears, indicating that dust does not remain in the disk for the length of time required to create a Jupiter with this theory. Since, it seems that hot gas giants are quite common, a faster means of forming planets needs to be found.

According to the other theory, which was developed by Alan Boss of the Carnegie Institution, gas giants are formed early in the life of the disk by the accretion of disk material from instabilities in the disk. By this model, gas giants can be produced in about only 1 Myr.

How do we observationally test these two theories? To answer that, Dr. Grady discussed two examples, the first of which is the star AB Aurigea. It is an optically bright (seventh magnitude) Herbig Ae (premain sequence, emission line A) star located in the northern celestial hemisphere. Its age is between 2 and 4 Myr. AB Aurigea has the same proper motion as a nearby solar-type star, SU Aurigea. Nebulosities are visible around both stars in the Digital Sky Survey images.

Detecting a faint nebulosity in the vicinity of a bright star such as AB Aurigea can be challenging. There are two techniques which can be used. The wavelength of the observation can be shifted to a regime where the nebula is bright and the central star is faint. This technique has been used at mid-IR and millimeter wavelengths. The resolution, however, is usually not very good.

Dr. Grady used another technique, coronographic imaging, where the light of the central star is blocked by an occulting disk or wedge to create an artificial eclipse. In some cases, material in the star's own circumstellar disk occults this star.

AB Aurigae was observed with the Hubble Space Telescope (HST) Space Telescope Imaging Spectrograph (STIS) with an occulting disk. The spectrograph recorded a bandpass between 2,000 to 10,000 Angstroms. An occulting wedge blocked out the image of the central star and out to about 77 astronomical units (au). When the Stellar Point Spread Function (SPSF) is removed from the image, a spiral structure and clumping are observed in the nebulosity surrounding AB Aurigea. This clumping is observed down to the resolution of the optical system, or 0.1" (arc seconds) which, at the distance to the nebula, is about 14 au. The nebula surrounding AB Aurigea was examined for evidence of an annular region in the disk cleared of dust which would indicate the presence of a protoplanet. However, no such region beyond the 77 au occulted region has been found.

Dr. Grady presented the data from another A star which she observed, a star in Sagittarius which has the exciting name of HD 163296. This celestial gem is an isolated, early A star, of type A2Ve. It is 122 +/- 15 parsec (pc) away and about 4 Myr old. Its circumstellar disk has been imaged in millimeter wavelengths. Once the SPSF was removed from the image, spots of nebulosity were seen around the star. It was first thought that they were residuals from the SPSF. However, images of the star were obtained during three observing runs, giving three different spacecraft orientations with respect to the nebula. Since the spots moved with the sky, not the with the telescope, then they are probably real and not an artifact of the analysis. The composite of the three images shows two bright arcs centered on the star and four knots. The knots, which are conspicuous in Lyman-alpha, are shock-excited, Herbig-Haro (HH) objects. There is also an extended Lyman-alpha halo around the star. The halo is apparently caused by resonant scattering of Lyman-alpha from a low-velocity stellar wind. This is the first detection of a spatially resolved disk wind from a pre-main sequence star.

Two interesting features are the blue- and red-shifted objects that extend outward from within two STIS pixels (6 au) from the star. These are images of bipolar outflow from the system consisting of a (blue-shifted) jet and a (red-shifted) counter jet. The jets represent the closest features to a pre-main sequence star ever observed to date. An interesting aspect of the jets is that stars of this age are not supposed to have bipolar outflows. These flows are known to occur in stars much younger, in the 10,000 to 100,000 year age bracket.

A close examination of the HD 163296 circumstellar disk reveals a annular clearing at a distance of 325 au from the star. This suggests the presence of a large object which has dynamically cleared the area. This is to be expected of a star older than HD 163296.

The bipolar outflow and protoplanet, together, present a contradiction and challenge what we know about young stars and planetary formation in their circumstellar disks. First we have an "older" star with bipolar outflow and, second, a "younger" star with an orbiting object, possibly a protoplanet. So, it appears that we do not actually know much about how and when planets are formed. Modeling planetary formation on the basis of our own solar system is probably not a very good idea.

There is another question about HD 163296. What is the nature of the object which has cleared out the annular region 325 au from the star? There are three possibilities: a late type stellar companion, a brown dwarf, or a giant planet. The late-type stellar companion can be ruled out because such a companion would likely be an x-ray source and no x-rays have been detected from HD 163296. The brown dwarf can also possibly be ruled out because the dynamics suggest that the orbiter be a single smaller mass object or, possibly, several bodies. A preliminary estimate for the mass required to clear out a region 325 au from the star is 1.3 times that of Saturn.

Note that this object has existed around the star long enough to modify the circumstellar disk. At the object's distance from the star, its orbital period would be in the thousands of years, and yet, has orbited enough times to clear the region. The resulting time frame provides a upper bound on the time it takes to form a planet like Jupiter.

Returning to the bipolar outflow, we note that there are signatures of planetary formation occurring at the same time that there is accretion in the vicinity of the star and matter being driven out by bipolar outflow. There are two knots associated with the approaching jet, one is at the tip of the jet and one lies beyond it along the axis of the jet. The knot spacing implies a 5-year interval between their ejections. This raises the questions: "Is this a sustainable phenomenon with a true period, or do these events look periodic but fade away? Could the HD 163296 jets be matter kicked out by perturbations caused by planetary migrations inward rather than the bipolar outflow phenomenon associated with much younger systems?" This is an important consideration because a migrating gas giant planet has been proposed as a source of hot Jupiters found around solar-type stars.

After the Hubble Space Telescope service mission has been completed, Dr. Grady and her colleagues plan to observe eight to ten young objects, at least one of which is 10 Myr old. Ground- and space-based IR observations of one 10 Myr object have shown evidence of silicates identical to that found in comet Hale-Bopp. The infrared excess in the star's spectrum is consistent with there being little or no material closer than several au from the star. We may be observing the infall of atomic or molecular species that do not last more than a minute in the star's radiation field. This may come from comets migrating inward like the Kreutz family (a 10 Myr system) in our own solar system.

As Dr. Grady said, in concluding her presentation, "These are the early days and we are just learning". We thank her for a excellent talk and look forward to having her return to tell us about the later days! ❍

Newsletter Deadline for February *Star Dust*, January 15, 1999

Please send submissions to Elliott Fein, at elliott.fein@erols.com. **Text must be in ASCII or Word. Graphics submitted must be in TIFF, GIF, or JPEG.** Thank you.

New Editor of *Star Dust*

This is my last issue. I wish to welcome Elliott Fein as the new editor and I hope you will help him in any way you can as you have helped me. Alisa Joaquin

Mid-Atlantic Occultations and Expeditions January and Early February 2000

by David Dunham

Asteroidal Occultations

DATE	Day	EST	Star	Mag	Asteroid	dmag	Dur s	Ap. in.	Location
Jan 10	Mon	01:35	SAO 118158	08.7	Polyxo	4.1	29	2	Savannah, GA
Jan 10	Mon	03:46	ACT18880907	10.4	Emma	2.8	11	6	Brunswick, GA
Jan 16	Sun	20:10	TRC18801817	09.6	Pales	2.2	16	5	Buffalo, NY
Jan 18	Tue	05:07	PPM 128772	10.2	Rachele	1.8	19	6	Hancock, MD
Jan 22	Sat	01:05	ACT29022681	11.0	Ursula	1.9	22	8	s. Florida
Feb 07	Mon	18:42	SAO 93783	08.9	Elpis	3.8	15	2	n. Michigan

Planned Grazing Occultation Expeditions

DATE	Day	EST	Star	Mag	%	alt	CA	Location
Jan 01	Sat	04:34	SAO 158801	8.0	24-	19	6S	Richmond, VA
Jan 02	Sun	04:35	SAO 159352	8.5	16-	09	6S	Bethesda, Lanham, s. Bowie, MD
Jan 02	Sun	05:10	gamma Lib	3.9	16-	19	8S	Matecumba Key, FL
Jan 09	Sun	17:45	delta Cap	2.9	9+	20	5S	Mercersburg & Scranton, PA
Jan 12	Wed	21:58	ZC 0044	7.4	34+	10	2S	Fairfax, VA; DC; Annapolis, MD
Jan 21	Fri	00:01	VV Cancri	9.5	0E	71	79U	Richmond, VA; lunar eclipse
Jan 30	Sun	04:05	ZC 2308	7.9	31-	16	11S	I-85 VA exit 39
Jan 30	Sun	05:45	SAO 159743	7.9	31-	29	12S	Henderson, NC
Feb 15	Tue	18:00	nu Gem	4.1	82+	48	9S	Annapolis, MD; Sun alt. -5

Note for Jan. 9: This spectacular graze occurs the day after the NCA meeting, occurs early (set up in bright twilight), and is not too far from DC. It is the best in the region during 2000; it should be easy to observe with binoculars or directly with 12x or higher camcorders, and might even be marginally visible to the naked eye for those with good eyesight. With the Sun 8 deg. down, the sky will be dark enough by graze time. We will meet at 15:30 (3:30 pm EST) at the intersection on the south side of Mercersburg where PA routes 16 and 75 first meet; this is 15 miles northwest of Hagerstown, MD and about 85 miles from DC.

Total Lunar Occultations

DATE	Day	EST	Star	Mag	%	alt o	CA	Notes
Jan 02	Sun	04:40	D gamma Lib	3.9	16-	10	-76S	Moon Az. 118 deg.
Jan 02	Sun	05:52	R gamma Lib	3.9	15-	21	90S	12x camcorders; Graze in FL
Jan 12	Wed	21:46	D SAO 128707	6.9	34+	12	59N	
Jan 12	Wed	21:50	D ZC 0044	7.4	34+	10	2S	n. of DC only; see grazes
Jan 14	Fri	20:06	D ZC 0291	6.8	55+	51	58S	possible double?
Jan 14	Fri	23:38	D SAO 110334	7.8	56+	16	60S	
Jan 14	Fri	23:56	D ZC 0306	6.8	56+	12	38N	Moon Azimuth 269 deg.
Jan 18	Tue	03:56	D 104 Tauri	4.9	88+	6	70N	Az. 289; dbl.,0.1"; ZC 764
Jan 18	Tue	18:43	D ZC 0888	6.0	93+	42	89S	close double
Jan 18	Tue	18:49	D SAO 094948	7.8	93+	43	63S	
Jan 18	Tue	20:16	D chi1 Ori	4.4	93+	59	11N	ZC 894; 5" to terminator
Jan 18	Tue	20:19	D 57 Orionis	5.9	93+	59	19S	ZC 895; 16" to terminator
Jan 19	Wed	00:49	D chi2 Ori	4.6	94+	53	71S	ZC 915; close double

Jan 19	Wed	22:03	D Mekbuda	4.0	98+	66	85S	ZC 1077, zeta Gem, close dbl.
Jan 21	Thu	23:26	D SAO 097632	9.1	0E	67	60U	During total lunar eclipse
Jan 21	Thu	23:45	D VV Cancri	9.5	0E	69	76U	Spec. M5; small var. range
Jan 21	Fri	00:19	R VV Cancri	9.5	0E	70	78U	SAO 97631
Jan 21	Fri	00:36	R SAO 097632	9.1	16E	70	65U	partial phase of eclipse
Jan 22	Sat	23:42	R 34 Leonis	6.4	94-	48	89S	ZC 1493; close double
Jan 24	Mon	04:16	R ZC 1625	5.8	87-	56	50S	possible close double
Jan 26	Wed	04:06	R ZC 1856	6.6	69-	49	24N	close double
Jan 27	Thu	03:56	R ZC 1965	6.5	59-	32	51N	close double
Jan 27	Thu	05:10	R SAO 139528	7.2	59-	45	58S	
Jan 30	Sun	04:24	R ZC 2308	7.9	30-	18	39S	Graze in s. Virginia
Jan 30	Sun	06:10	R SAO 159743	7.9	30-	30	43S	Graze in North Carolina
Feb 1	Tue	05:30	R ZC 2556	7.2	14-	11	84N	Az. 129 deg.
Feb 1	Tue	06:36	R SAO 185801	8.1	14-	20	56N	Sun alt. -8 deg.
Feb 7	Mon	18:36	D SAO 146581	8.7	6+	12	26N	Az. 248
Feb 7	Mon	18:38	D SAO 146578	8.2	6+	12	20N	Stars occulted just after
Feb 7	Mon	18:39	D SAO 146577	7.6	6+	12	17N	impact D, 1999 Nov. 18
Feb 7	Mon	19:04	D SAO 146596	9.0	6+	8	79S	50" from psi1 Aquarii
Feb 7	Mon	19:05	D psi1 Aqr	4.2	6+	7	76S	ZC 3419; Moon az. 252 deg.

"D" following the time denotes a disappearance, while "R" indicates that the event is a reappearance. When a power (x; actually, zoom factor) is given in the Notes, the event can probably be recorded directly with a camcorder of that power with no telescope needed. The times are for Greenbelt, MD, and will be good to within +/-1 min. for other locations in the Washington- Baltimore metropolitan areas unless the cusp angle (CA) is less than 30 deg., in which case, it might be as much as 5 minutes different for other locations across the region. Phenomena of Mercury's transit of the Sun on Nov. 15 are also given; 3rd and 4th contacts occur after sunset. "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" denotes the new Moon, "50+" the first quarter, "100-" or "100+" the full Moon, and "50-" the 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.

Two New Spectral Types

bt Nancy Grace Roman

"Oh Be A Fine Girl Kiss Me Right Now Sweetheart" is about to be lengthened. If, as seems likely, proposals from a large team working on sky surveys in the near infrared are accepted by the astronomical community, the letters L and T will be inserted after M. The temperature sequence for oxygen-rich stars will then be: OBAFGKMLT, with O the hottest and T the coolest. R and N are carbon-rich stars and S is for stars with essentially equal amounts of carbon and oxygen. In these stars, both elements are tied up in carbon monoxide and neither oxygen nor carbon molecules are very strong.

For many years, astronomers have searched unsuccessfully for stars cooler than LHS 2924, the coolest M dwarf. (The name of this star indicates that it was found by Luyten in a survey of stars with proper motions larger than 0.5 arcsec per year.) The temperature of this star is estimated to be about 2000K. Because they are so cool, these stars are very faint in the blue and even in the yellow regions of the spectrum. Now, there are two all-sky surveys starting in the near infrared, 2MASS in the northern hemisphere and DENIS in the south. The Sloan digital sky survey, which will provide surveys of limited regions of the sky to very faint magnitudes, will also include a near infrared channel. Already, these surveys are bearing fruit with more than 30 objects cooler than LHS 2924 (M9). Most, if not all of these objects, are brown dwarfs. That is, they are objects that are too small to transform hydrogen into helium in their interiors and hence are hot only because they have condensed or are condensing from interstellar gas and dust. Some may have transformed deuterium and lithium into helium but this provides only a brief period of energy generation.

These objects were first selected from the large number of stars observed by the surveys by the fact that they are not visible on the Palomar Sky Survey photographs, indicating that they are at least 5.5 magnitudes brighter in the near infrared than on the red Palomar plates. In the infrared, they are either quite red or quite blue! The latter results from the very strong molecular absorption in the redder region. Objects with intermediate infrared colors are likely to be asteroids.

The objects that meet these criteria were then observed spectroscopically. The most notable characteristic of the

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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

Department of Terrestrial Magnetism (DTM) Carnegie Institute — All seminars are on Wednesdays at 11:00 am (unless otherwise noted) in the Seminar Room of the Main Building.

"Extra Solar Planets," speaker, Paul Butler, DTM, Jan. 19.

Goddard Scientific Colloquium — All seminars will be held in Building 3 Auditorium at 3:30 PM.

"Soft Gamma Repeaters Are Magnetars," speaker, Alice Harding, GSFC, Jan. 21.

"Binary Galaxies and Dark Matter in the Universe," speaker, Yervant Terzian, Cornell University, Jan. 28.

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

"Stellar Coronagraphy: Recent Results on Compact Apertures," speaker, Pierre Baudoz, Observatoire de la Cote d'Azyr, Jan, 6.

"A New Spin on Horizontal-Branch Morphology: Unexpected Rotations and Abundances in Globular Cluster BHB Stars," speaker, Bradford Behr, Caltech, Jan, 20.

"Perspectives on NGST, SUVO, and Gossamer Science Goals and Instrumentation," speaker, Jon Morse, University of Colorado, Jan. 27.

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

"UV Imaging of the Cygnus Loop with UIT," speaker, Bob Cornett, GSFC/RITSS, Jan 5.

"Io and its Surroundings," speaker, Ron Oliversen, GSFC, Jan. 19.

"Line Formation in Herbig Ae/Be Star Winds," speaker, Jean-Claude Bouret, GSFC/NRC, Jan 26.

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 — "Astrolabs" January 29, 7:00 PM.

University of Maryland College Park Astronomy Department Colloquia — All colloquia are held on Wednesdays at 4:00 PM. Location will vary. Please check their website at http://www.astro.umd.edu/colloquia/ for current listings.

Meteor Showers

Full Moon

January 21

Major Activity

Radiant	Duration	Maximum
Quadrantids	Jan. 1-5	Jan. 3

Minor Activity

Gamma Velids	Jan. 1-15	Jan. 5
Alpha Curcids	Jan. 6-28	Jan. 15
Delta Candrids	Jan. 1-31	Jan. 15
Delta Hydrids	Jan. 5-Feb.14	Jan. 19
Alpha Carinids	Jan. 24-Feb. 9	Jan. 30

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spectra is the extreme weakening or disappearance of the titanium oxide bands. The metal oxides (TiO and VO) are replaced by metal hydrides (CrH and FeH) as the major molecular species. Lines of neutral alkali metals are also strong. Even lithium sometimes appears, confirming that those objects either were not subject to nuclear fusion or are not sufficiently convective to bring nuclear material to the surface. As the subclasses of the L sequence become later, TiO and VO, which at L0 are equal in strength to the metal hydride bands, become progressively weaker. In the cooler objects, CrH becomes stronger than FeH although both weaken with a decrease in temperature. Lines of neutral alkali metals become stronger with potassium broadening greatly, mimicking a molecular band.

The distinction between L and T is that only the latter display bands of methane overtone bands at 1.6 and 2.2 micrometers. The fundamental methane band at 3.3 micrometers may appear in the coolest L-stars. The brown dwarf, Gl 229B is the prototype for the T-stars. The distinction among subclasses for the T-stars is less well developed than those for the L-stars are. The primary distinction is that the near infrared red color, J-K, becomes increasingly blue as one goes to cooler stars. (The J band is centered near 1.25 micrometers; the K band is near 2.2 micrometers.) The T-stars are likely to have effective temperatures between 950 and 1300K; the effective temperatures of the L-stars are between 1300 and 2200K. All of the T-stars must be brown dwarfs. ❍

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)

[ ] Junior (Only open to those under age 18) Date of birth: ____________________
- [ ] *Sky & Telescope* and *Star Dust*. ($45 per year)
- [ ] Star Dust only ($15 per year)

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First name(s)	Last name	Telephone	E-mail

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Street or Box	Apartment	City	State	Zip Code + 4

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.

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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!**

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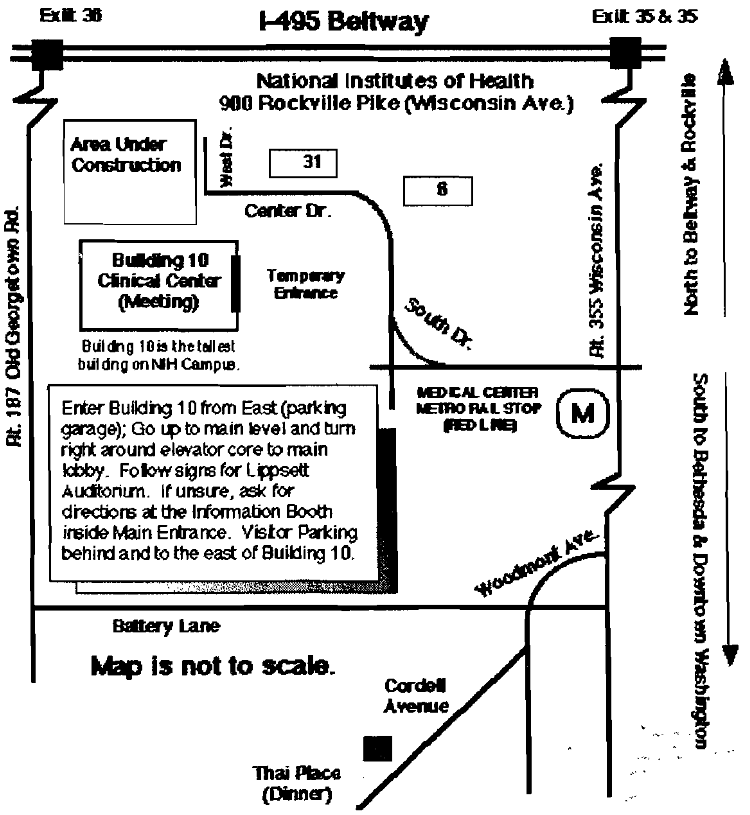
Getting to the NCA Monthly Meeting

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 Thai Place - Take Wisconsin Avenue toward Bethesda and bear right onto Woodmont (or take right onto Battery Lane and left on Woodmont). Follow Woodmont to Cordell and make a right. The restaurant is a few blocks down (4828 Cordell Avenue). There is parking around the corner on a side street. Seats are not guaranteed after 5:30.



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