Star Dust

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Dave Thompson to Lead Gamma-Ray Tour of the Universe

by Nancy Byrd

Dr. David J. Thompson, an Astrophysicist with the Laboratory for High Energy Astrophysics at NASA/Goddard Space Flight Center in Greenbelt, Maryland, will talk to NCA members and guests at the next NCA meeting at 7:30 PM on Saturday evening, October 3, 1998. The meeting will be held in the Lipsett Auditorium of the Clinical Center (Building 10) at the National Institutes of Health (NIH). Dr. Thompson will talk on the subject of "Cosmic Violence: The Universe Seen in Gamma Rays."

Dave Thompson is presently a Co-Investigator on the Energetic Gamma Ray Experiment Telescope (EGRET) on NASA's Compton Gamma Ray Observatory. His special scientific interest is gamma-ray pulsars. He has worked at Goddard since 1973. In 1993, he contributed to The Learning Channel television series, "A Practical Guide to the Universe."

He received a B.A. degree from the Johns Hopkins University and a PhD in physics from the University of Maryland. He lives in Bowie, Maryland, with his wife and two daughters.

Dr. Thompson provides the following abstract of his talk:

Gamma rays provide a view of the most energetic and often most violent sites in the Universe. During its seven and a half years in orbit, the Compton Gamma Ray Observatory has vastly expanded our knowledge of the gamma-ray sky. Gamma rays have been seen from the Moon, the Sun, pulsars, the Milky Way, the Large Magellanic Cloud, quasars, unidentified sources, and the still-mysterious gamma-ray bursts at the edge of the Universe. This talk will present an overview of how gamma-ray astrophysics helps us learn about the ultimate sources of energy. ❍

Triple Lunar Grazing Occultation and IOTA Meeting

by Wayne H. Warren Jr.

A rare occurrence of three nearby graze paths for events bright enough to observe played an important role in the date and location of this year's annual meeting of the International Occultation Timing Association (IOTA), which was held at Vanderbilt University's Dyer Observatory in Brentwood TN, just south of Nashville. The observatory was certainly an interesting place to meet, not only because it houses the oldest and most complete astronomical library in the southeastern US, but because it is the home of the International Amateur Professional Photoelectric Photometry organization (IAPPP), and it has been a center of development of photometry over the years. One of the earliest directors of the observatory was Edward Emerson Barnard. Another well-known director was Carl K. Seyfert, who was tragically killed in an automobile accident in 1960. He was succeeded by Robert H. Hardie, who was responsible for Dyer's vigorous photometric program, and who wrote the famous article on photoelectric photometry published in the University of Chicago's book *Astronomical Techniques*, the second volume of a classic 1960's series of books that many older astronomers studied in graduate school. (I still have most of the books on my shelf at home.) The current director is Douglas S. Hall, who is well-known to photometrists and who has worked closely with amateurs over the years. He is the publisher of the IAPPP Bulletin, currently being edited by Terry Oswalt of the Florida Institute of Technology in Melbourne, who is working a stint in the Astronomical Division of the National Science Foundation this year.

The grazing occultations took place on the morning before the scheduled meeting, which started on Saturday af-

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Calendar of Monthly Events

The Public is Welcome!

NCA Home Page: http://myhouse.com/NCA/home.htm

Fridays, October 2, 9, 16, 23, and 30, 7:30 PM - Telescope making classes at American University, McKinley Hall Basement. Information: Jerry Schnall, 202/362-8872.

Friday, October 2, 9, 16, 30, 8:30 PM - Open nights with NCA's Celestron C–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. Call before 6:00 PM.

Saturday, October 3, 5:30 PM-Dinner with the speaker, and NCA members at the Thai Place Restaurant, 4828 Cordell Avenue., Bethesda, MD. *See* map and directions on back page.

Saturday, October 3, 7:30 PM-NCA meeting, will feature Dr. David J Thompson, speaking on "Cosmic Violence: The Universe Seen in Gamma-Rays." For directions, *see* map and directions on back page.

Mondays, October 5, 12, 19, and 26, 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.

Tuesdays, October 6, 13, 20, and 27, 7:30 PM - Telescope making classes at Chevy Chase Community Center, Connecticut Avenue and McKinley Street, NW. Information: Jerry Schnall, 202/362-8872.

Saturdays, October 10, 7:30 PM - Exploring the Sky. Sessions are held at Rock Creek Park, in the field south of the intersection of Military and Glover Roads, near the Nature Center. Free to the public. Information: 202/426-6829.

Saturday, October 17, beginning 6:00 PM - Open House at Hopewell Observatory. See insert page.

Friday, October 23, 7:00 PM - "Skywatch" program at Patuxent River Park. Need another astronomer with telescope. Call Bob Bolster, (703) 960-9126.

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 1998*, the *Observer's Handbook 1998*. 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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ternoon, September 12, and continued through Sunday morning, ending just after noon to give attendees time to travel back home to return to work on Monday. Since the three graze paths were nearly parallel and not far from each other from Texas through Tennessee, Kentucky, West Virginia, Pennsylvania, and Massachusetts, our choice of sites was based on having to drive to Nashville after the events and on weather conditions between here and Tennessee.

The middle event was the real draw because it involved the brightest star, other than the Sun, that can be occulted by the Moon. This is Aldebaran, otherwise known as 87 α Tauri, HR1457, HD 29139, SAO 94027, and BD+16 629. Observing a star of *V* magnitude 0.85 graze the Moon's limb, passing in and out among the lunar mountains and valleys, is a spectacular experience, and many expeditions were planned well in advance. From as far south as San Antonio all the way to Newfoundland, we knew of at least 17 planned expeditions. Unfortunately, the remnants of Hurricane Frances wiped out all of Texas and imperiled Tennessee up until the last minute, when it backed off.

After learning of the iffy condition in Tennessee, where we had initially planned to join an expedition, David Dunham and I decided to drive to Huntington WV, where we met a member of the local planned observing party. However, lake effects clouds began drifting in from the north (and eventually severely hampered the Washington area expedition to Bedford PA, which was led by Richard Taibi and joined by David's wife Joan, my wife Martha, and a fellow astronomer friend, Bill Stein, of Fairfax. Therefore, David and I decided to go farther to the southwest, driving to Danville KY, about 25 miles southwest

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Triggered Star Formation

Reviewed by Gary Joaquin

During September's meeting, Dr. Harri A. T. Vanhala, of the Department of Terrestrial Magnetism (DTM), the Carnegie Institute of Washington, gave a presentation entitled "Star Formation Induced by Interstellar Shock Waves." His work is a collaborative effort with Alan P. Boss, also of DTM, A. G. W. Cameron of the Harvard-Smithsonian Center for Astrophysics, and Prudence N. Foster of the University of Tokyo. The review that follows represents a transcription of Dr. Vanhala's presentation notes, a copy of which he so generously provided, as well as some additional notes found in his very well organized web site, www.ciw.edu/trigger. We are grateful to Dr. Vanhala for a fascinating presentation.

Dr. Vanhala began by reviewing the current standard theory of star formation. Within a molecular cloud, protostellar cores begin to form during the first 1 to 10 million years. During the next hundred thousand years protostars and a nebular disk begin to form. During the next hundred thousand years material is ejected via bipolar outflow. Finally, during the next 1 to 10 million years, the disk begins to clear and the inflow of new material into stars terminates. Given this theory of star formation, Dr. Vanhala posed two questions:

1. How does the environment influence star formation, or more specifically, how do interstellar shock waves influence star formation?

2. How does the solar system fit into the picture? What does meteoritic evidence tell us about the time scales of stellar formation?

Studies of primitive meteoritic material have revealed evidence of short-lived radionuclides in the early solar system. The short half-lives of these particles require that the time interval between their production and incorporation into the first solids be 1 million years or less. The best explanation for the presence of these particles is that they were initially created in stellar interiors (e.g. supernovae) and transported by interstellar shock waves which deposited them into molecular cloud cores where they triggered the cores' gravitational collapse into stars. This explanation suggests the hypothesis that the formation of our solar system was triggered by the impact of an interstellar shock wave. After the solar system collapsed, its evolution is expected to have followed the standard theory of stellar evolution.

Progress in testing the triggered origin of the solar system has been uneven during the last 50 years. In 1953, Ernest Opik, the Estonian astronomer (and former faculty member at the University of Maryland in College Park) postulated that supernovae may play a role in star formation. During the 1960s and 1970s, evidence of short-lived radionuclides where discovered in primitive meteoritic material. In 1977 Cameron and Truran formulated the supernova trigger hypothesis. During the 1970s the first observational evidence for triggered star formation was recorded. The 1980s were a period of little progress. Observational evidence was scarce. Researchers challenged whether or not the triggered star formation hypothesis was even necessary. Questions persisted over the time scale of star formation. Counter arguments postulated that radionuclides originated from local radiation sources, not external shock waves. The 1990s have seen an increase in the amount of meteoritic data which enabled more precise time scales to be postulated. Also, the increase in available computational power has enabled the hypothesis to be simulated and tested.

Much of Dr. Vanhala's presentation focused upon the results of computer simulations of the impact of an interstellar shock wave on molecular clouds. He acknowledged that simulations have advantages and disadvantages. With computer simulations we can study complex systems and behaviors by modeling and adjusting parameters. Currently, the work is limited by the resolution of the study since simulations consisting of billions of molecules are not feasible. Also, there is always the concern regarding whether or not a simulation result is due exclusively to a computational property that may not be a reflection of the real world.

Two simulation methods have been used in this study. Foster and Boss ran simulations using the Piecewise Parabolic Method (PPM). Dr. Vanhala collaborated with Al Cameron on simulations using the Smoothed Particle Hydrodynamic (SPH) method. PPM is a two dimensional method that places a grid over a system and calculates the properties at any given grid point based upon the properties of the nearby grid cells. PPM offers higher resolution than the SPH method. The SPH method is three dimensional and particle-based. You divide a system into particles which overlap. The properties of the system can then be calculated as particle sums over the overlapping, nearby particles. The greatest advantage of the SPH method over PPM is that they are completely Lagrangian, i.e. the particles follow the behavior of the system. SPH does not use and waste grid points in places where nothing interesting is happening. SPH enables each particle to be uniquely numbered and traced throughout the entire simulation. Nonetheless, both methods produced simulation results that agreed remarkably well.

Dr. Vanhala ran computer simulations modeling time periods of 70,000 years, taking about two months of computer processing time originally on a DEC 3000 workstation and later using a variety of Alpha based PCs. His simulations studied molecular clouds of 1 to 10 solar masses, ranging in size from 0.01 to 0.1 parsecs (where 1 parsec = 3.26 light years). He studied the effects of a steady planar shock wave moving at velocities ranging from 10 to 50 km/sec. SPH calculations included magnetic effects and detailed thermodynamics. These simulations were designed to address several key questions:

Can interstellar shock waves trigger the collapse of molecular cloud cores? Simulation results supported the hypothesis that molecular cloud cores can be triggered to collapse by incoming shock waves, provided that the momentum of the shock wave is sufficiently high, but not high enough to tear the core

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apart. Shock wave velocities between 10-45 km/sec triggered collapse.

Temperature became an important factor in these simulations. Essentially, if a shock wave pushes a molecular cloud, and the cloud does not heat up, then the cloud will push back against the shock wave. Alternatively, if the gas in a cloud is heated sufficiently, a molecular core can become unstable and collapse under its own self-gravity. Typical molecular cores become unstable at 27 degrees Kelvin. Thermodynamics employed in the simulation calculations are very important in determining the stability of the core and the properties of the shock wave.

The evolutionary stage of the pre-impact stellar core influenced the results. More highly evolved cores can be triggered to collapse into a single star by shock waves traveling at lower velocities. More highly evolved cores can also withstand higher velocities without breaking apart. Less evolved cores can fragment during compression and form binaries.

Can material carried by the shock wave be injected into the collapsing core?

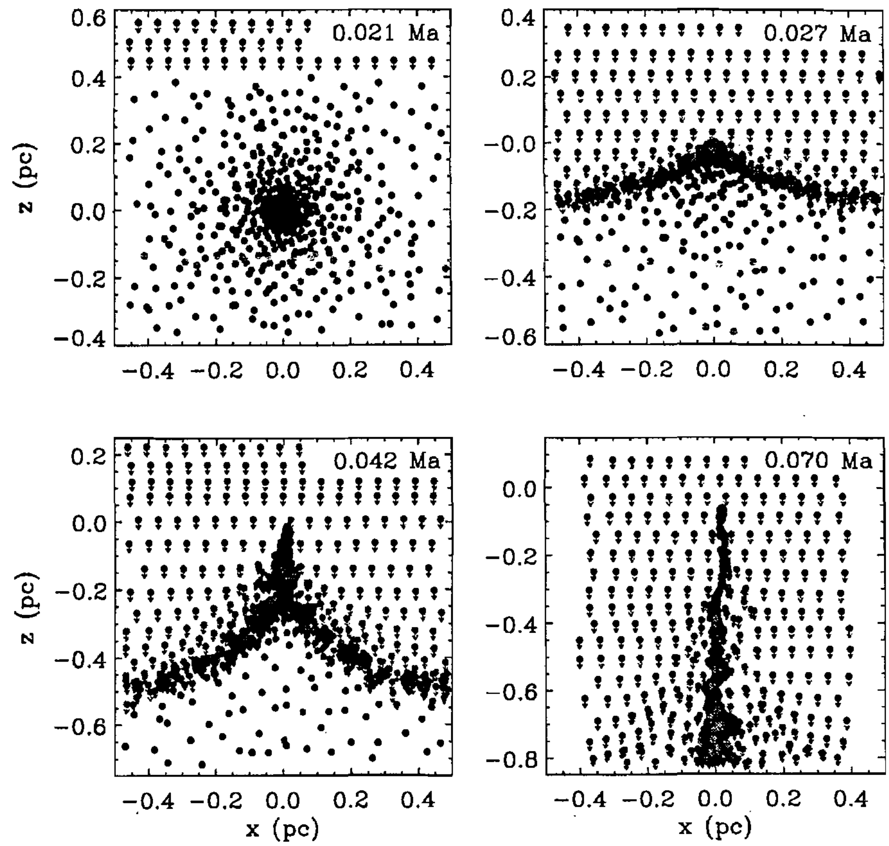
The hypothesis of the triggered origin of the solar system suggests that the interstellar shock wave triggers the collapse of the core and injects radioactive material into the collapsing system. Simulation results confirmed that material is indeed injected through Rayleigh-Taylor instabilities at the contact surface between the core and the shock wave with an injection efficiency of 10-20%. It is useful to note that injection efficiency does not depend significantly on the distance of the material from the leading edge of the shock wave. (A Rayleigh-Taylor instability describes what happens when a heavier fluid lies on top of a lighter fluid; the gravitational force causes the heavier fluid to form fluid fingers that flow down into the lighter liquid, causing mixing and turbulence.) Dr. Vanhala noted that much more work needs to be done in this area. The resolution of current studies is inadequate to observe the details of the process, important small-scale instabilities, and where the material is deposited on a solar system scale.

Is the time scale of the process sufficiently short for the survival of short-lived radionuclides?

Simulation model results have shown that the time elapsed between the first approach of the shock wave to the collapse of the core is between 10,000 and 100,000 years. Time is also required for these radioactive particles to travel from their sources of origin to a molecular cloud. A supernova a few parsecs away from a molecular cloud can eject particles initially moving at velocities of thousands of km/sec. Traversing this distance can take at most several tens of thousands of years, by which time the shock wave has slowed sufficiently to trigger a core to collapse without destroying it. The combined time interval between the production of the radionuclides and their injection to the collapsing core totals about 150,000 years. Since mean life of the shortest-lived detected radionuclides (^{41}Ca) is about 150,000 years, the conclusion can be made that the time scale of triggered star formation is sufficiently short.

Natural Shock Wave Sources

There are several possible sources and events capable of creating shocks of the required velocity magnitude (10-45 km/sec). Supernova explosions have already been identified as more distant sources of shock waves. Nearer to a cloud, shock waves can be produced by several sources: Asymptotic Giant Branch (AGB) stars produce shock waves. An AGB star is a red super giant star whose outer hydrogen thermonuclear reactions have largely ceased, but helium reactions at its stellar core



Interaction between the shock wave and the molecular cloud core in a 3D SPH simulation run employing variable γ thermodynamics. The shock wave material is denoted by the cloud material with directional arrows descending from the top of the figure towards the molecular cloud core. The shock velocity is 25 km/s. The panels correspond to t = 0 (a), 27,000 years (b), 42,000 years (c) and 70,000 years(d). The times marked in the panels show the time from the initial approach of the shock wave. The core is stretched to a thin filament (last frame), the head of which is collapsing. The peak density in the collapsing system is 1.72 x 10^{-11} g/cm^3, 2.4 x 10^6 times the original core density.

periodically ignite and eject particles. Other shock wave sources are Wolf-Rayet stars, named after the 19th century astronomers. Wolf-Rayet stars describe a class of super giant, young, hot, and unstable stars that eject shells of gas at very high velocities. Protostellar outflows within clouds occurring naturally in star formation sites are another source, reaching velocities between 10 and 100 km/sec. The ultraviolet radiation from hot massive stars can also ionize nearby cloud regions and accelerate gas to about 10 km/sec. Lastly, the collision of clouds alone can create shock waves suitable for star formation.

Examples of triggered star formation include the Cone nebula in Monoceros where the wind from a B2 star at the center of the system has triggered the formation of six young stellar objects. Star formations triggered by supernova explosions can be observed in the R Association in CMa R1 (where an association is a loosely "associated" group of stars, much less dense than a star cluster). Other good examples are the Upper Scorpius OB association, and the Trapezium cluster in Orion. In addition, ESO 210-6A in the Gum nebula may be the best known analogy to the triggered formation of our own Sun.

Triggered star formation seems to be a common occurrence during gravitational interactions between galaxies, but it can also be detected in individual galaxies. Examples include NGC 5128 (Centaurus A) where radio jet impacts affect an adjacent cloud, the ring galaxy AM 0644-741 (from the Arp and Madore catalogue of peculiar galaxies and associations) and its ring of massive star formation, and ultraluminous infrared galaxies which are thought to be powered by central star bursts triggered by cloud collisions. Note that many of the objects mentioned result from triggering processes very different from those thought to be responsible for the formation of our solar system. However, the basic principle is the same, that shock waves have initiated the formation of stars faster than they would have formed otherwise.

Further Work to Be Done

Further work is required to address (1) the distribution of binaries versus single stars generated from triggered collapse, (2) the details of injection, specifically, where and how the material is deposited on the solar system scale, (3) the influence of thermodynamics on injection, (4) more realistic shock structures that deviate with the planar structures studied in these simulations, (5) the incorporation of more physics into the simulation, and (6) making more observations with the goal of understanding how triggered objects may appear different from conventional, undisturbed systems. With more research we may be able to learn how common triggered star formations are and more about the kind of environment in which our solar system formed. ❍

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of Lexington. We didn't arrive there until about 0300 hours GMT on September 12 and the first graze was to occur at about 0450 GMT. We had to find a place to stay before the grazes, however, because it would have been too late after, so we located a small motel right in town, dropped many of our things off, and headed out to find sites south of town. We managed to get set up about 15 minutes before the graze of 6.7-magnitude ZC 680 and both successfully made observations. The next graze (Aldebaran) occurred at about 0720 hours GMT, the graze path being about 25 miles distant, thus giving us sufficient time to travel and set up. We observed that near Eubank KY, a small town about 23 miles SSE of Danville, near a town appropriately named Waynesburg KY. David tried to set up his video equipment for the first graze, but had some problems assembling everything in time, and so ended up observing visually. I did not try the video at 6.7 because that is close to my faint limit. However, for the Aldebaran event, we both tried video and David made successful observations, while I had a camcorder problem (the data collecting device in the field) that forced me to observe visually in the end. Of course, it turned out (Murphy's laws again) that David only had one disappearance and one reappearance caused by the highest hill in the graze region near the lunar north pole, while I was farther south and had multiple events, including several flashes and blinks. We were disappointed that the video observations were successful at the wrong site. For the third graze, where the star was only magnitude 8.3, I was set up along a fairly busy highway and was constantly bothered by traffic, even though the event occurred at 0920 GMT (0520 hours EDT). I never found the star, but David was able to make a few observations, although he reported that the graze was quite difficult. For the faint event, we were located south of Stanford KY, between Stanford and Halls Gap, about 10 miles SE of Danville. After sleeping for about 4 hours at the motel, we drove to Dyer Observatory to arrive not long before the meeting began at 1500 hours Central time.

Quite a number of interesting discussions were held at the meeting. One significant decision was made to move quickly to immediately make future issues of Occultation Newsletter (ON) available to IOTA members and ON subscribers on the web. Since a major percentage of IOTA expenses involve the production and mailing of paper copies of ON, there will be a considerably reduced membership for the electronic edition only. All past issues will be scanned and made available as an archive as well. The annual meeting for 1999 is already being planned around another spectacular grazing occultation of Aldebaran that will occur in the Denver area next April. ❍

Newsletter Deadline for November *Star Dust*, October 15, 1998

Send Submissions to Alisa & Gary Joaquin, at 4910 Schuyler Dr, Annandale, VA, 22003-5144. Leave a message on voice mail 703/750-1636. Text files or graphic files in .GIF or .TIFF may be sent via E-Mail to ajglj@erols.com or fax submissions to 703/658-2233. **No submissions will be accepted after the 20th.** There will be no exceptions. We need a reasonable amount of time to design, edit, and review this newsletter. Thank you.

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 Institution of Washington/ Department of Terrestrial Magnetism (CIW/DTM) — Seminars are held on Wednesdays at 11:00 AM in the Seminar Room of the Main Building.

"The MORPHS Project: Hubble Space Telescope Studies of Intermediate-Redshift Galaxy Clusters"," Speaker Alan Dressler, The Observatories, CIW, October 7.

"Plate Tectonics and Mantle Convection," speaker Lianxing Wen, DTM, October 14.

"Applications of New Ion Probe Techniques to Astrophysics," speaker Larry Nittler, DTM, October 28.

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 — "How Are Stars Born", October 17, 7:00 PM.

Scientific Colloquia, Goddard Space Flight Center — All colloquia will be held in the Building 3 Auditorium at 3:30 PM.

"Are There Really Any Living Things in Meteorites?", speaker Richard Hoover, Marshall Space Flight Center, October 2.

"Mars Pathfinder Update," Speaker Matthew Golombeck, October 30.

Space Telescope Science Institute (STScI)— Free lectures held the first Tuesday of each month at 8:00PM in the STScI Auditorium at Johns Hopkins University. Following the lecture visit the Maryland Space Grant Observatory. Free parking is available.

"How and When Do Bulges Form and Evolve?," STScI Bulges Mini-Workshop, October 5-7.

"L Dwarfs and Brown Dwarfs: The Other Solar Neighbors," Speaker James Liebert, University of Arizona, October 7.

"Gamm-Ray Burts," Speaker Bohdan Paczynski, Princeton, University, October 14.

"Particle Cosmology: The Space Telescope/Space Microscope Connection," Speaker Edward Kolb, Fermi National Accelerator Laboratory, October 21.

"Massive Star Evolution: What the Local Group Tells Us," Speaker Phillip Massey, National Optical Astronomy Observatories, October 28.

University of Maryland Department of Astronomy Campus Observatory, College Park, MD — "Imaging Exrtrasolar Planets: The Race is on!", speaker Dr. Lee Mundy, October 5, 9:00 PM.

"After the Dark Ages: When Galaxies Were Young (the Universe at $2<z<5$), 9th Annual October Maryland Astrophysics Conference, October 12-14.

"Discovery of Anti-Particles at the Center of the Milky Way Galaxy", speaker Dr. Marv Leventhal, October 20, 9:00 PM. (*See* their web site at http://www.astro.umd.edu)

Virginia Living Museum Planetarium, Newport News, VA — "Our Endangered Skies & More Than Meets The Eye," Sept. 19- Nov. 15. See their website for more events and programs at http://users.visi.net/~stargazr/html.

MASP '98

(Mid-Atlantic Star Party)
October 15-20

Rain or shine, the speaker schedule includes; Dr. Phillip Ianna, on parallax measurements of stars and the effects of light pollution; Norm Lewis, on interpreting TV weather reports with astronomical observing in mind; Steve Davis, on accessories built of wood to enhance observing; Johnny Horne, on astrophotography; Gayle Riggsbee, on astro-history; Eric Douglas, on planetary geology; others, on the Leonid meteor showers and promoting clubs. Time on Saturday. and Sunday is also scheduled for impromptu short talks from vendors and other attendees. One-day visitors should come Saturday, October 17th.

Observing • Astro Show & Tell • Vendors • Fellowship • Speakers • Swap Meet • Camping and More

Door prizes will include a Millennium Star Atlas ($250) from *Sky & Telescope*, an eyepiece from Pocono Mtn Optics, a pair of binoculars from Swift Instruments and much more.

Daily fee is $10 per adult. Event fee is $20 per adult including camping and daily fees. Children under 15 years attend free when accompanied by adult. MASP t-shirts are $10 each, sweat shirts $20 each, hooded sweats $25 each. Please specify quantity, and size (xxl or xxxl +$3).

Preregister by mailing your fees to:

Mid-Atlantic Star Party
244 Deerfield Rd.
Apex, NC 27502

www.bsa.net/masp
john@bas.net
919-362-5194

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.

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.* ($54 per year)
- [ ] Star Dust only ($27 per year)

[ ] Junior (Only open to those under age 18) Date of birth: ____________________
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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.

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!**

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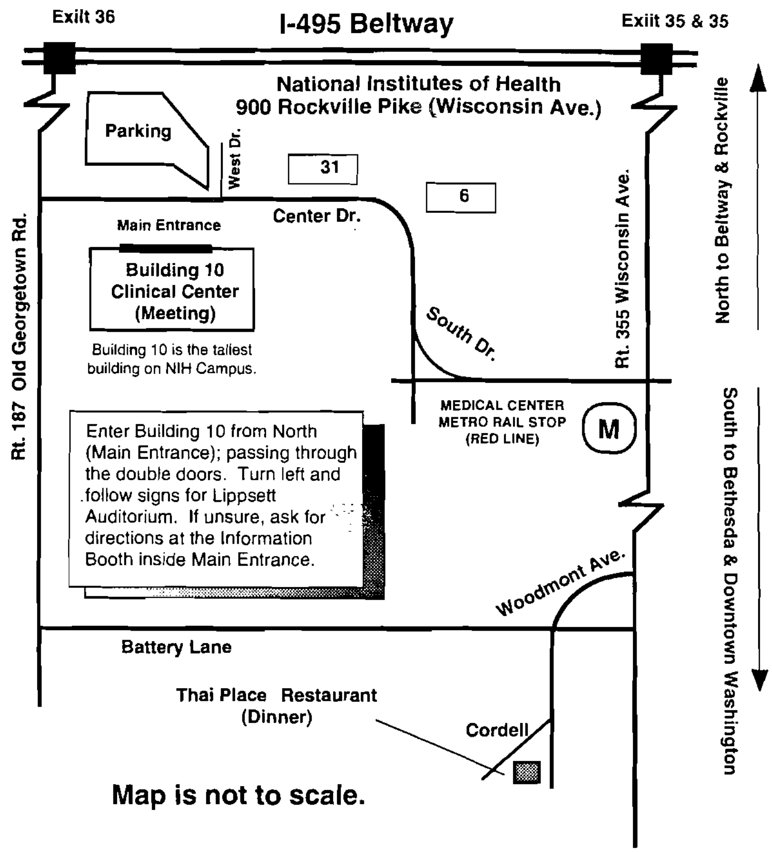
Getting to the NCA Monthly Meeting

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 Resaurant- Take Wisconsin Avenue toward Bethesda and head right onto Woodmont. Follow Woodmont to Cordell Avenue (2 blocks south of Battery). The Thai Place Restaurant is on the corner of Cordell Avenue and Woodmont (4828 Cordell Avenue). There should be adequate parking on the street outside the restaurant. Seats are not guaranteed after 5:30 PM.



Star Dust is published ten times yearly (September through June) by the National Capital Astronomers, Inc. (NCA), a nonprofit, 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. President: Andrew Seacord, 301/805-9741. Deadline for *Star Dust* is the 15th of the preceding month. Editors: Alisa & Gary Joaquin, 4910 Schuyler Dr., Annandale, VA 22003, 703/750-1636, E-mail: ajglj@erols.com. Editoral Advisor: Nancy Byrd

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