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S T A R



D U S T

National Capital Astronomers, Inc.

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## McCarthy Compares Structures of M-Clouds and Galactic Center



FR. MCCARTHY

**F**r. Martin F. McCarthy, Jesuit Chair, Georgetown University, will describe his studies of the structure and stellar populations of the large and small Magellanic clouds at the April 9 (Note date) National Capital Astronomers colloquium in the National Air and Space Museum.

Since 1972 he has frequented the Cerro Tololo Inter-American Observatory to study star fields in the Magellanic Clouds and compare the structure there with that in the galactic center. Using low-dispersion spectra, he seeks red giants of different types in the crowded stellar fields.

For this purpose, he first used the Curtis Schmidt, objective prisms, and infrared plates. Later, he made deeper surveys using a grism (grating-prism) with the CTIO 4-m telescope to classify more than 3,000 spectra which are now being catalogued for use by others.

He has found carbon stars to be abundant in the clouds, in marked contrast to the paucity of C stars found in Baade's window near the galactic center (near NGC 6522).

Martin Francis McCarthy of the Society of Jesus was born in Lowell, Massachusetts. He joined the Jesuit Order in 1940, and was ordained to the Priesthood in 1954 by Cardinal Cushing. He received his Ph.D. from Georgetown University under Fr. Francis Heyden, spent two years of post-doctoral work at Lick, Warner and Swasey, Yerkes, and the Astrophysical Observatory of Canada, and joined the staff of the Vatican Observatory in 1958. He is Chairman of the Committee for Astronomy to the International Astronomical Union for Vatican City State, served as President, IAU Commission for Photometry and Polarization, and was Chairman of the Committee on Resolutions at the General Assemblies of the IAU at Patros, Greece, and New Delhi, India.

### MARCH CALENDAR -- *The public is welcome.*

- Tuesday, April 5, 12, 19, 26, 7:30 pm -- Telescope-making classes at Chevy Chase Community Center, Connecticut Avenue and McKinley Street, NW. Information: Jerry Schnall, 362-8872.
- Friday, April 8, 15, 22, 29, 7:30 pm -- Telescope-making classes at American University, McKinley Hall basement. Information: Jerry Schnall, 362-8872.
- Friday, April 8, 22, 29, 9:00 pm -- NCA 14-inch telescope open nights with Bob Bolster, 6007 Ridgeview Drive, south of Alexandria off Franconia Road between Telegraph Road and Rose Hill Drive. Call Bob at 960-9126.
- Saturday, April 9, 5:45 pm -- Dinner with the speaker at the Smithson Restaurant, 6th and C Streets, SW, inside the Holiday Inn. Reservations unnecessary. Use the 7th Street and Maryland Avenue exit of the L'Enfant Plaza Metrorail station.
- Saturday, April 9, 7:30 pm -- NCA monthly lecture in the Einstein Planetarium of the National Air and Space Museum, Seventh Street and Independence Avenue, SW. Enter Independence Avenue side. Fr. McCarthy will speak.
- Saturday, April 16, 3:00 pm -- Discussion group on astronomical software with Drs. David and Joan Dunham. See page 32.
- Saturday, April 29, 10:00 am to 4:00 pm -- Astronomy Day celebration at the U.S. Naval Observatory with NCA. See page 34.
- Saturday and Sunday, April 29-30, 10 am to 3:00 pm -- Open house at the Garber Facility of the Smithsonian Institution, Silver Hill, Maryland. See page 34.
- Monday, April 25, 7:30 pm -- Human Resources Committee meeting at the University of DC, Room A06, Building 42. See page 32

For other organizations' events of interest see elsewhere in this issue.

## MARCH COLLOQUIUM

Dr. James A. Hughes, Director of the Astrometry Department of the U.S. Naval Observatory, discussed recent developments in astrometric techniques at the March 5 NCA colloquium in the National Air and Space Museum. He first stated the need for continual upgrading of coordinate and positional measurement accuracies.

The root-sum-square (circular) errors of catalog positions are continually increased by the proper-motion errors. Consequently, there is always a need for more accurate positional measurements from which proper motions are derived.

Hughes referred briefly to the many modern interferometry developments including speckle, radio VLBI (Very Long-Baseline Interferometer), MAP (Multichannel Astrometric Photometer), and HIPARCOS (High-Precision PARallax-Collecting Satellite), and a new ground-based interferometric technique developed jointly by SAO, MIT, NRL, and USNO, upon which his talk was focused.

In the interferometer light inputs from two beams, separated by about 10 meters, are combined by a beam splitter. The beams are sent to two mirrors which reflect the beams back to the beam splitter where they are combined to interfere. If the path lengths of these delay lines are such that the two beams arrive in phase, they interfere constructively to produce a fringe pattern. If one delay-line path length is fixed while the other is varied by moving the mirror, the fringe-forming position of the delay-line mirror is thus related to wavelength. The beams are maintained parallel to within a fraction of an arcsecond by tracking the direction of each incoming photon with a PAPA camera. (Inventor: Papadopoulos.)

To attain the necessary delay-line positional precision, a three-tier, cascaded actuator is used. A stepping motor and timing belt move the carriage to within a fraction of a millimeter. A voice coil (such as moves a loud speaker cone) is mounted on the carriage for finer position. The final element, a piezoelectric stack, provides a maximum motion of about 5 microns.

Hughes also described the two-wavelength spectroscopic technique for compensation of the ubiquitous, image-destructive atmospheric turbulence (called the seeing), the bane of most ground-based astronomical measurements.

Making use of the variation of refraction with wavelength (dispersion), the root-mean-square delay-line-position error is markedly reduced (not eliminated) by comparison of simultaneous measurements in two approximately 150-nm passbands in red and blue. The method is also effective in reducing the classical atmospheric refractive error except at large zenith angles. The two-wavelength position is given by the position in passband 1 corrected by the atmospheric dispersion times the difference in positions of passbands 1 and 2. The interferometer is not sensitive to the plane-parallel component of atmospheric refraction; these corrections are for the wedge effects.

The experimental device at Mount Wilson is used as a test bed for establishment of desiderata for a new instrument. Hughes discussed some of the experimental objectives.

One desideratum is sufficiently high sensitivity to measure the positions of faint, very distant quasars. The classical method of developing an inertial (non-rotating) reference frame involves transit-circle measurement of the complex motions and interactions of solar-system objects, relating these to measurements of stars, and subtracting out the solar-system motions. The complexities of this procedure could be greatly alleviated by the more direct method of measurement of the distant quasars whose proper motions (transverse to the line of sight - ed.) are only a few microarcseconds per year, hence, negligible. (At least at present! - ed.)

Last month's lecture referred to positional measurements (from above the atmosphere) of about 20 microarcseconds - about the thickness of a thin human hair (.003 inch) at 500 miles. One microarcsecond is the thickness of that same hair at 20 times 500, or 10,000 miles! It should be reiterated that this is not Direct optical resolution, but positional measurement.

Another desired feature is crossed baselines, in order to simplify the mathematical disentangling of right ascension from declination in the data reductions. Two baselines, optimally north-south and east-west, render the covariance matrix relating the measurements to the position of the source much more tractable.

The real-time metrology of the above-mentioned two-wavelength passbands is also needed.

There is a baseline-length compromise to be dealt with. Interferometry cannot be done on resolved objects. If the baseline is too small, changes at the micron level are too large a fraction of the baseline. If the baseline is too large, even

## OCCULTATION EXPEDITIONS PLANNED

Dr. David Dunham is organizing observers for the following occultations. For further information call (301) 495-9062 (Silver Spring, MD).

Date	Time	Place	Vis Mag	Pent Sunlit	Cusp Angle	Min Aper
Grazing Lunar:						
04-06-88	05:11	Largo, MD,	5.6	85	09S	5 cm
04-21-88	01:31	Gamber. and Balto., MD	8.5	23	14N	13 cm
04-22-88	04:45	Jennersville, PA	7.0	33	11N	8 cm
Asteroidal:						
			Star Mag	Delta Mag	Name	
04-04-88	00:01	New Jersey	8.4	5.0	(466) Tisiphone	15 cm
04-14-88	00:26*	Jacksonville, Fl	11.5	0.9	(52) Europa	20 cm
04-24-88	03:36*	Mexico	12.6	0.6	(59) Elpis	20 cm

\* Appulse. To be observed for possible satellites or path changes.

stars could be resolved, so no interference fringes could be obtained. Lengths of the present experimental baselines will be about 10 meters.

Thermal considerations, structure, delay-line length, environment, and site are all critical parameters in the development of the system.

The effects of seeing (turbulence) are minimal for an aperture which matches the statistical size of the turbulence cells. This is usually a rather small aperture, much smaller than that needed to gather enough light for the necessary sensitivity. Furthermore, with the long baseline needed, the turbulence will be different at the two apertures. How, then, can the two beams be interfered to obtain measurement fringes?

The clever approach to this problem is to use two large siderostats at the ends of the baseline, on the order of a meter in diameter, to gather sufficient light. The beams from these are then compressed to about 10 cm by an afocal optical system for transmission to the interferometer. There, the beams are interfered and the fringes are focussed to yield speckle patterns. A group of optical fibers transport these to a spectrometer where they are dispersed in wavelength to yield a two-dimensional output, one coordinate of which is wavelength. The other is the effective turbulence-cell size. Each of the latter is thus dispersed into a channel spectrum. The X-Y coordinates of each incoming photon can then be obtained with the PAPA camera.

The purpose of the whole procedure, of course, is to derive a correction for the position of the delay-line to obtain the fringe. The Fourier transformed autocorrelation function of the pattern results in a power spectrum which yields the delay-line correction.

Hughes summarized some provisional design considerations for the proposed new system: Baselines: two, n-s, e-w, 10 to 20 m. Siderostats: 75 cm to 1 m, probably on air bearings, if feasible, to avoid stick-slip at the 0.1-micron level, probably run with micro-stepping motors if sufficiently smooth, else with torquers, if adequate resolution. Mirrors centered on piers to minimize thermal expansion effects of piers, and referenced to an invar rod driven to bedrock. Beam compressor vertical, reflecting, compression ratio; about 10. Vacuum path from piers through delay lines. Utilities and control, beam combiner, detection, angle tracker, and another invar reference all underground to minimize thermal effects. Baseline motion is to be monitored by laser-heterodyne metrology. These are only preliminary considerations.

The Mount Wilson Mark-III instrument is successfully performing large-angle optical interferometry. Many stellar diameters have been measured as a by-product of the astrometry. Hughes expects "Incredible breakthroughs." Robert H. McCracken

## WASHINGTON ACADEMY OF SCIENCES TO PRESENT AWARDS

The annual Academy Awards for Scientific Achievement will be presented on Thursday, April 21, at 8:30 pm, in the Mary Graydon Center of American University. The ceremony will be preceded by a reception at 6:45 and dinner at 7:30.

National Capital Astronomers is the astronomical affiliate of the academy.

The awards are presented annually to scientists in the Washington, DC Area. The program was started in 1939 to recognize scientists for "noteworthy discovery, accomplishment, or publication in the biological, engineering, and physical sciences." The awards now recognize and comment scientific work of high merit and distinction in the following scientific areas: Biological, physical, engineering, mathematics and computer, and behavioral sciences, in the teaching of science, the Leo Schubert Award, and the Bernice Lamberton Award. In addition to the annual awards, a new Distinguished Career Award will be presented this year for the first time.

Reservations for the reception and dinner (\$15.00 each) must be received by Monday, April 18, but are not necessary to attend the 8:30 award ceremony only. Call Bob McCracken at NCA, 320-3621, to make reservations and for further information.

## NCA AFFILIATES WITH INTERNATIONAL DARK-SKY ASSOCIATION

*"It is better to extinguish a light than to curse the brightness."* Dr. Victor Slabinsky, NCA

Following a March 5 presentation to National Capital Astronomers by Dr. David Crawford, Astronomer, Kitt Peak National Optical Observatory and now a member of NCA, the Trustees accepted unanimously a proposal to affiliate National Capital Astronomers with the new International Dark-sky Association.

The association is being organized for the purpose of rising from complaints and talk about light pollution to unified, definitive action by the worldwide astronomical community. There are specific, planned actions to be undertaken to save the spectral environment from this reckless waste. We are looking forward to progress through an intensive, unified, program.

Those interested in individual membership may obtain information and membership papers from Bob McCracken. Call NCA: 320-3621.

## NCA WELCOMES NEW MEMBERS

David L. Crawford  
3545 North Stewart Street  
Tucson, AZ 85716

Brett Alan Dewitt  
1800 Hampshire Green Lane #13  
Alexandria, VA 22306

Andrew Ralston  
414 North Edgewood Street  
Arlington, VA 22201

James E. Roy  
1021 Arlington Boulevard, E706  
Arlington, VA 22209

Theodore K. Rudolph  
3100 Furman Lane  
Alexandria, VA 22306

Louis E. Sheffield  
3203 Campbell Drive  
Alexandria, VA 22303

Wayne H. Warren  
8001 Brett Place  
Greenbelt, MD 20770

## DISCUSSION GROUP ON ASTRONOMICAL SOFTWARE

The April 16 discussion group on astronomical software with Dr. Joan Dunham, who chairs the Software Working Group and authors the monthly computer column for *Star Dust*, will be held at 3:00 pm at the Dunham home, 9408 Ocala Street, Silver Spring, Maryland. Ocala Street is north of Franklin Street, four blocks east of Colesville Road, one-half mile inside the Beltway. Call Joan at 585-0989 for further information.

## HUMAN RESOURCES COMMITTEE APRIL MEETING SCHEDULED

The next meeting of the NCA Human Resources Committee will be held on Monday, April 25, at 7:30 pm in Room A06, Building 42, on the campus of the University of DC at Connecticut Avenue and Van Ness Street, NW. All members of the committee, as well as other members who are ready, willing, and able to contribute actively to increase the effectiveness of the organization are encouraged to attend. Call Chairman Kenneth R. Short, (703) 478-0051.

## AIR AND SPACE MUSEUM OFFERS PROGRAMS, TELESCOPIC SKY VIEWING

The following free, public programs will be held in the the National Air and Space Museum during April:

Saturday, April 2, 9:30 am -- John Ron Doel, NASM, will present "Same Sky, Different Story," in the Einstein Planetarium. Following the program, weather permitting, NCA Trustee and NASM Docent Stanley Cawelti will offer safe telescopic viewing of the Sun.

Wednesday, April 20, 7:30 pm -- Nancy Boggess, NASA Astrophysicist, present "The Infrared Sky" in the Albert Einstein Planetarium. Following the lecture, weather permitting, Stanley Cawelti will offer a telescopic tour of the night sky.

A Tuesday tutorial series, "Investigating Modern Astronomy," will be presented at 7:30 pm in the Einstein Planetarium: April 5, "Observing the Heavens: The Tools of the Trade," with Geoffrey Chester; April 12, "Exploring the Worlds Around Us," with Jeffrey Plescia; April 19, "Fading Glory: The Life and Death of Stars," with James Sharp; and April 26, "Reflections in a Pebbly River: The Milky Way," with Thomas Callen II.

## ASTRONOMY AND PERSONAL COMPUTERS: HARD PROBLEMS

The following is considered a "hard problem:" Schedule final exams at a university so that all of the exams are given within the designated week yet students do not find themselves scheduled for two exams at the same time. This type of problem can be solved with various algorithms of computational schemes, but all techniques to solve it take a long time. Another "hard problem" is to determine what subset of variously sized objects will most nearly fill a bag of a given size. Or, alternatively, to determine if there is a subset of objects that exactly fills the bag. These hard problems are ones for which it may be necessary to check all possible solutions before the right solution is found. They are similar to real-world problems that are troublesome to solve and consume considerable computer time, and programmer effort.

Many of the computational problems in astronomy may be difficult to solve, or hard to understand, but they are not "hard problems," because once the solutions (or algorithm to generate the solution) is understood, it can be computed directly. In contrast, the problem of scheduling observing time on the Hubble Space Telescope is a "hard problem." It may take so long to generate the "best" schedule, considering the conflicting demands and constraints, that it is not reasonable to expect to find the best. Techniques to solve such scheduling problems usually produce an approximation to a best schedule, one that might also be described as "not too objectionable to the most people."

A slightly different "hard problem" in astronomy is one in which solutions to a problem are sought by generating all possible answers and then attempting to classify them. For example, a project done at the University of Texas was to classify the types of trajectories comets could take when passing near Jupiter. To find the answers, a very large number of possible trajectories (about 40,000) were generated with pc's, and then sorted into families based on selected parameters. The researcher would use up to four pc's, running them at night and on weekends to integrate the trajectories. (The problem was formulated as a restricted problem of three bodies, with point masses representing the Sun and Jupiter, and a massless point for the comet. The paper on the results should be published later this year.)

Textbooks, such as Sara Baase *Computer Algorithms* (Addison Wesley, 1978), discuss "hard problems" and how to approach their solution. Baase's book, which is designed to be a computer science textbook for the junior or senior year, also gives references to other publications on hard problems.

Joan B. Dunham

## NASA GODDARD SCIENTIFIC COLLOQUIA SCHEDULED

On Fridays, at 3:30 pm in Building 3 Auditorium: April 8, "Evolution of Cometary Orbits," Scott Tremaine, U. Toronto; April 15, "Fundamental Science and Space Science Within the Horizon 2000 Programme," Roger Bonnet, ESA; April 29, "Great Discoveries with the 300-Foot Telescope," Jay Lockman, NRAO.

Coffee and tea will be served from 3:00. Enter the main gate and obtain a visitors pass from the guard. Call Jaylee Mead, 286-8543, for further information.

## FOR SALE

Questar 7-inch, cervit primary mirror, fully mounted, folding pier, five Questar Brandon eyepieces in case, light-pollution filter, dew cap, built-in Barlow, Porro erector, camera attachment. In original Questar cases. Mint condition. New about \$12,500; asking \$7,700. Prefer to sell in Washington area. Day, 687-5752; evenings, 986-0758.

## ESTATE SALE

Many optical, astronomical, electronic, and amateur radio items from the estate of NCA member Bob Wright. Call John Wright (Bob's son), 598-6133 (Laurel, MD). For list of major items, call Bob McCracken at NCA, 320-3621. If no answer, 229-8321.

## EXCERPTS FROM THE IAU CIRCULARS

1. December -- A team of researchers discovered a 110-ms pulsar in the globular cluster M15 by computer analysis of data from the Arecibo radiotelescope.

2. January 23 -- C. and E. Shoemaker discovered a comet (1988b) of 16th magnitude in Leo Minor with the 48-cm Palomar Schmidt telescope.

3. February 15 -- Alain Maury and Jeff Phinney discovered a comet (1988c) with the 1.2-m Oschin Schmidt telescope at Palomar.

4. February 165 -- K. Meech, University of Hawaii, using the 2.2-m telescope on Mauna Kea, found that the nucleus of Comet Wilson (1986 I) had split. Lunar and Planetary Laboratory and University of Arizona observers confirmed the second nucleus and obtained some positional data. Sekanina, Jet Propulsion Laboratory, calculated that the split occurred about the end of August, 130 days after perihelion.

5. February 19 -- M. Hartley, U.K. Schmidt Telescope Unit, discovered a comet (1988d) of 16th magnitude in Sextans. The orbital elements by Green indicate that it has a period of 6.76 years.

6. February 22 -- Infrared photometry of the distant asteroid (2060) Chiron at the NASA Infrared Telescope Facility showed it to be 0.7 magnitude brighter than expected. The University of Hawaii 2.2-m telescope showed no coma around Chiron, and no spectral-line emission was detected. Robert N. Bolster

## COMET LILLER

This ephemeris of Comet Liller (1988a) for the Washington, DC area is provided by Robert N. Bolster. The brightness is expected to reach a maximum of 6.7 about April 9.

Date	EDT	RA	DEC	D	r	Alt	Azi	Rise EDT
04-04-88	05:15	0h56m	37°42'	1.520	0.852	4°	43°	04:41
04-09-88	05:05	1h05m	42°46'	1.467	0.866	8°	40°	03:52
								Set EDT
Evening								
04-13-88	21:25	01:16	47°44'	1.414	0.887	9°	327°	23:06
04-19-88	04:45	1h32m	53°35'	1.365	0.920	15°	32°	Circumpolar
04-23-88	21:40	1h52m	58°56'	1.322	0.956	16°	336°	--
04-28-88	21:50	2h24m	64°38'	1.283	1.001	23°	340°	--

## ASTRONOMY DAY OPEN HOUSE AT NAVAL OBSERVATORY WITH NCA

The U.S. Naval Observatory open house will mark Astronomy Day on April 23 with National Capital Astronomers participation. The event will offer an opportunity to visit the major facilities at the Observatory, see special exhibits, displays, and demonstrations by the Observatory and NCA, and, weather permitting, safe telescopic viewing of the Sun in both white and hydrogen-alpha light.

Volunteers are needed. Call NCA: 320-3621.

## U.S. NAVAL OBSERVATORY TOURS IN APRIL

The Monday night public tours of the Naval Observatory will begin at 8:30 pm (EDT) on April 6, 13, 20, and 27. Passes will be issued to the first 100 persons in line at the main gate at 34th Street and Massachusetts Avenue, NW, beginning at the scheduled time.

Visitors will see various observatory facilities and, weather permitting, appropriately selected celestial objects with the historic 26-inch Clark refractor with which the satellites of Mars were discovered.

For details, call the taped Observatory message: (202) 653-1543.

## GARBER FACILITY OPEN HOUSE APRIL 23-24 WITH NCA

The Paul E. Garber Facility of the Smithsonian Institution will hold open house on Saturday and Sunday April 23-24 from 10:00 am to 3:00 pm with NCA participation. The Facility houses the National Air and Space Museum's reserve collection of more than 140 historic airplanes and hundreds of other artifacts.

See backup satellites, spacecraft, spacesuits, experts restoring historic items, and, weather permitting, safely view the Sun through especially equipped telescopes.

Volunteers are needed. Call NCA: 320-3621.

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# National Capital Astronomers

is an independent, non-profit, public-service corporation for advancement of astronomical sciences. NCA is an affiliate of the Washington Academy of Sciences.

## MEMBERSHIP

is offered to everyone: astronomers, scientists of other disciplines, educators, students, and others who share an interest in learning more about the universe. Membership includes subscriptions to *Sky and Telescope* magazine and the NCA newsletter, *Star Dust*.

## SERVICES AND ACTIVITIES

NCA offers a variety of programs, services, and activities appropriate to the wide range of its membership:

**Monthly public lectures** in the Einstein Planetarium of the National Air and Space Museum by specialists at the horizons of their fields, who present the details of current problems, approaches, and accomplishments. Dissemination of the immediately current status of the field is provided by month-to-month scheduling of the lectures. Some lectures are also cosponsored with the Washington Academy of Sciences.

**Expeditions** to many parts of the world to acquire astronomical data on asteroidal and lunar occultations and eclipses which contribute significantly to refinement of orbital parameters, the coordinate system, navigation tables, and timekeeping. Other results of this work under current study are, the discovery of apparent satellites of asteroids, discovery of apparent small variations in the diameter of the Sun, and profiles of asteroids.

**Discussion groups** in which participants exchange ideas and questions on preselected topics, moderated by a member or guest expert.

**Public information service** on many astronomy-related questions, such as predictions of the paths and times of eclipses and occultations, expedition schedules, data resulting from expeditions, guidance in the selection and purchase of equipment, assistance in developing programs, locating references, and the care and use of telescopes.

**Discounts** on many publications, equipment, and other astronomical aids.

**Working groups** on support areas such as computer software, photographic techniques and materials, and instrumentation.

**NCA Travel** to tour observatories, laboratories, and other points of interest. NCA sponsored tours for Halley's Comet to many parts of the southern hemisphere.

**Telescope-making classes** in which the student learns to grind and polish the precise optical surface that becomes the heart of a fine astronomical telescope.

**Public summer park programs** with telescopes, presented jointly with the National Park Service.

## PLEASE ENROLL ME IN NATIONAL CAPITAL ASTRONOMERS MEMBERSHIP

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