Star Dust

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Dr. Nancy Boggess to Discuss Recent Results From the Cosmic Background Explorer (COBE) Space Satellite

Dr. Nancy Boggess of the infrared Astrophysics Branch, NASA Goddard Space Flight Center, will bring us a one year progress report on the data generated by the Cosmic Background Explorer satellite (COBE). Last year Dr. Boggess spoke at the NCA March colloquium where she presented preliminary data on this first NASA space mission devoted to cosmology.

There are few directly observable measurements possible of the very early phase of our universe. COBE, NASA's first space mission devoted to cosmology, is specifically designed to measure the relics of the primeval universe. It's scientific objectives are to measure the Cosmic Microwave Background (CMB) spectrum and anisotropies in a large angular scale, and to perform a definitive search for the Cosmic Infrared Background (CIB). The CIB is expected to result from the cumulative emissions of luminous objects formed since the decoupling of matter and radiation allowed clumping of matter to form.

COBE, launched in November, 1989 performed an all-sky survey with its three instruments which span the wavelength range from 10^{-2}-10^{-6}m. The liquid helium coolant was depleted on September 21, 1990. Since that time, the Far Infrared Absolute Spectrophotometer (FIRAS) has been turned off but the near infrared photometric band s on the Diffuse Infrared Background Experiment (DIRBE) continue to gather more data, although with somewhat reduced sensitivity. The Differential Microwave Radiometers, located outside the cryostat continue to operate normally.

An overview of the mission, instruments, and results will be presented as well as a discussion of the cosmological implications. The COBE Science Working Group gave scientific guidance for the mission and the results.

Dr. Nancy Boggess received her B.A. (Cum Laud) in Mathematics in 1947 from Wheaton College and her M.A. in Astronomy from Wellesly in 1949. She completed her Ph.D. in Astrophysics form the University of Michigan in 1967 She has served as Program Scientist for all NASA infrared space programs in Astrophysics, the infrared SR&T programs, the Kuiper Airborne Astronomy program, and the IRAS science working group. Presently she is the COBE Deputy Project Scientist, RTOP manager for Infrared Submillimeter and Radio programs in astrophysics. She is a member of the American Astronomical Society, Sigma Xi, and the IAU, has published widely and received several awards.

*COBE is supported by the Astrophysics Division of the NASA's Office of Space Science and Applications. Goddard Space Flight Center is responsible for the development, operation and processing of the space data for COBE.

April Calendar..... *The Public is Welcome*

Saturday, April 2, 7:30 pm - NCA Monthly Colloquium will be held in room A-06 of Building #42 on the Van Ness Campus of the University of the District of Columbia (UDC), at 4200 Connecticut Ave NW. Dinner with the speaker at 5:45 PM at Charlie Chaing's Restaurant at 4250 Conn Ave. NW (dinner will be in upper level of restaurant).

For directions refer to map and description on last page.

Tuesday, April 2, 9, 16, 23, 30 7:30 pm - Telescope-making classes at Chevy Chase Community Center, Connecticut Avenue and McKinley Street, NW. Information: Jerry Schnall, (202) 362-8872.

Friday, April 5, 12, 19, 26, 7:30 pm - Telescope-making classes at American University, McKinley Hall Basement. Information: Jerry Schnall, (202) 362-8872.

Friday, April 5, 19, 26, 8:30 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 (703) 960-9126.

Wednesday, April 10, 7:30 pm - "Inflation!" by Alan Guth of the Harvard-Smithsonian Center for Astrophysics. He will explain the inflationary universe proposal. At the Smithsonian Institution as part of the Resident Associate courses in Astronomy. For information call (202)357-3030.

Saturday, April 20th is Astronomy Day at the National Air and Space Museum

Saturday evening, April 13/14
OPEN HOUSE AT THE HOPEWELL CORPORATION OBSERVATORY

NCA members, families, and guests are invited to the spring open house at Hopewell Observatory to view the spring sky and Venus, Mars, Jupiter and Saturn. Sunset will be at 7:46 and twilight will end an hour an a half later. Come earlier if you wish (any time after 6:00 pm) and bring your prepared picnic dinner. Coffee, tea, cocoa, and soft drinks will be provided by the Hopewell Corporation. From the Beltway (I-495) go west on I-66 25 miles to Exit 9 at Haymarket onto U.S. 15. Go left on 15 0.3 mile to traffic light, right onto Va. 55, 0.8 mile to Antioch Road (Co. Rt. 681). Go right on 681, 3.2 miles to end, left on Waterfall Road (601) 1 mile to County road 629. Right on 629 0.9 mile to narrow paved road at right. (Directly across from an entrance gate with stone facing on left.) Turn right, go 0.3 mile to top of ridge, around the microwave station and continue on dirt road through woods a few hundred feet to the observatory. Park along the road short of the buildings. The event will be cancelled if it is raining or hopelessly cloudy. For further information call (703)960-9126 or (301) 320-3621.

March Colloquium

Dr. JoAnn Eder from the Carnegie Institution of Washington gave the March colloquium a very informative talk on "S0 Galaxies: Disks Without Arms." She noted that the fact that "the Milky Way is one of the most spectacular features in the sky" led to investigations of its origin, which in turn led to the realization that our Galaxy was one of many galaxies in the Universe. This curiosity, in turn led to Edwin Hubble's access to the 2.5- m (100-in.) reflector at Mt. Wilson, California (a Carnegie funded instrument). He took many photographs of galaxies in the days before light pollution from the Los Angeles ruined the night sky there.

Hubble was then confronted with the task of classifying these galaxies he photographed. Hubble set out all the photographs he obtained of galaxies and tried to classify them as "pictures in his gallery of galaxies." He postulated that a galaxy category called an "S0" spiral (pronounced "S-Zero spiral") should exist marking the boundary between elliptical and spiral galaxies. S0's are the borderline case, thus defying easy categorization. It is at the point occupied by the S0 type that galaxy types go from elliptical to the two main branches of spirals: typical spirals, and barred spirals. Unfortunately, at first, Hubble could not find any examples of his postulated "S0" spiral category. When trying to explain what he was looking for in his search for this "S0" type, Hubble would respond with "they're just spiral galaxies without arms." For comparison, "the beautiful photogenic spiral galaxies" so commonly seen in popular literature are Sc spirals. They have "very small bulges." S0 spirals have no evidence of: dust, arm structure, or "little beads" indicating star formation (i.e. any evidence of "blotchy" structure on photographs or electronic images). If you just turned off star formation and got rid of the dust in typical spirals, then you would get what we see in S0's.

When S0 and spiral types are classified by their "bulge to total ratios" a "parallel sequence system" appears to be operating, whereby different classes of S0's appear equivalent to different classes of spirals, except that they don't have arms:

S0 Type		Spiral Type
S0a	Equivalent to	Sa
S0b	" "	Sb
S0c	" "	Sc

"Anemics" are galaxies possessing faint arms with only a little "blotchy" structure seen. They appear in type to be sort of between S0's and spirals.

The main question Dr. Eder examined was what are the main differences between S0's and spirals? When long exposures are made of a galaxy with big radio telescopes, a spectrum is generated in radio wavelengths indicating variations in the intensity of radiation received with wavelength around the 21-cm emission line. This observed apparent variation is due mainly to:

- Red shift of the entire galaxy as it moves away from us (i.e. the observer) along our line of sight.
- Rotation of matter (stars, gas, and dust) within the galaxy itself.
- The amount of matter in the galaxy that is emitting radio radiation, indicating whether that galaxy is undergoing rich, "anemic," or poor star formation.
- The galaxy's tilt to our (i.e. the observer's) plane of reference.

The above factors have to be sorted through to calculate the amount of matter in a galaxy. Neutral hydrogen emissions are easily received at the Earth's surface. When and where you find these emissions, you find neutral hydrogen molecules. Dr. Eder emphasized that the 21-cm radio emission does not require ionization of the hydrogen. Instead, it results from a spin frequency transition as the spin of the electron flips. It is just that there is a lot of hydrogen out there and sometimes some of its electrons flip the orientations of their spin. In the "spin up" state, the electron and proton revolve in the same direction. In the "spin down" state, they revolve in the opposite direction. Changing between one and the other state changes the energy state of the atom, resulting in a release of 21-cm wavelength radiation. Thus, ionization of the hydrogen is not required here to initiate this process. This 21-cm emission allows the study of hydrogen in galaxies near the limit of radio telescope exposure times, near 12 hours.

The phenomenon of galaxy formation (and thus star formation) is a matter of conjecture. One theory states that density perturbations of matter in the Universe are an explanation. When the perturbation is large enough, stars begin to form. But when the perturbation occurred, and its type greatly affects what type of galaxy results. The amount of gas left over after the cloud collapses to form a galaxy depends on the efficiency of star formation in a galaxy. Spiral galaxies are believed to contain the most active star formation. We don't know how spiral density waves lead to stars, nor how interstellar hydrogen gas goes to molecules. To have the interstellar medium coalesce into stars, one needs to have molecular hydrogen clouds, and have them be in a very stable state, i.e. cold and settled. To undertake this transition from hydrogen gas to molecular hydrogen requires dust to shield it from dissociating ultraviolet radiation and a very cold setting.

Why S0's don't have arms, JoAnn Eder and colleagues looked at 81 large galaxies, studying radiation in radio wavelengths. She also used the 0.9-m (36-in.) and 1-m (40-in.) optical telescopes for charge coupled device (CCD) imaging at Kitt Peak, Arizona and Cerro Tololo, Chile, respectively. She used such "smaller" telescopes so as to fit the entire galaxy in the field of view of her CCD sensor. This provided a single uniform image of each galaxy for analysis. Dr. Eder studied three principle spectral ranges: red, blue, and both Hα and doubly ionized Nitrogen (N^{2+}) adjacent emission lines. Unlike the hours long exposure times for her radio work, CCD exposure times in these optical wavelengths ranged from 8 minutes to 1 hour 30 minutes long, depending on the filter used.

The "surface density" of a galaxy is equivalent to its singly ionized hydrogen (HI) emission and its diameter in optical wavelengths. Some galaxies classed as S0's are gas rich S0's, based on their radio emissions, and have as much gas as spiral's. Using the CCD sensor, she found these galaxies to be essentially spirals with faint arms and a very smooth disk. These structures were revealed in the CCD images, but not on standard Palomar Sky Survey photographic plates, the arms might have been detectable in better photographs, but these were not taken prior to imaging with CCD. "Gas poor S0's" had gas, but less gas than spirals. These all show there is a continuum of star formation properties in galaxies. They range from rich star formation, to less, and less, and still less star formation, down to none at all. In other words, the gas eventually gets used up, and stars die off except long lived stars like the Sun that just burn on and on for billions upon billions of years. But these stars too eventually die, leaving a "dark galaxy" with no emissions in the electromagnetic spectrum. Anemic spirals have very faint arms, apparently indicating fading amounts of star formation. Dr. Eder offered three explanations as to why S0's don't have arms: star formation has ceased; the arms have faded; the smooth disk is left with long lived, sol type stars.

There is now strong evidence for a small bar in our Milky Way, but it is hard to tell. Observation is hindered because we are immersed within the Galaxy's disk, so our line of sight is edge on, and there is lots of dust blocking our line of sight towards the Galaxy's center. An alternative idea for galaxy formation postu-

lates that collision and interaction among galaxies stimulates star formation.

The more galaxies interact, the less you get arms in them, and the more you get a central bulge. This is in reverse of the Hubble sequence. Another possibility is that all galaxies formed at the same time, and some used up gas faster than others. Thus "early" type galaxies used up gas earlier, while "later" types (e.g. Sc spirals) are burning their gas more efficiently, and that is the reason why they can still be seen with spiral arms and forming stars. Dr. Eder pointed out that the terms "early" and "late," when referring to galaxy classification reflect traditional category names applied by Hubble to his galaxy morphology scheme. He thought galaxies evolved this way. But this in no way reflects the current position of the astronomical community since the mechanism and direction of galactic evolution is still hotly contested. Most of a galaxy's mass is in older, long lived, Sol type stars, while most of its brightness comes from hot, young stars that don't live long. Recently discovered, apparently newly formed, very distant galaxies (if the interpretation of the Hubble Constant is correct) are being measured as being mostly gas and few stars, with low surface brightness. Though they don't emit any electromagnetic radiation, one could theoretically detect "dead galaxies" by their gravitational lens effect on more distant, visible galaxies in line of sight with them and the observer. Though they are 'dark', the long dead corpses of stars and star stuff still possess mass.

She pointed out however, that a galaxy does not need spiral arms to have rich star formation. The Large Magellanic Cloud (LMC) and Small Magellanic Cloud (SMC) have lots of stars forming. The magellanic clouds are irregular galaxies, neither spirals nor ellipticals. Gas is returned to the interstellar medium by stars themselves as it is spewed out by exploding supernovas and puffed out in planetary nebulas emitted by stars. But it is now realized that this kind of recycling is not enough to replenish the galactic gas supply used up in star formation.

Do spiral density waves "encourage" (i.e. "trigger") star formation, or just organize the stars once they are already formed. Many argue that the clouds of molecular hydrogen and their associated dust, etc. will make stars anyway. So do the spiral density waves just organize the molecular clouds of hydrogen, or do they cause the star formation itself? At one colloquium Dr. Eder attended, one speaker used a "chicken and egg analogy" to explain the issue. If you randomly scatter chicken feed over a farm yard, then chickens go after it and subsequently lay eggs in a random pattern. But if you carefully arrange the feed in a pattern, say in rows, or along a spiral, then the chickens settle down in this pattern to eat the feed and thus lay eggs following this pattern. This is analogous to the spiral density waves "encouraging" star formation. The pattern (spiral density waves) of placement of the feed (hydrogen gas) will organize the chickens (clouds of star making dust and molecular hydrogen gas), which in turn will determine where the eggs (stars) will be laid. To this, N.C.A. member John Lohman commented that one can also say that the chicken is simply the egg's way of perpetuating itself.

Preparer's Note: According to the Royal Astronomical Society's Observer's Handbook 1991, our Galaxy is an Sb/c type, the LMC is an SBm III type, and the SMC is an Im IV-V type. There are no S0 types among the 22 galaxies comprising our Local Group, which also are the 22 nearest galaxies. And of the 40 optically brightest galaxies, four have S0 listed in their category type.

Daniel J. Costanzo

Occultation Expeditions Planned

Dr. David Dunham is organizing observers for the following occultations. For further information call the NCA-IOTA information line (301) 474-4945 (Greenbelt, MD).

Date Grazing Lunar:	Time EDT	Locality	Visible Magnitude	Percent Sunlight	Cusp Angle	Minimum Aperture
6-Apr	3:14	Mt. Freedom, NJ	2.9	59	1N	5 cm
18-Apr	23:05	Red Lion, NJ	8.1	23	13N	10 cm
21-Apr	22:29	Calvert Manor, MD	7.8	56	16N	8 cm
1-May	2:31	Dinwiddie, VA	3.1	94	7N	5 cm

Asteroidal:	Time	Locality	Star Mag.	Delta Mag.	Name	Aperture
25-Apr	22:00	N. Canada*	11.3	1.4	(451)Patientia	15 cm

*Appulse to be observed for possible satellites or path shift.

Excerpts from the IAU Circulars

R.N. Bolster

1• February 9 - H. Fukushima, National Astronomical Observatory of Japan, photographed an anti-tail extending 2.7 degrees from Comet Levy (1990c).

2• February 12 - R.H. McNaught, University of Adelaide,discovered a comet (1991g) of 17th magnitude in Crater on a U.K.Schmidt Telescope plate taken by Russell.

3• February 12 - Hainaut, Smette, and West, European Southern Observatory, observed with the 1.54-m Danish Telescope at La Silla a brightening of Comet Halley indicating a major eruptive event. Extension of the coma to approximately 200 000 km in size was also seen.

4• February 19 - Schramm and Borgeest, Hamburg Observatory, reported that quasar 3C 345 has brightened exponentially since August, and is now 1.5 magnitudes brighter than normal.

5•. March 24 - Matsuo Sugano, Kakogawa-shi, Japan, andGeorge Alcock, Peterborough, England, discovered a nova of 5th magnitude in Hercules. Sugano's discovery was made photographically, Alcock's with 10x50 binoculars. Nova Herculis 1991, which may still be brightening, is located at R.A. = 18h44.2m, Decl. = +12 deg. 10.8 min. (1950.0).

Astronomy and Personal Computers

Joan Bixby Dunham

Directory of Physics Courseware

The theme for the January/February issue of Computers in Physics is physics education. This issue contains a directory of educational software for 1991, done in cooperation with a educational software evaluation project at North Carolina State University. This 50 page list is sorted by topic and gives the target machine, price, and publisher for the software. I found several surprises in perusing the list. The first was how few entries there were under astronomy The second was how many of the programs were listed as for the Apple II computer. The third was how inexpensive many of the programs were, although it is not clear if these prices are for individual purchases of the software or unit prices for bulk purchases.

There is less than a page and a half of astronomy software, as compared with other topics, such as electricity and magnetism, or mathematical physics. Many of the programs are planetarium programs, such as Dance of the Planets, Voyager,or PC Planetarium. Many of these programs are advertised in Sky and Telescope,and have been reviewed there.

The list does have programs under other topics, though, which also contain astronomy-related topics or can be applied to astronomy. For example, there are many programs under mathematical physics, mechanics, and optics which would be of interest to an astronomy student.

I was intrigued by the number of programs for the Apple II with familiar names,programs that must be at least 7 years old. I was never particularly happy with the educational software I tried on our Apple. It is difficult to write complex software for the Apple II+ because of its limitations in program speed and size,to say nothing of the limitations in its graphics display. I would hope that the versions being sold today are better than those I tried in 1983, but I would caution anybody considering purchase of these programs to be very sure it is supposed to run on your particular configuration of hardware. This is also something that purchasers of software for other machines must also note. There is a relatively expensive mathematical physics program for the IBM PC on this list which would not run correctly on any of several machines I tried. (I understand there is a new version, but I gave up.)

Can We Teach Computers to Teach? This same issue of Computers in Physics has an article with that title and an editorial. The editorial basically says "Not really", but the article, written by Eric Mazur, author of the program Essence of Physics, makes a strong case for the answer of "Yes". This program is a Hypercard program for the Macintosh, and was a prize winner in the CIP educational software contest. I would recommend that anyone interested in developing educational software read Mazur's article. His design principles look very good and would certainly apply to other subjects.

How small can you go? HP is announcing a palmtop PC that weighs 11.6 ounces including batteries, comes with a spreadsheet hard wired in ROM, and will sell for about $700. This PC will be a MS DOS machine (whether or not it has disk drives is not mentioned), and will have a 16-line 40-character display. Is it a very small PC or a somewhat large calculator?

It is possible to be too small. The smallest scientific calculators I have ever seen were the Casio scientific calculator digital watches. I must admit I rarely use mine for more than simple four-function arithmetic. I can barely read the function keys in a strong light (green and red lettering on a black background). Others must have found them equally difficult, as Casio no longer makes these watches. They still make a 4-function calculator watch.

More new small computers are being announced all the time. IBM and AT&T in particular are announcing laptop computers based on the 80386SX. The IBM computer will be about $6000, and include a 60-megabyte hard disk; the AT&T computer will cost less, but have a 40-megabyte hard disk. Both of these will probably weigh less than 8 lbs. Others (Toshiba, Epson, Olivetti) are also selling or about to sell similar machines. Several smaller manufacturers (Acer America and Micro Express are two) are selling notebook 386SX computers with fewer features for under $2000.

As these super calculators and laptops become more widely available, we should see the prices for the 286 based laptop and notebook computers drop. This leads to an interesting problem for those of us still using the "old" portables we bought 2 to 4 years ago. When these machines need servicing, do we repair them(assuming we can find someone who will work on them) or replace them? My portable has an intermittent problem with its A: disk drive which (unfortunately)keeps the machine from booting. If the drive needs to be replaced, the cost could be as much as half the price of the HP palmtop. I might be able to find a new portable for not much more than the repair.

Computer Program to Pinpoint CERRES Releases

Using Joan Dunham's computation scheme (see march 1991 Star Dust), I wrote a BASIC program to compute the RA and DEC of a CERRES release and its altitude, azimuth and slant range given the time and date of the release and other information provided by the Marshall Space Flight Center's answering machine. This program runs on Microsoft s Quick BASIC© or GW BASIC. For a copy of this program and a set of operating instructions in ASCII on a floppy disk or via modem, call me at (301)564-6061

Leith Holloway

New Books

Lonely Hearts of the Cosmos,
by Dennis Overbye, Harper Collins, New York, 1991. 438 pages, $25.

Lonely Hearts of the Cosmos is the story of what is known about the birth, present, and future of the entire universe, how this knowledge was gained, and the lives of the great astrophysicists who study the cosmos. Overbye, a widely published physical sciences writer and editor, covers all the major ideas in general relativity, quantum mechanics, mathematics, observational astronomy, and astrophysics that have been used to reach our current, controversial understanding of cosmology. He does this at a level suitable for the serious amateur, and makes each concept and scientist available in his detailed index.

The author travelled extensively over the world to visit and become quite intimate with many of the key players (some of them NCA speakers) developing our ideas about the cosmos. Overbye discusses aspects of the career developments and personalities of these women and men, and how these great scientists interact with one another. For those who love astronomy and physics, this brilliant book is gripping reading!

The one real weakness of *Lonely Hearts of the Cosmos* is the over simplified and unnecessarily harsh judgements Overbye occasionally makes about decisions that various scientists made in the course of their careers; yet these judgements do stimulate the reader.

This book is very important for young people considering a career in the physical sciences. It shows them vividly the inner workings of 'big science', particularly in the academic world. The book will stimulate many readers to seriously question whether this is the world they want. If the answer is yes, Overbye's book will be a helpful guide to their general school and teacher choices. I urge NCA high school and college students to read *Lonely Hearts of the Cosmos* immediately.

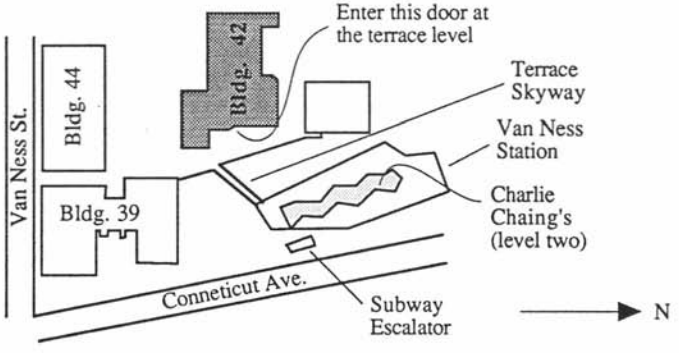
Bill Winkler

Naval Observatory and Smithsonian Programs

•Anyone who is interested in cataloging occultation timings the 5" telescope at the Naval Observatory is available. Those interested in participating must contact Jay Miller [h(301)530-7942 w(301)496-6941] to be checked out on operation of the instrument and for admission to the observatory. The solid occultation timings are posted on the 5" for that location.

Smithsonian Institution Resident Associate Programs Astronomy Courses
(Talks presented in the planetarium)
Wednesday, May 8, 7:30 pm - "Extragalactic Sociology", by Martha P. Haynes of Cornell University. She will discuss interactions among neighboring galaxies. Call (202)357-3030
Wednesday, June 5, 7:30 pm - "Galaxies and the Missing Matter" by Vera Rubin of The Carnegie Institution of Washington. She will present the latest findings in the area.
New Frontiers in AStronomy, an RAP 8 session short course coordinated by Sten F. Odenwald. Lectures meet tuesdays at 8:00 p. m., April 16- June 12.
Spring Stargazing at the U. S. Naval Observatory: an R.A.P. 8 session short course coordinated by Sten F. Odenwald. Lectures meet tuesdays at 8:00 p. m., April 16- June 12.

Getting to the NCA Monthly Colloquium



•From the Van Ness Subway Escalators:
Charlie Chaings can be reached from the second floor mezzanine in the Van Ness Station building (lightly stippled).
The lecture hall is on the terrace level of the University of the District of Columbia (three levels up from the subway escalators). There is a skyway walk from the third floor of the Van Ness Station building, or there are stairways and elevators if you walk through the Van Ness Station building, across the bus lane and tthrough the parking garage. The lecture room is nearest to the door by the skyway.

FOR SALE: Celestron Super Polaris C-8, Starbrigh coating, quartz drive, full-aperature glass solar filter Contact Tom Wiederrecht (703)764-9077

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