Star Dust

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Dr. JoAnn Eder Will Discuss Observations of S0 Galaxies

JoAnn Eder recently received her Ph.D in Astronomy from Yale University and is presently serving a postdoctoral fellowship at the Carnegie Institution of Washington's Department of Terrestrial Magnetism. Her research during the past ten years has focused on the nature of S0 galaxies. Dr. Eder's MS thesis researched the molecular hydrogen content of S0's at San Diego State University. Her dissertation expanded on that theme to more fully analyze their gas content, structure and environment.

In most systems of galaxy classification, S0 galaxies form a transition between the spheroidal ellipticals and the photogenic spiral galaxies. They have a prominent bulge and a distinct, smooth disk with no apparent arms. The dramatic arm structures of spiral galaxies are accentuated by the bright regions of ionized gas and dark dust lanes which are associated with the formation of hot, massive stars. Since S0's do not have these features, it has long been thought that they also lack the gas and dust which are the necessary fuel for star formation. Sensitive observations of the neutral hydrogen (H I) content of S0 galaxies have been made with the largest single dish radio telescope in the world at Arecibo, Puerto Rico. Contrary to expectation, over half of the S0's observed contain detectable H I. Some even have as much gas as that found in spiral galaxies of comparable size! Why, then, don't S0 galaxies have arms?

March Calendar.. *The Public is Welcome*

Saturday, March 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).

DIRECTIONS: From the Van Ness Metro station exit, walk west through entrance of UDC, crossing bus lane into garage. Exit garage on North side, climbing to level A of the campus. Building 42 is to the west as you emerge. (Alternatively, there is an elevator in Building 42.) The parking garage may be entered by car from Van Ness street. Charlie Chaing's restaurant is to the west of the entrance to UDC, and may be accessed from Connecticut Avenue or from the rear.

Tuesday, March 5, 12, 19, 29, 7:30 pm - Telescope-making classes at Chevy Chase Community Center, Connecticut Avenue and McKinley Street, NW. Information: Jerry Schnall, (202) 362-8872.

Friday, March 1, 8, 15, 22, 7:30 pm - Telescope-making classes at American University, McKinley Hall Basement. Information: Jerry Schnall, (202) 362-8872.

Friday, March 8, 15 and 22, 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.

February Colloquium

Dr. Judith Lean from the Naval Research Laboratory gave the February colloquium, an enthusiastic talk on "Variations in Solar Radiation".

The total irradiance from the sun is the electromagnetic power incident on a unit surface, normal to the sun's direction, integrated over all wavelengths (from X-rays through the ultraviolet, visible, infrared, and radio-frequency spectrum). The raw irradiance measurements are corrected to 1 Astronomical Unit from the sun to eliminate the variation in irradiance with the inverse square of the distance between the sun and the detector. Such corrected values were called the "solar constant" in the past. The irradiance in parts of the ultraviolet and radio-frequency spectrum is very variable, but this contributes relatively little variation to the total solar irradiance.

The Smithsonian measurements of the solar constant over the past century showed that any variation must be less than 1 percent. These ground based measurements were affected by variations in atmospheric transparency. Starting in 1978, satellite measurements from above the earth's atmosphere have revealed a 0.08% variation (peak-to-peak) in the 3 month average of total irradiance. These measurements come primarily from the Earth Radiation Budget (ERB) radiometer on Nimbus 7 and the Active Cavity Irradiance Monitor (ACRIM) radiometer on the Solar Maximum Mission (SMM).

These two very different radiometers show very similar daily variations for the total irradiance which proves that the variations are from the sun and not in the radiometers. The fact that both instruments show a steady increase since 1986, as we approach solar maximum, indicates that the irradiance decrease from 1982 to 1986 is also real and not an effect of instrument aging. It is interesting to note that there is a fairly constant 3.3 watt/m^2 (0.2 percent) difference in readings between the two radiometers; this shows that there are still problems in the absolute calibration of such instruments.

The total irradiance shows decreases as great as 2 watt/m^2 which last for a week; these decreases are well correlated with increases in the sunspot area projected onto the apparent solar disk. This shows that sunspots are a blocking factor for the total irradiance. But the irradiance variation over the 11 year sunspot cycle is anti-correlated with sunspots, that is, the irradiance is least at sunspot minimum. The reason is that sunspots in the photosphere are accompanied by plages (bright regions in the chromosphere) which are larger in area than the sunspots. The plages are connected to the faculae (bright regions in the photosphere). The enhanced emission from the faculae more than offsets the radiation blocking from sunspots; this results in the irradiance increase at sunspot maximum. When solar rotation brings large sunspot groups across the solar disk, their changing projected area causes the week-long dips in total irradiance seen at the earth.

One can form a mathematical model for the irradiance:

total irradiance =	quiet sun irradiance (about 1370 watt/m^2) + sunspot blocking term (depends on sunspot area) + faculae enhancement term (depends on sunspot number)

Note that the last-term dependence on sunspot number is not the same as dependence on total sunspot projected area. The sunspot number monthly means can be used in this model to evaluate the solar irradiance of the earth back to 1875. The predicted irradiance variations seem to be too small to explain the observed climatic changes since then.

Victor J. Slabinski

NCA Welcomes New Members

Louis Sheffield T.O.P.
3900 Larchwood Rd.
Falls Church, VA 22041

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	Locality	Visible Magnitude	Percent Sunlight	Cusp Angle	Minimum Aperture
20-Mar	19:02	Fredericksburg, VA	7	25	10N	6 cm
22-Mar	21:26	Harrisonville, VA	8.2	48	14N	10 cm
22-Mar	22:49	Bowie & Laurel, MD	9	48	14N	20 cm
6-Apr	3:14	Morrisonville, NJ	2.9	59	1N	6 cm

3-20 Last occultation of the Pleiades cluster until 2005: See March Sky & Tel.

Asteroidal:	Time	Locality	Star Mag.	Delta Mag.	Name	Aperture
25-Mar	19:53	Central Amer.*	10.4	2.5	(747)Winchester	20 cm
29-Mar	19:25	N. Canada*	9.8	4	(925)Alphonsina	15 cm
31-Mar	22:12	N. Canada*	8.0	5.7	(46) Hestia	10 cm
4-Apr	20:16	Labrador*	10.7	2.5	(17) Thetis	20 cm

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

Excerpts from the IAU Circulars

R.N. Bolster

1• **January 18** - D. Rabinowitz discovered an asteroidal object (1991 BA) of 18th magnitude which moved 7 degrees during 5 hours of observation with the Spacewatch telescope at Kitt Peak. From 7 positions measured by J.V. Scotti, Marsden calculated that the object missed the Earth by 0.0011 AU (170 000 km). The last observed position was at 0.0033 AU, the closest any natural object has been seen outside of the atmosphere. The asteroid was estimated to be 5-10 m in diameter.

2• **January 22** - C.S. and E.M. Shoemaker and D.H. Levy discovered a comet (1991d) of 15th magnitude in Hydra with the 46-cm Palomar Schmidt telescope. The preliminary orbital elements by Nakano indicate that the comet will pass perihelion in 1991 December at about 2 AU.

3• **February 7** - The Shoemakers and Levy discovered another comet (1991e) of 17th magnitude in Cancer with the 46-cm Palomar Schmidt. The orbital elements by Marsden indicate the comet has a period of 7.26 years.

4• **February 9** - The Shoemakers and Levy discovered yet another comet (1991f) of 17th magnitude in Virgo with the 46-cm Palomar Schmidt.

Astronomy and Personal Computers

Joan Bixby Dunham

Computing the Location of CRRES Releases

The CRRES (Combines Release and Radiation Effects Satellite) releases chemicals, barium, strontium, and lithium, at various points in its orbit to map the magnetic field near the Earth. The times and locations for the planned releases are given by Marshall Space Flight Center on the answering machine at (205) 544-5356. They give the time (in CST) and the spacecraft location as the latitude and longitude of the point on the Earth underneath the satellite and the height of the spacecraft above the Earth's surface.

David wanted to observe the lithium release scheduled for Friday night, Feb. 8, and derived the equations to convert the information to right ascension and declination. He computed the values with a hand calculator. Since the time of release was changed several times, it occurred to me that it would be easier to prepare a program to compute this. I tried to do it with a spreadsheet, and found that it is very easy, as long as the spreadsheet program can compute trigonometric functions (sines, cosines, arcsines, and arccosines, and square roots; tangents are not needed.) High precision is not necessary for these computations, so the single precision computations from a spreadsheet on a computer without a math coprocessor is sufficient. Also, since this was a quick and dirty computation, elaborate input/output routines are not necessary.

The equations are from spherical and plane trigonometry. First, the azimuth of CRRES from the observer's location is computed from a spherical triangle, then the elevation of the spacecraft above the horizon is computed from a plane triangle, and the the right ascension and declination of CRRES at the time of the release is computed from a spherical triangle. The information needed is the following:

(l, p) --the observer's longitude and latitude (longitude measured west)
(L, P) - the CRRES longitude and latitude
H ------the height of the CRRES above the Earth's surface
R ------the Earth's radius in kilometers (6378.16)
T------- the time of the release (in CST)
π the constant 3.14159... (my spreadsheet and my calculator both have this as a constant)

My spreadsheet program calculates trigonometric functions only as radians, so the first step is to convert the latitudes from degrees and minutes to degrees and decimals of a degree, and then to multiply that by $\pi/180$ to get radians. Then, to make later computations easier, compute the sine and cosine of p and P, and refer to the cells where those are stored instead of recomputing the trigonometric functions each time. Compute the difference in longitude (L-l) in radians, and the sine and cosine of that difference, and compute the longitude in hours and fractions of an hour (degrees divided by 15) for later use.

The first spherical triangle is one with apexes at the observer,the sub-satellite point on the Earth, and the North pole. The side between the observer and the North pole is of length 90° - p; the side between the sub-satellite point and the North pole is of length 90° - P, the angle between those two sides at the North pole is L - l. The side between the observer and the sub-satellite point is d, the arc distance on the Earth's surface between the observer and the sub-satellite point. The angle between the two sides at the observer is A, the azimuth of the satellite as seen by the observer. The distance d is computed from the law of cosines;the angle A from the law of sines. The law of cosines gives d as:

$$\cos(d) = \sin(p)*\sin(P)+\cos(p)*\cos(P)*\cos(L-l)$$

To compute this in a spreadsheet, compute the quantity to the right of the equals sign, and then take the arccos. Many spreadsheet programs (mine included) compute the trigonometric functions in radians. Since d is only used as an intermediate quantity to compute A, it is not necessary to convert from radians to degrees.
The azimuth, A, is computed from:

$$\sin(A) = \frac{\sin(L-l)*\cos(P)}{\sin(d)}$$

If L-l is negative (CRRES is east of the observer), and CRRES is south of the observer (P less than p), then A is between 90 and 180°. If L-l is positive, A is between 180 and 270°. Since CRRES is an equatorial satellite, it is always south of observers in North America. You may need to add π to the result from computing A to get the correct quadrant.
The CRRES elevation above the horizon is computed from a plane triangle with one apex at the center of the Earth, one at the observer, and one at the spacecraft. The side of the triangle between the center of the Earth and the observer has the length of the radius of the Earth, R. The side between the center of the Earth and

CRRES has the length of the radius vector of the orbit,or H + R. The third side has the length of the slant range, S. The apex angle at the center of the Earth is d; the apex angle at the observer is 90 + h, where h is the elevation above the horizon. The slant range, S, is computed from the law of cosines for plane trigonometry, and the elevation, h, from the law of sines. The slant range is:

$$S = \sqrt{[R^2 + (R+H)^2 + 2*R*(R+H)*\cos(d)]}$$

S is in kilometers, since R and H are both given in kilometers. Then the elevation is:

$$\cos(h) = (R+H)*\frac{\sin(d)}{S}$$

If h is negative, then CRRES is below your horizon (or, more likely, you have made an error somewhere).

Then h and A are used to compute the hour angle and declination (HA and DEC) of CRRES at the time of the release. from a spherical triangle with one apex at the zenith, one at the north pole, and done at CRRES. This is known as the astronomical triangle. The side between the zenith and the north pole has length 90 - p;between the north pole and CRRES has length 90 - DEC, and between the zenith and CRRES has length 90 - h, the zenith distance. The angle at the zenith is A, the angle at the north pole is HA, the hour angle.

The declination is computed from the law of cosines, as:

$$\sin(DEC)=\sin(p)*\sin(h)+\cos(p)*\cos(h)*\cos(A)$$

and then the hour angle is:

$$\sin(HA) = \frac{\sin(A)*\cos(h)}{\cos(DEC)}$$

The HA is positive if A is less than 180°, negative if A is greater than 180°.

The hour angle is the difference between the right ascension, RA, and the local sideral time, LST. The LST is computed for the time of the event, and then the RA is found. The easiest way to compute the LST is using the equations for 1991 given on page 30 of the 1991 "Observer's Handbook." For dates in February, this is to first compute the Greenwich mean sideral time, and then subtract the observer's longitude, l, as follows:

$$GMST = 8.6476 + 0.06572*(\text{day of month}) + 1.002738*(\text{time in UT})$$

This equation basically computes the Greenwich mean sideral time (GMST) at 0 hour UT for the date, and adds to it the number of sideral hours that have elapsed since. Another equation is given in the Astronomical Almanac, but easier method is to use the Greenwich siderial time at 0 hr UT given in the AA and add to it 1.002738*(time in UT).

$$LST = GMST - l$$

where l, the observer's longitude, has been converted to hours (by dividing the longitude west in degrees by 15).
Then the RA is:

$$RA = HA + LST$$

For computations done for Friday, February 8:

l = 38° 59 min
p = 76° 52 min west
L = 66.1° west
P = 1.3°
H = 33,387 km
Time of release = 10:30 PM CST = 4:30 UT on Feb. 9
RA = 9 hr 26.8 min, DEC = -5.1°

Intermediate quantities:

d = 38.95°; S = 35,035 km; A = 162.7°; h = 44.5°; GMST = 13.7513 hours

The CRRES release was not done Friday night. It was delayed until Monday. It was a brilliant red flash, visible in binoculars but not naked eye, that was detectable for only a few minutes.

Naval Observatory and NASA Goddard Programs

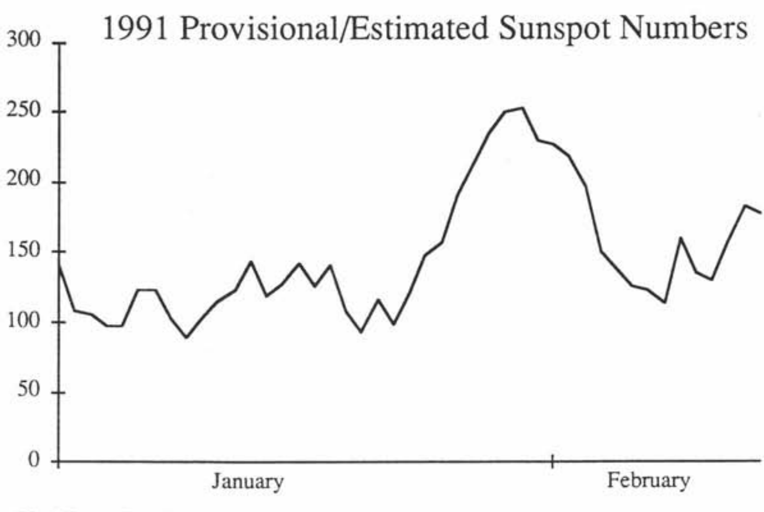
The international crisis has created the need for increased security at these facilities and possibly restricted access. For information call:

NASA Goddard — Call and give your name which will be placed on a list for entrance. You must call before arrival. Contact Tracy Cleggin at (301)286-4403.

Naval Observatory — Call ahead and bring a picture ID with you. The only access is through the South Gate. Contact Lt. Barbara Swerdowski at (202)653-1398 for access to the 5" scope.

These pictures of the barium release by the CERRES sattelite were taken on Sunday, January 13, 1991 at 11:12 pm EST by NCA member Ben Burke. The cloud of barium vapor was green and visible in the ESE near zenith. The release began as a bright point of light then spread out and dimmed reaching about the size of that of a full moon before fading.



Submitted by Nancy Byrd
Source: Peter O. Taylor, American Relative Sunspot Numbers.
*The information for this chart is available on the Astronomy forum of Compuserve.

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SERVICES AND ACTIVITIES:

A Forum for dissemination of the status and results of current work by scientists at the horizons of their fields is provided through the monthly NCA colloquia. (See monthly ***Stardust*** for time and location.) All interested persons are welcome; there is no charge.

Expeditions frequently go to many parts of the world to acquire observational data from occultations and eclipses which contribute significantly to refinement of orbital parameters, the coordinate system, navigation tables and timekeeping. Other results of this work under continuing study include the discovery of apparent satellites of some asteroids, discovery of apparent small variations in the solar radius, and profiles of asteroids.

Discussion Groups provide opportunities for participants to exchange information, ideas, and questions on preselected topics, moderated by a member or guest expert.

Publications received by members include ***Sky & Telescope*** magazine and the monthly publication of NCA, ***StarDust***.

The NCA Public Information Service answers many astronomy-related questions, provides predictions of the paths and times of eclipses and occultations, schedules of expeditions and resulting data, assistance in developing programs, and locating references.

The Telescope Selection, Use, and Care Seminar, held annually in November, offers the public guidance for those contemplating the acquisition of a first telescope, and dispels the many common misconceptions which often leads to disappointment.

Working Groups support areas such as computer science and software, photographic materials and techniques, instrumentation, and others.

Telescope-Making Classes teach the student to grind and polish, by hand, the precise optical surface that becomes the heart of a fine astronomical telescope.

NCA Travel offers occasional tours, local and world-wide, to observatories, laboratories, and other points of interest. NCA sponsored tours for comet Halley to many parts of the southern hemisphere.

Discounts are available to members on many publications and other astronomical items.

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

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Nancy Byrd, Secretary, 4215 Holborn Ave., Annandale ,VA. 22003.

The following information is optional. Pease indicate briefly any special interests, skills, vocation, education, experience, or other qualifications which you might contribute to NCA

Thank you, and welcome!

Stardust is published eleven times yearly by National Capital Astronomers, Inc. (NCA), a non-profit, public-service corporation for advancement of astronomy and related sciences through lectures, expeditions, discussion groups, conferences, tours, classes, public programs, and publications. NCA is an affiliate of the Washington Academy of Sciences. President Kenneth R. Short. Deadline for ***Stardust*** is the 15th of the preceding month. Information: Nancy Byrd, 4215 Holborn Ave. Annandale, VA 22003. Editors, Therese & Brady Byrd (703)237-0369

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