

AD ASTRA

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The Newsletter of the Atlanta Astronomy Club

May 1988

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CLUB CALENDAR

Next Meeting: Friday, May 20, 8:00 p.m., at the Bradley Building.
Monthly Program: Annual Show and Tell. Members are requested to bring any slides, pictures, telescopes, or astronomically related matter to share with the club. Election of officers for 1988-89.

AD ASTRA is published monthly during the academic year by the Atlanta Astronomy Club, Inc. The AAC, a non-profit organization, is dedicated to the advancement of amateur astronomy, and fostering the social, literary, and educational needs of its members. Meetings are held on the third Friday of each month (second Friday of December) unless otherwise announced in this publication. Membership dues are \$25 annually and include a subscription to *Sky & Telescope* magazine and use of club observatory facilities.

Submissions: Article submissions are strongly encouraged, and may be delivered to the editor for consideration.

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CLUB MINUTES

The April 15, 1988 of the Atlanta Astronomy Club was held at the Bradley Building with President Lee Wilson presiding.

I. Former member Harry Johnson donated to the club a 6" mirror, 6x30 finderscope with brackets, and a 90 degree prism. The donation was presented by Bill Close and the items are in the possession of Sharone Franklin until the membership decides on how they would be used.

II. Dr. Ralph Buice introduced Hal McAlister, professor of Astronomy at GSU university.

III. Dr. McAlister presented a talk on High Angular Resolution astronomy and his efforts to build an interferometer. He explained that by bringing light beams together from two or more telescopes, a pattern of interference is created. The interference patterns are analyzed mathematically and the results can reveal information such as: stellar angular diameter, stellar masses and luminosities, cepheid distance calibration, starspots, planets around stars, extragalactic quasars, etc.

IV. Dr. McAlister estimates the need for \$8 million dollars to construct the array of telescopes needed for high angular resolution work. The funding would come from funding and private donations.

THE FUNDING CRISIS IN ASTRONOMY

by Don Barry

In nature, decisions tend to be made based on ruthless rules of selection and competition. A mother bird feeds the hatchlings which complain most strenuously -- the weaker brethren starve and then die. In Washington, powerful interest groups retain lobbyists who make nuisances of themselves on Capitol Hill, promising votes, campaign funds, and other rewards. They get what they ask for; small interests find themselves cut to feed the noisy mouths, and eventually disappear altogether.

Astronomy is not a major "mouth" in the federal budget. Although space astronomers scored a coup with funding of the \$1.5 billion Hubble Space telescope, funded through NASA, almost all ground-based astronomical funding is done through the National Science Foundation. This large grant for the Hubble instrument made astronomy almost overnight one of the richest fields per researcher, but it lent no money to ground-based astronomy. Perhaps because a congressman does not see much of a distinction between these two areas of astronomy, ground-based astronomy has been suffering greatly.

Astronomy does not have the fiscal connections of say, physics, which is funded by the National Science Foundation, the National Institute of Health, the Strategic Defense Initiative, the Defense Department, and Aerospace and Electronic concerns. From NSF, ground-based astronomy has had to make do with only \$85 million per year over the last decade. As inflation has progressed, that means that in level funding, astronomy has actually been *cut* by almost a quarter in that time.

In response to belt-tightening, a few rich Universities (call them the "haves") have sought private funding for large telescope installations. As a result, a few worthy projects such as the Keck 10 meter instrument have a chance of being built in the next few years. Once built, however, like Palomar in the 40's, these private instruments will be solely available to the staffs of their sponsoring institutions. The "have nots" are being forced to go the same route, lest they be shut out of astronomy.

To avoid this fiscal-scientific darwinism, the National Optical Astronomical Observatories was created. Operating major observatories like Kitt Peak, Cerro Tololo, and numerous smaller instruments, NOAO accepts observing proposals from the entire astronomical community, and allocates time on its instruments on the basis of merit, as determined by a representative scientific committee. Many astronomers in our city use NOAO facilities -- without them, many schools and astronomers would simply not have the ability to support ongoing work in astronomy.

This year, NOAO must cut \$2 million from its budget to stay in operation. Over the last few years, many irreplaceable technical staff have been released because there was no money to pay them. Major facilities like the McMath solar telescope lay like great speckled birds, unpainted in a decade for lack of funds.

Over the next few months, major cuts will be made in NOAO's services. It is entirely possible that Kitt Peak, the McMath telescope, the Vacuum Solar Telescope, or even Cerro Tololo may be closed. Alternately, the entire gamut of smaller telescopes oper-

ated by NOAO may be mothballed, reducing the observing services offered by at least a factor of three. Only one thing is certain, and that is that a major crisis in ground-based optical astronomy is at hand.

Mr. Erich Bloch, director of the National Science Foundation, promised when appointed three years ago to double the budget of NSF, and that astronomy could ride the coattails of the general increase. In that period, NSF funding has barely kept pace with inflation, and as stated before, astronomical funding has actually declined in constant dollars. Why has astronomy become a neglected stepchild? Why is it being allowed to starve?

Perhaps the answer is because it has not made enough noise. Two years ago, NOAO decided to close its Sacramento Peak facilities to try to delay the crisis upon us now. Astronomers and the New Mexico Congressional delegation rose up in arms, forcing NOAO to keep the facility operational, at least temporarily. But no new funding was forthcoming. When questioned why astronomy hasn't been given a higher funding priority in general, Mr. Bloch has responded that he has not received input from astronomers or the public alerting him of any funding shortage, and therefore has felt under no obligation to provide greater support.

Other fields actively campaign NSF for funding. But there are probably one hundred physicists and engineers for every astronomer. Astronomy, isolated by the additional level of NOAO and Associated Universities for Research in Astronomy (AURA) between it and the funding source, is almost a voice in the wilderness. But in the current crisis, a number of astronomers are beginning to unite and voice their concerns to NSF and to Congress.

You can participate in this process. In a nation with almost 200,000 subscribers to popular astronomical magazines, hundreds of astronomical clubs, and substantial popular interest in astronomical research, a great deal of support can be raised for increased astronomical funding.

Some of astronomy's best selling points are its accessibility and provocativeness. Few other fields of research generate results easily appreciated by the public. The lovely photographs found in magazines, the knowledge of cosmology and our place in the universe, and the explanations for the fantastic processes occurring in odd places -- these all are tangible and saleable results of an investment in astronomy. Astronomy also, because of its technical and equipment-intensive nature, improves our national technical base, and provides spinoff optical and equipment technologies for use in other areas.

You can be heard, in letters to Congress, and to the NSF. The funding crisis in astronomy can be reversed, but only if enough people argue vocally for an aggressive commitment. The points listed above are good ones to include in letters, since they show other benefits of astronomy that may not be obvious to politicians. Help save astronomy!

Some useful addresses are:

Mr. Erich Bloch
Director, NSF
1800 G Street, N.W.
Washington, D.C. 20550

Senator Sam Nunn
Senator Wyche Fowler
Senate Office Building
Washington, D.C. 20510

SUMMER EVENTS

Saturday, June 25: A club picnic will be held at the Walter Barber Jr. Memorial Observatory at 3:00 p.m. Lee Wilson has announced a "clean-up, paint-up, and cook-out" to put the place back in order. If rained out, a later date will be planned, perhaps in the fall.

Friday, July 15: The Lanier Museum of Natural History in Gwinnett County is offering a series of classes and exhibitions revealing the natural world at night (club member Brian Page is teaching a class on bats) As part of this, the museum would like to feature the night sky. Thus, the museum needs the expertise of a few good astronomers to conduct public observing on 15 July 1988. The museum is located near Buford.

If you can bring a telescope and help with this display please call Brian Page at 921-8403 as soon as possible. He is putting the schedule together soon and very much wants astronomy on the agenda.

Friday, August 12: Club member Don Barry is scheduled to give a presentation on Meteors and Meteorites at the Etowah Indian Mounds followed by an observing session of the Perseid Meteor showers, weather permitting. Contact the Etowah Indian Mounds park for more information.

CLASSIFIED

For sale: Celestron C5, six months old. Immaculate condition. Complete with star diagonal, 2X Barlow, 3 eyepieces, drive, wedge, footlocker, Celestron tripod, and a variety of photographic accessories. \$700 (negotiable).

Contact: John Weatherford, 2570 River Oak Dr., Decatur, Ga. 30033. Home: (404) 320-6845, Office: (404) 875-5551

For sale: Parks 12.5" dobsonian, f/5. Best offer. "I am a victim of aperture fever, but this telescope is *too* big for me." Contact Chet Lapeza, 3650 Jim Moore Rd., Dacula, GA 30211. Office: (404) 488-4144, Home: (404) 962-6770

HOW TO FIND VENUS IN THE DAYTIME

special to the Ad Astra from Compuserve

Today, May 2, I spotted Venus at 1:30PM, high in the sky, and followed it for a half hour. I localized it as follows:

- (1) Yesterday, I noted its current celestial coordinates.
- (2) Using a star map, I plotted the spot on the map that was sixteen hours west of Venus, at the same declination. Yesterday, this spot was in Coma Berenices. Remember that on a star map, west is to the right, toward decreasing right ascension.
- (3) Last night at 9:30 p.m. I found this spot on the sky.
- (4) I positioned myself so that this spot on the sky could be seen just over the top of a tree near my house.
- (5) I marked my position on the ground so that I would be able to stand in the same position again this afternoon.
- (6) I went out today at 1:30PM and stood in the previously determined spot, looked above the top of the tree, and voila, there she blows, and all that.

Notice that, sixteen hours before Venus would be there, I lined up a spot on the sky that is sixteen hours west of Venus. The interval of sixteen hours was chosen only because it resulted in convenient viewing times. Other viewing times would result in a different interval (but using the same method). For example, if Venus were a 'morning star', I might desire to see it high overhead at 10AM. So I would go out at 9PM the previous night to line up the spot on the sky that is thirteen hours west of Venus, so that thirteen hours later, at 10A the next day, Venus would appear at that spot.

Venus' current elongation from the sun is 42 degrees east (an "evening star"). I think it was about as difficult to see at 1:30 p.m. as a +4.5 magnitude star is at night. Yesterday at 7:00 p.m., with the sun much lower in the sky than Venus was, it seemed about like a +3.5 magnitude star with regard to its ease of detection. A faint whisp of cirrus cloud passed over today and made a great difference in its detectability -- a very clear sky is important for detecting Venus in the daytime. It also helps to block the glare of the sun with a tree or a building -- so, on the previous night, when you position yourself for the next day's daytime observation of Venus, try to find a spot that will be in the shade at the desired hour the next day.

I can usually detect stars of magnitude +6.5 from my dark-sky site. If daytime Venus is as difficult as a nighttime +4.5 magnitude star, then I should be able to detect in the daytime objects that are 2 magnitudes fainter than Venus. Since Venus is magnitude -4.5, I should be able to just detect a -2.5 magnitude object in the daytime, given comparable elongation and declination. I'll try it with Jupiter some day!

Note: as this issue goes to press, several club members, including Rick Clark and Don Barry, have seen Venus by naked eye in the daytime. Greatest brilliancy was reached on May 6th, and it will continue to be visible for a few weeks prior to inferior conjunction in mid-June. It is an even more spectacular crescent in telescopes.

PROJECTS FOR ASTRONOMY CLUBS

by Bill Bagnuolo

Every club needs to have a number of short and long term projects; these keep members' interest and make the club more interesting. Here are some things I think we could do as a club. Perhaps readers can identify even more things possible for the club to do.

1) Telescopes: Alternate observing sites can be found and made accessible to club members. The 20" is attractive for a number of projects, such as seeing-improvement with forced air convection, instrument packages for computer aided guidance and control improved setting circles, and add-on instruments like filar micrometers, spectroscopes, photometers, or special instrumentation for speckle interferometry and planetary photos. These projects are all within reach of a moderate sized club.

2) Interest Groups: Interest groups within the club might be started. One favorite of mine is a "finish up your telescope club". (I have two unfinished telescopes myself.) Like weight-watchers, it's easier to do it with the help of your friends. Other groups in photography, solar astronomy, or even radio astronomy might find interested members.

3) Meeting Programs: A variety of "special programs" are possible if there's enough interest. Trips to famous old observatories, or visits by famous old astronomers can be arranged. There is a 24" Clark refractor in nearby South Carolina (featured recently in *Sky & Telescope*) that would make a nice day trip for interested members.

4) Crazy Ideas: A good astronomy club should at least consider some "blue sky" projects -- ambitious goals for the future. A pet project of mine is to put four 29" spherical mirrors, by Coulter or some other vendor, together on a poncet table mount for a 1.5 meter (60"! "Poor man's MMT", which would be the world's biggest amateur telescope. Other long-term projects might be off-axis telescopes, quality solar telescopes, or IR/radio telescopes.

5) Community Projects: Regular interaction with state parks and community centers like Fernbank can improve membership, inform the public (and further current projects like our Light Pollution Committee's work), and create extra opportunities for the club.

Many of the above goals are ambitious and challenging, but I hope they will provoke constructive debate, and spark some ideas on what people in the club would like to do.



NGC 4725
Ring Galaxy
with Bright Bar
by Richard Jakiel

SMALL, ROUND, AND DIM

by Richard Jakiel

Perhaps the easiest galaxies to observe structural details are bright edge on spiral galaxies. The Sombrero galaxy, NGC 4594 or M 104 is the brightest and easiest edge on to view galaxy of the spring skies. It is a giant Sa-Sb spiral galaxy tilted only 6 degrees from our line of sight. The most striking feature is the broad dark lane bisecting the galaxy into two nearly equal portions. This dark lane is distinctly visible with an 8 or 10 inch telescope, and can be followed over the entire length of the galaxy in the club's 20 inch scope. The central bulge is large and distinct, with a bright nearly stellar nucleus.

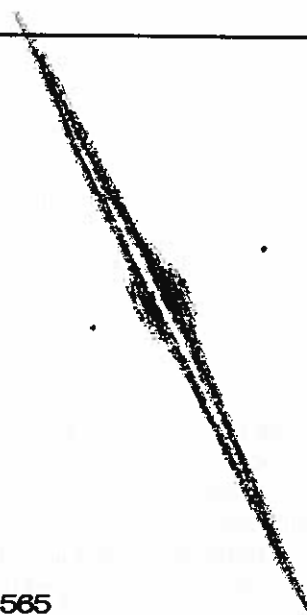
About forty degrees north of M 104 lies a truly spectacular edge-on galaxy, NGC 4565 in Coma Berenices. NGC 4565 is extremely large and quite bright, spanning a most impressive 15 arcminutes, or about half the diameter of the Moon. At the accepted distance of 20-25 million light years, this corresponds to about 90 to 100,000 light years. In the club's 20", it stretches across the field of the 13mm Nagler, with a sharp narrow dark lane neatly bisecting the galaxy. In an 8 or 10 inch scope, the appearance is similar to the view given by the 20", due to the high surface brightness of the galaxy.

In nearby Canes Venatici, and about 8 degrees north of NGC 4565 there is an interesting pair of distorted edge-on galaxies. The brightest of these is NGC 4631, a huge irregular/Sc spiral galaxy only slightly smaller than NGC 4565. Measuring in at 12.5'x1.5', and at a very bright 9.7 magnitude, I always found it rather strange that Messier did not catalogue this, or several other bright galaxies in this region. In the 10" f/6 scope, NGC 4631 is distinctly non-symmetrical, while in the 20", numerous bright patches and dark rifts are visible across the span of the galaxy. There is no distinct nuclear bulge present, and a small dwarf elliptical, NGC 4627, lies just to the north. About 30' SW of this galaxy is NGC 4656/57, a highly distorted Sc spiral with two bright condensations and a distinctive "L" shape. The distorted appearance of both galaxies is the result of dynamic interaction between these galaxies.

Two other unusual galaxies are M64, the "Blackeye", and NGC 4725, both located a short distance apart in Coma Berenices. NGC 4826, better known as M64, is a bright spiral galaxy with a large, irregular dust lane. The dust lane is visible in a 6" scope, and begins to show irregularities in a 10" scope. In the club's 20" scope, the dark lane is highly irregular with several prominent bays and protrusions.

Nearby is NGC 4725, an interesting spiral galaxy of unusual shape. In 1940 and 1969, two bright supernova have been observed in this large 9.8 magnitude galaxy. In a 8 or 10" scope, a bright central bar is visible embedded in a faint, diffuse envelope. At Villa Rica, the 20" at 175x shows faint diffuse rings surrounding the main bar. Several bright knots are visible on the bar along with a bright stellar nucleus.

Finally, spring time heralds the arrival of the bright globular clusters, which are always major "crowd pleaser" and "show stopper" objects. M3 in Canes Venatici fits the bill well, being easily resolved in an 8 or 10" scope, and truly spectacular in the club's main instrument.



NGC 4565
20' f/4.5 @ 175x



NGC 4631 + 4627
Dwarf Elliptical



M3 - 20' f/4.5
175x

MORE MUSIC AND ASTRONOMY

by Jack Campin, UK

(Ed. Note: Being well enmired in the 19th century, I was very pleasantly surprised to be set straight on 20th century astronomical music by Mr. Campin of the United Kingdom, with whom I've been corresponding over a computer network. The following must be a nearly exhaustive index on this field, which he was kind enough to provide -- Don Barry)

The twentieth century has done a lot better than you think. Here is what I can come up with off the top of my hat:

Most famously, the aria "E lucevan le stelle" from Puccini's *Tosca*.

The British composer Reginald Smith Brindle is a keen amateur astronomer, and has written many pieces with astronomical connotations -- the only one I have heard more than once is *Andromeda M31* for solo flute, which uses some astonishing multiphonic effects -- sonic images of swirls of stars and dust.

Prokofiev wrote a short cantata called *Seven, They Are Seven* based on a Chaldaean text about seven Somethings in the sky - whatever they are, Prokofiev builds up a shrieking frenzy about them. Varese's similarly violent and extreme *Arcana* is prefaced with a quote from Paracelsus' *Hermetic Astronomy*: "One star exists higher than all the rest. This is the apocalyptic star; the second star is the ascendant. The third is that of the elements, and of these there are four, so that six stars are established. Besides these is still another star, Imagination, which begets a new star and a new heaven".

Brian Ferneyhough has written an organ piece called *Sieben Sterne*, which I think uses similar imagery, though I don't know the work.

At the extreme opposite expressive pole from these is the last movement of Michael Colgrass's "As quiet as ..", "... the first star coming out".

Liszt wrote a nearly atonal piano piece called *Unstern* (Unlucky Star) of extreme creepiness that you would probably ascribe to Scriabin or Schoenberg if you heard it without an announcement, so I'll count it as an honorary modern work. Another guess-the-composer test is Stravinsky's *Zvezdoliki, the King of the Stars*, a rather peculiar early choral work.

There are lots of generic pieces about the night - many of Bartok's slow movements are "night music", starting with one of the piano pieces in *Out of Doors* and including the middle movements of his *Fourth String Quartet* and *Third Piano Concerto*. There is a piece by Klaus Huber called *Noctis Intelligibilis Lucis*, which I think is based on a text about mediaeval Christian theology. It's years since I heard it, but I retain an image of chilly remoteness. A rather more human piece is Elizabeth Lutyens' *Quincunx* based on a text by Sir Thomas Browne.

Solar astronomers do quite well, with Carl Nielsen's *Helios Overture*, Carl Ruggles' *Sun Treader*, the series called *Sun Music* by the Australian Peter Sculthorpe, Edison Denisov's *The Sun of the Incas*, Pierre Boulez's *Le Soleil des Eaux* (almost -- it's actually about water pollution), and a recent composition called *The sun, That Great Luminary of the universe* by a young British composer (George Benjamin?).

Lunar astronomers get Janacek's opera *The Excursions of Mr. Broucek* (in which he visits the moon), Carl Orff's opera *Der Mond* (which I've never heard), Schoenberg's *Pierrot Lunaire*, and Kazuo Fukushima's *Hi-Kyo* for flute and strings ("Flying Mirror", a traditional Japanese poetic image for the moon). There is also an electronic work by Morton Subotnick called *Silver Apples of the*

Moon; I've not heard it.

Planetary atmosphere studies only make it into music in the finale of Schoenberg's *Second String Quartet*.

Olivier Messiaen has written three pieces I know of with astronomical links - *Quartet for the End of Time*, inspired by seeing the aurora borealis when he was in a prisoner-of-war camp in Germany; the movement "Joy of the Blood of the Stars" from the *Turangalila Symphony*; and above all a movement in *Et Exspecto Resurrectionem Mortuorum* about the stars singing together at the Day of Judgment - this piece is for wind band, and Messiaen says it is ideally played in the open air, to echo among high mountains; an astronomical observatory sounds exactly like what he had in mind.

Not quite astronomy, but Philip Glass recently wrote an orchestral piece about the Michelson-Morley experiment called *The Light*. The only other experimental instrument celebrated in twentieth-century music seems to be Stonehenge, in the finale of Vaughan Williams' *Ninth Symphony*.

Morris Pert's *The Ultimate Decay* starts with the Big Bang on the organ and ends with an electronic noise representing the grand-unification decay of all baryons, via a weird assortment of texts of which Wiccan invocations are the most audible. Unlike most of these pieces it's not about optical observing; more like light entertainment while waiting beside a tank of water down a disused mine for the cosmos to rot away to nothing. Elliott Carter's *Double Concerto* is based on a similar idea of the fate of the universe (and is better music) but derives it from a literary source - Alexander Pope, of all people.

Iannis Xenakis' *Pleiade* is a huge percussion piece of immense tranquillity; maybe the most approachable music he's written.

The Swedish Karl-Birger Blomdahl wrote an opera *Aniara* on a poem by Harry Martensson about a colonizing starship that goes off course into oblivion. I heard it once but can recall nothing about the music.

Karlheinz Stockhausen wrote a cycle of astrological pieces called *Tierkreis* (Zodiac), extracted from his humungous super-opera - like a lot of his later music it manages to be very beautiful and very silly at the same time. I think his *Goldstaub* (Gold dust) has a stellar connotation, but I don't know it. The opera cycle is intended to be autobiographical; it has a prelude in which Stockhausen modestly describes his childhood as the Archangel Michael on a remote planet.

Roberto Gerhard wrote a set of three astrological compositions for chamber ensemble at the end of his life - *Libra, Gemini* and *Leo*. Like "The Planets", they are character studies.

Also with a distantly astrological connection, Harry Partch's *Castor and Pollux Plectra and Percussion Dances* is great fun. There is one rhythmic pattern in it that I can guarantee will rattle around inside your head for the rest of your life after one hearing.

John Cage's *Atlas Eclipticalis* was composed by transcribing a star map directly into musical notes. Charles Dodge's *Earth's Magnetic Field* does something similar with geomagnetic recordings.

And for nights when nature is uncooperative: Debussy's *Nuages*, or for optimists, Nielsen's unaccompanied flute piece *The fog is lifting*.

The Soviet composer Sophia Gubaidulina seems to believe something very close to a form of Pythagoreanism (with the additional ancient Greek belief that certain harmonics are also meant to connect with the structure of the human psyche - hence the open string effects in her second string quartet). Whether she's written anything specific to this query I don't know, but try to find some of her music anyway - she's one of the most original composers living.

Good listening, watching or both simultaneously.

OBSERVER'S ALMANAC

by Don Barry

Moon Rise, Set, and Phase
(All times are EDT)

Date	Rise	Set	Phase	Date	Rise	Set	Phase
05/15	06:04	20:46	0%	06/06	01:31	12:57	62%
05/16	06:46	21:53	0%	06/07	02:01	14:04	51%
05/17	07:34	22:55	2%	06/08	02:30	15:11	39%
05/18	08:28	23:50	5%	06/09	02:58	16:17	29%
05/19	09:27	—	11%	06/10	03:28	17:24	19%
05/20	10:28	00:37	18%	06/11	04:02	18:31	11%
05/21	11:28	01:16	26%	06/12	04:40	19:38	5%
05/22	12:26	01:48	35%	06/13	05:25	20:42	1%
05/23	13:23	02:16	44%	06/14	06:17	21:40	0%
05/24	14:19	02:42	54%	06/15	07:14	22:29	0%
05/25	15:14	03:05	62%	06/16	08:14	23:11	3%
05/26	16:11	03:29	72%	06/17	09:16	23:46	7%
05/27	17:10	03:54	80%	06/18	10:15	—	13%
05/28	18:12	04:21	88%	06/19	11:13	00:16	20%
05/29	19:17	04:52	93%	06/20	12:09	00:43	29%
05/30	20:25	05:29	97%	06/21	13:04	01:07	38%
05/31	21:32	06:14	99%	06/22	13:59	01:30	47%
06/01	22:35	07:09	99%	06/23	14:56	01:54	56%
06/02	23:31	08:13	96%	06/24	15:55	02:19	66%
06/03	—	09:24	90%	06/25	16:58	02:48	75%
06/04	00:18	10:36	82%	06/26	18:05	03:22	83%
06/05	00:57	11:48	73%	06/27	19:13	04:03	90%

(---) indicates phenomenon does not occur on given day.

SATELLITES TONIGHT

Over the summer, we may have the opportunity to see the Space Shuttle if it indeed makes its promised return to our nation's (ahem) space fleet. Although it is difficult to provide predictions for unlaunched vehicles, if the shuttle does make a trip to orbit, look in evening twilight for an object slightly brighter than Mir to pass by. Otherwise, the Russians will continue to regale us with tales of their success in space.

Monday evening, 23 May 1988 after 09:15 PM EDT

Time(EDT)	Az	El	H Range	LHA	RA/2000	D/2000	Mag
10:19:25PM	316.6	18.4	U 01207	06:42.0	06:08.7	+48d27	+3.0
10:20:44PM	320.5	38.0	U 00734	04:43.9	08:08.2	+57d55	+1.9
10:22:02PM	041.9	81.1	R 00480	23:28.8	13:24.1	+40d08	+1.0

Shadow entry.
SALYUT 7 USSR

Tuesday evening, 24 May 1988 after 09:16 PM EDT

Time(EDT)	Az	El	H Range	LHA	RA/2000	D/2000	Mag
09:47:49PM	322.2	17.9	U 01226	07:02.2	05:20.8	+52d45	+3.1
09:50:26PM	040.1	65.2	R 00520	22:19.5	14:05.6	+50d24	+1.6
09:51:44PM	111.1	36.5	D 00753	20:44.6	15:41.9	+05d06	+2.5

Shadow entry.
SALYUT 7 USSR

Wednesday evening, 25 May 1988 after 09:17 PM EDT

Time(EDT)	Az	El	H Range	LHA	RA/2000	D/2000	Mag
09:16:12PM	327.3	17.1	U 01259	07:25.4	04:29.9	+56d20	+3.2
09:18:49PM	038.8	52.5	R 00588	21:04.4	14:52.8	+56d38	+2.3
09:21:25PM	113.6	17.4	D 01238	19:51.4	16:08.8	-08d44	+3.9

Shadow entry.
SALYUT 7 USSR

Friday evening, 27 May 1988 after 09:18 PM EDT

Time(EDT)	Az	El	H Range	LHA	RA/2000	D/2000	Mag
09:52:08PM	258.5	17.6	L 01231	04:36.3	08:02.5	+00d34	+2.3
09:53:26PM	229.3	20.4	L 01122	03:13.8	09:26.3	-18d20	+2.3
09:54:44PM	201.3	16.6	L 01270	01:41.4	11:00.0	-35d46	+2.6

Shadow entry.
SALYUT 7 USSR

Saturday evening, 28 May 1988 after 09:19 PM EDT

Time(EDT)	Az	El	H Range	LHA	RA/2000	D/2000	Mag
09:20:34PM	261.8	20.9	L 01108	04:32.6	07:38.5	+05d03	+2.3
09:21:52PM	228.3	25.1	L 00980	02:58.0	09:14.3	-15d27	+2.0
09:23:10PM	196.1	19.8	L 01143	01:13.7	11:00.0	-34d21	+2.4

SALYUT 7 USSR

Time(EDT)	Az	El	H Range	LHA	RA/2000	D/2000	Mag
10:30:07PM	256.3	26.2	R 00694	04:03.6	09:17.2	+03d54	+0.0
10:31:23PM	229.7	48.6	R 00439	03:23.9	09:58.4	+57d19	-0.5
10:32:39PM	022.1	25.6	R 00708	16:50.7	20:32.1	+69d12	+1.9

MIR USSR

Monday evening, 30 May 1988 after 09:21 PM EDT

Time(EDT)	Az	El	H Range	LHA	RA/2000	D/2000	Mag
09:29:56PM	237.4	28.8	U 00648	03:12.4	09:15.9	-07d13	-0.2
09:31:12PM	318.7	72.7	R 00351	01:05.2	11:24.4	+45d42	-1.0
09:32:28PM	036.8	28.6	D 00653	18:02.8	18:27.7	+58d17	+2.0

MIR USSR

Tuesday evening, 31 May 1988 after 09:21 PM EDT

Time(EDT)	Az	El	H Range	LHA	RA/2000	D/2000	Mag
09:47:16PM	287.2	16.9	R 00949	05:38.9	07:10.9	+23d19	+0.9
09:48:32PM	325.4	22.0	R 00793	06:48.1	06:03.3	+57d25	+1.0
09:49:48PM	002.3	16.3	R 00974	12:29.1	00:23.2	+72d26	+2.3

MIR USSR

Thursday evening, 16 June 1988 after 09:30 PM EDT

Time(EDT)	Az	El	H Range	LHA	RA/2000	D/2000	Mag
09:37:57PM	349.3	21.3	R 00810	09:19.9	04:24.3	+74d21	+1.5
09:39:13PM	037.3	32.9	R 00584	18:35.9	19:08.4	+59d01	+1.7
09:40:29PM	087.4	21.9	R 00788	19:08.7	18:37.2	+14d00	+2.3

Shadow entry.
MIR USSR

Friday evening, 17 June 1988 after 09:30 PM EDT

Time(EDT)	Az	El	H Range	LHA	RA/2000	D/2000	Mag
09:54:33PM	298.8	28.2	U 00657	05:14.2	08:50.0	+37d57	+0.2
09:55:49PM	222.9	63.8	L 00369	01:12.1	12:53.2	+13d12	-1.2
09:57:05PM	151.4	27.3	D 00666	22:09.8	15:56.8	-23d13	+0.4

Shadow entry.
MIR USSR

AD ASTRA

Please direct all address changes or corrections to:

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McDonough, Georgia 30253

Membership renewals to:
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FIRST CLASS

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