THE U. S. NAVAL OBSERVATORY STAR

Volume 7, Number 3 "All the News that Fits, We Print" December 1997

From The Superintendent:

CAPT Dennis G. Larsen

Happy Holidays!

I've been here for a little over two months, and it has been a real eye-opener for me to actually see how much you/we all do for our country, in both military and civilian support. The USNO contributes far more to the defense of our nation than most anyone in the Department of Defense (DoD) realizes. Because of this, we must make it a priority to make DoD understand the significance of our work. Precision Time and Time Interval (PTTI) and Astrometry are the backbones of most C4IR advanced systems, but buried so deep into their basic structure that most people are not aware of their presence. I am preaching to the choir, I know, but we must all remember what we do and why, to keep the importance of our jobs in the forefront of our minds. You -- every command member -- contributes to USNO's successes and accomplishments. You should be proud of your contributions. I hope that I can be your representative to convey these accomplishments and critical needs when the time comes to submit our budget and make long range plans for the future.

On another note, I have been very pleased with the progress that the revitalized Partnership Council has made. I think that every Council member is open and honest, and sincerely wants to represent you. We all want a better place to work and I am confident that with the efforts of the Council members and your help, we will get what we want. In addition to our regularly scheduled Council meetings, our plans are to have open Council meetings once per quarter, so all command members have an opportunity to actively participate and see what we are talking about. Your input to all Council meetings is valued, so please contact any Council member with ideas for improvements to your work environment and/or in efficiency of work accomplishment. I hope we can make it possible for everyone to feel that they are an integral part of the command, and their job satisfaction and performance makes a difference to us all. Please be constructive with your ideas and inputs, keeping in mind our mission.

So far, the budget for FY-98 is not out of balance, though we do need to ensure our customers are aware of our resource limitations and contribute to our mission accomplishment as appropriate. As we put together the budget for FY-99 and the next five years, I will keep you informed. There are some concerns with projected shortfalls in the coming years, so we must work together to be more efficient in the execution of our programs. In addition, the senior scientists and the front office will need to find customers who are willing to pay their dues in order to keep our services from degrading. A senior officer from the Joint Chiefs of Staff visited us early in October. He not only understood the importance or our work, but he expressed deep concern over the possibility of reduced production and distribution of our services. Because people like him understand

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what we do, I am optimistic about our future and the ability we have to continue providing quality service to our customers, the nation and the world. Keep up the great work . . .

D. G. Larsen

From the Scientific Director:

Dr. Kenneth L. Johnston

1997 Nobel Prize in Physics: Research Supported by ONR 6.1 Leads to 6.2 Development of Precise Clock for US Master Clock

The 1997 Nobel Prize in physics was awarded for the development of methods to cool and trap atoms with laser light. It was awarded jointly to Professor Steven Chu, Stanford University, Palo Alto, CA; Professor Claude Cohen-Tannoudji, College de France and Ecole Normale Superieure, Paris, France; and Dr. William Phillips, NIST, Gaithersburg, MD. Dr. Phillips was (and currently still is) supported by ONR 6.1 funding.

The Prize winners developed techniques for using laser light to cool neutral atoms and gases to micro-Kelvin temperatures. They also developed techniques for isolating these atoms, thus capturing them in various kinds of "atom traps". This additional control over the atoms allows the possibility of more precise atomic clocks to be fabricated. Dr. Phillips 'research included clever ways of using magnetic fields to aid in the optical slowing down of atoms in atomic beams. He developed a technique dubbed "Zeeman slowing" which uses a coil with a varying magnetic field along the axis on which atoms and opposing laser beams travel, so that the cooling atoms remain in resonance with the laser light. In 1985, Phillips demonstrated that sodium atoms thus cooled could be captured in a purely magnetic trap. Phillips also cooled and confined (but technically didn't trap) atoms in optical molasses, something Chu is also cited for, and managed to develop several techniques to measure the temperature of these atoms. He found temperatures as low as 40 micro-Kelvin -- six times lower than the "Doppler limit" -- the lowest temperature thought to be attainable.

The explanation of this phenomenon lies in the sub-structure of the lowest energy level of the atoms (the hyperfine levels). Cohen-Tannoudji elucidated the details of the explanation for this. Having broken the Doppler temperature limit, another "fundamental" limit arises at a yet colder temperature, due to the quantum nature of light. In the cooling process atoms absorb light at one wavelength and re-emit it at another in a random direction. Atoms must recoil when they emit a photon. Thus a "recoil limit" occurs -- the temperature imparted by the last photon emission. This proscribes the lowest achievable temperature: 2.4 micro-Kelvin for sodium atoms and 0.2 micro-Kelvin for heavier cesium atoms. Professor Cohen-Tannoudji then developed a method that technically doesn't cool, but that causes the slowest (coldest) atoms to fall into a "dark state" -- a state that can no longer interact with light and is thus immune to the recoil limit. With this technique temperatures 16 times lower than the recoil limit have been achieved. The combination of all these techniques provides such cold atoms that the construction of an "atomic fountain" becomes possible. Such a fountain would spray atoms up from a trap and let them fall back down due to gravity. When exposed to microwave radiation in a cavity in both the upward and downward parts of the journey one can design a very precise frequency standard. Dr. Phillips implemented such a fountain "clock" a few years ago as a proof of concept. He has since extended his laser cooling to three dimensional arrays or lattices of atoms trapped in standing wave light fields, which can also be launched. All of these research accomplishments (and others) were supported by ONR 6.1 grants.

Due to these results, the United States Naval Observatory has initiated a 6.2 program to bring these developments out of the laboratory and into an operational system, namely the Nation's Master Clock. This work, initiated in FY97, has as a goal to produce a working prototype by FY2000; to enter an operational demonstration in 6.4 in FY2002; and expected operation in the Master Clock in FY2004. It should improve the precision of the Master Clock by an order of magnitude, i.e. to 0.1 nanoseconds. This precision is necessary to support future GPS operations for precisely guided munitions, wide band communication links, and precise navigation.

Cesium Fountain Development at USNO

Dr. Eric Burt

Time Service Department

The cesium fountain development at the Observatory is being carried out by Chris Ekstrom and Eric Burt. So far, we have set up a laser-cooling laboratory in which the fountain will be built and have begun the construction of the apparatus itself. To date we have assembled the various laser systems and associated optics needed, and the vacuum chamber in which the atoms will reside. We have been able to successfully trap and cool atoms using the techniques developed by Phillips and have measured very cold temperatures.

A cesium fountain works much like a conventional cesium beam atomic clock (such as the HP5071 in use at the USNO). In a cesium beam clock the atoms are shot out of an oven and pass through two microwave interrogation regions. It turns out that the longer the atoms spend between the two regions, the better the precision of the clock. The natural approach would be to try to find a way to slow down the atoms coming out of the oven. A cesium fountain takes this one step further. Instead of using an oven for the source of atoms, the fountain uses a laser-cooled atom trap. These very cold atoms are "tossed" up through the interrogation region just like a ball thrown upwards. When they fall back down, they pass through the interrogation region a second time. Thus, one interrogation region serves the same purpose as the two separated regions in the cesium beam clock.

Since atoms emitted from an oven in a cesium beam clock are traveling hundreds of meters per second, the time spent between the two regions is a few thousandths of a second. By contrast, in a fountain, the time spent by the atoms going up and back down is about one second. This increase in time is at the heart of how a cesium fountain is expected to out perform a cesium beam by an order of magnitude or more and is only possible due to the ability to cool the atoms to low temperatures. The temperature of a group of atoms is directly related to their average speed relative to each other. Hence, the higher the temperature, the faster a group of trapped atoms will spread out after being released. Since the atoms are now required to spend such a relatively long time between the two interrogation regions, if they weren't cooled to ultra-cold temperatures they would spread out too much and too few would return on the downward trajectory.

At this time the accepted lowest temperature that can be reached in cesium using an optical molasses is about 2 micro-Kelvin (*millionths* of a degree above absolute zero). So far we have achieved temperatures of about 15 micro-Kelvin without an optimized molasses. It is expected that the 2 micro-Kelvin required for a successful fountain will be achievable with the careful optimization of the various parameters that define the molasses.

For more details and pictures of this and other Clock Development projects, please visit our USNO web page, "clocks of the future", at http://tycho.usno.navy.mil/CD/cd.html.

The Fleet Evaluates STELLA

John Bangert

Astronomical Applications Department

Celestial navigation at sea is the ancient art and science of determining a ship's position by measuring the positions of visible celestial bodies.

The Global Positioning System (GPS) is the Navy's primary means of navigation, but celestial navigation is still routinely used as an independent, secondary method. Navigation by the stars, as traditionally practiced by Navy navigators, is a rather tedious and involved process. The navigator must plan the observations, make the observations using a marine sextant, then reduce the observations to determine position at sea. The reduction process is carried out on "strip forms" using the Navy Navigation Workbook, *The Nautical Almanac* (a USNO product), and a calculator. In practice, the reduction process is similar to determining your income tax – the mathematics are not complicated, but many steps and forms are involved, and it is easy to make a mistake.

In February 1993, the Astronomical Applications (AA) Department received a formal requirement from the Chief of Naval Operations

(N6). The requirement letter tasked us to create an "automated celestial navigation calculation capability for the fleet" that would "meet or exceed the capability provided in printed celestial navigation publications ... be validated for fleet use ... [and] be standardized to permit uniform training." Work began immediately on the STELLA project. STELLA – an acronym for **S**ystem **T**o **E**stimate **L**atitude and **L**ongitude **A**stronomically – is a PC-based (MS-DOS) computer program that provides the Navy with a standard, automated means of performing the computations required for celestial navigation. It satisfied the CNO's requirement by providing an integrated set of planning and reduction tools for celestial navigation. It is based on new mathematical approaches to celestial navigation developed in the AA Department.

STELLA was released to the fleet in September 1995, following a long period of development and testing. The STELLA team then waited patiently for some feedback on the product. We already knew how STELLA performed in the laboratory, but we were anxious to know how it performed in real-life situations at sea. Much to our disappointment, however, very little information was forthcoming from the fleet navigators. In late 1996, a decision was made to conduct a survey of STELLA users. The main goals of the survey were to assess the level of fleet satisfaction with the product, to gather information on the computing environment available to fleet navigators (information that was hard to come by), and to solicit comments and suggestions for improving future versions of STELLA. The survey questions were formulated within the AA Department. Additional input and review was provided by CDR Terry Tielking, the USNO Deputy Superintendent at the time. Survey forms were distributed to attendees of the Surface Ship/Submarine Navigation Readiness Meeting in Norfolk, VA on 25 March 1997 and then mailed to the fleet during April.

The survey forms were mailed to approximately 300 ships – about the number of ships active in September 1996. Two forms were mailed to each ship: one addressed to the leading quartermaster (the senior enlisted navigator) or the navigation team, and the other addressed to the Navigator. By 1 July 1997, 204 completed forms – about 2/3 of those mailed – had been returned to the AA Department. The completed forms came from 169 ships – approximately half of the total active ships. Of these 169 ships, 142 were surface ships and the remaining 27 were submarines. Thirty-five of the total responses were additional forms completed by other crew members aboard the 169 ships.

Key results from the survey were:

- More than 90% of all respondents knew about STELLA.
- Eighty-eight percent of the respondents had actually used STELLA.
- About 64% of the total respondents (and about 73% of the submarine respondents) rated STELLA as being a "great help" to their ship's navigation department, and an additional 35% rated it as being "some help".
- About 60% of the respondents rated STELLA as easy or better-than-average to use. Only about 2% rated it as hard to use.
- The most common computer configuration being used to run STELLA is an 80486 system running Windows 3. However, many users are running STELLA on more modest equipment – about 30% are running it on an 80386 system and about 32% are running it under MS-DOS.

Many respondents chose to comment on STELLA. Most of the comments were quite favorable. Many respondents also made suggestions for new features to be added to future versions of the program. There were a few recurring themes in the suggestions:

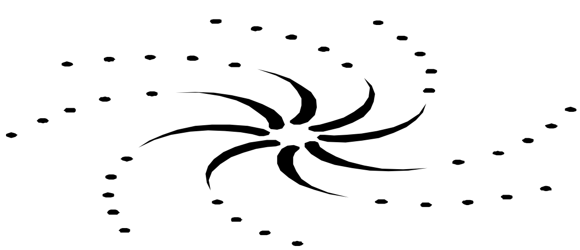
- Make a Windows version of STELLA.
- Add tides and currents computations.
- Add a voyage planning feature.
- Have the Navy update and clarify its policy on celestial navigation.

STELLA also fared well in comparison to popular commercial navigation software packages onboard many ships. While some users preferred the commercial products to STELLA for various reasons, others noted that the commercial programs have never been validated for Navy use, and that they are expensive. There is little doubt that the underlying technology in STELLA is superior to that in the commercial products. We believe that the remaining needs of the navigators can be addressed in future versions of STELLA, and with a Navy-authorized tides and current program.

The results of the STELLA survey are already driving future development of the product. A version of STELLA specifically designed for Windows 95 and Windows NT was already in the works before the survey was undertaken. Now the schedule has been accelerated, with plans to complete the product in late 1998. It is also clear that we must continue to support an MS-DOS version of STELLA for those navigators left with older computer equipment. It is a relatively easy task to update the current DOS version of STELLA for use beyond 1999, a task that we plan to complete by the end of next year as well. The suggestion to add a voyage planning feature to STELLA is a good one that we will likely implement in a future version of the product.

Acting on the other two suggestions is more complicated. Following discussions, the Navy Oceanographic Office has been tasked to perform a detailed examination of relevant, existing software that computes tides and currents. We feel that the computation of tides and currents does not belong in STELLA, but the navigators' need is real and must be addressed. The issue of a new policy on celestial navigation is an especially difficult one. STELLA has provided Navy navigators with new technology and a new tool, but existing policies do not address its "legal" use. Any new policy on celestial navigation must take many things into account – the requirement for keeping the Navigation Workbook, the role of software such as STELLA, quartermaster training, and a potential increase in vulnerability due to increased reliance on computer technology.

All in all, the STELLA survey was a very valuable exercise. It has given the development team essential feedback on the shipboard use of the software, the navigators' computing environment, and navigation policy issues. It is clear that STELLA has been a success. The survey results will help us make future versions of the product even better.



Astronomical "Seeing"

Jeff Beish

Time Service Department

INTRODUCTION

From the first moments this observer gazed into the night sky with a telescope it was apparent our atmosphere was anything but crystal clear.

The Earth's atmosphere is not completely transparent or as stable as we would like it to be. Experienced observers are well aware that turbulent air currents can cause telescopic images to blur or shift in the eyepiece field. We have coined the phrase "astronomical seeing" to quantify the effect the atmosphere has on image quality.

None of this should be a surprise to anyone who has peered through a telescope, even at the Moon. At times the Moon appears like it is swimming in water or above a smokestack! Planetary and star images can be affected even more by the atmosphere, making them nearly impossible to study at times.

A TURBULENT ATMOSPHERE

Atmospheric turbulence is caused by flowing currents of warm and cold air mixing together. Most of the disruptive atmospheric turbulence occurs very near the Earth's surface up to around 30,000 feet. Above this altitude the atmosphere begins to thin out and winds tend to blow in the same direction.

Jet streams are belts or bands of rapidly moving air above about 20,000 feet in altitude. There are two jet streams that affect the U. S.: the polar jet stream flows across the far northern U.S. and Canada, while the sub-tropical jet stream flows across the southern part of the country. These jet streams tend to change in latitude seasonally and meander across the country like a river of turbulent water.

The air at altitudes above or below a jet stream may be calmer or flowing parallel to the surrounding air, but any crosswinds or vertical wind shear within this flow can cause a decrease in "seeing". The southern edge of a jet stream will often contain cirrus clouds that tend to help seeing at times and hinder it at others. Cirrus clouds, or "mare's tails" as they are often called, are usually uniform streaks indicating smooth airflow. However, the clear region just north of this band of cirrus clouds may be very turbulent. Irregular, disturbed cirrus clouds are not good.

Turbulence and thermal currents can cause starlight to change direction and intensity. Because the density of air varies with temperature, and the refractive index of air depends on its density, starlight does not traverse through air without interference. Each thermal "cell" can act as a tiny lens on the starlight passing through it. Random intensity fluctuations of starlight passing through these cells are called "scintillation."

You can easily see the effects of scintillation by looking up at night right after the passage of a cold front. The sky may be very clear, but the stars appear to twinkle and change colors.

CLOSER TO HOME

Let's now look at the atmosphere from the surface up to a few yards of altitude. While we cannot do much about the atmosphere, we do have some control over where we locate our observing site. Near the Earth's surface there are obstructions (such as mountains, hills, lakes, trees, buildings, etc.) which can disrupt the air flow and cause bad seeing.

When planning an observing site it is important to select high ground if possible. For astronomical purposes, air flow tends to be less turbulent over hills than in valleys.

An effect that occurs near buildings is similar to one that happens near mountains. The wind may not blow your telescope around as much on the leeward side of the house, but seeing will suffer. The peaked roof and heat rising from the house causes turbulent downdrafts that spoil the air flow over your telescope. Move your telescope to the "upwind" side and seeing should improve.

The main force that disrupts the air above a forest comes from vertical air circulation within the trees. Also, in pine forests, the thick layer of the heat-storing floor litter releases thermal plumes after the Sun sets. This heat, combined with the vertical air currents, causes much turbulence over the trees. The author avoids setting up a telescope in a dense pine forest. However, all is not lost for tree dwellers. A forest may be beneficial to daytime telescopic observing. It is well know among glider pilots that air above a forest is calm during the day- time, suggesting that seeing may be good during the daylight hours.

THE "ASTRONOMICAL SEEING" IN SOUTH FLORIDA

Air circulation over the ocean and shorelines in coastal areas is very complex and defies a simple explanation. However, those living near coastal areas often find that astronomical seeing can be excellent, at times providing the best conditions for high-power telescopic viewing.

The seeing in south Florida is excellent most of the time during all seasons. The atmosphere tends to be very stable near the coast because of the influence of warm, humid air from the Gulf Stream. Sea breezes are a common daytime occurrence in this region, generating sea breeze fronts from the coastline to a few miles inland. In this area there is much mixing. At night land breezes develop that flow seaward, stabilizing the air from a few yards above the surface to around 1,500 to 2,000 feet altitude, creating an inversion. Above this altitude the air may be variable and winds are usually from the seaward direction. Although we do see numerous clouds, they are usually the "fair weather" daytime cumulus type, dissipating in the nighttime inversion, and have little effect on nighttime "seeing".

In 1990, this writer measured hundreds of star trails from glass plates to determine the steadiness of the South Florida air over a period from the early 1960's through the 1970's. A precision measuring engine was used on plates taken by the U.S. Naval Observatory's 8-inch f/22 Photographic Zenith Tube (PZT). I concluded that the typical seeing for all seasons at this observing site was less than one arcsecond. Unfortunately, the logs and notes were destroyed during Hurricane Andrew and the study will have to be done again.

During the mid- to late-1970's some planetary observers in south Florida noted that the seeing was changing. Excellent seeing periods were fewer and the atmosphere in general was not as stable as "usual." Following the peak period of an "El Niño" event from 1979 through 1983, the seeing became very good -- ranging from excellent to perfect for long periods of time. It then appeared to return to mediocre throughout the late 1980's and early 1990's.

By 1992 the sky was just not as steady as usual. Thanks to several volcanoes erupting around the world the sky also became brighter than usual. The sky in the daytime was not its typical deep blue; instead it was hazy and bright. The night sky-glow had also increased noticeably and the seeing seemed to have diminished accordingly.

During the first months of 1994 the sky appeared to be clearing. Then, in June, a big storm blew up in Africa. It sent dust into the upper atmosphere, which eventually spread over south Florida. This happens occasionally, so we just wait until the dust settles (so to speak). The seeing was about as bad as it could be that month, but by the second week of July the sky cleared and seeing returned to excellent again.

During July of 1994, several local astronomers and noted ALPO members assembled at my observatory to use the 16-inch f/7 Newtonian to record the Comet Shoemaker-Levy 9/Jupiter event. Typical magnifications used during the two or three weeks of observing ranged from 390x to 600x. Occasionally, I would treat them to observing at 1,125x. A few observers were stunned by the amount of surface details seen on Ganymede! It was the usual ho hum stuff to the local inhabitants....

FURTHER READING

Elements of Meteorology, By: Miller and Thompson, Charles E. Merrill Publishing Company, Columbus, OH. ISBN 0-675-09554-9.

Descriptive Micrometeorology, by R. E. Munn, Advanced in Geophysics, supplement 1, 1966. LCCCN 65-26406, Academic Press, 111 Fifth Ave., New York 10003.

Amateur Astronomer's Handbook, by: J.B. Sidgwick, Dover Publications, Inc., New York ISBN 0-486-24034-7, 1971.

A Manual for Advanced Celestial Photography, by: Brad D. Wallis and Robert W. Provin, Chapter 12, "High Resolution Photography: Seeing", Cambridge University Press, New York, ISBN 0 521 2555538, pp. 257-266, 1988.

Security News

USNO POLICE EMERGENCY NUMBERS

Main Gate (24 hours): 762-1468

Shift Lieutenant: 762-0336

Shift Sergeant: 762-0338

Local Emergency Number: Dial 99 + 911
(When calling the local emergency number please notify the USNO police in order to escort the emergency personnel and vehicles to the scene).

Congratulations are in order for Lieutenant Eric O. Cooper and Lieutenant Larry Graves on their promotion to Supervisory Police Officer.

USNO POLICE ADMINISTRATIVE HOURS:
0800 - 1100, Monday through Friday (Issuing of USNO ID Badges, Decals/Vehicle Registration, Key Issue, Fingerprinting, etc.)

Gates (Hours of Operation):

34th Street Gate: Open 24 Hours/7 Days A Week,

South Gate: Open Monday - Friday, 0545 - 1830

Wisconsin Gate: Open Monday - Friday, 0715 - 0900 and 1530 - 1900

Wisconsin Turnstile: 24 Hours Daily (Must have USNO Swipe ID Card to re-enter)

Davis Street Gate: Closed

Gilliss Avenue Gate: Open as Directed Otherwise Closed

USNO
H*A*P*P*E*N*I*N*G*S

Candice Baines is all smiles at her Farewell Luncheon. She's leaving USNO to pursue a career in writing fiction.
(Above): Candice with Steve Gauss (AD Head), Superintendent CAPT Dennis Larsen, and Ken Johnston (SD).
(Below): XO CDR Mark Gunzelman and Wanda Ferguson enjoy the buffet.
(Photos by Annette Hammond)

USNO
H*A*P*P*E*N*I*N*G*S

Dr. Alan Fiala (AA) receives his Special Act Award from Superintendent CAPT Dennis Larsen. SD Dr. Ken Johnston and XO CDR Mark Gunzelman listen as CAPT Larsen reads the Citation.

SK2 Bonnie White (RM) received a rousing sendoff to her new duty station based in Norfolk.
(Left) CAPT Larsen presents Bonnie with the Citation of her Meritorious Service Medal.
(Right) Comptroller Gail Witcher introduces Bonnie's replacement, SK2 Maryam Abdullah.

USNO
H*A*P*P*E*N*I*N*G*S

Clemence Portrait dedication

On 14 September, a portrait of USNO's first Scientific Director, Dr. Gerald Clemence, was dedicated in the Library. Dr. Clemence was an astronomer from 1930 - 1945, Director of the Nautical Almanac Office from 1945 - 1958, and Scientific Director from 1958 - 1963. On hand for the occasion were members of the Clemence family, including his brother, Vail. (left).

Also on hand were several current and former USNO employees who worked under Dr. Clemence. (All photos by Steve Dick)

(Above): Bob Rhynsburger, David Scott, and Bernice Morrison.

(Below): Dr. Alan Fiala, Julie Duncombe, and Ray Duncombe.

The Stars This Winter

Geoff Chester

Public Affairs Office

The Winter Solstice occurs on December 21st at 3:27 pm EST. The year's earliest sunset occurs on December 7th at 4:46 pm.

The Full "Long Night Moon" occurs on December 13th at 9:37 pm, and the Full "Old Moon" occurs on January 12th at 12:24 pm. This year's display of the Geminid meteors will be washed out on December 13th and 14th by the full Moon, but the Quadrantid meteors, which peak on the morning of January 3rd, should occur in dark skies after local midnight.

During the first week of December you can see all five of the naked-eye planets in the evening sky. Start with Mercury, very low in the southwest some 45 minutes after sunset. A very thin crescent Moon lies a few degrees to the right of Mercury on December 1st. Mercury quickly drops from the sky over the next few days.

Venus is the very bright object in the southwestern sky at dusk. Venus will sink toward the horizon toward the end of December, passing close to much fainter, ruddy Mars on the 22nd.

Jupiter is the other bright planet that you'll see in the early evening. In mid-December Jupiter will be in the southwestern sky at around 7:30 pm.

Saturn is on the meridian at 7:30 in mid-December.

I've always thought that it was more than coincidence that the stars of the wintertime sky stand out as clearly as they do. Part of this has to do with the weather, which tends to offer up crisp, clear nights free from the hazes of summer. By far the greatest factor, though, is the stars themselves.

Dominated by the imposing figure of Orion, the winter sky seems ablaze with the dazzling blue fires that punctuate this distinctive star pattern. Orion is visible from every inhabited corner of the globe, and serves as a signpost to other stars and constellations.

Orion's three "Belt Stars" straddle the Celestial Equator; looking to the southeast they point to Sirius, the "Dog Star", brightest in the heavens and lead star of the constellation Canis Major, the "Greater Dog". Starting at Sirius, we can make a great clockwise sweep around Orion. We first pass Procyon, the lead star in the paltry asterism of Canis Minor, the "Lesser Dog". From here we proceed through the Gemini twins, Pollux and Castor, before reaching the top of the circle at Capella, nestled in a corner of the Pentagon-shaped constellation of Auriga. From Capella we then head south, passing Aldebaran, the fiery eye of Taurus, the Bull, and Rigel, the star that marks one of Orion's knees. We complete the circle back at Sirius.

In the center of this "Great Winter Circle" lies a star with a distinctive ruddy tinge. Betelgeuse often blazes brighter than Rigel, its counterpart below Orion's belt, but its light output varies irregularly over time. How bright does it appear to you this winter?

As you gaze at these bright fires of the winter sky, think for a moment about a wonderful quirk of nature. As we now endure the longest and coldest nights of the year, we enjoy the benefit of the brilliant star-lit sky. Within the confines of the "Great Winter Circle" lie 9 of the 25 brightest stars in the entire sky! That's worth a few minutes in the cold...

Volunteers Needed for Monday Night Tours (Still!)

Geoff Chester

Public Affairs Office

As many of you know, the Observatory hosts a tour for the general public every Monday night, except on Federal holidays. This tour is the only chance that most people have to see the workings of a modern, world-class observatory, and it is very popular. This summer we have had a full capacity crowd each week, with many people having to be turned away.

The tour consists of three parts, each lasting approximately 25 minutes. The three "stations" are the lobby of Building 1, where a short video is shown, the Master Clock in Building 78, and the 12-inch telescope (26-inch if the weather precludes viewing through the 12-inch). Approximately 90 visitors are allowed in for the tour. They are divided into three groups of 30 persons and "rotate" through the stations for the tour, which lasts from 8:30 to 10:00 PM.

It takes a good deal of effort to make these tours proceed smoothly, but most of all it takes a bit of time commitment from those few staff members who like to show off their work place.

I'd like to involve more of you in this worthwhile effort. I don't ask for much, just one evening per month would be fine. If you'd like to help out, just let me know. I'll put you to work right away!

From The Editor:

Geoff Chester

Public Affairs Office

I wish all of you a safe and happy holiday season!

Well, another issue of the "Star" has hit the deck. You'll probably notice some cosmetic changes since I'm using a different word processor for this issue, but the content remains the same: your contributions! I'd like to thank the authors of this issue's articles, and I would like to encourage all of you aspiring wordsmiths out there to have a go at a topic near and dear to you and send it in for a future issue. I hope to make this a quarterly endeavor, so keep those ideas flowing!

In my few short months here (which have seemingly flown by at breakneck speed) I have come to know many of you and the interesting projects that you are working on. USNO does some amazing things, and I am here to tell the world about them...but I can't do that unless I have some input from you! Our mission here is as vital to the security of our country as it is to the more "glamorous" fields of astronomy, and it's up to us to let everyone know that fact.

This publication serves as a conduit of information to your peers here at USNO. I'd like to see it used as a bulletin board for ideas, projects, and activities that concern all employees at our various stations. I know there are doings out at Flagstaff, but I can't print 'em if I don't get 'em....

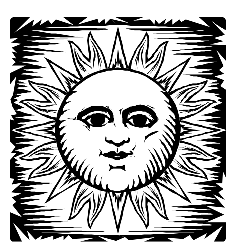
So send me whatever you've got. I want the "Star" to be informative and fun at the same time, so no reasonable offers will be refused!

Comings and Goings at USNO

There have been more changes at USNO since the last issue of the *Star*. Below are lists of civilian employees who have left us and those who have joined. To the former we say "Fair winds and following seas", and to the newcomers, "Welcome aboard!"

DATE	DEPT	DEPARTED
8/15/97	SO	Deborah Powell
8/15/97	RM	Kattrina Ross
8/22/97	TS	Partap Verma
8/22/97	FM	Twanna Gossom
8/22/97	SD	Hoang Nguyen
8/22/97	096	Christa Edwards
9/05/97	TS	Laprise Scott
9/05/97	FM	Tyese Marks
10/03/97	SO	Joe Phillips
10/11/97	096	Karen Watkins
10/11/97	IT	Candice Baines

DATE	DEPT	NEW EMPLOYEES
8/03/97	AD/FS	Melvin Dyck
8/03/97	OS	Linda Foote
9/28/97	AD	Christian Hummel
9/28/97	TS	Tran Minh
9/28/97	AD/FS	Tyler Nordgren
9/28/97	AD	Norbert Zacharias
10/12/97	EO	Suzette Forman
10/12/97	O96	Rhonda Peason



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