Amateur Astronomy
-
Amateur Science

Tom Krajič

If you’re reading this newsletter, then you probably have a fascination for the night sky. You might even like to share your astronomy fascination with others through star parties, public outreach, teaching, etc. I’ve had the fascination since childhood and it’s enriched my life in many ways, but my passion for astronomy has also taken me in other directions – recently towards amateur science.

Amateur science? Yes. My astronomy experience continues to change. Instead of being a celestial tourist, I’m an explorer. I measure things, analyze what I measure, and submit my data to a professional or write a paper on my own.

Does this sound boring? It depends on your outlook. If you like solving puzzles, get a thrill from discovery, and enjoy collaborating with others, then amateur science may be worth looking into.

How do you start? Amateurs normally take a different approach than professionals when choosing what to study. Professionals first decide what kind of data they want to collect and then determine what equipment will meet their needs. Most amateurs first look at what equipment they have available, and then decide what data can be collected.

Do you need a large telescope, electronic CCD camera, computer, observatory…all at considerable expense? Not necessarily. You can start with equipment as humble as a pair of binoculars and a note pad, or even your unaided eye! Let’s start with binoculars and see what kind of science we can do.

Even a newcomer to amateur science can use his or her eyes to compare the brightness of stars. Measuring brightness is part of the science of photometry, and that’s what we’ll start with. Experts state that roughly one percent of all stars are variable. Visit http://www.stargazing.net/david/constel/howmanystars.html and note that if you can see stars to fifth magnitude with the naked eye, you have about 1,400 stars in the northern sky within your reach. One percent of that is 14. With binoculars you can see to magnitude 7 and 13,000 stars are in your reach. One percent of that number is 130. Even with modest equipment many variable stars can be seen. Where can you go to learn more?

Visit the American Association of Variable Star Observers (AAVSO) at http://www.aavso.org/ but don’t let all the information overwhelm you. Briefly read through the introductory presentation http://www.aavso.org/aavso/about/estimate.html to get an idea of how to make visual brightness estimates and use charts to study a particular star. Next look over http://www.aavso.org/observing/aids/easystars.shtml and http://www.aavso.org/observing/aids/binocularstars.shtml to see what stars are well suited to beginners with binoculars or small telescopes. If this interests you, start looking over http://www.aavso.org/publications/manual/. You may have noticed that the stars listed above are long period variables – stars that take days, months, even years to go through one cycle of rising and fading. If that does not strike your fancy, AAVSO has other observing programs at http://www.aavso.org/observing/programs/ from simple to complex, from visual to CCD.

What if you like observing the moon and planets? No problem. Visit the Association of Lunar and Planetary Observers (ALPO) at http://www.lpl.arizona.edu/alpo/. If you like Mars, ALPO wants your help to keep track of dust storm development. If you observe Jupiter you can submit drawings and reports on white oval activity...they sometimes
President’s Message

My last article was a retrospective of 2004 so I think it is only fitting that the first article for 2005 be prospective in nature. Those of you who know me personally you know me as a skeptic of all things paranormal and therefore I put little faith (read absolutely no faith whatsoever) in fortunetellers. Having said that, I predict a very good year for TAAS. I do not predict this from speaking to spirits but rather from a more scientific approach. Why am I so certain of a good upcoming year? It is based on examining the immediate past, considering the people of TAAS, and looking at the state of our programs in the present.

How do we top a great Winter Solstice Banquet? We have a fantastic first General Meeting, that’s how. Our first General Meeting of 2005 is a great example of how these events are supposed to be. The crowd was enthusiastic and energized. Dr. Trish Henning gave a wonderful account of the structure of the universe hidden behind the dusty curtain of the Milky Way and how her research in radio astronomy revealed that structure. The talk was technical enough to satisfy the most geeky among us (myself included) while presenting it at a level that the most novice among us could understand and enjoy it. In addition to the highly entertaining talk a new slate of officers was voted in. Immediately following the meeting the officers met to endorse a new Board of Directors for the coming year, which brings me to the next part of my process for predicting the future.

Despite the amazing progress made last year there was a bit of adversity facing our society. Burnout is a frequent problem that threatens volunteer organizations. Quite frankly some members were getting pretty tired. The new members of the Board are bringing some much-needed energy to TAAS. We now have a new Vice President, Secretary, Treasurer and two new directors. You are stuck with the same old President for now but I’ll do my best to keep up. I am highly encouraged with the fresh ideas I have already heard from the “new blood”. I think you will see some new features in the General Meetings as well as other areas that promise to make this next year a very exciting one.

And now for the state of the programs: Not long after the new board was installed we held a retreat to help the new members transition into the jobs and to hold frank discussions on what we needed to do to make this society the best it can be. The education program is being beefed up with a new Education Outreach Coordinator. This position had been vacant for some time and we were struggling to keep the program going as we have in the past. We now have a chance to move forward while maintaining the high standard of quality that the schools of New Mexico have come to expect. We have a new program to teach the night sky to people new to astronomy with the Messier Special Interest Group. GNTO was already in very good shape after the past year and will continue to provide a pleasant dark-sky location for all to enjoy. All in all the state of the programs are better than I had hoped for at this point in the New Year.

With all this new energy about I hope the excitement is contagious. There are still plenty of opportunities for everyone to participate in TAAS. I encourage all to experience the satisfaction of volunteering in TAAS programs. The Board is developing materials to assist new event owners when hosting TAAS events to make it as easy and pleasant as possible. Experience the thrill in knowing that YOUR event brought so much enjoyment to so many. Be a TAAS volunteer!

TAAS General Meeting News

February 2005

Chaco Canyon’s National Park Interpreter, Mr. G.B. Cornucopia, will be the guest speaker at the February 26 general meeting of the Albuquerque Astronomical Society. Chaco Canyon was an active Anasazi cultural center from about 900 through 1130 AD. About 30 ancient masonry buildings, containing hundreds of rooms each, attest to Chaco’s importance. Some structures are thought to have served as astronomical observatories or calendars. In particular, numerous ledges along the canyon provided points from which line-of-site to the rising or setting moon and sun signaled significant cultural dates. The story of the sun dagger is particularly intriguing.

The general meeting begins at 7:00 P.M. in Regener Hall on the UNM main Campus. A social hour follows the meeting. Please join us.
Following recent tradition, there was no GNTO Committee meeting in January, and so no meeting report. Our January 8 observing event was largely clouded out. Five hearty folks made the trip down to GNTO and for fairly good viewing near the zenith for several hours. One telescope was set up, and Dale Murray managed to get a few long exposure film images of Comet Machholz. When the clouds finally filled in overhead and the winds continued, we called it an early night and went home.

In contrast, the weather and turnout were very good for our January 15 observing and training event. Dale and I lead an enthusiastic group for Level I training, and later Carl Frisch gave a well-attended CCD imaging demonstration. Over fourteen telescopes were in operation that night with over thirty people in attendance. After the training, Larry Cash ran the Isengard for group observing. A late moonset helped to keep things interesting, but everyone seemed to have a great time.

We got the new JMI MotoFocus motor installed on the Isengard focuser, thanks a clever adapter that Barry Spletzer constructed. The new motorized focuser reduces tube oscillations, since focusing can now be done without touching the tube. We had a number of positive comments about this upgrade when it was first used on January 15. Another new piece of equipment inaugurated the same night was the new Johnsonian Design Equatorial Platform. This platform was funded by our most recent Intel grant and we plan to use it as part of our video imaging system. We hope to have the video imaging system at school star parties and public outreach events like Oak Flat observing nights. There is some vibration of the platform, so we are looking for a suitable vibration dampening material to isolate a scope from the platform.

As I reported last time, Tom Bisque of Software Bisque helped us upgrade several GNTO copies of the Sky V5 Level 4 to TheSky V6 Professional with a small site license for the cost of a single license upgrade. Using part of the GNTO site license for TheSky V6 Professional, I installed one copy on the education Outreach laptop for School Star Parties. This can be used to conduct planetarium shows with the laptop and multi-media projector.

The February 5 GNTO observing event was clouded out. We did not cancel the event because a small number of people were at GNTO to learn to set up CCD imaging equipment. This activity is an extension of the imaging workshops that Carl Frisch is conducting in Los Lunas. Five people arrived for the equipment introduction around mid-afternoon, but when thick cloud cover was evident by sunset, they packed up and headed back to town.

Karen Keese has an article elsewhere in this issue of Sidereal Times with more details about the one-on-one imaging workshops that Carl Frisch is offering in Los Lunas. This program is part of the GNTO Committee’s efforts to re-energize the imaging program at GNTO. If you are interested in attending an imaging workshop in Los Lunas, please contact Karen Keese at pr@taas.org, or contact me, and Carl will call you to make arrangements.

Our scheduled events for March include the GNTO Open House, Equinox Picnic, and training sessions on March 5 and a “New Moon” observing opportunity on March 17. The GNTO Open House will start at 3:00 P.M. This is the perfect opportunity to visit GNTO for the first time, or to check on recent site improvements. The Spring Equinox Picnic will start at 4:30 P.M. with our usual semi-coordinated mix of potluck dishes and good fortune. The barbecue grill will be available and hot dogs and hamburgers will be provided. More details will be available via email on the Board of Directors’ Email list (the BODOEL), our TAAS-L listserver, and at our general meeting on February 26.

We will begin the March 5 Level 1 training around 5:30 P.M. Level 1 training covers most of the equipment used at GNTO, from the Isengard 16” reflector down to our 6” and 16” loaner dobbsonian scopes. After dark, we will offer another in our popular series of two-part Constellation tours, hosted by Larry Cash and Karen Keese. If enough people are interested, we may offer a Level 2 training session prior to the constellation tours. Level 2 training covers computer hardware and astronomy-related software available at GNTO.

If conditions permit, we may offer a CCD Imaging demonstration as part of our efforts to revive Level 3 training and our imaging program. Be sure to mark your calendars now for this opportunity to learn about your observatory and enjoy the relaxed company of fellow observers. Between the Open House, picnic, training and constellation tours, this will be a great chance to visit GNTO, especially if it is your first time at your observatory!

Plan a trip to GNTO soon. We have two great loaner scopes on easy to use dobsonian mounts, and our Isengard 16” is providing some really great views these days. Plus, you owe it to yourself to see the new drive system on the Isengard! With all this great equipment at our facility, you do not need have your own equipment to enjoy GNTO. The comfortable Ortega Building is available for socializing and our Guest Trailer is available for coffee and hot chocolate, so you are encouraged to bring snacks to share.

GNTO committee meetings are open to all TAAS members and this is a great way to get more involved with your observatory. We need your help. Our next scheduled meetings are February 17 and March 17. We meet at 6:30 P.M. at JB’s Restaurant on Eubank just north of I-40. If you have questions about access and availability of GNTO, please contact me (Peter Eschman, gnto@taas.org, home phone: 873-1517).

I hope to see you soon at your observatory.
February 2005

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Planet Rise & Set for Feb 15, 2005
- Mercury: 06:03 12:30
- Venus: 06:25 16:22
- Mars: 02:30 13:10
- Jupiter: 02:33 09:18
- Saturn: 11:25 09:32
- Uranus: 02:21 18:28
- Neptune: 06:19 16:48
- Pluto: 02:40 13:45

The Night Sky Program (http://www.nmheritage.org/sky/index.php), conducted by the New Mexico Heritage Preservation Alliance (NMHPA), is in the final process of preparing a Consumer Guide for Night Sky Friendly Lighting. The program may be contacted at (505) 989-3696, (505)989-7745, or sky@nmheritage.org.

City of Albuquerque: At the January 20, 2005, Environmental Planning Commission (EPC) public hearing, proposed outdoor lighting amendments to the zoning code were heard. The EPC voted for a 60-day continuance due to extensive opposition. (During this time, the City Planning Department is supposed to meet with concerned interest groups to try to work out some changes.) Business representatives were all opposed to the lighting changes, including those from PNM (local power company), a car dealer association, a gas/convenience store association, an apartment company), a car dealer association, a gas/company), a car dealer association, a gas/

Several spoke in favor of the need for more regulations, including two members of the 2000-2001 Night Sky Protection Task Force that had made prior recommendations, also in the form of text amendments to the zoning code. (However, that proposal stalled in review and exceeded the one year time limit, expiring without further action.) The EPC Chair pointed out that they simply send recommendations on to the City Council, but do not make final decisions. At this point, they see 5 main areas of concern with the proposal:
1) Implementation times (for requiring non-conforming lighting to be retrofitted or replaced).
2) Impact of lower light levels (if any) and crime.
3) Additional exemptions that may be needed (e.g., flagpoles)
4) Previous task force's recommendations might be out of date. Implement updates considering current technology. EPC will not appoint a new force, but the City Council could. Planning to meet with concerned interest groups.
5) Consider offering rebates (City and PNM) for retrofitting existing lighting that is non-compliant.

For further information, contact Josh Skarsgard, Research Analyst, Planning Department, (505) 924-3935 (jkskarsgard@cabq.gov.)

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The Official Newsletter of The Albuquerque Astronomical Society
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<td><strong>Sunday</strong></td>
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**ATM Workshop**

Ray Collins/Mike Pendley atm@taas.org

The Amateur Telescope Making Workshop meets the first and third Wednesdays of each month at Valley High School, 1505 Candelaria—the north side of Candelaria, just west of 12th street. The meetings begin at 7 P.M. and are in Building E, Room #3.

**TAAS General Meeting**

Saturday, February 26, 2005

7 P.M.

Regener Hall

UNM Campus

(see map back page)

**Subject:**

Chaco Canyon

**Speaker:**

G.B. Cornucopia

**Notes**


GNTO = General Nathan Twining Obs.

GNTO Training = GNTO Observing and Training.

UNM = University of New Mexico Observatory. Call the TAAS hotline @254-8227, or the UNM hotline @ 277-1446 to confirm, or unm_coordinator@taas.org.

ATM = Amateur Telescope Making. Call Michael Pendley for information @ 296-0549, or atm@taas.org.

P & A = UNM Physics and Astronomy. Corner of Lomas and Yale.

= School Star Party.

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merge. Saturn also has storms that can be seen at the eyepiece. Like the AAVSO ALPO also encourages folks to start an observing program with modest equipment: a 2.4 inch refractor, pencil, and paper. See: http://www.lpl.arizona.edu/~rhill/alpo/difficult.html. Find your favorite solar system object and see what observing program is underway.

Don’t work alone! Join an established group, such as the AAVSO or ALPO that has both amateurs and professionals. There are a couple good reasons for this. First, this will be an invaluable resource for mentoring to keep you from making simple mistakes, and guiding you toward observing programs that have scientific value. Second, you get the opportunity to collaborate with other amateurs and professionals from around the world. This can be not only productive from a science standpoint, but also very satisfying and rewarding.

As an example, I recently collaborated with Russ Kobb, a Canadian amateur astronomer, when I lived in Uzbekistan, Central Asia. He was studying a spotted, rotating star and had problems determining the period of rotation. He could only observe the star a few hours every night, and that was not long enough to eliminate all potential rotation periods. I was on the other side of the Earth, and could take data when it was daylight in Canada. My contribution helped Russ determine the star’s period, and his results can be seen online at http://konkoly.hu/cgi-bin/IBVS?5534. Such collaboration is sometimes challenging, but the rewards more than justify the effort.

As amateur astronomers we should not compete with professionals. Instead we should complement them. We use our strengths to supplement what the professionals can’t do. Some variable stars, such as dwarf novae, are inactive and faint 99% of the time. There is little scientific value in studying them during these long stretches and professionals can’t afford to do that. However when one of these stars goes into outburst it becomes a valuable scientific target. How do professionals know of an outburst? From amateurs that monitor these strange stars. One amateur email report, followed by a confirming report from another observer...can set the ‘big scopes’ in action!

I’ve briefly covered only a few observing projects you can do with photometry, but there are other ways you can study the sky.

Part of astrometry is the science of position measurements. This is very important when working with asteroids and comets. If you have a CCD equipped telescope you can use software to measure object positions to surprising accuracy.

Spectroscopy measures the brightness of an object at many different, discrete wavelengths. You’ll need a CCD equipped telescope and a spectroscope. While this can make your rig expensive, when a nova is discovered in the summer Milky Way you can be the first to measure its spectrum, which will provide valuable information about the star’s composition and activity.

Patrol or search projects (novae, supernovae, comets) can be done visually, with that old film-based camera that’s gathering dust these days, or with new-fangled electronic gear. You may not need to measure position, brightness, or time very accurately. Instead you are looking for a change in star patterns, and then alert others to confirm and study your discovery in greater detail.

With humble equipment, some perseverance and patience, you can start a meaningful path toward learning and discovery of the heavens above. Thanks to the internet you have an incredible amount of information available at your fingertips for background research, and unprecedented opportunity for real time collaboration with other astronomers around the globe. As you learn more about various observing projects, you’ll find one or two that spark your interest more than others. Follow your heart and let your passion fuel your studies. You may find that it’s a unique blend of intellectual discipline and food for the soul.

Astronomy is one of the few fields where an amateur can contribute meaningful research. There has been a long history of professional-amateur collaboration in astronomy, and that trend will continue in the future. There are simply too many objects to study, and not enough astronomers. The opportunities are endless, so dive right in!

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PS. Feel free to contact me if you have questions about observing programs. I’m more than happy to help!
Mitchell Elementary School Star Party, Thursday January 13th
(Cold and clear skies after the passage of a front)
What a success! IAAS docents really shined as over 250 students and parents viewed Saturn, Comet Machholz and other celestial delights through big dob and GOTO cassegrains. Scope docents included Gordon Pegue, John Laning, Chris Wilson, Bob Hufnagel and Greg Poulter. Meanwhile inside the gym, comets were being made by Dale Murray and questions were being fielded by Bob Havlen during his “Ask an Astronomer” slide presentation. Last but not least, Ray and Ina Collins put on quite a show with their own version of “Measure the Rainbow.” IAAS docents included: Dale Murray, Shannon Mann, Gordon Pegue, John Laning, Chris Wilson, Bob Hufnagel, Greg Poulter, Ray and Ina Collins and Bob Havlen.

Oñate Elementary School Volunteer Assistance, Friday January 28th
(Cold and clear skies after the passage of a front)
Telescope volunteers showed up at the last minute to help make Oñate’s science night a success. Volunteers included: Shannon Mann, Bob Hufnagel and John Laning.

Madison Middle School Star Party, Thursday February 10th
Unfortunately cancelled due to overcast skies ...

SY Jackson Elementary School Star Party, Thursday March 10th
Come out and join us at 4720 CAIRO DR NE for a great star party!
The Messier 2005 SIG held its second meeting on 1 Feb 05. Due to cloudy skies no observing was possible.
The third Messier SIG meeting was 9 Feb 05. The sky tried to cooperate and we were able to get in about 2.5 hours of observing. Ten people showed up for the session and we had a terrific time beginning our goal of observing all of the Messier objects. Due to some scattered clouds we were limited in being able to observe the entire sky. However, we did locate and identify seven of the ten Messier objects for the month of February. If our next session has clear skies, we will be able to easily locate and identify the remaining three February objects.
The next two observing sessions will be 1 and 9 Mar 05. Once again we will meet at Dee’s house. Persons wishing to participate may arrive any time after 6:30 P.M. and stay as long as they desire. The sessions will continue until everyone has completed their planned observing.
On 3 Mar the group will meet at GNTO for the first observing session with the Isengard telescope. Details for the GNTO meeting will be distributed in two weeks. The URL, which gives you the SIDS 12 Month Messier List is http://www.maa.agleia.de/Messier/E/Xtra/12months/12months.html
It is not too late to join the Messier 2005 SIG. If you are interested contact Dee at 856-1593 or friesend@comcast.net. Directions to Dee’s house are available on the TAAS web site.

UNM Report
Jay Harden, UNM Campus Observatory Coordinator
unm_coord@taas.org
Jay is at home caring for Ruth, so I have the watch for a while longer.
21 January 05: Tonight is the first observation of the winter term. The parking lot has been paved, though the lighting system has yet to be installed. However, the weather simply would not cooperate. High clouds blotted out all but a ghost of the moon.
28 January 05: A fair weather window presented itself this evening, but we only had about 9 visitors.
28 January 05: What is the bad news is that the parking lot lights have not been installed. The bad news is that the keepers of the clouds "rubbed us out" again.
11 February 05: Light rain was the culprit tonight.
The NASA Institute for Advanced Concepts (NIAC) seeks to identify creative and innovative students who possess an extraordinary potential for developing advanced concepts in the fields of aeronautics, space and the sciences. Each Student Fellow intends for these awards to benefit talented individuals who have shown extraordinary originality and dedication in their academic pursuits and a marked capacity for self-direction. The Fellowship shown extraordinary originality and dedication in their academic pursuits and a marked capacity for self-direction. The Fellowship intends for these awards to benefit talented individuals who have shown extraordinary originality and dedication in their academic pursuits and a marked capacity for self-direction. The Fellowship seeks exceptional creativity, and the promise for important future and potential for the fellowship to facilitate subsequent creative work.

Applicant must be a U.S. Person
Applicant must apply no later than their junior year of college
Please visit http://niac.usra.edu/students/call.html for more information.
Proposals are due April 15, 2005.

FOR SALE - 20" F 5 Obsession dobsonian, primary mirror by Galaxy Optics, with QSP high reflective coatings, Lumicon 12 x 80 straight through finder, JMI NGC Max digital setting circles, JMI NGF 2 electric rayford focuser, full light shroud and metal tipped wood ramps for vehicle access. Delivered Spring 1996. Used about 20 times. Like new condition except mirror needs a rinse. With all paperwork & instructional video. Original cost $6700, asking $4400. You pick up in Albuquerque or will deliver as far as N.M. border or can custom pack and commercial ship at buyer’s expense. Call Bill at 505-856-9203 or E-mail at Abqwood @ AOL.com.

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Exhaust farther out on the lever (moving faster) does more effective the rocket fuel is. The lever shows this. Must send a lot of stuff out the back very fast in order for same place. The long and short of all this is that the rocket called the center of gravity or center of mass) stays in the exactly balance each other out so the balance point (also and all the gas moving (much more rapidly) to the left will still balance. That is, the rocket moving to the right whether it is started or stopped multiple times, the lever start up the rocket. At any point later in time, imagine friction, air resistance and all those nasty details and at the fulcrum of a lever so it is just balanced. Next, ignore illustration this. In the top of the figure, a rocket is placed at the fulcrum of a lever so it is just balanced. Next, ignore friction, air resistance and all those nasty details and start up the rocket. At any point later in time, imagine all the rocket exhaust streaming away and the rocket itself again on this very long lever (the lower part of the figure.) No matter how fast or slow the rocket motor operates or whether it is started or stopped multiple times, the lever will still balance. That is, the rocket moving to the right and all the gas moving (much more rapidly) to the left exactly balance each other out so the balance point (also called the center of gravity or center of mass) stays in the same place. The long and short of all this is that the rocket must send a lot of stuff out the back very fast in order for the rocket to go fast.

The faster the exhaust leaves the back of the rocket, the more effective the rocket fuel is. The lever shows this. Exhaust farther out on the lever (moving faster) does more to balance the rocket than exhaust closer in. One of the best rocket fuels is liquid hydrogen and oxygen. Hydrogen-oxygen can push the exhaust out from the rocket at 10,000 mph. Even with such fast exhaust, it takes a lot of fuel to get a rocket up to speed.

At slow speeds, a little fuel can do a lot. As the speed goes up, the amount of fuel needed really goes up. The table below shows how much fuel it takes to get a one pound payload up to speed. At high speed, each additional 10,000 mph takes about 2.7 times as much fuel as all the fuel used up to that point.

Sure it takes a lot of fuel to go fast, but why go fast? Even a slow space probe will get where it’s going eventually, right? That brings up the second issue. There is a minimum speed needed to do space flight. The most common example is for satellites orbiting in low Earth orbit (no more than a few hundred miles up) This includes the Space Shuttle and the International Space Station. These need a certain speed to be in orbit, otherwise they will just fall to Earth. For low orbit, this speed is about 18,000 mph. At this speed, it takes over 6 pounds of fuel for each pound of payload. In other words, fuel must be at least 85% of the total weight of the rocket. In reality, the amount of fuel is even greater because of other factors.

In the case of Earth orbiting satellites, the gravity of the Earth determines the required speed. When travelling between the planets, it’s the gravity of the Sun that counts, and it really counts. A satellite in low orbit around the Earth must go 18,000 mph to stay in orbit. At Earth’s distance from the Sun, it takes a speed of 66,000 mph to stay in orbit around the Sun. Such high speed is a real problem for a rocket. Of course, a rocket taking off from Earth is on a platform (the Earth) already moving at 66,000 mph. This gives the rocket a significant head start, but it still takes a lot of fuel to travel between planets.

In order to travel directly between any two planets, there is a path, called the Hohman transfer orbit, that uses the minimum amount of energy. Figure 2 shows this orbit. The space probe travels in an elliptical orbit with the point closest to the Sun (perihelion) and farthest from the Sun (aphelion) just matching the orbits of the initial and final

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**Table 1: Fuel for a one pound payload**

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**Figure 1: The basis for rocket propulsion**
Before I get into the details of how the slingshot effect works, one more piece of background is needed. This deals with some details about orbits. We normally think of orbits as circular or elliptical. All the planets and their satellites travel like this. In addition to circles and ellipses, bodies can travel in open orbits as well. Open orbits occur when an object is moving too fast to be captured into a closed orbit. The most common objects we see with open orbits are comets. The current Comet Machholz may have an open orbit. With such an orbit, the comet passes by the Sun once and does not return. The slingshot maneuver makes use of open orbits.

With any orbit, open or closed, the orbital speed at any fixed period of time before or after the closest point of approach (the periapsis) is the same. Figure 3 shows this. The probe approaching the planet has the same speed on the way in as it does on the way out. The arrows show the magnitude and direction of this speed. So, if the speed is the same coming and going, how does this effect solve are problem? The answer lies in relative speeds.

Consider the Moon in orbit around the Earth. Figuring its speed based on the orbit size and period, you find it travels at 2080 mph. Similarly, the Earth moves at 66,630 mph around the Sun. The left side of Figure 4 shows the Moon at 4 points in the orbit. The Moon’s velocity relative to Earth is shown by the arrow at each position. The speed is always the same, but it changes direction through the orbit. On the right side of the figure, the motion of the Earth around the Sun is included. The motion of the Moon relative to the Sun can be determined by drawing scale arrows for the Moon’s speed around the Earth and the Earth’s speed around the Sun. Connecting the arrows head to tail gives the velocity of the Moon relative to the Sun. Even though the Moon travels at constant speed around the Earth and the Earth moves at constant velocity...
speed around the Sun, the changing direction makes the Moon's speed relative to the Sun change throughout the orbit. The change in speed is not much, but it is a change. The maximum possible change in speed is twice the orbital velocity of the satellite. This is shown in the figure as the difference in speed between the top and bottom Moons (68710 - 64550 = 2*2080).

In this example, the change in speed is limited because the orbital velocity is low. This is a requirement of a closed orbit. For an open orbit, the speed can be arbitrarily high. Figure 5 shows such a case. This is identical to Figure 3 except that it includes the orbital speed of the planet. Here, the speed of the exiting probe is much greater than the speed it up. The Galileo probe to Jupiter is a great example. Figure 6 shows the Galileo's path. The probe was launched towards the Sun rather than towards Jupiter, flew by Venus followed by 2 passes by Earth. On each flyby, the probe picked up about 10,000 mph. On approaching Jupiter, Galileo used a close flyby of Io to slow it back down so it would not fly right past Jupiter.

This can be used to slow down a space probe as well as speed it up. The Galileo probe to Jupiter is a great example. Figure 6 shows the Galileo's path. The probe was launched towards the Sun rather than towards Jupiter, flew by Venus followed by 2 passes by Earth. On each flyby, the probe picked up about 10,000 mph. On approaching Jupiter, Galileo used a close flyby of Io to slow it back down so it would not fly right past Jupiter.

The slingshot effect allows spacecraft to probe deeper into space than otherwise possible. As with Galileo, the path can be very complicated and requires enormous precision and meticulous planning, but the results are obviously worth it. A final note is that, by speeding up the spacecraft, the planet involved loses some of its orbital energy and slows down. Galileo, in it's two flybys, slowed the Earth down by about 0.000000005 inches per year. Only another 13 trillion Galileo's and we could do away with leap years.
Like discarded lumber and broken bricks around a construction site, comets scattered at the edge of our solar system are left-over bits from the “construction” of our solar system.

Studying comets, then, can help scientists understand how our solar system formed, and how it gave rise to a life-bearing planet like Earth.

But comets have long been frustratingly out of reach - - until recently. In January 2004 NASA’s Stardust probe made a fly-by of the comet Wild 2 (pronounced “vilt”). This fly-by captured some of the best images and data on comets yet ... and the most surprising.

Scientists had thought that comets were basically “rubble piles” of ice and dust—leftover “construction materials” held together by the comet’s feeble gravity. But that’s not what Stardust found. Photos of Wild 2 reveal a bizarre landscape of odd-shaped craters, tall cliffs, and overhangs. The comet looks like an alien world in miniature, not construction debris. To support these shapes against the pull of gravity, the comet must have a different consistency than scientists thought:

Now we think the comet’s surface might have a texture like freeze-dried ice cream, so-called ‘astronaut ice cream’: It’s solid and can assume odd, gravity-defying shapes, but it’s basically soft and crumbles easily,” says Donald Brownlee of the University of Washington, principal investigator for Stardust.

Scientists are currently assembling a 3-D computer model of this surface from the photos that Stardust took. Those photos show the sunlit side of the comet from many angles, so its 3-dimensional shape can be inferred by analyzing the images. The result will be a “virtual comet” that scientists can examine from any angle. They can even perform a virtual fly-by. Using this 3-D model to study the comet’s shape in detail, the scientists will learn a lot about the material from which the comet is made: how strong or dense or brittle it is, for example.

Soon, the Stardust team will get their first glimpse at the primordial makings of the solar system.

It’s heading our way: ancient, hard-won, possibly surprising and definitely precious dust from the construction zone.


The Stardust spacecraft used a grid holding aerogel to capture dust particles from comet Wild 2. In this test, high velocity dust particles are stopped unharmed at the end of cone shaped tracks in a sample of aerogel.

This article was provided by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.
Minutes of the Board of Directors

January 27th, 2005
UNM Physics and Astronomy Building Conference Room

MEETING MINUTES

Directors present: Dale Murray (President), Becky Ramotowski (Vice President), Gordon Pegue (Secretary), Heather Mann (Treasurer), David Blair, Larry Cash, Ray Collins, Pete Eschman, Bob Hufnagel, Shannon Mann and Shane Ramotowski.

Directors absent: Dee Friesen

Meeting called to order at 7:06 P.M.
Welcome to new Board Members
Dale welcomed David Blair, Shane and Becky Ramotowski to the Board of Directors.

Corrections to the December Minutes
None to report.

Treasurers Report
Total Funds: $16,350.92; Total Expenses: $0.00; Total Income: $605.00. Written interim report submitted by Heather. Heather noted that in the future, all reports will consist of two parts: an interim report submitted to the Board when the BoF meeting occurs prior to the end of the month and a final report prepared after receipt of bank statements. The final reports will be distributed to the appropriate BoF personnel. Heather also indicated that a purchase order for the large glass blanks has been received from UNM.

Correspondence
Dale reported on a request he received from an individual representing the Hyatt Tamaya Resort Hotel requesting our assistance in hosting a star party for an Electrical Contractors convention in September. Consensus of the BoF was to pursue this event only if TAAS is compensated in the form of a donation.

Event Retrospect
a. The January 22nd meeting went very well with over 50 individuals present to hear Trish Henning describe her work in locating and classifying galaxies in the “Zone of Avoidance” using radio telescopes tuned to the 21cm band. The election of new officers was also held. Officers elected for 2005 were Dale Murray, Becky Ramotowski, Gordon Pegue and Heather Mann.
b. The January 15th GNTO observing session was attended by 30 to 35 people and 15 scopes.
c. The January 13th school star party at Mitchell Elementary was very successful with over 250 students and family members entertained by 10 TAAS educational docs and 6 scopes.
d. The January 8th GNTO observing session was mostly clouded out, however 5 intrepid souls managed to attend. Dale indicated that he imaged comet Machholz with a film camera piggybacked on his scope.

event Prospect
a. The February 5th GNTO observing session is the “new moon” event.
b. A school star party at Madison Middle School is scheduled for Thursday, February 10th.
c. The February 12th GNTO observing session will feature the unveiling of the refurbished seating benches around the main observatory building.
d. The regularly scheduled meeting of the GNTO Committee will take place on Thursday, February 17th. Members are encouraged to attend.
e. The February 26th General Meeting will feature Interpretive Ranger GB Cornucopia of the Chaco Culture National Historical Park.
f. The March 5th GNTO observing session will feature the annual Spring Equinox Picnic as well as equipment training sessions.
g. A school star party at SY Jackson Elementary School is scheduled for Thursday, March 10th.
h. The March 12th GNTO observing session will be a “new moon” event.

Committee Reports
a. Membership: No report.
b. GNTO: No report as January is the committee’s annual vacation month. Pete indicated that 1) the equatorial platform funded by the Intel grant has arrived, 2) the motor focus unit for the Isengard Telescope has been installed and performs wonderfully and 3) Tom Bisque has graciously updated our corporate license of TheSky V6 Pro to a 5 user site license.
c. Education: Interested participants met after the General Meeting of January 22nd to discuss future activities. It was also noted that TAAS Calendar entries for school star parties need to be made.
d. Grants and Other Income: Dale reported on a possible benefit offered to employees of Sandia National Labs who volunteer for non-profit organizations like TAAS. The benefit would take the form of a donation based on hours volunteered.
e. Special Projects: Ray reported that due to the languishing state of the “Big Glass Task Force” and its directive to formulate a protocol for handling the large mirror blanks as a TAAS asset, he will undertake to develop a preliminary protocol and distribute it to the task force members. He also reported that good progress is being made on the prototype telescope.

Old Business
a. TAAS resolutions
Pete moved and Gordon seconded that all current TAAS resolutions covered in the TAAS Compendium be held over as active for the year 2005. After a brief discussion where all BoF members were urged to review the compendium prepared by Barry Spletzer, the motion passed with 9 in favor and 2 abstentions.
b. Larry spoke about TAAS Hotline management and communication process.
c. Education memberships
Pete brought to the attention of the BoF that no official record of the changes made to the Education class of TAAS membership exist. Heather moved and David seconded that an Education class membership be created for students and teachers K thru 12 with dues set at $15 per year, monies directed to the General Fund. After a brief discussion, the motion passed unanimously.
d. Ray and David reported that the La Semilla project is dead as far as TAAS is concerned.

New Business
a. Dale reported that a suitable replacement for our UNM Coordinator is becoming a critical issue. Interested members are urged to inquire through Dale. This item was tabled pending future updates.
b. Pete reported that with the increased interest shown locally in the proposed changes to the city zoning codes with respect to lighting ordinances, more participation in the TAAS Dark Sky Special Interest Group is encouraged.
c. Pete reported that the computer equipment hosting taas.org will be moved to another location on the UNM campus due to his impending retirement from UNM.
d. Larry reported that all was in readiness for the TAAS Board of Directors Retreat, scheduled for Saturday, January 29th.

Meeting adjourned at 9:20 P.M.
## 2005 TAAS Board of Directors/Staff

<table>
<thead>
<tr>
<th>Position</th>
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<th>Phone</th>
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MEMBERSHIP: You may request a membership application by sending e-mail to membership@taas.org or calling (505) 254-TAAS (8227). Applications may also be downloaded from the Web site. Annual dues to The Albuquerque Astronomical Society are $30/year for a full membership and $15/year for a teacher or student (grades K-12). Additional family members may join for $5/each (teacher, student and family memberships are not eligible to vote on society matters). New member information packets can be downloaded from the website or requested from the TAAS Membership Services Director at membership@taas.org. You may send your dues by mail to our newsletter mailing address or give your check to the Treasurer at the next meeting.

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