Houston Astronomical Society

November, 2013

GuideStar

November, 2013

Volume 31, #11

At the November 1 Meeting

Comet ISON

Justin McCollum

A.K.A. Professor Comet, and HAS Member

Justin will focus primarily on ISON and its origins in the Oort Cloud. The presentation will be short since there not much known about ISON other than people's observations of it and scientific opinion about it. The talk will stay away from the Internet and mass media about it being 'The comet of the century', although Justin will make a comparison of it with comet Ikeya - Seki and Kohoutek of 1973. He will also concentrate on how its orbital conditions compare with the great comet of 1680. It is difficult getting thru the mire of data since there is not a general scientific consensus on its fate.

Highlights:

HAS Web Page:

http://www.AstronomyHouston.org

See the *GuideStar's* Monthly Calendar of Events to confirm dates and times of all events for the month, and check the Web Page for any last minute changes.

The *GuideStar* is the winner of the 2012 Astronomical League Mabel Sterns Newsletter award.

The Houston Astronomical Society is a member of the Astronomical League.

All meetings are at the University of Houston Science and Research building. See the last page for directions to the location.

Novice meeting: ····· **7:00 p.m.**

"Everything You Wanted to Know About Comets, but Were Afraid to Ask" — Justin McCollum

See page 15 for more information

General meeting: ····· **8:00 p.m**

See last page for directions and more information.

The Houston Astronomical Society

The Houston Astronomical Society is a non-profit corporation organized under section 501 (C) 3 of the Internal Revenue Code. The Society was formed for education and scientific purposes. All contributions and gifts are deductible for federal income tax purposes. General membership meetings are open to the public and attendance is encouraged.

Officers & Past President

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Dr. Lawrence Pinsky, U. of H.
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Dues and Membership Information

Annual Dues:Regular $36
Associate.....$6
Sustaining $50
Student $12
Honorary..... N/C

All members have the right to participate in Society functions and to use the Observatory Site. Regular and Student Members receive a subscription to *The Reflector*. *The GuideStar,* the monthly publication of the Houston Astronomical Society is available on the web site. Associate Members, immediate family members of a Regular Member, have all membership rights, but do not receive publications. Sustaining members have the same rights as regular members with the additional dues treated as a donation to the Society. *Sky & Telescope* and *Astronomy* magazines are available to members at a discount.

Membership Application: Send funds to address shown on last page of *GuideStar*. Attention - Treasurer, along with the following information: Name, Address, Phone Number, Special Interests in Astronomy, Do you own a Telescope? (If so, what kind?), and where you first heard of H.A.S.

Table of Contents

Other Meetings...

Johnson Space Center Astronomical Society meets in the the Lunar and Planetary Institute on the 2nd Friday of each month. Web site: www.jscas.net

Fort Bend Astronomy Club meets the third Friday of the month at 8:00 p.m. at the Houston Community College Southwest Campus in Stafford, Texas http://www.fbac.org/club_meetings.htm. Novice meeting begins at 7:00 p.m., regular meeting begins at 8:00 p.m. Website: http://www.fbac.org

North Houston Astronomy Club meets at 7:30 p.m. on the 4th Friday of each month in the Teaching Theatre of the Student Center at Kingwood College.Call 281-312-1650 or E-mailbill.leach@nhmccd.edu. Web site: www.astronomyclub.org

Brazosport Astronomy Club meets the third Tuesday of each month at the Brazosport planetarium at 7:45 p.m. The Brazosport planetarium is located at 400 College Boulevard, Clute, TX, 77531. For more information call 979-265-3376

GuideStar deadline for the December issue is November 15th

President's Message

by Bill Pellerin, President

What's Going on with the HAS?

- **Election of officers for 2014 —** The nominations from our nominating committee are:

  President: Bill Pellerin
  Vice President: Rene Gedaly
  Secretary: Bill Flanagan
  Treasurer: Don Selle
  Director-at-large: Ash Alashqar
  Director-at-large: Brian Cudnik
  Director-at-large: John Haynes
  Director-at-large: Mark Holdsworth
  Director-at-large: Bram Weisman
  Telescope: Allen Wilkerson
  Field Trip and Observing: Steve Fast
  Program: Brian Cudnik
  Publicity: Bram Weisman
  Novice: Debbie Moran
  Audit: Scott Mitchell
  Observatory: Mike Edstrom
  Education: Debbie Moran
  Welcoming: open

  Nominations from the floor will be taken on the night of the meeting. If you wish to nominate someone other than yourself you must confirm in advance that the person you nominate is willing to serve in the office for which he or she will be nominated.

- **Thanks to Greg Barolak** who served as a board member in 2013, and to everyone who contributed to the organization for the benefit of the membership.
- **Bylaws & Articles of Incorporation changes —** The HAS has been working to reestablish our non-profit status with Colorado County, where the HAS observatory and observing site is located. It's a long story, but we, as an organization must modify our bylaws and our Articles of Incorporation to specify that if the Houston Astronomical Society ceases to exist that any left-over property must go to a non-profit. Members will be asked to vote to accept these changes in order to avoid property tax. See the statements in this issue. Our bylaws say that in order to have a vote we must have 15% of our membership present. This is 66 members at our current membership level. I encourage you to come to the meeting so we can meet our quorum requirements. **The Board of Directors of the HAS supports the adoption of these changes.** Scott Mitchell had been working hard on behalf of the HAS to get this all worked out. Thanks very much to Scott for his additional contribution to the HAS.
- **Board meeting—** November 20, 7:00 p.m. at the Houston Arboretum in Memorial Park. Anyone can attend the board meeting, but only board members can vote on issues presented to the board.
- **Outreach committee —** Alan Rossiter has resigned from his responsibility as Outreach Committee leader. Thanks to Alan for his strong support of this effort. Our outreach efforts have increased substantially thanks to the leadership of Alan. **Bram Weisman** has stepped up to take on this responsibility. Bram recently completed the successful Camp for All event (October 11) and has been a participant in many other public star parties. Thanks to Bram for taking this on.
- Stephen O'Meara (*Astronomy* magazine), will be at our December 6 meeting to present on "Seeing the Impossible; The Unsolved Mystery of Saturn's Spokes"

Cheers,

..Bill Pellerin

President

November/December

Calendar

Date	Time	Event
November		
1	3:00 p.m.	Venus at greatest elongation east
	7:00 p.m.	HAS Novice Meeting, U of H
	8:00 p.m.	HAS General Meeting, U of H
2		Prime Night, Columbus Site
3	2:00 a.m.	Daylight Saving Time ends, Change clocks back 1 hour
	6:48 a.m.	New Moon
9	11:58 p.m.	Moon at first quarter
17		Leonid Meteors Peak
	9:15 a.m.	Full Moon
	8:00 p.m.	Mercury at greatest elongation west
	8:00 p.m.	C/2012 S1 ISON 0.38 deg N of Spica
20	7:00 p.m.	Board meeting
25	1:29 p.m.	Moon at last quarter
	7:00 p.m.	Mercury 0.31 deg SSW of Saturn
28		Thanksgiving Day
	5:00 p.m.	C/2012 S1 ISON at perihelion
30		Prime Night, Columbus site
December		
2	6:21 p.m.	New Moon
6	7:00 p.m.	HAS Novice Meeting, U of H
	8:00 p.m.	HAS General Meeting, U of H
9	9:12 a.m.	Moon at first quarter
13		Geminid meteors peak
17	3:28 a.m.	Full Moon
21	11:11 a.m.	Winter Solstice
22	3:00 p.m.	Ursid meteors peak
25		Christmas Day
	7:49 a.m.	Moon at last quarter
26	4:00 p.m.	Comet C/2012 S1 ISON nearest to Earth

Send calendar events to Doug McCormick - skygazer10@sbcglobal.net

For the latest information on club events, go to http://www.astronomyhouston.org/

Check the web site: www.astronomyhouston.org

The HAS website not only has news and information about our society, but also a variety of features to manage your membership and connect with other club members. Current members can post photos, trade gear, pay dues, manage discount magazine subscriptions, swap stories in the forum, and more.

Questions about the site? Need a hand to get your account set up?
Contact webmaster@astronomyhouston.org.

The HAS web site is the winner of the 2012 Astronomical League award for excellence.

Follow the *GuideStar* on Twitter at:

GuideStar_HAS

Join Facebook and look for:

Houston Astronomical Society

Starline

Call 832-go4-HAS0 (**832-464-4270**) for the latest information on the meeting and other information about activities within the HAS.

HAS Board Meeting

HAS Board meetings are scheduled regularly (see the calendar, above). All members are invited to attend these meetings, but only board members can vote on issues brought before the board.

Observations... of the editor

by Bill Pellerin, GuideStar Editor

December, brrrr

It feels odd to me to be seeing 'December' in the calendar section of the *GuideStar*. It seem like only yesterday that it was August and hot. As I write this, we're only about 6 weeks away from December, the holidays, the shortest day of the year, and so on. As much as I don't like being out observing with mosquitoes buzzing my ears (in the summer), I really dislike being cold. Nothing drives me away from the telescope like being cold.

What do I do? I have a ski suit that I bought at one of the sporting goods supply stores some years ago. The jacket consists of two pieces, an inner jacket and an outer jacket. I also have a pair of ski pants that I can pull on over my blue jeans and keep the lower half of my torso warm. I also have a (not yet used) Mad Bomber hat. I use gloves that have the tips of the fingers open so I can feel small parts (eyepiece screws, etc.) when I'm outside. The final piece of clothing I (sometimes) use is called 'moon boots' — very warm and furry inside and generally water resistant outside. Not good for doing a lot of walking, however.

I also use the chemical hand warmers, available from a sporting goods supply store. These are activated by contact with the air and they stay warm for several hours. I put them in the pocket of my jacket and put my hands in those pockets as needed to absorb the warmth. There are also chemical warmers for boots, but I haven't used them.

I must admit, as a native Texan, to being something of a wimp about cold weather. Folks who have lived in cold weather for a significant fraction of their lives seem to tolerate cold better.

That said, astronomy is a fairly sedentary activity, without much moving around. Getting up and going for a short, brisk, walk can help warm you up.

Take a break — this isn't an endurance contest. Go inside a warm space to thaw out and have a warm beverage (see Rene Gedaly's item in this *GuideStar*).

Another approach — (imagers only) — once you set up your telescope and camera and autoguider, etc., you can walk away from your setup and connect to your near-telescope computer from another computer (in a warm place). Some versions of Windows has this capability built-in and there's a lot of software you can find that provides this functionality. Assuming your 'warm-room' isn't far from your telescope, you can intervene if there are problems that require that you lay hands-on the setup. Otherwise, much, if not all that you want to do can be done from the 'warm-room'.

I heard of a guy who used a remote USB port device and moved his computer to his warm trailer. Using this remote USB capability he could control the telescope pointing, the imager, the guider, and the focuser.

Yes… doing one of these 'remote control' capabilities gets you out of the dark sky, but it also gets you into a warm place.

Until next time...

clear skies and new moons!

..Bill

Notice of Vote to Revise Bylaws and Articles of Incorporation -- 11/1/2013

Notice is hereby given that a resolution to amend the bylaws and articles of incorporation of the Houston Astronomical Society (HAS) will be presented to the membership for voting at the November 1, 2013 General Membership meeting. The purpose of the amendments is to help secure the tax exempt status of the HAS for county, state and Federal taxation. This notice has been sent to all members by email, been sent to list server subscribers by email, and has been posted on the HAS Web Site

Proposed Amendment to the Bylaws of the Houston Astronomical Society:

Article XIII: Upon the dissolution of the corporation, the distribution of all property in the corporation will be in the following priority in accordance with the Texas Business Organizations Code or its successor: [a] all liabilities and obligations of the corporation shall be paid, satisfied and discharged; [b] property held by the corporation on a condition requiring return, transfer, or conveyance because of the winding up, dissolution, or termination shall be returned, transferred or conveyed in accordance with that requirement; and [c] the remaining property shall be distributed only for tax exempt purposes to one or more organizations that are exempt under Section 501(c)(3) of the Internal Revenue Code or described by Section 170[c][1] or [2] of the Internal Revenue Code as provided in a plan of distribution adopted by the corporation under Texas Business Organizations Code.

Proposed Amendment to the Articles of Incorporation of the Houston Astronomical Society:

Article Nine
Article IX: Upon the dissolution of the corporation, the distribution of all property in the corporation will be in the following priority in accordance with the Texas Business Organizations Code or its successor: [a] all liabilities and obligations of the corporation shall be paid, satisfied and discharged; [b] property held by the corporation on a condition requiring return, transfer, or conveyance because of the winding up, dissolution, or termination shall be returned, transferred or conveyed in accordance with that requirement; and [c] the remaining property shall be distributed only for tax exempt purposes to one or more organizations that are exempt under Section 501(c)(3) of the Internal Revenue Code or described by Section 170[c][1] or [2] of the Internal Revenue Code as provided in a plan of distribution adopted by the corporation under Texas Business Organizations Code.

(Continued from page 17)

that such an encounter might explain the planet's highly elliptical orbit and the off-center debris disk.

But Mamajek thinks that such an encounter would also have had a good chance of disrupting the planetary system altogether. He instead suggests Fomalhaut was born in a sparse star-forming region that formed along molecular gas filaments, rather than in a molecular gas core.

Ultimately, Reipurth notes, there's no sure-fire way to know the prehistory of a specific object. Multiple formation scenarios will simply have to duke it out in theorists' simulations.

This content distributed by the

AAVSO Writer's Bureau

Just Looking

A *GuideStar* Interview by Clayton L. Jeter

John Hall— Glass Guy

I first met John Hall at the "South Texas Star Gaze" near Freer, Texas (this star party is no longer) in February 2006. John gave a talk there on optics, a topic that he loves and knows all about. John is the owner of "Pegasus Optics", he is known as one of the premier mirror makers here in the U.S.....or the world for that matter.

I have observed through hundreds of telescopes and you just can't beat a Pegasus mirror for a pristine view of the Cosmos. If you're building your own telescope, think Pegasus. You cannot go wrong. If your concerned about the quality of your own mirror, Let John test it and let him refigure the primary mirror for you. Stunning results!

Let's see what Mr. John Hall is all about.... (glass I bet). Here's John…

The John Hall bio…

John Hall was born in Arkansas, finished high school and college in Texas (BA in General Studies, University of Texas at El Paso.)

He worked for the Department of Defense and the General Services Administration until his retirement in 1994. His duties as a Quality Assurance Specialist included electronics, microelectronics, defense and aerospace programs in support of man-rated NASA programs. His career included collateral details such as metrology (the science of measurement applied to calibration systems), Management Information Systems, computer programmer/instructor, and supervisor of quality audits of major defense and aerospace supplier operations.

John was stationed in Asian countries as a Quality Assurance Specialist a total of eight years, and has certified fluency in Asian and European languages. (Chinese, Japanese, Spanish, etc.)

In 1989, John started a part time business in optical fabrication under the name Pegasus Optics. He has used various forms of test and measuring equipment and professional equipment in his optical work, including home-made lapping machines and auxiliary test equipment. He has fabricated and used interferometric and null test equipment, although his mainstay test is the modified Foucault test. John's business in optical fabrication went full time in 1994. He has made over a thousand mirrors in sizes through 30" aperture.

John became an avid astronomer and mirror-maker through his interest in observing and in making his own telescope optics. He has personally designed and constructed many telescopes through 28" aperture since his early childhood years, many of them of unique design. His design philosophy emphasizes portability and user-friendly features to facilitate the 'scopes adjustment and ease of use. As part of his retail optical business, John provides advice and assistance to purchasers of his telescope optics. He has also addressed amateur groups on ways to optimize optical performance.

John has three children and six grandchildren, who reside with their families in Tucson and Atlanta. John presently resides in Austin, Texas.

John's professional and leisure goals include continuing optical fabrication, traveling, and facilitating the advancement of amateur astronomy.

The John Hall interview…

Clayton: It's great John to have you here for this interview. Your Bio is quite impressive. Let's get to the interview…

When did you first peer into a telescope? Was this observation with a mirror that you had made? Can you remember what you observed?

John: I first looked through a 2" f/20 non-achromat (80" focal length) housed in a long mailing tube. I got it for 50 cents from a comic book ad, and the fact that I got it from a comic book should have been prophetic in itself, as its images were indeed comical and

(Continued on page 8)

(Continued from page 7)

as colorful as the comic book I bought it from (a Captain Marvel comic book, as I recall. Sha-zaam!). My second telescope was a 3" Edmund reflector I bought with paper route savings, and the next was a 4" mirror/scope I made in my pre-teen years, later followed by an 8" I made in my high school junior year. That bought me a lot of notoriety, and when the local astronomy group advertised that "John Hall of El Paso will speak on mirror making at UT El Paso" I expected that perhaps a handful of people would show up. To my surprise (and horror!) the hall was filled to overflowing with several hundred folks who wanted to know how anyone (particular 17-year-old like me) could make a telescope mirror. How times have changed! Incidentally, I stumbled through that presentation, thanks to my singular experience with public speaking provided through my Boy Scout Public Speaking merit badge. Bottom line: they started a mirror-making group, and quite a few folks succeeded in making their own mirrors. By then, I was enlisted in the U. S. Air Force, so unfortunately didn't get to see first light with them. (They mostly made 8" F/7 mirrors, like my own.)

Clayton: I usually attend 5 star parties each year. How about yourself? I'm thinking that by attending these various parties around the country, it might be good for your business. Your thoughts?

John: I occasionally get out with friends for a viewing session, and have enjoyed quite a few star parties around the country. I've only been observing once this last year, due to an illness earlier this year. The last time was just this past month, checking out a 24"F/3.9 reflector, which performed quite well. Undoubtedly it's true that showing up at star parties is about the best form of publicity for people involved in marketing astronomical products.

Clayton: Mirror test results are confusing. Can you describe a few of the most commonly used techniques and contrast them in terms of strengths and weaknesses?

John: I've used null tests, star tests, interferometry, Ronchi, artificial star, etc. The null test is only as good as the lens that produces it and the accuracy of spacing. Same for interferometry, which additionally includes (in nearly all versions of the predominant Fizeau test) a spherical reference element that also affects accuracy. Plus, astigmatic distortion induced by the supports must be subtracted through a computer algorithm from two orientations of the mirror. Most interferometrists do not use the interferometer in-process due to prolonged set-up time, and during parabolizing usually use a simpler test, such as the Foucault test or null test, reserving the interferometry for the final certification. The Foucault test is self-calibrating, since it has no reference elements, but the main objection to it is that it is more subjective and difficult to obtain accurate measurements, and dependent on operator experience to accurately gauge contrast between conjugate zones. It also does not sample all the mirror, but usually is partially covered by a mask or "pin-stick" whose inner and outer borders define the center of zones tested. The Ronchi test is not quantitative, although it is useful to visually gauge the mirror's freedom from zones. The knife-edge is very sensitive to mirror roughness and also to turned down edge, whereas interferometry is less sensitive to these defects.

The ultimate determination of mirror quality is the skill of the mirror maker more so than the method of test. Too many buyers of telescope mirror optics place far too much emphasis on wavefront spherical aberration as expressed by RMS, or peak-to-valley error, or Strehl ratio, etc. The over-all smoothness of an optic, or freedom from "zoniness," is a more important predictor of optical performance. There's much more I could add to this discussion, but that swamp is deep and wide, and we could get lost there…If anyone has additional questions, they can address them to me by phone or e-mail.

Clayton: There has been a dramatic change towards faster and thinner mirrors. What challenges do these present to the mirror maker? And what are the advantages and disadvantages for the end user?

John: The faster the mirror, the tighter the tolerance needed to produce a good-performing mirror. Prior to the availability of coma correctors and highly-corrected eyepieces, coma was a limiting factor, and mirrors faster than F/4.5 suffered noticeably from off-axis coma. Nowadays, as long as the mirror maker can make a precise parabola in faster f/ratios (e.g., F/2.5 – 4.5) then it's technically feasible to correct coma enough to produce a satisfactory image, although the effect of a large central obstruction (>.25) is a limiting factor in telescopes smaller than 20". (As the scope

(Continued on page 9)

(Continued from page 8)

gets much larger, the size of the diagonal doesn't grow proportionally as much.)

Clayton: I have recently heard the term of "Float" glass….just exactly what material is this?

John: Float glass is synonymous with plate glass, which is "floated" on a sheet of liquid during manufacture. It was the glass of choice of amateur mirror makers until the mid-50's, which Pyrex became widely available. Do not confuse float glass with "borofloat," which is a borosilicate glass, unlike plate glass, that has largely superceded "Pyrex" borosilicate, which is no longer manufactured by the Corning Company. Borofloat appears to actually be an improvement over the Corning-manufactured product in terms of homogeneity and ability to take a good anneal.

Clayton: I have been told that "Pyrex" glass is no longer produced. Any reason why? And if so, what glass material do you use to make your outstanding mirrors?

John: I still have some remaining Pyrex blanks on hand. I've made mirrors from glass ceramics, such as Zerodur and Astrosital, as well as plate (float) glass, crown and flint. My only source for new blanks is Borofloat, which is quite a bit pricier than the Pyrex I previously bought.

Clayton: What's your attraction to the night skies? Got a favorite object?

John: I'm torn between lots of really splendid objects, but I'd have to list the generic favorites M-51, the Lagoon Nebula, of course the Orion nebula and its Trapezium area stars, and of course I can't neglect the planets, particularly the giant planets with their moons, not to mention our own moon.

Clayton: How would you like to see your own astronomy grow?

John: I'd like to make a larger reflector (1M league) and popularize a particular unperforated Dall-Kirkham design that allows you to observe in a seated position without resorting to a really short f/ratio. The design features a low-magnification spherical secondary with a tertiary that directs the light out the side of the scope like a Newt. Since the compound f/ratio is about F/6 – F/7, and a conventional tunable coma corrector helps to reduce residual coma, this combination is appealing to me and should be popular once it catches on. The secondary obstruction, particularly with 1-meter+ scopes is about 25%. I made such a telescope primary (25") for Ed Villareal in San Marcos, with an 8" secondary made elsewhere, and he should be rolling it out for first light when the scope is complete later this year.

Clayton: I'd like to know a little about your personal telescope(s). I'm sure you're a fan of the Newtonian but what are your thoughts on the Schmidt Cassegrain or Refractor design?

John: My personal telescopes in the past included a 20" F/3.7, a 24" F/5, 28" F/4 and a slew of other scopes that I made, used and later sold. I used to star-test each mirror after completion and before coating many years ago, and for that purpose I made a "test-bed" telescope that would accommodate different mirror sides with minor modification, and I had an assembly of top ends for different diameters. Additionally, I've made more telescopes than I can count, but the gross number is over 100, possibly approaching 200.

Schmidt-Cassegrain telescopes provide a remarkable value and functionality in a compact package, and with the benefits of mass-production and market competition, they're accessible to most amateurs, although pricier than Newtonians.

Refractors, particularly multi-element refractors including apo's, deliver pristine images, although the price-per-photon is beyond the reach of most of us, and you really need an aperture beyond 8" (that pretty much excludes refractors!) to get the resolution (since it's proportional to aperture) that most astronomers want.

Clayton: Tell us a bit about your world travels….any observing from overseas? Been to Vietnam? Met any mirror makers in the orient?

John: I've traveled to just about every country in SE Asia early on, including but not limited to Vietnam and its neighbors, both pre-Vietnam conflict, during the war, and was stationed with the U. S. Embassy there after the war in what was then known as Saigon for two years. I was also stationed in Okinawa, Taiwan, Japan, and Korea, and traveled to the Philippines and many Pacific Islands. I did my Asian Studies post-graduate work at the Manoa Campus of U. of Hawaii. In recent years I've made multiple trips to China for a total time of about 3 months. One of the benefits of living and traveling in the areas I've visited is that I've learned at least a smattering of the local languages, and was/am passably fluent in Japanese and

(Continued on page 10)

Kids Outreach & Public Star Parties

By Bram Weisman, coordinator

Name: Hyde Elementary School Family Science Night
Date/Time: 12/10/2013 5:30 PM - 7:30 PM
Type: Star Party during school Family Science Night. School will be having other science related information, activities, and science fair awards.
Number of visitors expected: 300
Location: Hyde Elementary School, 3700 E. FM 518 (Deke Slayton Hwy), League City, TX 77573

Name: The Houston Arboretum ISON Comet watching
Leader: Bill Flanagan
Type: Mostly Adults – Arboretum Members. A morning at the Arboretum
Date: Saturday MORNING, 12/14/2013
Time: 5:00 – 8:00 AM
Location: Houston Arboretum, 4501 Woodway Drive

Details – especially times – are subject to change

(Continued from page 9)

Chinese (Mandarin) in which I have a certificate of advanced written and verbal proficiency.

I haven't observed overseas, although I've met a few Chinese amateurs, and on a fairy recent trip to Suzhou I met with a professional group for a dinner – what a feast! -- and had an interesting conversation with them about traditional/ancient Chinese astronomy. amateur astronomy, however is not as popular in Asia as it is in most parts of the globe. I left with a lot of souvenirs and books from that trip, mostly in Chinese. I still peruse them and remember the people who provided them.

Clayton: Do you have any helpful advice to pass on to mirror makers just starting out in this hobby?

John: By all means find a local group that is active in observing, and hopefully, in one form or another, mentors its membership or offers some challenge and goals, such as a Messier List, etc. certificate. Talking with like-minded amateurs and professionals and sharing your observing interests is the most stimulating way to advance in your knowledge of and enjoyment of the hobby. Go to all the star parties you can, the friendships you make can last a life-time. I wish amateur mirror-making were more popular, simply because that one of the most fun things you can do, and gives a person a feeling of accomplishment, bragging rights and satisfaction that is hard to match. Go there, and get the T-Shirt! <Smile>

Clayton: Is there an email address that you have that a Houston Astronomical Society member could contact you for an additional question or two?

John: Yes, at Pegasus Optics, web site at http://www.pegasusoptics.com. Or contact at halljhn1@att.net or telephonically at (210) 560-5724.

Clayton: Thanks John for taking the time to share your interest and thoughts within our HAS newsletter, the *GuideStar*. We wish you luck with all of your astronomy interests. Please come visit our society when in the Houston area, we'd love to see you.

John: It's an honor and a pleasure to have this interview with you. Thank you for this opportunity, and I wish you and your club members the best. I'll look forward to meeting with your society next time I'm in Houston.

Clayton: Clear skies always

John: That's my favorite farewell – Clear Skies!

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*Clayton is an avid SCT visual observer and a longtime member of the **H**ouston **A**stronomical **S**ociety. Contact him at: stonebloke@gmail.com*

Seeing Doubles

How Observing Double Stars Advanced Astronomy

By Don Selle, Observatory Chair

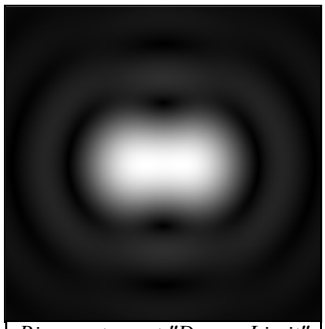
There is no doubt that double star observing is a favorite activity of many amateur astronomers. Double star observing has most of what it takes to keep us coming back again and again.

Many double stars are some of the most beautiful objects in the night sky. They are well distributed on the sky, ensuring that many interesting pairs are available to be observed all year round, and many are accessible to smaller scopes from a suburban backyard. Really dark skies are not required for most double star observing, though a darker sky can enhance your view

Pretty double stars are excellent targets for outreach events. Most veterans of public events will be prepared to show off one or more pairs to the public. As inevitably happens, partly cloudy skies can threaten to disappoint attendees, and pretty bright double stars can help save the day. Next to the Moon Saturn and Jupiter, colorful double stars like Alberio are relatively easy to find and many can still be observed if thin clouds get in the way.

Albeiro

Double star observing can also be a major challenge, both of the optical quality of your telescope as well as of your visual acuity. There is nothing better than a close double to demonstrate how well your objective is figured or how well your scope is collimated. English astronomer W. R. Dawes (1799 – 1868) used double stars to test the resolving power of various telescopes. His empirical formula, 4.56/D, typically known as the "Dawes Limit" describes the minimum angle in arc seconds (1 degree = 3600 arcsec) that can be resolved in a telescope of diameter D inches. It turns out that this is a pretty good match to the theoretical diffraction limit derived mathematically by English Nobel prize winning physicist Lord Rayleigh (1842-1919) nearly 50 years later.



Binary stars at "Dawes Limit"

The term double star refers to two stars which are in the same line of sight and which may or may not be close together. Optical doubles share the same line of sight and appear to be close together but in fact are independent from each other and may be very far apart. A good example is the naked eye double star Alghedi in Capricorn. This pair of class G stars (similar to our sun) have apparent magnitudes of 3.6 and 4.3 and are separated by about 6.5 arc minutes in the line of sight. Though close together on the sky they lie 108 and 686 light years from earth, and are clearly independent of each other.

Binary stars are stars that are gravitationally bound to each other. Some binaries are so close to each other that as they orbit their common center of mass, they literally touch, with the larger star of the pair pulling hot gas away from the smaller. Typical binaries though are separated by several light years.

There are several types of binary stars, which are distinguished by the way they have been discovered. Visual binaries, like Alberio, are both visible to the naked eye or in a telescope as two distinct stars. It is their common distance or proper motion on the sky are what tells us that they are bound together.

Astrometric binaries cannot be separated visually, but close observation of the primary star shows a wobble in its proper motion as it moves slowly across the sky. This wobble is caused as it orbits the center of mass of the two stars, pulled out of a straight line by its unseen secondary. Sirius (aka the dog star) was the first astrometric double star discovered, when this motion was measured in by Frederick Bessel in 1844.

Eventually Sirius's very dim secondary was observed in 1862 by telescope maker Alvin Clark as he was testing a new 18.5 inch refractor. Much later, the small companion to Sirius would be recognized as the first of a new type of star, a white dwarf. Clark nick-named the companion star "the pup", and it remains a challenging target for amateur astronomers today, due to the extreme difference in the brightness of the two stars. The "pup" is well positioned to

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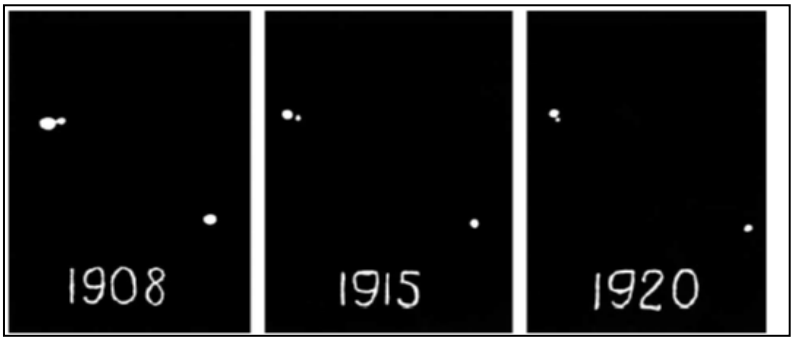
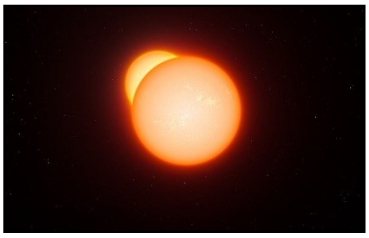
be observed this winter.



Binary Star - Yerkes Observatory Photo as published in Fundamental Astronomy Springer

Sometimes we are fortunate enough that the plane of the orbit is in the line of sight towards Earth. As the stars orbit each other, they will pass in front of one another. As they do, the total brightness of the pair varies in a very specific way. Such binaries are called eclipsing binaries and the way in which the total brightness varies (known as their light curve) can tell us about the size of the stars themselves.



Eclipsing Binary

Spectroscopic binaries are stars that cannot be separated by a telescope. They are detected when changes in the spectrum of their light are measured over a period of time. These changes are due to the orbital motion of the primary star, caused by its invisible companion star. As the speed of the primary's motion changes relative to the Earth, this "wobble" causes a Doppler shift which is measured in the spectrum of the brighter visible star.

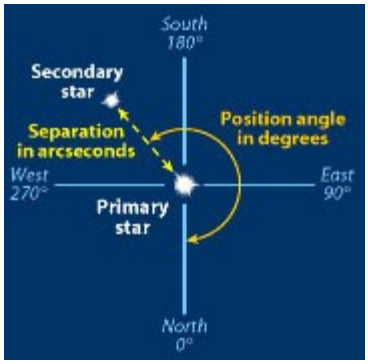
Though not the first to observe double stars, William Herschel was the first astronomer to systematically observe them over many years. Like Galileo before him, Herschel realized that double stars could be a convenient tool for measuring stellar parallax, a means for measuring the distance to the stars.

Herschel hoped to find several good pairs of stars that would allow him to measure the parallax of the brighter star, as the Earth traversed its orbit. Parallax would cause the brighter star to appear to move relative to the dimmer more distant star. Towards that end, he began to catalog any double stars he noted in his 'sweeps' of the night sky . Though he would never detect a measurable parallax, his observations over a 39 year period would lead Herschel to several other key discoveries.

Because he was such a careful observer, in 1783 Herschel noticed that Castor and its dim companion had the same proper motion. He did not however connect this combined motion to the fact that the two stars were bound together by their mutual gravity, but rather attributed it to the motion of our solar system.

By 1802 Herschel noted that several of his pairs of stars changed their positions relative to each other, as if they were orbiting each other. Over the next two years, he presented this proof to the Royal Astronomical Society, based on fifty pairs of double stars measured over 25 years, and declared that some double stars were indeed orbiting each other bound by their mutual gravity. He also calculated approximate orbital periods for several pairs, including a period of 342 years for its smaller companion to orbit Castor.

Herschel also realized that these binary stars were for all intents, located the same distance from Earth. This meant that that differences in the brightness of gravitationally bound double stars was not due to the differences in their distances from us, but due to differences in the actual brightness of the stars themselves. He thus opened the way for further study and understanding of the nature of stars.



Measuring a Binary Star - Sky and Telescope illustration

Herschel was the first to catalog double stars. Starting with his first catalog of 269 double stars in 1782, Herschel would discover and catalog 806 double stars each carefully measured several times over the years, with most having the distance of separation and the position angle of the companion star recorded.

(Continued on page 13)

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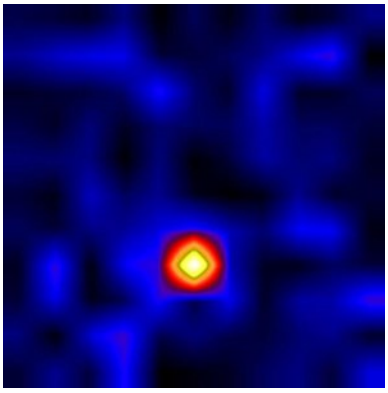
Astronomers since Hershel have discovered and cataloged many tens of thousands of double stars. In fact it is currently estimated that as many as 3 out of 4 stars are part of binary or multiple star systems. It turns out that this is a very fortunate thing for our understanding of the stars.

During the mid 19th century, Herschel's pioneering work sparked interest in double stars with many of the prominent astronomers of the day picking up the torch from him. By the last decades of the 1800s, observing and measuring binary stars became a major focus of astronomical research. Because this activity was accessible to the owners of smaller telescopes, even amateurs began observing and measuring binary stars as a primary activity, and this practice continues today (see for example http://www.skyandtelescope.com/observing/objects/doublestars/3304341.html.

During the last decades of the 19th century, astronomy was going through a major change, as the "New Astronomy", what we now call astrophysics, was starting to come into prominence. The advent of stellar spectroscopy and astrophotography in the mid 1870s was the driver.

With these tools, it became possible to measure the stars, intrinsic brightness, their temperatures, chemical compositions how far away from us they are and the speed at which they traveled through space. But in order to tie all of this information together into a theory of how stars work, how they form and evolve, astrophysicists need to know how big the stars are, their masses and their diameters. It was the observation of binary stars that added this data for the astrophysicists to use.

The observation of binary stars played a key role in the development of astrophysics. By observing binary stars over the course of many years, it is possible to make sufficient measurements so that a calculation of their orbits can be made, even if the orbital period is very long. Once the orbit has been calculated, adding the known distance to the stars (typically measured by the parallax method) it is possible to calculate the mass of the stars. In addition, if the stars are eclipsing binaries, it is also possible to determine the diameters of the stars as well.



This X-ray image of Cygnus X-1 was taken by a balloon-borne telescope - NASA Image

This is the only way to directly measure the mass and diameter of stars. Without this data, stellar astronomy would be an inexact science, able to describe stars and their lives only in relative terms or with estimated values.

Observation of binary stars has not been confined to stars in the prime of their lives but has also extended to the end of their lives as well. In 1964, during a rocket flight designed to measure X-rays, one of the strongest X-ray sources in the sky was discovered and named Cygnus X-1. Over the next few years, continued study of this X-ray source would lead to the consensus that this was a compact source orbiting a blue supergiant star. By 1973, there was strong consensus that the compact source was in fact a stellar mass black hole – the first black hole that had ever been directly observed.

In 1974, the first binary pulsar was discovered by Joseph Taylor and Russell Hulse. Their observations showed that the pulsar's frequency changing in a very regular way. The astronomers would eventually conclude that the pulsar was actually part of a binary system and that the companion to the pulsar is a neutron star with an almost identical mass.

Measurements of this binary pulsar would allow the astronomers to very accurately confirm Einstein's theory of General Relativity. Their mass and rotational speed make pulsars the only real tools that astronomers can use to test Relativity. Continued measurement of this pair over several years showed that the orbital period of the pair was measurably slowing down. Relativity predicts that the orbital period of two neutron stars in a binary pair should slow down as orbital energy is radiated away by gravitational waves. This is exactly what Taylor and Hulse measured and for their work they received the Nobel Prize for physics in 1993.

Not only have end of life binary stars been useful for testing General Relativity, but they have been used to probe the depths of our universe. Type 1a supernova are formed by a binary pair of stars, one a

(Continued on page 14)

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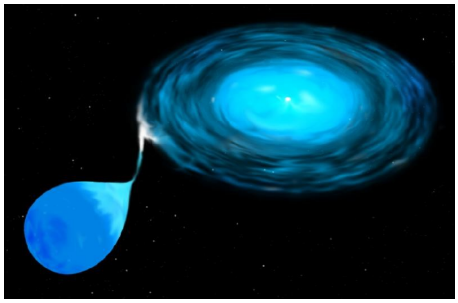
white dwarf, and one that is thought to be a supergiant star. As the orbit of the two stars spirals them closer together, the white dwarf will eventually begin to steal gas from the outer envelope of the degenerate supergiant star.



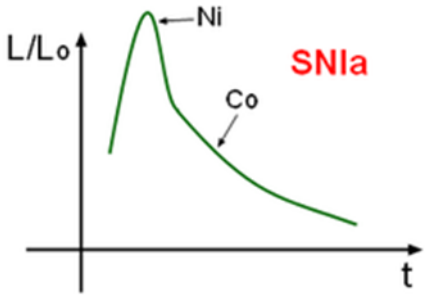
White dwarf accreting mass from its supergiant companion - NASA Image

The added gas on the outside of the white dwarf increases its mass, and causes the outer layers of the dwarf to heat up dramatically. At some point, the outer portion of the white dwarf becomes so hot and so massive that a thermonuclear reaction is triggered. It quickly grows more intense, as the white dwarf is unable to shed the increasing energy generated.

Finally the nuclear fire begins to run away, in a reaction which continues to grow quickly larger until the white dwarf explodes as a supernova. In a matter of seconds, the explosion consumes all of the gas on the exterior of the white dwarf, generating more energy than the entire galaxy it resides in.

The fact that supernovae are such energetic and bright events was not lost on two teams of astronomers who were hoping to probe distances in the universe that had not been able to previously measure. It turns out that Type 1a supernova all have a very similar light curve as the explosion occurs, the hot gases expand and begin to cool, glowing less brightly. This has made them a perfect "standard candles".

Both teams, the High Z Supernova Search Team, and the Supernova Cosmology Project would use these standard candles to probe long distances and far back into the history of our universe. In 1998, the High Z team published observations indicating that the expansion of the universe, once thought to be at a constant rate throughout time, was actually accelerating. In 1999, the SN Cosmology Project would confirm the observations and the fact that a "Dark Energy" exists (the nature of which is still not known) and is driving this acceleration. For their work, the leaders of these two teams, Brian Schmidt and Adam Reis of the High Z team and Saul Perlmutter of the SN Cosmology Project, would share the 2011 Nobel Prize in Physics



The fact that so many stars formed in binary or multiple systems, has been a great advantage to the science of astronomy. These stars have yielded a great wealth of information that has helped us understand the cosmos.

When we observe double stars, we are following in the footsteps of some of the greatest astronomers in history, who unlocked this information. Understanding this legacy makes these night sky wonders just a little bit more beautiful, and adds to the sense of awe we all get from observing our cosmos first hand.

Editor's note:

You can still contribute to double star science by contributing to a database of double star observations. These observations are for the purpose of confirming the Dawes limit (mentioned in this article) and determining the ability to split double stars of unequal magnitude. Information on the project is at this URL:

http://www.billboublitz.com/Haas_Project/hbsop_index.html

Another of Bob's Legacies

By Rene Gedaly

Warm your hands at the HAS Observatory & Dark Site

Some time back, Bob Rogers and I got into a discussion about the use of the dark site, or more precisely, the lack thereof. We recounted times that we'd been either the sole observer or one of only two or three observing on a clear, moonless night. What a shame. Bob, our previous observatory director and whose passing was way too soon, was understandably concerned. There are many reasons, and many people, instrumental in turning that around—not least of whom was Bob—and if you are a new member, fear not about observing alone on a designated HAS prime night.

It's hot chocolate time at the HAS dark site—and coffee, tea, and hot cider, too!

In addition to the good company you'll find there, you may also be pleased to know that now that the evenings have lengthened and the night air has cooled, you can stay warm with a cup of coffee, tea, or hot chocolate from our dark site beverage bar. Available most prime nights, you'll find the beverage bar in front of the Dob shed, south side. Pour yourself a cup and talk shop with another member.

And when you do take a sip from that first cup of joe, think about Bob. He was instrumental in making sure we observers could warm our cockles over good conversation and a piping hot beverage. Here's lifting one to you, Bob.

Rene

Novice Presentation November/December, 2013

Professor Comet / Novice Graduation

By Debbie Moran

The Novice presentation in November will be a talk by Justin McCollum, our own Professor Comet, which I will call "Everything You Always Wanted to Know About Comets But Were Afraid to Ask," or "Comets" for short. Comet ISON will be nearing our neighborhood soon, but may not meet its promise. But whether it is naked eye or needs a little help, this talk will prepare you to observe this and other comets in the future. Learn how to find and recognize comets in the telescope, know their component parts, origins, orbits, how they are discovered and named. I will be unable to attend this meeting myself, but will leave you in Justin's capable hands. He spent many years as Novice chairman himself.

For December, I would like to do a program called Novice Graduation. I will be seeking novices from the last year or so who would like to report on their adventures in stargazing, telescope shopping, imaging or public outreach. Let us know what objects became your favorites, what observing lists you may have tried, how you decided on any equipment you may have purchased, what problems you solved. We have new novices waiting to hear what you learned. This will bring us full circle to repeat some basic principles in January again for the next crew.

Observatory Corner

By Mike Edstrom, Observatory Committee Chairman

Hello,

Have you ever heard the saying "I've got good news and bad news"? Well I have them, first the drilling is finished at the site North and East of the Dark Site. Now for the bad news, there's another well being readied for drilling to the North and West of the site so it looks like another 6 – 8 weeks of noise and light pollution. We'll know more once the drilling starts.

One Scout Troop survived the wet weather during their visit to the site and it appears the troop that visits later in the month will have better weather. Their service projects sure help the site.

The electrical lines for the private observatories are being installed and will be finished before this article is published. We have 5 of the 12 spots committed and 5 more people interested in a pad. If you are interested in a plot please contact Ed Fraini, Don Selle, Steve Goldberg or me. We have an opportunity to construct a concrete pad or wooden deck if you want to install a dome at a reasonable price but with a small amount of sweat equity.

As a safety reminder please read the sign posted on the side of the metal building at the Dark Site which has directions to the hospital and contact information for the sheriff's department it also has the address to the site in case of a medical emergency.

And the Work Goes On...

I **need** to remind everyone that we need to start filling out Log Reports at the site so I can give this information to the Fondren Foundation. The property is on a 99 year lease and part of the Lease agreement is that HAS needs to report every year to the Fondren Foundation that the property is being used. The Log Reports are located in the box in the middle of the field. Just open the cover, fill out the report and then slide it into the slot that is in the inside of the cover and then close the box. It is very important that everyone fill out a Log Report so that we are showing that the Observing site is being used. Your help on this is very much appreciated.

If you have a Randalls card, and have not done so, please have it coded for the Houston Astronomical Society. Our number is #6618. The Society gets 1% of the gross sales that member spends at Randalls. Randalls totals up the amount spent each quarter and will send us a check if the amount goes over $2,500, otherwise the total roles over to the next quarter of zeros out at the end of the calendar year. So please link your Randalls card to the Houston Astronomical Society so that the society can benefit from this Randalls program. Our number is #6618. This is very easy to do, just go to the Courtesy Booth and tell the person there what you want to do.

If you have any suggestions or thoughts for the site, please let me know.

Thank you,

Mike Edstrom

medst22531@msn.com

Fomalhaut Star System Actually a Triple

By Monica Young, Sky & Telescope, www.skyandtelescope.com

Turns out "the lonely star of autumn" has not just one, but two distant companions, making it one of the most widely separated systems known.

Fomalhaut, *Piscis Austrinum*'s brightest star, is an odd fish. Fomalhaut itself is a regular *A*-class star, twice the size of the Sun, accompanied by a smaller, *K*-class companion. The system made headlines in 2008 when astronomers discovered the controversial exoplanet candidate Fomalhaut b. Even after the dust mostly settled, the planet's highly elliptical orbit remained unexplained.

It's unclear whether the planet's orbit is aligned with the far-out debris disk that rings the young star. And stranger still, the debris disk itself is off-kilter, its center offset from Fomalhaut A by 15 times the Earth-Sun distance.

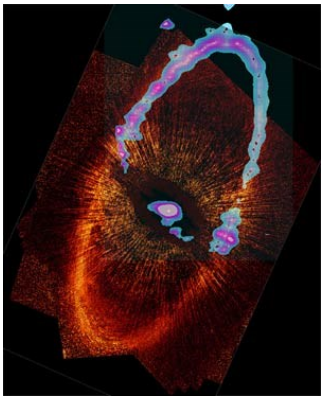
An artist's illustration of the disputed exoplanet Fomalhaut b. The planet might be sweeping out the edge of a massive ring of dust around the young star.

ESA / NASA / L. Calcada

Now Eric Mamajek University of Rochester and Cerro Tololo Inter-American Observatory, Chile) and his colleagues are adding a piece to the puzzle as they announce the discovery of another companion star, dubbed Fomalhaut C, in a study to be published in the *Astronomical Journal*. Though the star was first catalogued in 1980, this is the first suggestion that it might be bound to Fomalhaut.

"I'm just amazed that a 12th magnitude (not terribly faint as things go) companion to a very nearby star could have been missed for this long," says Mamajek.

In this case, "companion" is a term best applied loosely. The red dwarf star lies 2.5 light-years from Fomalhaut A (and 3.2 light-years from Fomalhaut B), making the stars one of the most widely separated systems known, wider than both the Alpha Centauri and Alcor-Mizar systems. From our point of view, Fomalhaut A and C lie 5.7° apart in the night sky, the equivalent of 11 full Moons.



The Hubble Space Telescope and ALMA reveal Fomalhaut's off-kilter debris disk, offset by 15 a.u. from the star, which is blocked out in the middle. Click on the image to see the candidate planet Fomalhaut b.

HST: NASA, ESA, P. Kalas, J. Graham, E. Chiang, E. Kite (University of California, Berkeley), M. Clampin (NASA GSFC), M. Fitzgerald (LLNL), and K. Stapelfeldt and J. Krist (NASA JPL); ALMA: Boley et al. / ApJL 2012

Huge separations make it extremely difficult to prove that stars in such systems are gravitationally bound, says Bo Reipurth (University of Hawaii). "The motion is small, the binding energy is minuscule, and the errors on the measurements are sometimes significant," he explains. "There is no such a thing as the 'widest known binary,' just a lot of more or less good candidates."

Mamajek and his colleagues pinned down the stars' exact movements by watching their proper motions (their travel across the night sky) using data collected as part of the Research Consortium on Nearby Stars, as well as by measuring their spectral lines to catch the telltale Doppler signature signifying movement toward or away from Earth.

Origins

Widely separated binaries such as Fomalhaut challenge theories of star formation, because the systems' stars lie farther apart than the size of most molecular gas cores, in which stars form.

So Reipurth suggests an alternative scenario for Fomalhaut C: an encounter of the third kind. Earlier in the system's 440-million-year-old history, Fomalhaut C might have orbited A more closely, until an encounter with another object ejected it into a far-out orbit. That third object couldn't have been Fomalhaut B, Reipurth notes: it would have had to be a star in a tight orbit that eventually spiraled into Fomalhaut A. Reipurth speculates

(Continued on page 6)

Shallow Sky Object of the Month

Alpha Capricorni—Algedi

Object: Alpha (α) Capricorni

Class: Easy double star

Constallation: Capricornus

Magnitude: α^2, 3.6; α^1, 4.3

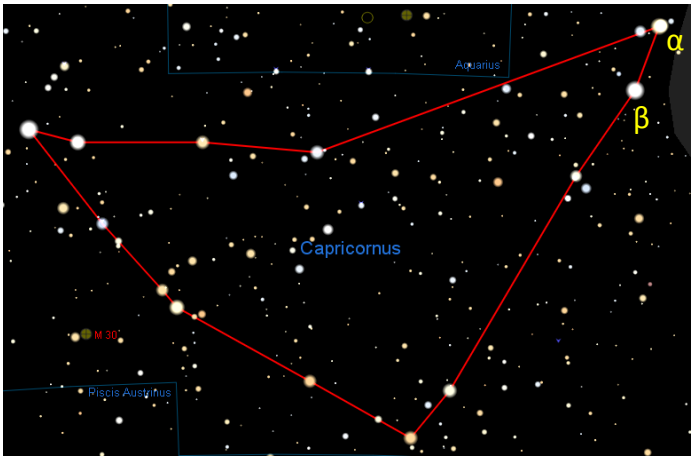
R.A.: 20 h 18 m 03 s

Dec: -12 deg 32 min 41 sec

Size/Spectral: α^2, G8; α^1 G1/ 6.6 arc minutes

Distance: α^2, 109 ly; α^1 690 ly

Optics needed: Unaided eye, binoculars or small telescope



Why this is interesting

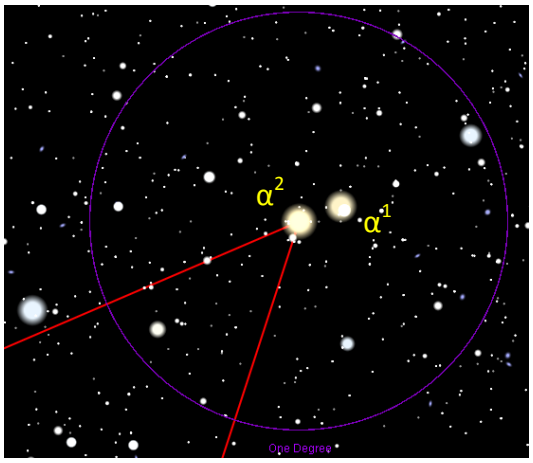
I've seen the constellation Capricornus many times; it requires a reasonably dark site to see the it, however. The star of interest for this article, Alpha, transits about 17:00 local time in mid November and sets at about 22:30. So it's well positioned for viewing during the early evening. It'll be in the western sky during the evening, so look for this double star as soon as the sky darkens enough for you to pick it out.

The constellation name represents a 'sea goat' — whatever that is — purported to be half goat, half fish. It looks like a boat, perhaps, to me and is relatively easy to pick out in the sky.

Alpha is the westernmost star system in the constellation, but not the brightest star in the constellation, as the name would have you believe; it's the third brightest star. It turns out that α^1 is actually the more luminous star (930 times as luminous as our sun) and would be substantially brighter than α^2 (43 times as luminous as our sun) if the stars were the same distance. So, α^1 is about 22 times more luminous than α^2. Luminosity is a measure of the intrinsic brightness of the star, independent of distance. More precisely, luminosity is a measure of the total power output of the star measured in watts. The Sun has a power output of 3.846×10^{26} watts. No dim bulbs here.

Double star observers know that there are optical double stars and actual double stars, where the components of the system are gravitationally bound to each other. Alpha is an optical double star, with the two components at considerably different distances from us (see above), and not gravitationally bound. Sharp eyed observers will be able to split this double with no optical aid; everyone else will be able to split the double with any pair of binoculars you have at home. At 6.6 arc-seconds separation the distance between the two stars represents about 1/5 of the distance across the moon.

Bonus: β Capricorni, also called Dabih, is also a double star, but you'll need optical aid to split this one. The two stars are 3rd magnitude and 6th magnitude, easily visible in the smallest of telescopes, though the



Alpha Capricorni

The circle is one degree on the sky.

Star chart generated by TheSkyX © Software Bisque, Inc. All rights reserved. www.bisque.com

6th magnitude star may be difficult from the city. They're 3.5 arc-minutes apart so very easy to split. (Albireo's components are only 35 arc seconds apart.) Unlike α, these stars are gravitationally bound to each other so this is not an optical double.

Parking at the University of Houston Main Campus

For the monthly Houston Astronomical Society Meeting

The large-scale map at the right shows the location of the 15F parking lot, on the west side of Cullen Boulevard.

The detail map (below) was provided by the University of Houston Parking department to define the area that is available for parking while attending the Houston Astronomical Society monthly meeting. This parking is available from 6:30 p.m. until 10:00 p.m. on the Friday night of the HAS meeting (usually the first Friday of the month).

This parking is free. If you get a notice from the UH campus police on the night of the meeting, call the UH Security office and let them know that this area has been made available on HAS meeting night by the Parking Department.

From Google Maps

Houston Astronomical Society

P.O. Box 20332

Houston, TX 77225-0332

General Membership Meeting

The Houston Astronomical Society holds its regular monthly General Membership Meeting on the first Friday of each month, unless rescheduled due to a holiday or a conflict with other events at the University of Houston.

Board of Directors Meeting

The Board of Directors Meeting is held on dates and at locations scheduled by the board. Information provided to *GuideStar* will be published. The meetings are open to all members of the Society in good standing. Attendance is encouraged.

***GuideStar* Information**

The H.A.S. *GuideStar* is published monthly by the Houston Astronomical Society. All opinions expressed herein are those of the contributor and not necessarily of Houston Astronomical Society. The monthly Meeting Notice is included herein. *GuideStar* is available on the HAS web site to all members of H.A.S., and to persons interested in the organization's activities. Contributions to *GuideStar* by members are encouraged. Electronic submission is helpful. Submit the article in text, MS-Word format via email BillPellerin@sbcglobal.net. Copy must be received by the 15th of the month for inclusion in the issue to be available near the end of the same month. Or, bring copy to the General Membership Meeting and give it to the Editor, or phone to make special arrangements.

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The Houston Astronomical Society welcomes you to our organization. The HAS is a group of dedicated amateur astronomers, most of whom are observers, but some are armchair astronomers.

The benefits of membership are:

- Access to our 18 acre observing site west of Houston -- a great place to observe the universe!
- A telescope loaner program -- borrow a HAS telescope and try observing for yourself!
- A monthly novice meeting, site orientation meeting, and general meeting with speakers of interest.
- Opportunities to participate in programs that promote astronomy to the general public (such as Star Parties at schools)
- A yearly all-clubs meeting for Houston area organizations
- Meet other amateurs and share experiences, learn techniques, and swap stories

You're invited to attend our next meeting.

You'll have a great time.

Houston Astronomical Society

Meeting on Friday, November 1, 2013

7:00 Novice Meeting, room 116 Science & Research 1 Bldg

8:00 General Meeting, room 117 Science & Research 1 Bldg

University of Houston

Directions to meeting:

From I-45 going south (from downtown)

- exit at Cullen Boulevard
- turn right on Cullen
- turn right into the parking lot (past the parking garage)
- Science and Research is across the street (2nd building back)

From I-45 going north (from NASA/Galveston)

- exit at Cullen Boulevard
- turn left on Cullen
- turn right into the parking lot (past the parking garage)
- Science and Research is across the street (2nd building back)

Parking:

There is Free Parking**. See Parking map and detailed information on parking on the preceding page.**