Vol. 52, no. 5

The W.A.S.P.

May 2020

The Warren Astronomical Society Paper

W.A.S. Meetings Go Online

Our members step up and keep meetings going during these difficult times.

Experimenting with various chat apps, like Discord and Webex, we continue to hold meetings during social distancing, live-streaming the meetings on YouTube.

Even our “Open House” event at Stargate is now online, hosted by the Northern Cross Observatory (and Doug Bock does take requests.)

The WASP

Published by
Warren Astronomical Society, Inc.
P.O. Box 1505
Warren, Michigan 48090-1505

Dale Thieme, Editor

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The Warren Astronomical Society, Inc., is a local, non-profit organization of amateur astronomers. The Society holds meetings on the first Monday and third Thursday of each month, starting at 7:30 p.m.

First Monday meeting:
Cranbrook: Institute of Science
1221 North Woodward Ave
Bloomfield Hills, Michigan

Third Thursday meeting:
Macomb Community College
South campus, Bldg. J, Room J221
14600 Twelve Mile Rd.
Warren, Michigan

Membership and Annual Dues

Student	Individual	Senior Citizen	for families
$17.00	$30.00	$22.00	add $7.00

Astronomical League (optional)$7.50

Send membership applications and dues to the treasurer:
c/o Warren Astronomical Society, Inc.
P.O. Box 1505
Warren, Michigan 48090-1505
Pay at the meetings
Also via PayPal (send funds to treasurer@warrenastro.org

Among the many benefits of membership are
Loaner telescopes (with deposit). See 2nd VP.
Free copy of each WASP newsletter.
Free use of Stargate Observatory.
Special interest subgroups. See chairpersons.

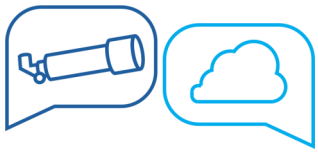
The Warren Astronomical Society Paper (WASP) is the official monthly publication of the Society.
Articles for inclusion in the WASP are strongly encouraged and should be submitted to the editor on or before the end of each month. Any format of submission is accepted. Materials can either be transmitted in person, via US Mail, or by email (publications@warrenastro.org)

Disclaimer: The articles presented herein represent the opinion of their authors and are not necessarily the opinion of the Warren Astronomical Society or this editor. The WASP reserves the right to edit or deny publication of any submission.

Stargate Observatory is owned and operated by the Society. Located on the grounds of Camp Rotary on 29 Mile Road, 1.8 miles east of Romeo Plank Road, Stargate features an 8-inch refractor telescope under a steel dome. The observatory is open according to the open house schedule published by the 2nd VP.

Snack Volunteer Schedule

The Snack Volunteer program is suspended for the duration. When it resumes, volunteers already on the list will be notified by email.



Discussion Group Meeting

Come on over, and talk astronomy, space news, and whatnot!

In This Issue:

President's Field of View

The night was clear and calm and tolerably warm for earliest April in Southeastern Michigan. The stars of the Winter Hexagon, a resurgent Betelgeuse at their center, glittered through the still-naked branches of maple trees. Yet those jewels of the first magnitude had competition, as to the west the Evening Star outshone them all as the mighty Cullinan overpowers the storied balas rubies and sapphires in Her Majesty's crown. It blazed like a shard of mirror aimed at the sun, which is in essence what Venus is, and appeared to boast eight projecting rays— just as the Old Babylonians drew their Star of Ishtar. The unaided eye could perceive a shimmer of starlight around the planet. Venus, in conjunction with the Pleiades for the first time in eight years, had just passed through the Seven Sisters as though it were the Lost Pleiad come home in splendor. It was a perfect moment for sidewalk astronomy.

And yet, I could not ask a single person to look through the eyepiece. Not the right-hand neighbor as he stepped out for air or the left-hand neighbor as she saw us from the porch. Not the young couple out for a nighttime stroll who were debating, loudly, the nature of the scintillating object in the western sky. Not the couple out walking their dog, who passed us by at a safe distance.

Plague deprives us of myriad small pleasures along with the greater harms it inflicts, and the simple joy of inviting a stranger to look through the eyepiece of a telescope is now morally and legally untenable. At best, we could shout at our neighbor in her haven on the enclosed porch, just as I later reported to her the progress of the ISS as it too made a perfect apparition over our street. Jonathan took pictures to share widely, to let history know that for once Michigan had a clear enough, dark enough sky to let us appreciate a transient event.

I remain immensely proud of this society and the way we've managed to keep up our calendar of events in a time of crisis, though it saddens me to look over the prospects for May and the Astronomy Day that might've been. One day, we'll be able to invite our neighbors to the eyepiece again. In the meantime, we'll continue to offer a full spectrum of safe events so that the W.A.S. can fulfill its mission to the public while keeping up our own bonds of camaraderie.

Stay safe, clear skies, and we'll meet again.

The planned 50th Anniversary celebration is cancelled. May reschedule next year, Gary Ross will keep us informed.

Astronomy at the Beach 2020

Dear Telescope Volunteers,

The biggest astronomy outreach event of the year is coming up September 25 and 26. The first quarter moon will be near Jupiter and Saturn, then a very bright Mars will rise (opposition is Oct 13). Last year we had 60+ telescopes and over 4,000 people across the two nights. We expect similar numbers this year, if COVID-19 allows (a go/no-go decision will be made by early August).

The location is the Island Lake State Recreation Area in Brighton – the "Island Lake picnic grounds" on Google Maps. You'll need a recreation passport on your license plate to enter (or pay the $15 daily fee). Our hosts, the DNR, are highly excited to have us and will be directing traffic and telling us where to park.

This year we plan to do a better job of "light management", by asking the public to not use bright white flashlights or phones. The DNR will be helping to screen headlights from the telescope field.

We need you, your telescope and your passion for sharing the night sky. Please put Sept 25-26 on your calendar.

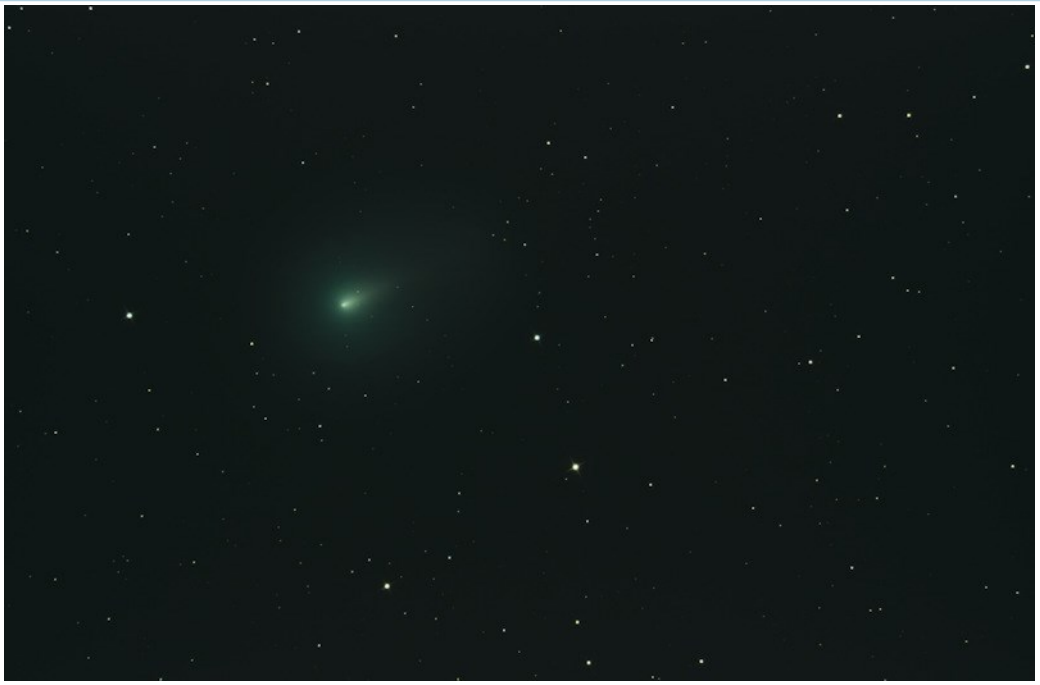
Brian Ottum
V.P. Communications, AatB

https://www.glaac.org/astronomy-at-the-beach/

https://www.facebook.com/events/island-lake-recreation-area/astronomy-at-the-beach-2019/316483612518549/

The View From C.W. Sirius Observatory

Comet ATLAS (C/2019 Y4)



C/2019 Y4 ATLAS, or Comet ATLAS, is a comet with a near-parabolic orbit discovered by the ATLAS survey on December 28, 2019. But around April 2, 2020, the comet started slowly breaking apart and disintegrating. A comet is defined as an icy dirt ball, small Solar System body that, when passing close to the Sun, warms and begins to release gases, a process called outgassing. This produces a visible atmosphere or coma, and sometimes also a tail. These phenomena are due to the effects of solar radiation and the solar wind acting upon the nucleus of the comet. C/2019 Y4's currently green or aqua color arises from emissions of diatomic carbon.

Comet ATLAS gets its name from the Asteroid Terrestrial-impact Last Alert System, which is a robotic astronomical survey and early warning system used for detecting smaller near-Earth objects a few weeks to days before they would impact Earth. It was discovered on CCD images taken through a 20" reflecting telescope from the Mauna Loa observatory in Hawaii.

At the time of its discovery, the comet shone at magnitude 19.6 in the constellation Ursa Major, as viewed from Earth. Between the beginning of February and near the end of March, Comet ATLAS brightened from magnitude 17 to magnitude 8, representing a 4000-fold increase in brightness. I took this image of ATLAS on April 2, from the CW Sirius observatory, when it was at magnitude 7.8, then located in the constellation Camelopardalis. At that time ATLAS was approx. 90,000,000 miles from Earth. ATLAS was predicted to be approx. 72,000,000 miles at its closest approach to Earth on May 23, making it a magnitude 3 comet visible to the naked eye. Observations taken between December 28, 2019, and January 9, 2020, indicated a 4,400-year orbital period and a perihelion of 0.25 AU to the sun. Similarities were noted between the orbital elements of C/2019 Y4 ATLAS and the "Great Comet of 1844" (C/1844 Y1), suggesting that C/2019 Y4 is a fragment of the same parent body.

I was hoping to report that comet ATLAS would become a great astronomical viewing event for us around the middle of May, but its disintegration prevents that from happening. There are currently more comets on their way towards us, let's hope they get close enough, and last long enough for us to enjoy their rare beauty.

About CW Sirius Observatory:

C.W. (Cadillac West) Sirius Observatory is located 15 west of Cadillac Michigan. Owned and operated by WAS member Bill Beers. The dome is an 8' Clear Skies Inc dome which houses an 11" f/10 SCT telescope, a 102mm f/7 refractor telescope, Celestron CGEM DX mount, and uses an ASI ZWO 071 color CMOS camera, as well as a QHY8L color CCD camera. The telescope can be remotely operated from inside Bills house.

NGC 4567 and NGC 4568

Siamese Twins Galaxies

April 21, 2020

The objective for the night's run was to capture the supernova in NGC 4568 (SN 2020fqv) at magnitude 15.3. On March 31 2020 the Zwicky Transient Facility detected the rapidly-rising supernova.

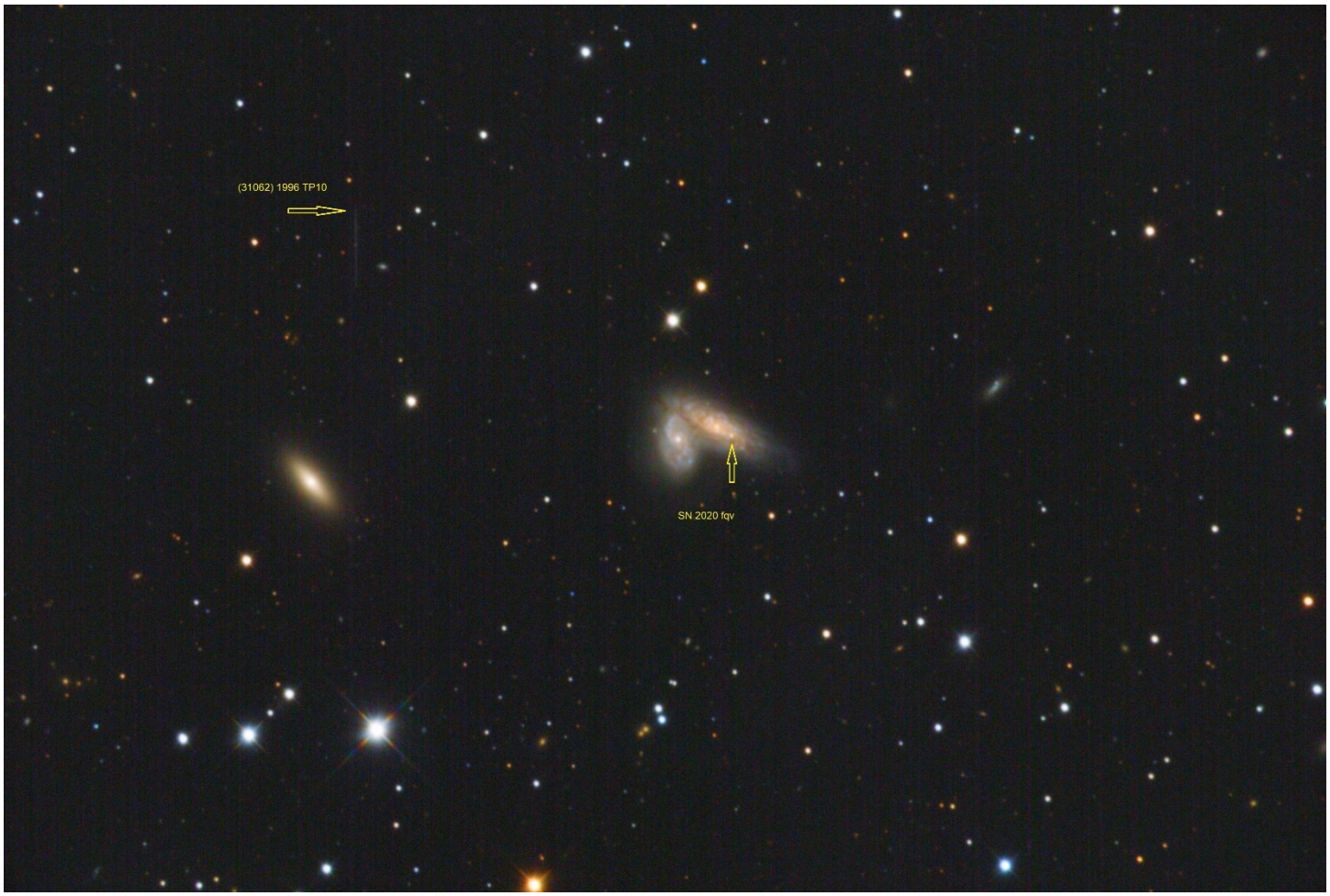
NGC 4567 and NGC 4568 (nicknamed the Siamese Twins or the Butterfly Galaxies) are a set of unbarred spiral galaxies about 60 million light-years away in the constellation Virgo. They were both discovered by William Herschel in 1784. They are part of the Virgo Cluster of galaxies.

These galaxies are in the process of colliding and merging with each other, as studies of their distributions of neutral and molecular hydrogen show, with the highest star-formation activity in the part where they overlap.

Along the way, I managed to capture an asteroid (31062) 1996 TP10 at magnitude of 16.7. This asteroid has a orbital period of 1,902 days, and was discovered on October 9, 1996, by Hiroshi Kaneda, and Seiji Ueda. I used TheSkyX to identify this object during the session, using the large asteroid database that is available from the Minor Planet Center.

Note: Comet C/2019 Y4 (Atlas) from last month's report has broken up and is dimming now.

Doug Bock



Presentations

Monday, May 4, 2020

Online Presentations

Main Talk:

"Zwicky and Baade"

By Ken Bertin

Fritz Zwicky and Walter Baade were 20th century astronomers whose accomplishments in cosmology and astronomy clearly changed significantly our understanding of the universe. Their work on supernovas, neutron stars, gravitational lensing and dark matter deeply impacted how we perceive how everything operates in outer space.

Zwicky's extensive catalogues of galaxies and galaxy clusters are still being used to this day. He was also a humanitarian and is remembered for his contributions in that area.

Zwicky's contributions were tainted somewhat by his contemptuous nature known and remembered more for his curmudgeonry than for his brilliance and accomplishments in the areas of astrophysics and jet/rocket design and production.

Baade was better know personally for his gentlemanly behavior and his respectful treatment of his colleagues. Beyond his discoveries made in conjunction with Zwicky, he discovered numerous asteroids and is known for his identification of the first class of minor planets now called Centaurs which cross the orbits of the giant planets.

Both men were heavily rewarded for their work. Their personalities are truly a highlight of their lives which will also be covered in this presentation.

These two are the 19th and 20th astronomers Ken has covered and along with his ITN production makes his 515th presentation.

Ken Bertin is a hobbyist astronomer for over 65 years, Past President and VEEP of WAS, Solar System Ambassador, 10 Total Solar Eclipses, 4 Annular eclipses, 6 Transits of Mercury, 2 transits of Venus. 15 Lunar eclipses.

Short Talk:

"There's No Place Like Home "

Observing the Local group

By Jonathan Kade

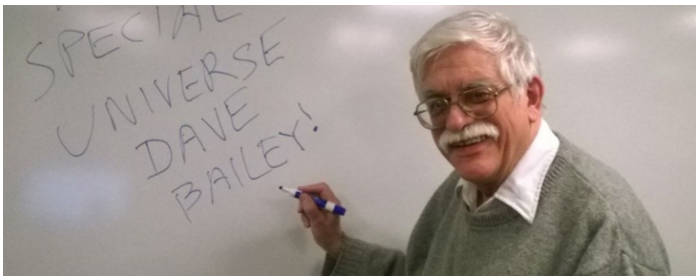
Jonathan Kade gives you a tour around the local intergalactic neighborhood, visiting familiar neighbors like the Andromeda Galaxy (M31), the Pinwheel Galaxy (M33), and the Magellanic Clouds; less familiar neighbors like Leo A and NGC 185; and more distant neighbors just outside the Local Group like NGC 55 (the

(Continued from page 6)
Whale Galaxy) and NGC 300. We'll talk about what you can see at the eyepiece and what amateur photographers can capture with their cameras. Jonathan promises it will be a beautiful day in the neighborhood.

Jonathan is the current Publications Director of the W.A.S. He does very little because Dale Thieme is the W.A.S.P. editor and does all the real work. Jonathan is a professional software developer, despite what you might assume from our club website. His hobbies are all fundamentally grounded in subtlety, but he is very enthusiastic about them.

Thursday, May 21, 2020

Online Presentation



"Where is extraterrestrial life likely to be found? "

By Dave Bailey

The book, "Rare Earth", was written by two professors who believe that we humans might be the only intelligent creatures in the entire Milky Way Galaxy. I myself believe there are intelligent species on many other planets. But I have to answer Enrico Fermi who asked, "Where are they?" My answer is, "Most of them live in red dwarf star systems." I'm guessing there might be 100,000 of these inhabited stellar systems in our galaxy. In this talk, I will explore the astrophysics, both stellar and planetary, in such red dwarf systems. Perhaps a biologist, hearing my talk, might be inspired to write another talk, which would explore how such a red dwarf star and planet could foster a species at least as smart as our own.

Astronomy has always been a major part of Dave Bailey's life - his parents met at Yerkes Observatory! Dave is in the minority in the club; he is more of a theoretician than an observationalist. He doesn't own a major telescope. As an optical engineer, he has worked on several different kinds of spy equipment (details classified). He has done laser isotope separation (NOT on uranium). He has worked with laser weapons, both offensive and defensive, and nerve gas detectors (details not classified). Living up to his reputation as the club's resident Einstein, Dave's presentations to the club continually expand our minds and challenge our preconceptions. In normal times, they also generally use whiteboards instead of computers, and come with multi-page handouts. If you're looking for some mental exercise, don't miss his presentation!

To follow along, Dave provides his notes for the presentation. We've included them in this newsletter, starting at page 30. Print them out and follow Dave in interstellar space.

Space Pirate Radio

Tune in to Captains Marty Kunz and Diane Hall for live radio Wednesday nights at 9:00 pm ET on Astronomy.fm

WAS PRESENTATIONS

If you would like to present either a short talk (10-15 minutes) or a full-length talk (45-60 minutes) at a future meeting, please email Dale Partin at: firstvp@warrenastro.org.

Movie Review

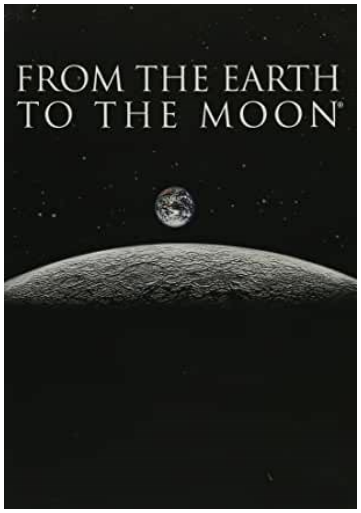
By Diane Hall

From the Earth to the Moon (1998)

To pass the time during our era of self-distancing, President Diane Hall has resumed last year's series of space-themed movie reviews. We pick up this month with an in-depth look at…

"The Original Wives Club"

For Episode Eleven, director Sally Field steps away from the NASA boys' club and covers, well, the original set of Gemini-era astronaut wives. We start off the episode inside the Apollo 16 spacecraft on its outbound journey; newly-married CMP Ken Mattingly (Zeljko Ivanek) has just lost his wedding ring, which floats aimlessly in the capsule. Flashback time, and we're immersed in a bizarre "fashion show" where astronaut wives parade on the catwalk because… ah, who knows? It's absurd and humiliating and we feel it. We squirm for these women. We first are introduced to the two Marilyns, Marilyn See (Debra Jo Rupp), whose husband Elliot didn't survive Episode One, and Marilyn Lovell (Elizabeth Perkins), wife of unsinkable astronaut Jim (Tim Daly). Flash back again, and Marilyn L. and the three Lovell children arrive in the desolate construction site that's going to be their new home. Once the homes in "Space City" are built, Marilyn L has a potluck where the veteran wives like Marge Slayton (JoBeth Williams) and Trudy Cooper (Sally Field herself) give the newcomers advice on what it means to be "married to the Statue of Liberty," most of which boils down to "don't ruin your husband's career!" Both Marilyns soon find out that being an astronaut's wife involves distracting other wives when fatal accidents happen.



We then skip from the Marilyns' drama into the lives of the two Pats, bubbly Pat McDivitt (DeLane Matthews) and jittery Pat White (Jo Anderson). The Pats get the honor of a visit to the White House after their husbands' successful Gemini IV mission, making them the envy of the Wife Potluck circuit. Unfortunately, Pat White's husband then gets assigned to Apollo 1, which means one evening she finds Jan Armstrong (Ann Cusack) waiting on her doorstep as a distraction… and so it goes. We jump from there to the Borman household, and we learn in short order that Susan Borman (Rita Wilson) uses copious amounts of booze to cope with being an Astronaut Wife. As things turn sour in Space City for couple after couple, the potlucks turn to acerbic chain-smoking sessions where ex-wives lament not being widowed. Ow.

I get the sense this episode was polarizing for a number of viewers; it has the second-lowest rating of any *From the Earth to the Moon* installment on IMDB save for the inessential "We Interrupt This Program" aka "I Can't Believe It's Not *Apollo 13*!" I'm inclined to lay that low score at the feet of misogyny; I agree overall with the consensus on the high points and rough patches of the series, but "Original Wives Club" is the outlier and I can't help but feel a substantial chunk of the audience looked at the dye jobs and silly hats and said "Meh, girl stuff." Unfortunate, that.

Now, I will say that it does seem weird that in an episode that technically fills the "Apollo 16" slot in the lineup and focuses on the wives of the "New Nine" astronauts we first met in the series opener that so little time is allotted to poor Barbara Young (Deirdre O'Connell), the Original Wife of astronaut John. We get only a fleeting glimpse at her, with zero attention given to her interior life or how it felt to be married to a much-travelled astronaut *or* how and why the Youngs' marriage fell apart. The other Apollo 16 wives don't even rate a mention; the producers' bias for the enduring marriages of the Lovells and the Bormans is evident here. Did I mention Mrs. Tom Hanks plays Susan Borman? As for the remaining women of the New Nine, Jan Armstrong presents an enigma left unplumbed and Faye Stafford (Wendy Crewson) feels like the heroine of another, different tale we're not going to hear tonight… but probably should. I had to count on my fingers to realize I missed Jane Conrad (Cynthia Stevenson). In short, maybe we could've used *two* episodes on the travails of the Houston home front.

Still, in many ways this feels like the true series finale; all the fresh-faced young pilots answering to "Max Peck" in Episode One will come to this: some die, some cheat, and some find out years after the fact what was actually going on in their household when they were riding rockets. This episode picks up on threads left behind by "Apollo One" and "1968" and ties them off so you can see the knots and tangles. Ultimately, the closure to the saga of the Lovells and the Bormans matters more to what this series is trying to say than the good-natured antics of the Apollo 16 crew… or the mystery of Ken Mattingly's misplaced wedding ring (don't worry, Charlie Duke finds it).

Rating: 4 out of 5 Moons and I wanted more Faye Stafford.

Over the Moon

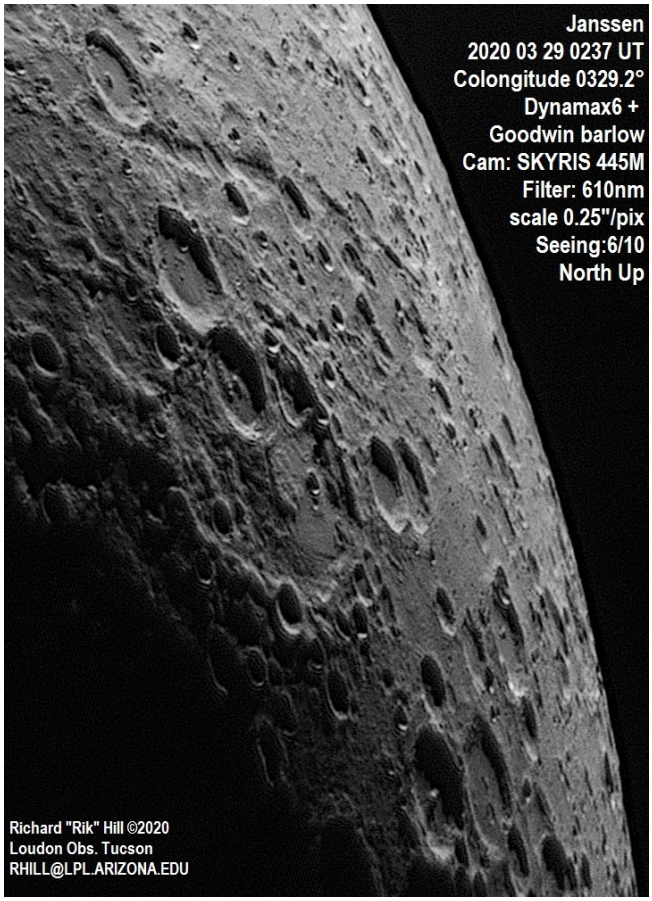
With Rik Hill (and his Dynamax6)

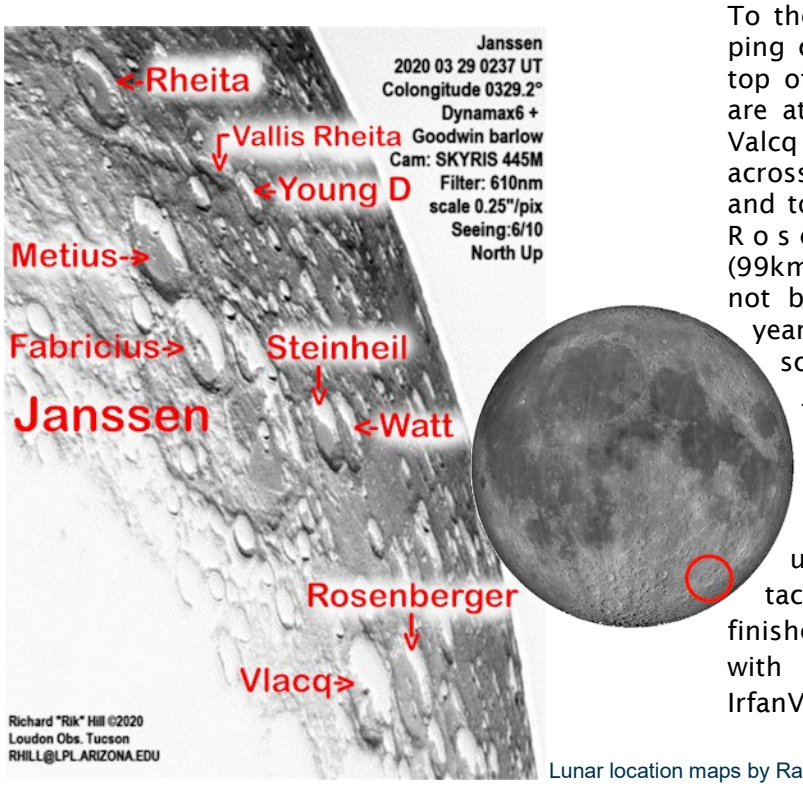
Janssen Redux

Slowly struggling back to normal here. Shot in the hip has me walking a bit and I've been able to start working on the sky again. Whoopie! I'll have a double shot of that next time!!

During my downtime I bought a Dynamax6 for a very good price. Almost unused by the original owner it was just a process of kicking out the cob-webs, tightening screws and aligning optics. The latter has been the hardest and may eventually re-quire disassembly and cleaning of the secondary alignment system before the final tweak can be had. Still it's done a good job of it.

Near center we see Janssen, a low large crater of 196km diameter with fascinating rimae curved across it's floor. To the north are two nicely defined craters. Just inside the northern border of Janssen is Fabricius (80km) with a central peak and a central mountain range! Further north just outside Janssen is a crater 10km larger, Metius. Above Metius is a gash in the Moon. This is Vallis Rheita created from a series of merged craters with large crater Rheita (70km) on the left end and Young D (46km) on the right end.





Lunar location maps by Ralph DeCew

To the right of Janssen can be seen two overlapping craters. First is Steinheil (70km) which is on top of Watt (68km). Two more impressive craters are at the bottom of this image. The left one is Valcq (92km) with a central peak casting a shadow across the floor and to the right is Rosenberger (99km). All in all not bad for a 40 year old 6" telescope!

This image was a stack of a 1800 frame AVI using AVIStack2 (IDL) and finished processed with GIMP and IrfanView.

Rik's "new" Dynamax6, ready for action.

A MYOPIC VIEW OF THE HISTORY OF CRITERION MFG. CO.

By Richard Hill

Editor's note:

Rik Hill's recent acquisition of the DYNAMAX 6 prompted this editor to do a search on the scope. Turns out Rik wrote an article about the company a while back, doing a history based on the ads of Criterion (and others). He gave permission to repost the article here. The links to the ads were left in place.

Rik points out that the article coverage ends before the DYNAMAX 6 came out.

This little article is exactly what that says, a view of the history of this telescope company, epic in the 3rd quarter of the 20th century. This history is as seen from the pages of Sky & Telescope and Review of Popular Astronomy magazines. Many amateur and professional astronomers were able as adolescents, to step up to serious amateur observing thanks to the good quality, economically priced (and financed) telescopes made by Criterion. This has sponsored in recent years, a renewed interest in these instruments and their histories though the company itself has been out of business for over 2 decades as of this writing (2005).

After World War II, when so many men and women left the service of their country (both military and in the civilian war occupations) they settled down and among other pursuits the hobby of amateur astronomy took off. At first this interest was fed by war surplus binoculars and small telescopes with companies like Edmund Salvage Co., A. Jaegers, Harry Ross and others. There were few firms that made finished instruments for astronomy. A couple of companies like Tinsley, C.C. Young and Skyscope, had small finished telescopes but that was pretty much it. So, amateurs of the day largely had to use the surplus materials to fabricate their own telescopes.

As the 1950s opened there was a growing demand for finished instruments of higher quality than a spyglass. As mentioned above, Tinsley had always had a line of amateur sized instruments but they were relatively expensive. Late in 1951, United Trading Company came out with two excellent quality *Unitron* refractors, that were priced substantially below Tinsley. A year later United Trading Co. became United Scientific Co. and carried another refractor model in their line. Edmund responded to this with a similarly priced refractor of their own to compete with the Unitrons. Over the year 1953 Fecker, C.C.Young, K.T.Smith, Wilmot Sales jumped in with their own finished instruments while United Scientific more than doubled the number of models in their line. Young and Smith were the largest companies producing (or advertising) finished reflectors but Smith limited their line to a single 4" model.

Fecker's instrument quickly ran out of the price range of the amateur astronomer, certainly the young tyro. In Dec., 1954 they had an ad for a 5" Cassegrain that appears to have many of the features of the Celestron 5 (and other such small Schmidt-Cassegrain telescopes) well ahead of their time!

By April, 1954, there was an ad for Criterion Co., Dept. TSA 2, 331 Church St., Hartford 3, Connecticut (Fig. 1). They had an f/25, 1.6" refractor, finished, on a alt-azimuth tripod for $26.95. It appeared, from the drawing in their ad and indeed the ad itself, very similar to a refractor being sold by Wilmot (for $3 more) and to parts being sold by Edmund for $21.50. The source for the parts was likely the same. While small, this refractor was of excellent quality for the aperture.

Fig. 1

Two months later the first Dynascope was advertised for $44.95. It was a 4" f/10 Newtonian reflector. On a very simple equatorial mount and wooden tripod. This telescope came with 3 eyepieces and

(Continued on page 11)

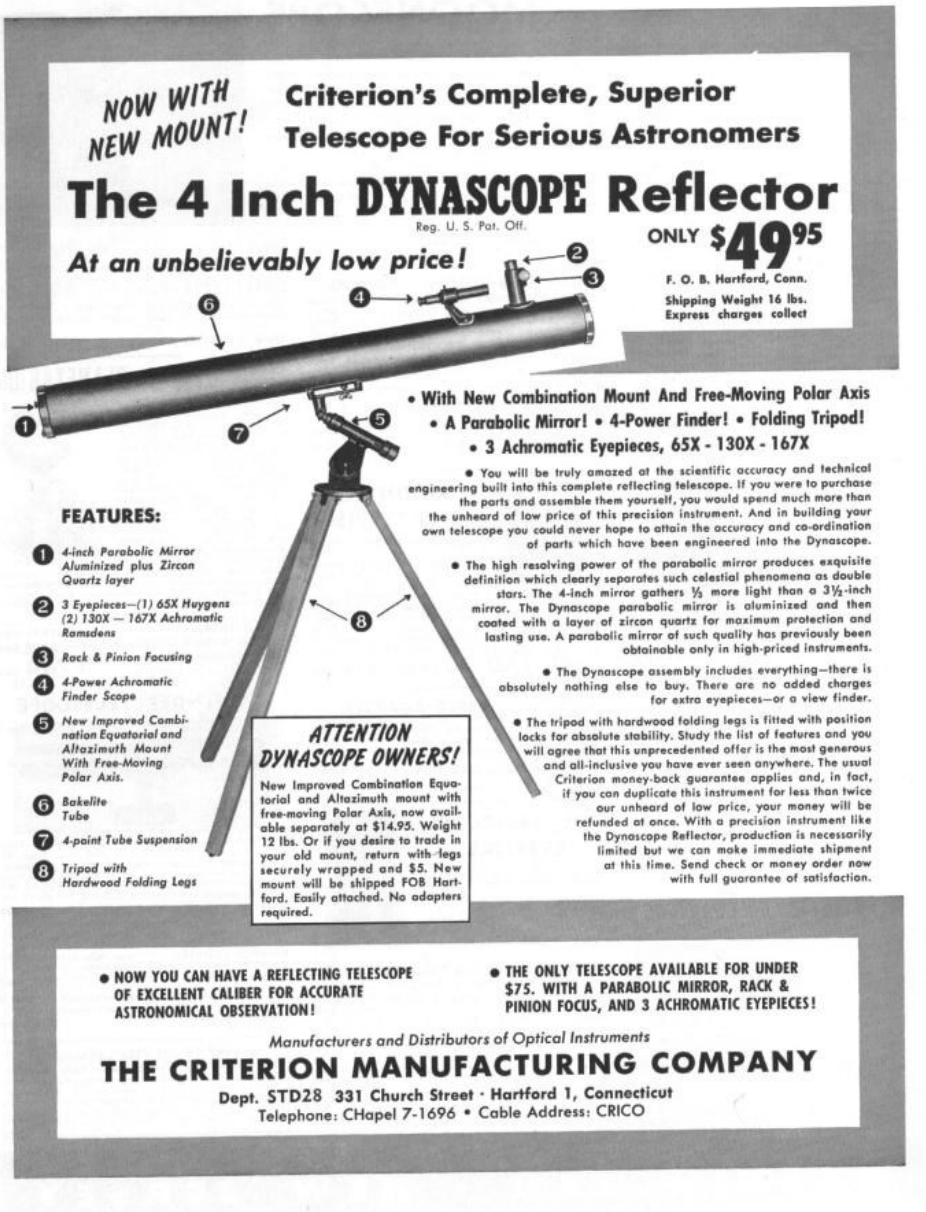
(Continued from page 10)

though the mount head was of light construction this was serviceable because of the ultra-light tube made of Bakelite. The distinctive smell of this material would become very familiar to many amateur astronomers over the years. They advertised this instrument as "The only telescope available for under $100 with a paraboloid mirror, rack & pinion focus, and 3 achromatic eyepieces." And they were quite right.

Other telescopes were also introduced during this year. Edmund, not to be outdone, met this competition with their "Palomar Jr.", a 4 1/4" f/10 reflector on a German equatorial mount. While the mounting was heftier, so was the price tag of $74.50. This pricing pattern between Edmund and Criterion would become typical over the next 30 years. Another telescope also made it's debut in this year and it too would become a household brand name for amateur astronomers was Questar. But this was out of the range of most young amateurs. For the same money one could buy a Unitron of greater aperture.

During 1955 there was a blossoming of companies that carried finished instruments. Companies like Cave, Garth, SkyScope, Laboratory Instruments, Jaegers, Harry Ross all made their entry with ready-to-use instruments and Edmund introduced a 6" f/8 Newtonian of their own. In July, Criterion raised the price of the 4" by five dollars. Most of these price changes and new introductions of equipment would be advertised in the magazines in June or December in later years and more frequently the latter in order to catch the holiday shopping time. In keeping with this, in Dec., 1955, Criterion came out with a new higher end 4" telescope. This one had a full German equatorial with a friction brake on the south end of the polar axis. It was priced a bit more than the Edmund 4" but had what appeared to be a better mount. In the ad for the telescope was a small note that said "Inquire for details of convenient Time-Payment Plan.

Fig.2



A year later, in August 1956, Criterion advertised an improved mount for their basic 4" (fig 2). They had replaced a rather flimsy latitude adjuster with one similar to that on their deluxe 4" and mounted the axel to that. It was a good improvement and at no increase in price. They offered an upgrade to owners of the older mounts for a modest price and an upgrade to the deluxe style mount for $14.95. This was a very good offer. In October they reached a milestone. For the first time they ran two separate ads in Sky and Telescope. One ad was for the 4" Deluxe Dynascope and the other was for a number of parts (rack & pinion, mirror cell, eyepieces). Another fine telescope company, Coast Instrument Inc., that made the Trecker-Scope, offered time payment plans up to 24 months.

(Continued on page 12)

(Continued from page 11)

Just before Christmas Unitron announced a time payment plan so there were on their back cover and the inside ad. Then 3 companies that instituted time payment plan for their instruments after Criterion. It would be interesting to know if this resulted in significantly increased sales. Since this technique lasted for over 20 years (until the common use of credit cards!) it's reasonable to suppose that this made telescopes more readily accessible to many kids eager to observe but with meagre incomes from paper routes, lawn mowing, car washing etc.

Also in the December issue for 1956, The basic Dynascope 4" was still selling for $49.95, the Deluxe Dynascope for $79.95, but Criterion ran a curious full page ad on p.78 of Sky & Telescope that started in large bold type: "attention all astronomers! Watch and wait for a new phenomenon... soon to appear". This was an announcement that they were about to come out with an "addition to the fine family of Dynascope instruments," a 6" reflector. But it was not until the following May that the telescope was introduced in a two page spread that announced the 6" Dynascope with hidden tripod (in a steel pier) for $475.00. It was a heavy instrument and hefty price tag. At the bottom of the ad they said "Also available in sizes to 16." " There was no change in the price of the 4" telescopes so there was a wide disparity between the high end 4" ($79.95) and the low end 6" above.

This pricing disparity must have been felt at Criterion because in October they came out with a stripped down model of the 6" with no motor, just a tripod and probably only 3 eyepieces though that is not stated. In fact, what it actually was, was not clear from the ad. The photo showed the deluxe model but in a box in the add it was stated that the clock drive, setting circles and "permanent pedestal" were extra. The price tag for this was $265 and it thus temporarily filled the aforementioned gap. Again, there were "easy payment" plans available. The probable confusion was cleared up when they ran a small inset picture of the standard model.

By 1958 Criterion pretty regularly had two or more pages of ads in every issue of Sky & Telescope. In March they advertised yet another improvement for the 4" mountings. This was their "crosstie" on the tripod. It was a thin metal bracket on each leg, about halfway down, that all met in the middle

(Continued on page 13)

Fig. 3

(Continued from page 12)

where they screwed together to keep a leg from spreading suddenly causing the instrument to fall over. It was yet another good idea.

In the December issue they had 3 pages of ads! One page was for the 4" models, another for the Deluxe models like the new 6" and the third was parts. Among the parts, Criterion was now selling a line of achromats to 4" diameter. These were in rather deep cells possibly as deep as 3-4" suggesting that this might have been an unusual, large airspace design. I never saw one and don't know anyone that has.

A little late for the holiday season, the Dyn-O-Matic for all 4" Dynascopes was introduced in January 1959, with much fanfare in a two page spread (fig.3). The basic Dynascope, with the non-counterweighted mounting and 3 eyepieces, had one at a total price of $79.95 (Normally it was now $59.95 without the drive which represented a $10 increase over the month earlier. There were now two deluxe models, one with a lightweight aluminum tripod and another with a light weight equatorial head. The latter came with 3 eyepieces, weighted 33 lbs. And cost $109.95 The Super-Deluxe had a heavier head, with a beefy tripod (including the crossties), slow motion control on the declination axis, setting circles, 5 eyepieces and a larger finder scope. It was priced at $159.95 and was quite a handsome telescope, far better quality than any other 4" reflector on the market.

So, what made the Dyn-O-Matic drive different from every other that was available? Criterion had a design that had a cork padded slip clutch in the drive. Two pressure plates pinched a brass ring gear with the cork between. Thus, when the drive was working one could point the telescope elsewhere without having to disengage the main drive gear. This was apparently an innovation. The pressure of the two plates on the ring gear was controlled by two or three spring loaded screws. I have used one of these for nearly 40 years and it still works fine with original parts!

But in the lower right corner of this two-page ad was an almost overlooked new model. It was a 6-inch f/8 Dynascope, with setting circles, three eyepieces and a rotating tube. Without the fanfare accorded the 4" models this RV-6 sold for only $35 more than the Super-Deluxe 4" model! It did not have the slow-motion declination control, but it did have a mirror that was 50% more in diameter! This telescope would eventually drive the 4" models to extinction. Other companies selling 6" telescopes could match it's price, but not with a drive.

Fig. 4

Business must have been good because in 1960 they ran as many as 4 pages of advertisements in Sky & Telescope. One page would be for the Deluxe models, another for the RV-6, a third for the 4" models and a fourth for parts. Things seemed to be booming. In May they began to regularly run the time payment coupon of $74.95 down and the rest

(Continued on page 14)

(Continued from page 13)

paid in 6, 12 or 24 months. This replaced the occasional little box note that instructed the buyer to call and arrange time payments. This price, time payments and the wonderful quality of workmanship let the RV-6 clean up. In only one year, May 1961, the last *full page* 4" Dynascope ad appeared in Sky & Telescope. They would go on to be advertised for another six and a half years in Review of Popular Astronomy and in occasional sidebar additions to the ads for accessories in Sky & Telescope, but these ended too after September 1969. I suspect the reason for the full-page ads RPA was that this magazine was geared primarily to the amateur observer whereas Sky & Telescope aimed for a broader market of armchair amateur astronomers, telescope makers, observers and students. RPA even had a regular column called "Through the Three Inch" specifically addressing the owners of 3" refractors and 4" reflectors.

Things remained remarkably stable for a number of years, no price changes no more instruments added. In August 1967, the RV-6 ads were enhanced with photos and testimonials. Then in October, 1969, the RV-8 was introduced in a 2 page spread on the inside back cover of Sky & Telescope. The introductory price was $399.95 and those that snapped one up at this price were wise. By January 1970, the price had jumped by $60 to $459.95 and he venerable old RV6 went to $249.95. This must have cut sales off at the ankle because in May the RV8 ads disappeared and the RV6 price dropped back down to $199.95! The RV8 ads returned in September at the old price of $399.95 but were gone again a year later. I would dearly love to hear the story back all of this!

In August, 1971, it was the end of an era. The last Deluxe line ad appeared in the pages of Sky & Telescope. In that ad the prices were:

6" Standard $325
6" Deluxe $525
8" Standard $395
8" Deluxe $625
10" Deluxe only $895

(Continued on page 15)

Fig. 5

YOU ASKED US FOR IT! You and other demanding amateurs and professionals have wanted a compact, precision, optically superb telescope designed for your needs. Now it's here...

The Magnificent New Criterion DYNAMAX 8

A major advance in telescope design and engineering, offering:

TOTAL PORTABILITY An 8" telescope with unique features that weighs only 24 pounds... may be used on tabletop or tripod... operated on AC, DC, or manually... set up virtually anywhere for observation or photography.

TOTAL PERFORMANCE Exquisite optics with the extreme resolution and characteristics required for observation and photography of faint astronomical objects, with advanced, complete, built-in guidance system... providing new standards of precision, flexibility, and operating ease. Unexcelled results!

TOTAL VERSATILITY Designed to meet fully the needs of the observer and astrophotographer without compromise... to be practical and convenient for all telephotography techniques—even exotic scientific applications.

An 8" Schmidt-Cassegrain designed from the outset for exacting performance... with all these new, exclusive features—all at no extra cost!

We began with a clean sheet of paper on the drafting table, to develop a wholly new concept of a totally portable telescope able to satisfy the precision requirements of the demanding observer. For example:

1. Variable-frequency drive. No telescope represented as fully astrophotographic should be without a variable drive to compensate precisely for the motion of any celestial object. The new Dynamax 8 includes a completely variable drive—not just solar. Here is the easily controlled drive essential for top-quality long exposures.

2. Positive latitude adjustment. To avoid frustrations, a latitude adjuster must be accurate, simple to set up, and highly stable. Any error or wobble can prove a severe handicap. Criterion design, recognizing the astronomer's needs, solves this problem by giving the advanced guidance system exact accuracy and stability.

3. Electric and manual slow motion. This Dynamax 8 feature permits simple, extremely accurate electric centering of objects. For terrestial photography or observing, the same pinpoint centering can be obtained easily by manual slow motion.

4. Setting circles readable from observing position. No need with this unique design to get up and check declination circles on the other side of the instrument! All settings can be plainly read from the observer's end of the telescope—a feature of enormous convenience. Large RA circle reads in both time and degrees.

5. Pilot light and toggle switch. With an electric drive so smooth you cannot tell if it is running, this exclusive design becomes a necessity as well as a valuable aid! Now even in the dark you can tell instantly if the drive is running. This feature helps prevent error and spoiled pictures... adds to reliability and enjoyment of your instrument.

6. AC, DC, Manual drive—all three! Portability becomes meaningful when you have DC drive as well as AC and manual, for still photography. The Dynamax 8 DC drive is included, not extra, and operates from a 12-volt car battery or other 12-volt source.

7. Hand-held controls. All variable drive controls are on a small box you can hold easily in one hand, operate in the dark. Instant override.

8. Three eyepieces. 30 mm. (70X), 18 mm. (117X), 12.7 mm. (165X) included at no extra cost; others available optionally.

9. 8 x 50 finder. Large achromatic, coated, wide-field finder scope with cross hair, more than adequate for this superb 8" instrument.

10. Modern exterior design. You will constantly enjoy the sleek configuration of the Dynamax 8, expressing beautifully the precision built in, and thoroughly functional in providing convenience and ease of handling, along with typical Criterion sturdiness. Weather-resistant polished metal and baked enamel finish.

Because we designed "from scratch" to meet the demands of discriminating observers and telephotographers, we believe you will find the new Dynamax 8 an instrument of outstanding performance capability—splendidly efficient, completely equipped.

TOTAL TELEPHOTOGRAPHY CAPABILITY!

We believe this is the first portable instrument with fully engineered, "designed in" capability for both astro and terrestial telephotography—enabling the competent amateur to produce "professional" quality pictures with ease and reliability. The variable drive features alone put it into a class by itself, fully capable of long, "locked on" exposures.

A Scientific Instrument, A Scientific Education

On Earth, the magnificent optical qualities permit an almost unlimited variety of applications, including television, laser, scientific measurements, and industrial applications; and breathtaking "close-up" insect, nature, and wildlife observation and photography the entire family will enjoy.

For teaching, the small size, light weight, sturdiness, and easy operation of the Dynamax 8 make it an ideal instrument for astronomy, geology, natural sciences, ecology, and photography applications.

THE "WHY" BEHIND THE CRITERION UNCONDITIONAL GUARANTEE OF SATISFACTION

We guarantee unsurpassed optical quality. The extreme resolution that for many years has delighted thousands of Criterion telescope owners stems from our position in the optical industry, as one of the most outstanding telescope making organizations in the entire world. Mirror and Lens-making techniques are so advanced that we compete to advantage on superb quality optics with any other manufacturer, here or abroad. We are constantly engaged in design and production of a vast variety of optical instruments and optical components requiring the highest precision standards.

In addition, Criterion many years ago began revolutionizing telescope manufacture by improving and simplifying mechanical design. The result has been sturdier, more "foolproof," easier to use, more practical instruments than "cut and fit" methods produced—and at far less cost! Thousands of our Dynascopes® have proved our engineering leadership.

A quarter century of meeting the demands of serious astronomers enables us to know the features needed for most satisfying results in use. These are incorporated in initial design—as in this new Dynamax 8—rather than being "compromised in" later.

This is why we can guarantee your Dynamax 8 to give you unsurpassed performance, or we will take it back and refund every cent. We believe, however, that you will agree there has never been, at any price, a portable, compact telescope with the quality and features of the Dynamax 8... and that you will find it a joy to use, a lifetime investment in observing and telephotographic pleasure.

Amazing Features In An Instrument You Can Carry In One Hand!

- **8" Schmidt-Cassegrain Type**
  Full 8" aperture, compound catadioptric optical system, balanced and locked in alignment, guaranteed to perform to limits of aperture with sharpest images possible. Silken-smooth internal focus.
- **Better than 2,000 mm. Focal Length**
  Tube only 17" long, but internal "folding" optical system gives effective focal ratio of f/10. Sealed tube insures dustfree optics.
- **Constant and variable drive—both!**
  Extremely smooth electric drive, plus variable drive AT NO EXTRA COST. Manual controls, plus hand-held, push-button box—push a button and center electrically... a feature generally limited to complex large telescopes.
- **Large field of view**
  View or take pictures of the entire surface of the moon in sharp detail—or star fields, clusters, nebulae.
- **AC, DC, or Manual Drive**
  Use regular 110v AC, or 12v DC. Manual controls override electrical instantly without adjustment or wear.
- **Highly stable mount**
  Rock-solid in use, permitting long-exposure photography. Simple, stable latitude adjuster, Equatorial position for astronomical use, altazimuth for terrestial viewing and telephotography.

DYNAMAX 8

Complete with
- Electric plus Variable Drive (AC, DC, Manual)
- Setting Circles
- 8 x 50 Finderscope
- 3 Hi-acuity Eyepieces
- Star Diagonal
- Latitude Adjuster
- Photo and Telextender Adapters

$795.00

FOB Hartford, Conn.
Shipping Wt. 30 lbs.
$20 Crating Charge

Criterion Manufacturing Company
Dept. STB-1, 331 Church Street, Hartford, Conn. 06101
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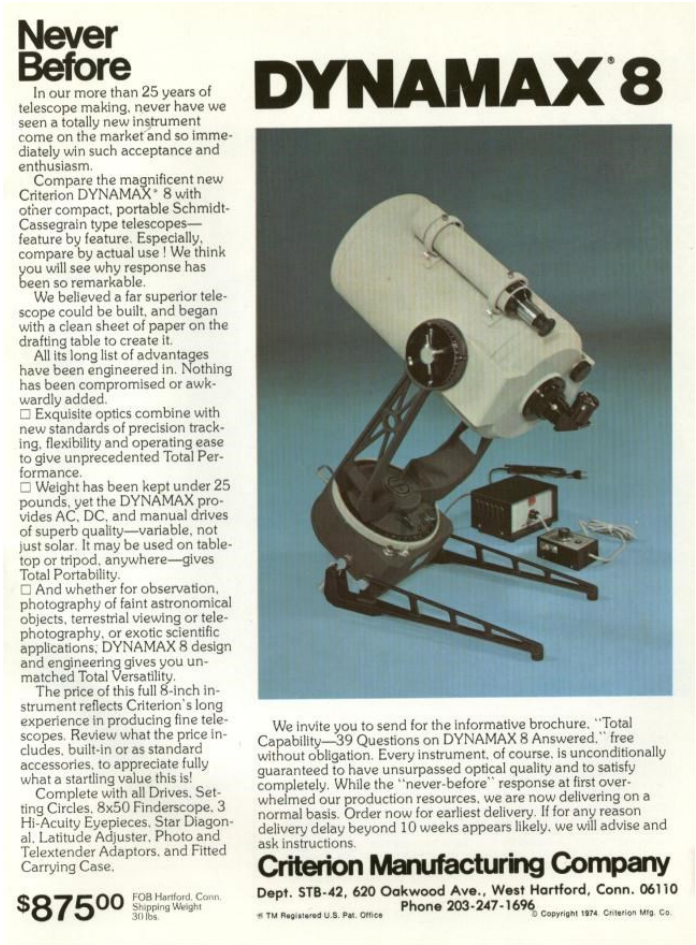
(Continued from page 14)

12" Deluxe only $1575
16" Deluxe only $4200

The reason for this became clear two months later when, probably due to increasing pressure on sales from the Celestron Pacific Co, Criterion embarked on a new venture with the Dynamax 8 for $795 (Fig. 5). The price was competitive and the design, in the opinion of this writer, was more classy. However, there were reports that the lighter fork led to some mechanical vibrations and that the optics were not as good as Celestron. By this time Celestron had a full line of Schmidt-Cassegrain telescopes: 5", 8" and 14". With more people living in apartments and the new condominiums, having a smaller instrument without sacrificing aperture was becoming a HUGE selling point. Nationally, inflation was taking off at this time but not at Criterion. The RV6 price remained at $199.99 making this a spectacular bargain at the time.

This all changed in the mid-1970s when in April 1974 Criterion moved from the address they had always been at, 331 Church St. to 620 Oakwood Ave. Then in Nov. The price of the Dynamax 8 went to $875 (fig. 6) and the RV6 went to $229 . A year later Criterion moved into the serious solar market

Fig. 6



Never Before

In our more than 25 years of telescope making, never have we seen a totally new instrument come on the market and so immediately win such acceptance and enthusiasm.

Compare the magnificent new Criterion DYNAMAX® 8 with other compact, portable Schmidt-Cassegrain type telescopes—feature by feature. Especially, compare by actual use! We think you will see why response has been so remarkable.

We believed a far superior telescope could be built, and began with a clean sheet of paper on the drafting table to create it.

All its long list of advantages have been engineered in. Nothing has been compromised or awkwardly added.

□ Exquisite optics combine with new standards of precision tracking, flexibility and operating ease to give unprecedented Total Performance.

□ Weight has been kept under 25 pounds, yet the DYNAMAX provides AC, DC, and manual drives of superb quality—variable, not just solar. It may be used on tabletop or tripod, anywhere—gives Total Portability.

□ And whether for observation, photography of faint astronomical objects, terrestrial viewing or telephotography, or exotic scientific applications, DYNAMAX 8 design and engineering gives you unmatched Total Versatility.

The price of this full 8-inch instrument reflects Criterion's long experience in producing fine telescopes. Review what the price includes, built-in or as standard accessories, to appreciate fully what a startling value this is!

Complete with all Drives, Setting Circles, 8x50 Finderscope, 3 Hi-Acuity Eyepieces, Star Diagonal, Latitude Adjuster, Photo and Telextender Adaptors, and Fitted Carrying Case.

$875.00 FOB Hartford, Conn. Shipping Weight 30 lbs.

DYNAMAX® 8

We invite you to send for the informative brochure, "Total Capability—39 Questions on DYNAMAX 8 Answered," free without obligation. Every instrument, of course, is unconditionally guaranteed to have unsurpassed optical quality and to satisfy completely. While the "never-before" response at first overwhelmed our production resources, we are now delivering on a normal basis. Order now for earliest delivery. If for any reason delivery delay beyond 10 weeks appears likely, we will advise and ask instructions.

Criterion Manufacturing Company

Dept. STB-42, 620 Oakwood Ave., West Hartford, Conn. 06110
Phone 203-247-1696

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and introduced the Solar Prominence Viewer for the hefty price of $455. For years they had a good white light solar filter that was used like a Barlow lens but the flat glass in the end of the tube nearest the secondary mirror, had a mirror coating on it (overcoated) that reflected nearly all the sun light back down the tube and back out towards the sun. It was the best solar filter before the advent of the mylar-type filters.

In Sept. 1976 a new telescope came into being, the Dynamax 6. It used the same fork as the Dynamax 8, making it more stable, and sold for $610. This did not help them. It was not a competitive price with the Celestron 5. Then, eight months later the RV6 price was raised another $20 to $249, the same price tried back in 1970.

A device called the "Golden Pyramid Tripod" was introduced in May 1978. It was designed for the Schmidt-Cassegrains. There were no pictures of it so the reason for the name was never clear. In Nov. this year the RV8 was made available again for $459.95, also the price tried in 1970. The next summer, July, 1979, The RV6 price was raised again to $279. It's interesting to note that this was Meade's price for the same instrument. In less than a year, the following May, the RV6 price was again raised this time to $359.95. This had to be damaging to sales since several other telescope companies had 6" Newtonians for substantially less.

During all this the RV8 remained at $459.95. That changed in July 1981 when no price was listed for the instrument. That became clear in August when it was then listed for $589.95. A month after that the Dynamax 4 was in and ad in Sky & Telescope and that was the only advertisement for it by Criterion, ever.

January 1982 saw some unannounced changes. On the inside back cover of Sky & Telescope was the "New Criterion 4000", a table-top Schmidt-Cassegrain. It was identical to the 4" Dynamax. In March the last RV6 ad appeared, still at $359.95, with the RV8 still available at $589.95. Late in the year the Criterion ads disappeared. Then in December Bushnell offered the "Criterion 8000" which bore and uncanny resemblance to the Dynamax 8.

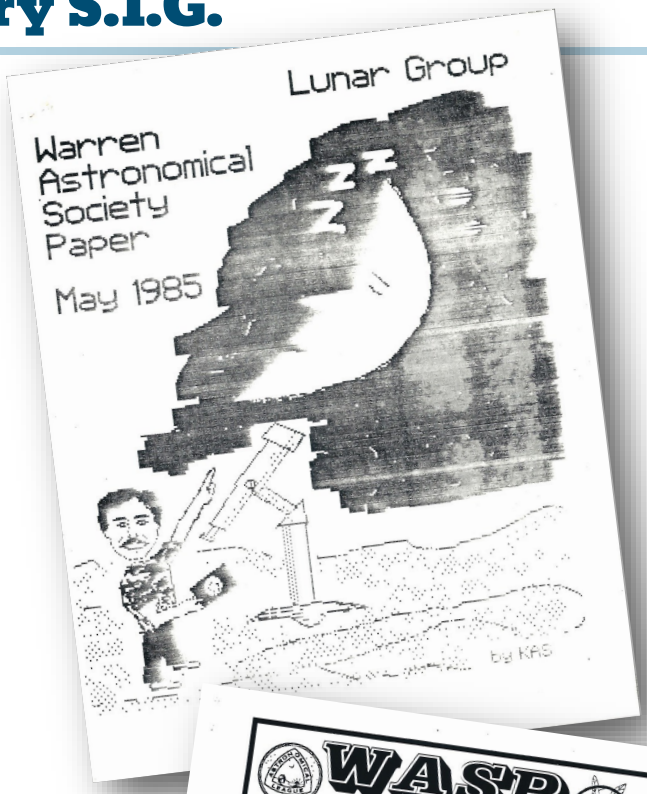
These were the last vestiges of the once great company that brought astronomy to so many amateur astronomers. Bushnell was soon bought out by Bausch & Lomb and the Criterion line disappeared altogether. Thus ended the life of a company that inspired hundreds of amateur astronomers and even sent some on their way to professional careers.

History S.I.G.

May 1985

I'm guessing the cover of this issue was created on a computer and printed on a dot-matrix printer, beyond that, I refuse to hazard a guess. It is signed "KAS" and the only match I could find in the membership roster of that year was Ken Strom. Was he in the Lunar Group?

The closest thing we have to an article in this issue is: "Location of the Sun, Moon and Planets", submitted by Raymond Bullock. The intro to this chart states, "The following tables show the ALTITUDE, AZIMUTH, MAGNITUDE, DIAMETER (In Minutes and seconds of arc), and ILLUMINATED PERCENT of the object, for three times on each of the four Saturday night/Sunday Mornings in May, 1985."



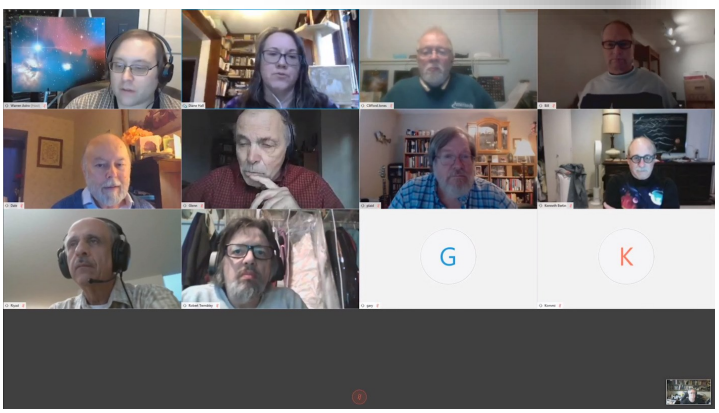
May 1995

Brian Benning recounts an experience attending an event at Stargate as a new member in "First Timers". In "Computer Chatter", Larry Kalinowski gives the upcoming Windows 95 a backhanded compliment…I think. And solar observing gets its day in the sun: "Observer's Corner: FORK ON THE SUN" by Ben Tolbert.

From the Scanning Room

I was about to write a "letter to the Editor" and realized that would be like talking to myself, which I do too much of, anyway. So, I'll put my thoughts here as it is something which took place in the Scanning Room. Monday, April 6th, I participated in the livestream of the "Cranbrook meeting". I cannot begin to express how delighted I was to see all those familiar faces again. While I'm saddened that it is being done under such trying circumstances, being in a live meeting is so much better than waiting for the video of presentations to appear on YouTube (still enjoy those, sometimes repeatedly). Finally, I want to extend a big thank you to Jonathan Kade and Doug Bock for engineering this endeavor.

Dale Thieme,
Chief scanner



Right: Screenshot from the virtual meeting.

Adventures in Armchair Astronomy

By Dale Thieme

January 6, 2020, Gary Ross gave a talk on "The Shining Mountain", an observing tale that involved lunar libration. He had spotted this sunlit "mountain" near the Orientale Basin (also known as Mare Orientale) and enlisted his buddy in California in trying to spot it again. The whole talk then was a description of what they went through to see this apparition again, including a false sighting. After the talk, as Gary fielded questions, Jonathan Kade googled, got an image displayed on his phone and shared it with the group. I grew curious about the Orientale Basin and the "shining mountain" and asked Jonathan to send the image. He sent a bunch. I didn't see any mountain, shiny or otherwise. I did, however, have a book on the moon, which I acquired at the 2018 WAS banquet and left to collect dust. I blew off the dust and dug through the pages to see if it said anything about the basin. Plenty, as it turned out. Two and a half pages worth from the chapter about lunar impact craters, I scanned them into a PDF file and sent along to Gary.

In his response, Gary wondered if I thought I was Ralph Baldwin (along with speculating that an image of me snuck into the pages of the book-*Fig. 1*). Now that bit puzzled me. In the section I scanned, Ralph was mentioned as an astronomer who proposed an impact theory for crater formation, but what bearing did that have on the present conversation? I had an idea- I went back to the video and at the end, Gary talks about Ralph, who resided in Grand Rapids but wouldn't condescend to associating with the GRAAA as he didn't want them to "come to depend on him." With that, Gary held out the book Ralph wrote and dropped it on the floor.

But, I thought, "Hey, another moon book and this one is the one that got the impact theory really rolling!" Off to Amazon I went and found a used copy and ordered it. It is copyright 1949, but so much reads like a modern book about the moon that it's easy to lose sight of that fact. But it didn't offer any more information about the Orientale Basin, per se. Ralph did write another book on the moon in '63.

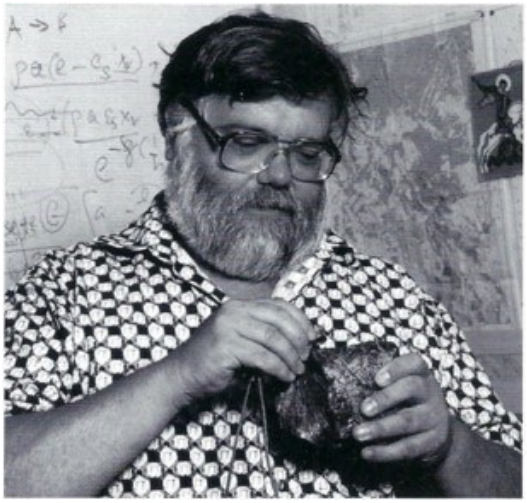


Figure 1 My doppelganger?

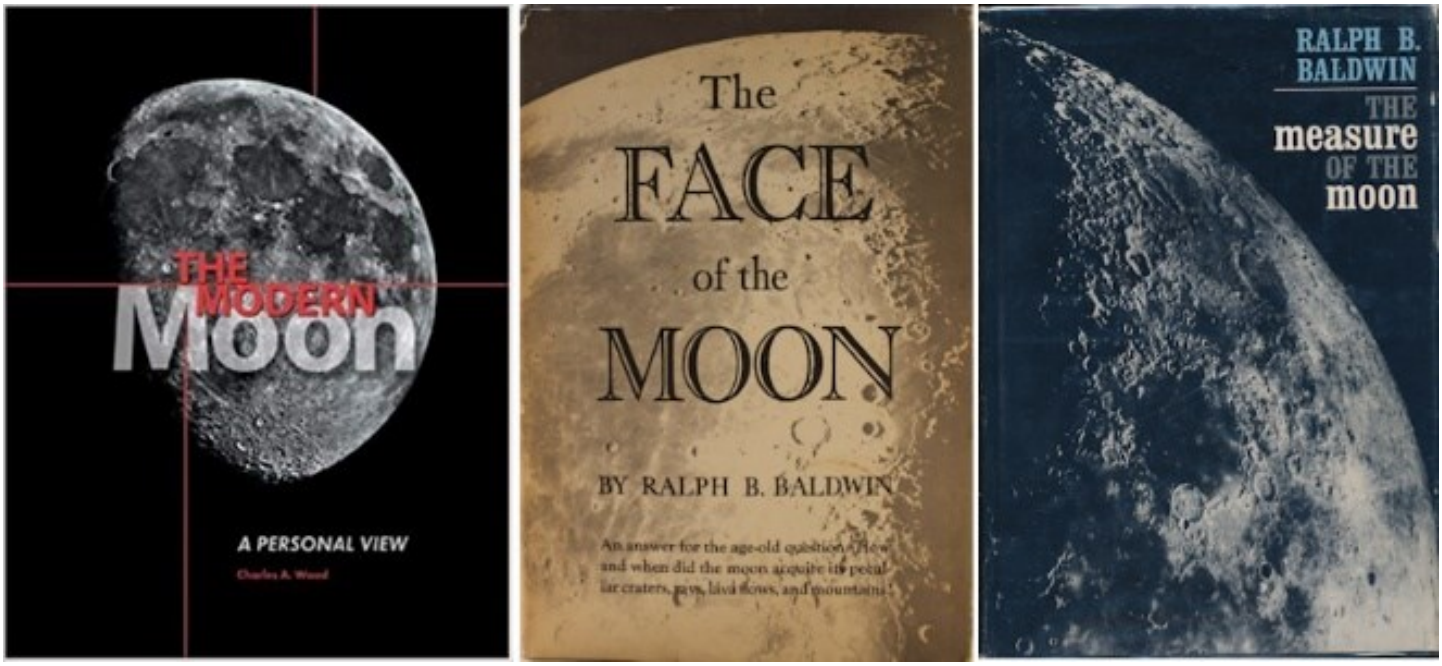


Figure 2, Left: the book that fueled my curiosity; Center, the first book by R. Baldwin; Right: the follow up by same.

Of course, I ordered a copy of that. The book turned out to be a doubling down on the impact theory, based on the deluge of information that came in since the first book (a much thinner tome.) In the book, I was pleasantly surprised to find that a back-cover pocket still held a folded map of the Moon—rather unexpected in a used book. I did find out Ralph and I have a few things in common, an interest in astronomy, married a Lois, and retired to Florida where he died (but I'm not having that!)

I didn't expect *The Modern Moon* to talk about any shining mountain but hoped for a clue as to what could appear as such to a chap with a five-centimeter telescope. A promising section stated, "…Orientale does have three relatively dis-tinct rings. The outermost ring (named the Cordillera Mountains) has a conspicuous inward-facing scarp with radiating furrows of ejecta extending outward from it. The outer Rook Mountains define an intermediate, scarp-faced ring, and the inner Rooks form a broken circle of mounds and massifs." Looking at the overhead image of the Orientale basin, I could imagine the far side rings, if they had enough elevation, could stand out against the dark basalt in front of them as libration eased them into the sunlight. There was one sunlit saddle shaped elevation that looked promising, located at a latitude southwest of Grimaldi (*fig. 3*).

I'm not discouraged, Robert A. Garfinkle just published a 3-volume set on the moon and I preordered a copy - should arrive in April. Maybe that will help, if not with the Orientale basin, then maybe at least with process of lunar libration. Something that still gives me a headache.

Addendum: The books arrived, Luna Cognita *(vol. 1-3), and are a trove of lunar information. Next month, I'll go into more detail about the Orientale basin.*

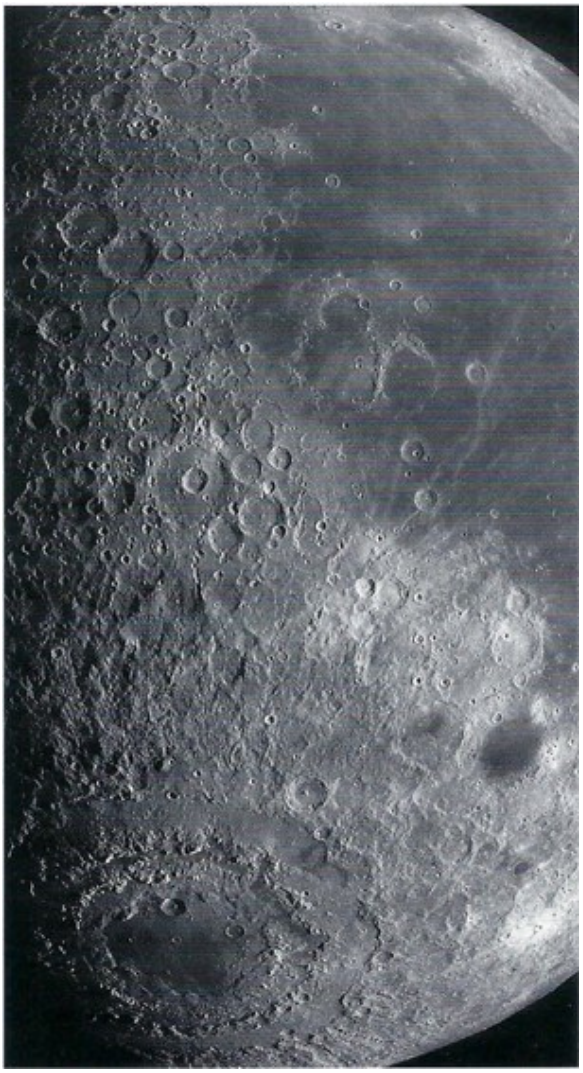


Figure 3 Orientale basin at bottom left. The image shows some promising bright elevations, too.

W.A.S.P. Photo and Article Submissions

We'd like to see your photos and articles in the W.A.S.P. Your contribution is ESSENTIAL!

—

This is YOUR publication!

Send items to: publications@warrenastro.org

Documents can be submitted in Microsoft Word (.doc or .docx), Open Office (.ods), or Text (.txt) formats, or put into the body of an email. Photos can be embedded in the document or attached to the email and should be under 2MB in size. Please include a caption for your photos, along with dates taken, and the way you 'd like your name to appear.

Stargate Observatory

Special Notice

Due to the measures taken during the Covid-19 pandemic On-site Star Parties and group events are cancelled.
During this time, you are encouraged, when the skies co-operate, to join the livestream with Northern Cross Observatory on the open house schedule (4th Saturday of the month)
Past livestream are available on the Warren Astronomical Society's YouTube channel:
https://www.youtube.com/channel/UC12jUX4Gmweg6fTtUuqa8CQ

Observatory Rules:

1. Closing time depends on weather, etc.
2. May be closed one hour after opening time if no members arrive within the first hour.
3. Contact the 2nd VP for other arrangements, such as late arrival time. Call 586-909-2052.
4. An alternate person may be appointed to open.
5. Members may arrive before or stay after the scheduled open house time.
6. Dates are subject to change or cancellation depending on weather or staff availability.
7. Postings to the Yahoo Group and/or email no later than 2 hours before starting time in case of date change or cancellation.
8. It is best to call or email the 2nd VP at least 2 hours before the posted opening with any questions. Later emails may not be receivable (secondvp@warrenastro.org).
9. Generally, only strong rain or snow will prevent the open house... the plan is to be there even if it is clouded over. Often, the weather is cloudy, but it clears up as the evening progresses.

Stargate Report

Stargate observatory and the Dob shed along with all equipment are in good condition as of May 2nd at 7:15 pm.
The observatory will remain closed until further notice due to the COVID-19 pandemic.

Riyad I. Matti
2020 WAS 2nd VP, Observatory Chairperson

Treasurer's Report

Treasurer's Report for 5/03/2020

MEMBERSHIP

We have 80 current members

INCOME AND EXPENDITURES (SUMMARY)

We took in $1,701 and spent/transferred $418 We have $22,104 in the bank $51 in checks and $677 in cash, totaling $22,833 05/03/2020.

INCOME

Row Labels	Sum of Credit
AL 2020	$ 45.00
calendar 2020	$ 150.00
donation	$ 346.88
membership	$ 347.00
merch	$ 84.00
renewal	$ 727.00

EXPENSE

Row Labels	Sum of Debit
Calendar Shipping Cost	$ 30.35
Snack Reimbursement	$ 70.00
Snack Supplies	$ 2.12
Speaker Expense, Dinner	$ 54.23
Speaker Expense, Driving	$ 261.00

GLAAC REPORT 4/30/2020

Beginning Balance: $2,237

INCOME

No activity

EXPENSES

No activity
Ending Balance: $2,237

Mark Jakubisin
Treasurer

Astronomical Events for May 2020

Add one hour for Daylight Savings Time
Source:
http://www.astropixels.com/ephemeris/astrocal/astrocal2020est.html

Day	EST (h:m)	Event
01	21:49	Regulus 4.2°S of Moon
04	14:00	Eta-Aquarid Meteor Shower
04	16:00	Mercury at Superior Conjunction
05	22:03	Moon at Perigee: 359656 km
07	05:45	FULL MOON
08	16:40	Antares 6.5°S of Moon
09	23:00	Mercury at Perihelion
10	04:01	Moon at Descending Node
12	04:40	Jupiter 2.3°N of Moon
12	13:18	Saturn 2.7°N of Moon
14	09:03	LAST QUARTER MOON
14	21:00	Mars 2.8°N of Moon
18	02:45	Moon at Apogee: 405584 km
22	05:00	Mercury 0.9° of Venus
22	12:39	NEW MOON
23	21:40	Venus 3.7°N of Moon
24	05:53	Mercury 2.8°N of Moon
24	16:34	Moon at Ascending Node
26	14:43	Pollux 4.6°N of Moon
27	13:44	Beehive 1.7°S of Moon
29	03:44	Regulus 4.3°S of Moon
29	22:30	FIRST QUARTER MOON

Saw a Fireball?

Report it to the American Meteor Society!

www.amsmeteors.org/members/fireball/report-a-fireball

Outreach Report

This is worth repeating:
The NASA/JPL Solar System Ambassador program has several libraries looking for online presentations by SSAs or NASA Night Sky Network members - *which the W.A S. is.* I can send you that list if you are interested, but I think this is something our outreach team might want to consider doing for local libraries.

Astronomy at the Beach Planning

GLAAC is requesting that member clubs provide some sort of hands-on activity to be hosted at their tables this year's event. Suggestions are welcome! GLAAC is looking into becoming a 501(c)(3) in their own right. I've included minutes from the Feb. 13 AATB planning meeting below.

AATB Planning Meeting: Thursday May 14 2020, at 7:00PM

- ***Everyone is Welcome!***

Online at: https://umich.zoom.us/j/451974838
(Password: 0000)

W.A.S. Calendar Entry: [LINK]

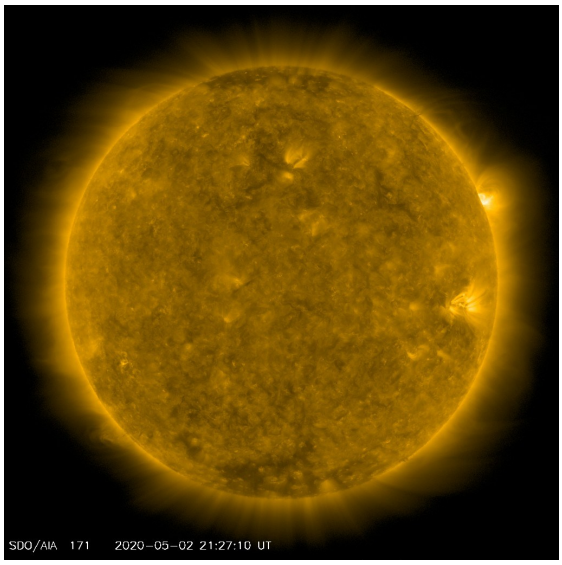
Even if you can't make it to the April planning meeting, you can join the groups.io site to get emails and updates from the planning committee. https://glaac.groups.io/g/main.

Member Spotlight

Doug Bock continues to host frequent virtual observing sessions - catch them here:

Doug's DISCORD channel: https://discordapp.com/invite/gFxx63h

Doug's YouTube channel: https://www.youtube.com/c/DougBock_BoonHill/live



I will be giving my presentation on the Sun remotely to Connie's science classes over Google Meetup in mid-May.

(Continued on page 22)

amazonsmile
You Shop. **Amazon Gives.**

If you're shopping on Amazon, make sure to use Amazon Smile. It costs you nothing, and if you select us as your charity, Amazon will donate 0.5% of every purchase you make to the Warren Astronomical Society.

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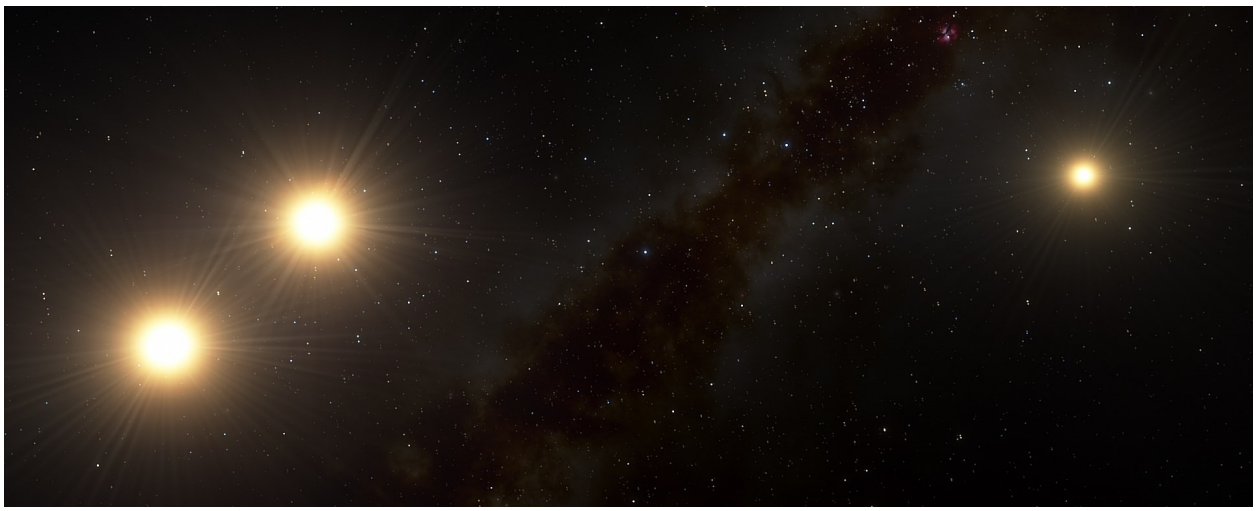

Artist's concept of the EZ Aquarii triple star system. Credit: SpaceEngine - Bob Trembley

Great Lakes Association of Astronomy Clubs

Meeting Minutes 2020-04-10

Online:

- Jeff Kopmanis
- Adrian Bradley
- Goef Vasquez
- Brian Ottum
- Shannon Murphy
- Mike Ryan
- Bridget Harwood
- John Wallbank

Discussion Items:

1. **Valley tent rental:** not paid as of this date, but working with Valley
   No deposit until July if possible
   How to get them the money for the deposit

2. **Covid-19 issues**
   When is the last date we can cancel if the Gov does not lift the assembly ban? *Due to digital media and school cancellation, we can defer this until the **July** meeting.*
   Any contingency plans that we might be able to come up with?
   Cutoff date for printing handouts: only a few days
   Rely on Social media and digital events in late **August**
   John: there may be social distancing advisory still in place - mandatory masks?
   Bridget: feeling is that the DNR wants to open the parks

3. Telescope Field Participant Survey/Registration/Letter - Brian
   Need ALL scopes!
   Need to know if there are large scopes/equipment
   Need to know if they need power
   Tell clubs to include it in their meeting agendas and discussion
   Convey current dates (9/25,26)
   GLAAC Board Contacts for more information
   Club Demo participation
   Food Vendor: Scott Smith, South Lyon Boys Cross Country - smithslxc@gmail.com, (248) 207-5135

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4. **Fundraising - John**
   *Impossible or difficult at this time. Revisit for **May***
   Printed material is helpful for approaching donors

5. **501c3/Incorporation**
   Bank account first - Account is titled under WAS
   Incorporation
   501c3 paperwork

6. March Task List:

Move to adjourn: John motioned, Adrian 2nd, 8:15pm

To-Do for May

John/VP - Fundraising letter
Geof/John - Incorporation as GLAAC, (501c3, Bank Account). Goef and John.
Brian: Telescope Participant Letter
John: talking to Scott Smith about food vendor
Brian/BobT: Flashlight/Lighting blurb for FB/AATB site
JeffK/ShannonM: Hubble Cards - solar system ambassador web site - https://solarsystem.nasa.gov/ambassadors/596/ John Williams Goodalls have Hubble Cards (w/ PDFs). Set of 58 cards with various objects on them. Originally designed by author of starrycritters.net. GLAAC had them printed.
Brian: email Planewave contact (Kevin) for demo

In order to have another successful year of Astronomy at the Beach, we need the W.A.S. to give an interactive demonstration at our table inside the big tent. Our surveys have shown that the public LOVES the astronomy and science-related demonstrations staffed by the Michigan Science Center, Cranbrook, Wayne State, some planetaria and some of the clubs. Just make sure it is simple, impactful and interactive. These demonstrations are critical for the nights that may be cloudy. There will be no keynote speaker.

Brian Ottum - V.P. Communications, AatB

-Bob Trembley

Join the Astronomical League!

The mission of the Astronomical League is to promote the science of Astronomy. The major benefit of belonging to this organization is receiving the quarterly newsletter, The Reflector, which keeps you in touch with amateur activities all over the country.

Also:

- Participate in the Observing Program
- Avail yourself of the League Store
- Astronomy Books at a discount
- Attend Astronomical League Conventions

Only $7.50 annually,
(Membership starts July 1)

alcor@warrenastro.org

Meeting Minutes

CRANBROOK BOARD MEETING
April 6, 2020

Members present: Diane Hall, Dr. Dale Partin, Riyad Matti, Glenn Wilkins, Mark Jakubisin, Jonathan Kade and Bob Trembley. Diane called the meeting to order at 6:06.

Due to ongoing national gathering restrictions to lower exposure to the COVID 19 virus, this was again a "virtual" meeting. This time we used the Cisco Webex platform for both the Board meeting and the regular meeting. The WAS YouTube platform was added to the regular meeting. Twenty-six watched on YouTube while twenty-two watched on Webex. The Board members agreed that an "open" platform was needed for the Board meeting and also for control of the regular meeting. The Board would appreciate comments from anyone, especially those watching on YouTube.

Diane expressed her thanks and appreciation to the many members who made it possible to continue our regular activities under extraordinary circumstances. She further highlighted the importance of keeping in touch with each other while waiting for normalcy to return.

OLD BUSINESS

Stargate - Riyad reported that the Park Authority is looking into our expressed issues regarding light pollution, and concerns about safety issues with rocks in the observatory pathway. If no answer is received soon, Riyad will ask for a status report.

Promo Plaque for Stargate – Bob Trembley sent an E-mail inquiry to Wolcott on April 6 asking about the addition of a roadside sign for Stargate. Waiting for an answer.

Dark Sky event – No reported progress

2019 Year in Review Project – No reported progress

Macomb Discovery Center – Diane plans to schedule a meeting with them. Bob noted that they are in need of a meeting facility.

NEW BUSINESS

Diane reported that the next GLAAC video meeting has a timing conflict with our Macomb meeting that needs to be addressed.

990 Report – Still on schedule to be processed in May although Federal timing requirements may be relaxed due to the virus crisis.

OFFICER and OBSERVING REPORTS

Dale reported that speaking slots are at least tentatively in place for 2020. Some presenters have expressed concern about their ability to handle the new technology from home, even with the offered assistance of our technical experts. Dale will continue to work with all presenters to the extent of his technical abilities, and request assistance as required. It was agreed by the Board that the presentation for our annual banquet will be an eclipse video since we are not certain at this point if gatherings will even be allowed at that time.

Mark reported that we currently have $22,155 in cash and 78 paid members. Details in the WASP. The WAS mail has not been picked up for 6 weeks due to virus concerns. The Board recommended that a way be found to pick up the mail at least every other month. Mark agreed to seek a safe way to make this happen and advise the Board if a resolution cannot be found.

Riyad reported that there has been no activity at Stargate. Although special group activities will not be held under current health restrictions, Riyad thought it may be possible for reasonable numbers of WAS members to set up properly spaced scopes for casual observing. It is thought that access keys are available in the lock box. If the observatory is used, it would be best to limit only one person in the building at a time to avoid 911 calls! Riyad will visit Stargate in the next few days to confirm feasibility of this overall suggestion.

Jonathan reported that the WASP was published before this meeting.

Dale Thieme showed us an impressive new Moon publication.

Jeff MacLeod managed to count 33 Pleiades stars in his scope under rare clear skies. You can participate in Jeff's Astro Chats through the WAS site.

Doug Bock showed recent pictures of M101 & the Sombrero Galaxy.

Jonathan showed us assorted photos he took with his I Phone, 10" scope and new Orion adaptor.

Riyad reported that Betelgeuse continues to brighten.

Bill Beers reminded us that he is always available for help with any questions regarding astro photography or related subjects.

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CRANBROOK VIRTUAL MEETING – April 6

Diane called the meeting to order at 7:30

In the News/Sky was presented by Dale Thieme (AKA Plaid) Topics as follows:

. Globular clusters around the Milky Way have had multiple encounters with the M.W.
. Gravity waves have been detected from white dwarf binaries
. LISA to be launched in 2034
. James Webb scope mirror assembled for test. Launch 2021
. Space X booster exploded during restrained test

In the Sky

. Venus at -4.5 magnitude

. Mars, Saturn & Jupiter in the morning sky. See if you can spot a moon around Saturn.

. Comet Atlas was expected to become prominent in small scopes but seems to be dimming. (Breaking up?) Recent pic by Doug Bock shown.

SHORT TALK

Diane stepped in to replace Gary Ross who was unable to overcome the unexpected technical difficulties. Her presentation was called Your Friendly Neighborhood Astronaut, Al Worden of Jackson, Michigan.

Her report covered his education at West Point & U of M, experiences as a test pilot in the Air Force and his surprising relationship with Mr. Rogers and his popular TV show, Mr. Rogers' Neighborhood.

SHORT BREAK

MAIN TALK

Dr. Partin introduced Bob Trembley who told us about the extreme trials & tribulations astronauts have experienced to date and will have to overcome in the future as we move beyond the moon and outside our solar system. Bob started with early science fiction stories, continued through our modern experiences and finally into possible future propulsion systems and way beyond.

The meeting was closed at 9:42 but sadly without the usual invitation to continue discussions at the Red Coat Tavern.

MACOMB VIRTUAL MEETING – April 16

Webex became active about 7:00 to resolve any remaining technical and presentation issues. About 7:25 our You Tube account was also activated for those preferring that format. Doug Bock again was the technical "wizard" pulling all the right strings joining both programs together to the extent possible. Jonathan Kade was the Webex facilitator and technical advisor for presenters not familiar with the software. President Diane Hall, in conjunction with Dr. Partin and many others, led the team in making everything happen thus allowing the WAS to continue regular meetings under extraordinary conditions!

Diane Hall called this meeting to order at 7:30 P.M. for 20 Webex participants and 24 additional viewers on You Tube. Her first order of business was to thank all those who contributed to making all this possible. She noted that most, if not all, of Michigan astronomy organizations have not been able to realize much more than minimal activities.

In-the-News

Diane presented the following news stories –

Sun orbiting the Milky Way black hole – tracking the orbit of S2 over time has confirmed General Relativity predictions regarding the shape and paths of the orbit over time.

Earthlike planet – Kepler 1649c is circling a red dwarf star about 300 light years from us. Although conditions appear to be favorable for a possible second earth, red dwarfs are inherently unstable making adequate time for life to evolve rather unlikely.

Supernova – SN2016 has exhibited record brightness. Mass estimates are 50 to 100 times that of our Sun meaning that this may have been the result of a violent merger of stars in a binary system.

Oumuamua – Computer modeling suggests that this rocky, cigar shaped object may have been ejected out of a distant solar system when a planet was pulled apart after drifting too close to the parent sun. There may well be millions of these rocky objects moving through outer space.

Tax deferral – An astronaut about to go into orbit reportedly used his status to apply for timing relief on his tax report. Seems like a valid reason to me.

In-the-Sky - Diane reporting.

Lyrids – This annual meteor shower is beginning now and is expected to peak on April 21. Viewing conditions are expected to be favorable with respect to the moon and sky location.

Comet Atlas – It is confirmed that the core has indeed broken up and brightness has decreased somewhat thus disappointing those hoping for a memorable sighting in May.

OFFICER REPORTS

Diane reported that GLAAC met last Friday. Planning for the annual Fall event has been hampered by approval delays currently on hold. The DNR will not likely be able to determine until August If large

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gatherings will be allowed this Fall.

Diane also noted that the Board is investigating the feasibility of holding a virtual discussion group meeting in the near future.

OBSERVING REPORTS

Atlas - Doug Bock and Bill Beers showed current and earlier pictures of the comet showing the difference in magnitude over time, and the change resulting from the breakup recognized about 11 days ago. Peak brightness was noted on March 21. It is currently about 1.17 AU from earth and will be 70 million miles from the sun at perihelion per Ken Bertin.

Phone adaptor – Bill Beers showed his Celestron NexYZ smart phone adaptor. It is available through Amazon with free shipping for $41.99. Since it is adjustable in 3 planes, it can even be used with most binoculars for photography. Bill uses it with his 11" scope to produce surprisingly good photos. Now if his phone could only be used for time exposures…. Bill would be happy to receive questions via E-Mail.

Solar activity – Although nothing significant seems to be going on currently, Riyad reported interference lately over some ham radio bands. Perhaps there is something going on in the Sun with non-visible emissions?

Satellites – Jim Shedlowsky has received reports from friends in Arizona about seeing "swarms" of objects in the night sky, apparently from recent launches. He asked the audience about similar sightings from Michigan, but nobody could report any comparable experience.

INTERMISSION – Diane announced a 15-minute intermission. It was interesting that many of the Webex participants used this opportunity for social exchanges usually happening pre-meeting and at the snack break.

MAIN PRESENTATION

Dr. Dale Partin introduced our WAS friend Dr. Gerald Dunifer, professor emeritus, now retired from Wayne State University. The presentation was entitled Cosmic Fireworks.

Professor Dunifer opened by telling us of his active interest in fireworks and small explosives as a young boy. In recognition of this hobby, his father built a small laboratory for him well away from the main house! As his education progressed, Jerry naturally developed a passion for the much bigger explosions found throughout the universe. Many of these are explored in the topics below.

Solar flares – Not in the same categories as those below, but still well beyond the power of anything ever designed by man.

Novae – They emanate from the surface of white dwarf stars about the size of the earth but, of course, much denser. Mass is accumulated from a binary companion until a critical level is reached. Sirius B is the closest known example of the typical white dwarf.

Kilonovae – These are typically about 1000 times more energetic than a nova and result from the merger of two neutron stars which are usually about 10 miles in diameter with extreme density.

Supernovae – These exploding stars are classified as types 1 or 2. There are several sub types within these two groups. The Crab nebula is called SN1054 and was widely recorded by naked eye observers in the year 1054 AD. A type 1A explosion starts with 2 red giants, one of which draws mass from the other until it ends in a violent explosion and collapses into a black hole. Depending on distance, these events can be daytime-visible at minus 19.3 actual. A type 2 event happens when a single large star collapses to a black hole reaching peak brightness at about 14 days.

These events are well studied and understood. Once the type is established along with the time since the event occurred, the measured (apparent) magnitude can be used to compare to the absolute magnitude and thereby determine the distance to the galaxy where it happened, at that point in time. A very useful tool indeed.

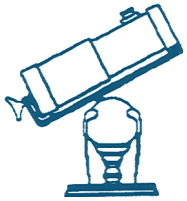
Quasars – The peak periods for these monsters occurred roughly 10 billion years ago. The most famous example is 3C273 in Taurus. They originate in active super massive black holes found in galaxy cores. As they consume suns, powerful jets are formed from the poles at very high speeds. Light and energy is given off far beyond that emitted even by supernovae.

Of course, the Big Bang was undoubtedly the mother of all explosions.

A member asked about what is considered a safe distance from a supernova. Jerry responded that 30 light years should be adequate.

Diane formally closed this meeting at 9:40

Glenn Wilkins
Secretary



The Warren Astronomical Society is a Proud Member of the Great Lakes Association of Astronomy Clubs (GLAAC)

GLAAC is an association of amateur astronomy clubs in Southeastern Michigan who have banded together to provide enjoyable, family-oriented activities that focus on astronomy and space sciences.

GLAAC Club and Society Meeting Times

Club Name & Website	City	Meeting Times
Astronomy Club at Eastern Michigan University	Ypsilanti/EMU	Every Thursday at 7:30PM in 402 Sherzer
Capital Area Astronomy Club	MSU/Abrams Planetarium	First Wednesday of each month 7:30 PM
Farmington Community Stargazers	Farmington Hills	Members: Last Tuesday of the month Public observing: 2nd Tuesday of the month
Ford Amateur Astronomy Club	Dearborn	Fourth Thursday of every month (except November and December) at 7:00 PM
Oakland Astronomy Club	Rochester	Second Sunday of every month (except May)
Seven Ponds Astronomy Club	Dryden	Monthly: generally the Saturday closest to new Moon
Sunset Astronomical Society	Bay City/Delta College Planetarium	Second Friday of every month
University Lowbrow Astronomers	Ann Arbor	Third Friday of every month
Warren Astronomical Society	Bloomfield Hills/ Cranbrook & Warren/ MCC	First Monday & third Thursday of every month 7:30 PM

GLAAC Club and Society Newsletters

Warren Astronomical Society: http://www.warrenastro.org/was/newsletter/
Oakland Astronomy Club: http://oaklandastronomy.net/newsletters/oacnews.html
Ford Amateur Astronomy Club: http://www.fordastronomyclub.com/starstuff/index.html
Sunset Astronomical Society: http://www.sunsetastronomicalsociety.com/
University Lowbrow Astronomers: http://www.umich.edu/~lowbrows/reflections/

WAS Member Websites

Jon Blum: Astronomy at JonRosie
Bill Beers: Sirius Astro Products
Jeff MacLeod: A Life Of Entropy
Bob Trembley: Balrog's Lair
Bob Trembley: Vatican Observatory Foundation Blog

Doug Bock: https://boonhill.org
Facebook: Northern Cross Observatory https://www.facebook.com/NorthernCrossObservatory
Boon Hill and NCO Discussion https://www.facebook.com/groups/369811479741758
YouTube channel: https://www.youtube.com/channel/UC-gG8v41t39oc-bL0TgPS6w

This article is distributed by NASA Night Sky Network

The Night Sky Network program supports astronomy clubs across the USA dedicated to astronomy outreach. Visit nightsky.jpl.nasa.gov to find local clubs, events, and more!

Become a Citizen Scientist with NASA!

David Prosper

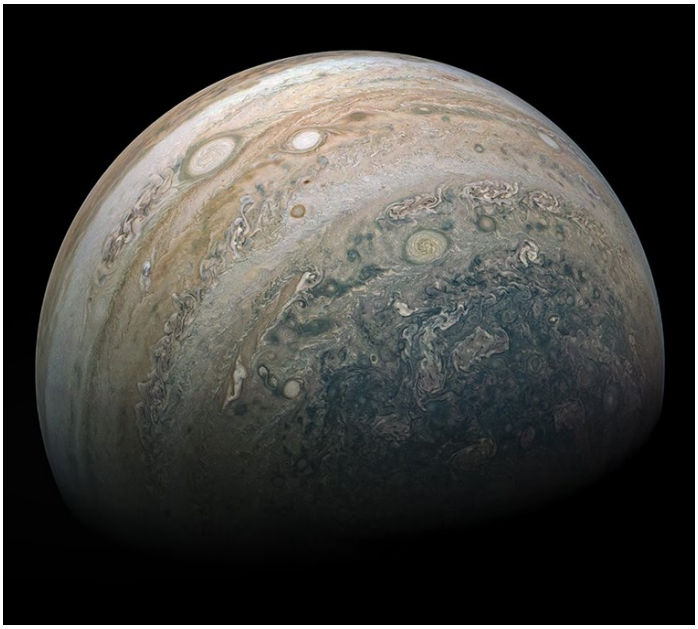
Ever want to mix in some science with your stargazing, but not sure where to start? NASA hosts a galaxy of citizen science programs that you can join! You'll find programs perfect for dedicated astronomers and novices alike, from reporting aurora, creating amazing images from real NASA data, searching for asteroids, and scouring data from NASA missions from the comfort of your home. If you can't get to your favorite stargazing spot, then NASA's suite of citizen science programs may be just the thing for you.

Jupiter shines brightly in the morning sky this spring. If you'd rather catch up on sleep, or if your local weather isn't cooperating, all you need is a space telescope - preferably one in orbit around Jupiter! Download raw images straight from the Juno mission, and even process and submit your favorites, on the **JunoCam** website! You may have seen some incredible images from Juno in the news, but did you know that these images were created by enthusiasts like yourself? Go to their website and download some sample images to start your image processing journey. Who knows where it will take you? Get started at bit.ly/nasajunocam

Interested in hunting for asteroids? Want to collaborate with a team to find them?? The **International Astronomical Search Collaboration** program matches potential asteroid hunters together into teams throughout the year to help each other dig into astronomical data in order to spot dim objects moving in between photos. If your team discovers a potential asteroid that is later confirmed, you may even get a chance to name it! Join or build a team and search for asteroids at iasc.cosmosearch.org

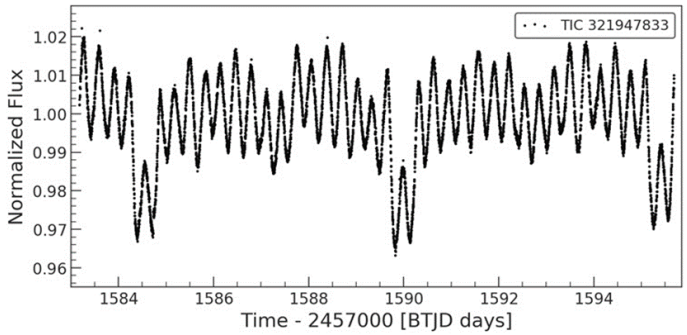
Want to help discover planets around other star systems? NASA's TESS mission is orbiting the Earth right now and scanning the sky for planets around other stars. It's accumulating a giant horde of data, and NASA scientists need your help to sift through it all to find other worlds! You can join **Planet Hunters TESS** at: planethunters.org

Intrigued by these opportunities? These are just a few of the many ways to participate in NASA citizen science, including observing your local environment with the GLOBE program, reporting aurora with Aurorasaurus, measuring snowpack levels, training software for Mars missions – even counting penguins! Discover more opportunities at science.nasa.gov/citizenscience and join the NASA citizen science Facebook group at facebook.com/groups/Sciencing/ And of course, visit nasa.gov to find the latest discoveries from all the research teams at NASA!



Left: GREAT SOUTHERN JUPITER: Incredible image of Jupiter, submitted to the JunoCam site by Kevin M. Gill. Full Credits : NASA/JPL-Caltech/SwRI/MSSS/Kevin M. Gill

Below: Light curve of a binary star system containing a pulsating (variable) star, as spotted on Planet Hunters TESS by user mhuten and featured by project scientist Nora Eisner as a "Light Curve of the Week." Credit: Planet Hunters TESS/NASA/mhuten/Nora Eisner



Last Word

Jonathan Kade, Publisher

Reaching out, in these uncertain times

Statewide Astronomy Night passed by with nary a whimper on April 17. International Astronomy Day is May 2, and needless to say there are no public events for it. It's very frustrating to see the most well-attended outreach events of the spring slip by without a single gathering. I bought my first zoom eyepiece from Orion recently, and when it arrived I told Diane it was for outreach. "What outreach?" she sighed.

However, there are a lot of things we're doing to keep the outreach torch burning. Many astronomy clubs across the state and across the world have gone into total hibernation until this is all over. Instead, the W.A.S. has redoubled our online programming, and has been able to keep our usual schedule completely stable. Thanks to members willing to try new things and experiment with giving online presentations using Discord and WebEx, we've been able to keep our presentations going. Thanks to Doug Bock's dedicated online observing, we've been able to keep showing the sky to the general public. And thanks to our many WASP contributors, Dale Thieme has been able to keep publishing a great newsletter!

Meanwhile, our members have been experimenting with new ways of doing outreach. I did some live lunar observing using my phone attached to my 10" dob, as previously discussed in this column. Jeff Macleod has been running a very successful several-times-weekly science show on Facebook, though we've simulcast it a couple times on our YouTube channel. Many members are sharing astronomy news and views with their families.

And it's paying off! We're actually seeing more new people participating than we have at in-person meetings in the past. We've seen family members joining meetings together, and even kids joining the fun. I'd like to challenge everybody to keep sharing what the club is doing with their friends and families, both to hopefully to get them interested in astronomy and astronomy clubs when this is all over, and to keep everybody a little closer at a time when it's too easy to feel alone.

While the lack of outreach opportunities is pretty hard on those of those who enjoy teaching and sharing, there are some upsides. I sometimes think back to a quotation from William F Denning's *Telescopic Work for Starlit Evenings*, as quoted in the April 1971 WASP:

> Every man whose astronomical predilections are known, and who has a telescope of any size, is pestered with applications from friends and others who wish to view some of the wonders of the heavens. Of course it is the duty of all of us to encourage a laudable interest in the science, especially when evinced by neighbours or acquaintances; but the utility of an observer constituting himself a showman, and sacrificing many valuable hours which might be spent in useful observations, may be seriously questioned. The weather is so bad in this country that we can ill spare an hour from our scanty store.
>
> Is it therefore desirable to satisfy the idle curiosity of people who have no deep-seated regard for astronomy, and will certainly never exhibit their professed interest in a substantial manner? Assuredly not. The time of our observers is altogether too valuable to be employed in this fashion. Yet it is an undisputed fact that some self-denying amateurs are unwearying in their efforts to accommodate their friends in the respect alluded to. My own impression is that, except in special cases, the observer will best consult the interests of astronomy, as well as his own convenience and pleasure, by declining the character of showman; for depend upon it a person who appreciates the science in the right fashion will find ways and means, to procure a telescope and gratify his tastes to the fullest capacity.
>
> Some years ago I took considerable trouble on several evenings in showing a variety of objects to a clerical friend, who expressed an intention to buy a telescope and devote his leisure to the science. I spent many hours in explanations &c.; but some weeks later my pupil informed me his expenses were so heavy that he really could not afford to purchase instruments. Yet I found soon after that he afforded £30 in a useless embellishment of the front of his residence, and it so disgusted me that I resolved to waste no more precious time in a similar way.

In that spirit, I'd also like to challenge you to improve your observing. Now that travel restrictions have been eased on travel to cottages up north, if you have access to another observing site in a darker part of the state, and if you can travel safely while maintaining appropriate physical distancing from other people, it's an especially great time to work on your own skills. Even if you're stuck in the metro Detroit area, there are plenty of skills you can work on anywhere: familiarity with the sky, ability to star hop, use of averted vision, and your expectations of what different objects actually look like visually. Or you can practice eyepiece astrophotography as we discussed last issue, or get more serious with real DSLR photography.

It's a running joke in certain corners of the internet right now that every sentence should be preceded by "in these uncertain times". The continued enthusiasm and participation of W.A.S. members is one thing that has remained certain, and for that I'm very grateful.

"Where is Extraterrestrial Life Likely to be Found?"

May 24 Presentation Notes

by Dave Bailey, April 2020

Two professors at the University of Washington, Peter D. Ward and Donald Brownlee, have written a book called Rare Earth, which has the sub-title: "Why complex life is uncommon in the universe". Complex life means things like humans and oak trees. Simple life means bacteria and such things, (many of which, however, differ more from bacteria than they differ from humans).

Extremophiles and un-bacteria

These creatures are so fascinating that they are worth looking at briefly.

Un-bacteria is a word I have coined, to describe organisms which sort of resemble bacteria but are unrelated. Many of them can survive and even thrive in extreme environments, such as very salty water, almost-freezing or almost-boiling water, water with significant concentrations of acids or bases, inside ice, inside a rock, total absence of light, total absence of O_2 molecules, et cetera. These particular species are therefore called **extremophiles** (not a word coined by me). Not all of these un-bacteria are extremophiles, and some extremophiles can get along in ordinary environments, although in those places they must of course compete with a large assortment of more conventional species.

I believe that all species do require liquid water for their growth and their reproduction. High salt content will of course allow some species to survive at somewhat below the normal freezing point of water. More remarkably, very high pressure, such as can occur at volcanic sites in the deep ocean, allows survival up to at least 169 degrees C. (That's a C, not an F!) Those species have to be very careful with their biochemistry, since some bio-molecules can fall apart at such high temperatures. That 169C number may have been exceeded by now; the Rare Earth book dates back to 2000 AD.

For me the most impressive extreme environment is the interior of a rock. Admittedly, many rocks do contain water molecules in at least trace quantities. Also, an impure, dirty rock should contain other essential elements such as carbon, nitrogen, sodium, magnesium, phosphorus, sulfur, et cetera.

A rock-resident faces more difficulties than just the issue of nutrition. It must excavate a cavity in the rock which is large enough to house the next generation of creatures. And if, as seems likely, sexual reproduction is advisable every few generations in order to limit the adverse effects of in-breeding, then it must digest its way thru the rock, in hopes of finding a mating partner eventually. (Some ordinary bacteria do mate from time to time. The technical term for this behavior is conjugation.)

Complex life forms take a long time to evolve

I agree with Professors Ward and Brownlee on this point, although I tend to change the verb tense. I say, complex life evolved, past tense, surprisingly late in our Earth's history, and our Earth is the only life-bearing planet we know about. Our Earth, and our Solar System, may not be typical, and other stars and planets may become hospitable for life, and complex life, a lot sooner than our Earth did.

Ward and Brownlee are always pessimistic, so much so,

that they are willing to estimate that the number of human-like civilizations in our entire galaxy, capable of mounting Apollo expeditions to their planet's moon or moons, may be only one! That is, we may be alone in our galaxy!

I myself tend to be much more optimistic. Without doing any explicit calculations at all, I would guess there are 100000 such civilizations in our galaxy, not one. 100000 is really a tiny number, given the huge number of stars in our galaxy, many or most of which presumably have solar systems with planets.

It's also a huge number, given the rather short distances between stars. The expected distance to the nearest such civilization comes out to be only 171 light years! That is, the probability that the nearest one is closer than 171 light years is 50%. This number is based on a listing of 40 nearby stars, in Pasachoff & Kutner's book University Astronomy. I omitted our own Sun from the count. I counted binary stars as single, except I did count Proxima Centauri as a separate star, since it is so distant from Alpha Centauri A and B.

As one would expect from two university professors, Rare Earth is a carefully thought-through book. I certainly take it seriously, though I tend to disagree with its bottom line. (And I have spotted a spectacular numerical error, of a factor of 1000!) (To see the error, compare pages 267 and 282.)

Here are some of Ward's and Brownlee's assertions, many of which I agree with:

The age of the Earth is 4.6 billion years.
A variable star is likely to be inhospitable to life.
A star too bright in the ultraviolet is inhospitable to life.
A massive star is inhospitable to life.
A star with a short main-sequence life span is inhospitable to life, since the evolution of complex life may take longer than that.
A good solar system must include: 4 gas giants, including a good Jupiter
4 terrestrial planets
An asteroid belt
And a good Moon.
A planet with rotation tidally locked to its star is inhospitable to life. (I shall discuss this issue later in this write-up.)
Some disasters may be inevitable: Significant asteroid impacts
Other mass extinctions
Snowball Earth (global glaciation)
I.I.E. (to be discussed later)
The Earth must be the right size.
The ocean must be the right size.
The land-to-ocean ratio must not be too large or too small.
Chemical abundances are extremely important.

Plate tectonics is extremely important, and it is probably mandatory.
The characteristics of the Earth must be moderately time-stable. The ocean must continue to be the right size for a significant time, for example.

Various short-term disturbances must not occur, since the Earth can get itself "stuck" in a dysfunctional state, without being able to recover itself.
For example, there must be at least some continents of full-size. An Earth with only archipelagos: just lots and lots of Indonesias, Japans, Philippines, Caribbeans, and Aleutians, might not support complex life over the long term, even if it later did return to a large-continent regime. (I will not try to justify this assertion, since it comes from Ward and Brownlee, not from me.)

Through Earth history there has been a clear correlation between types of life and the prevailing temperatures on Earth. Thus extreme thermophile species, which can live at temperatures above 100 degrees C, first appeared 3.8 billion years ago, when Earth was very hot. But complex plants first appeared half a billion years ago, when Earth was much cooler, like 45 degrees C max. This insight comes from Schwartzman and Shore, 1996, and it may be vulnerable to the classic Latin fallacy of "post hoc ergo propter hoc" (After it, therefore because of it.) Perhaps in truth the evolution of complex plants caused the Earth to cool significantly, not the other way around. Both are possible.

Today, we humans vote with our bathtubs on this issue. We enjoy our hot showers, not cold showers, so evidently we think our present-day Earth is slightly too cold. As global warming accelerates, we may think again.

On page 3 we will list some useful stars and planets

Note on general accuracy: Do not regard the listings below as authoritative. I got these data from different astronomy books, of different publication dates. Books differ in how they list particular stars. Two different books list the star Alpha Centauri B as K0, L=.42; and K5, L=.36 for example. Unbelievably, Sirius also!

Note on distance: The stars listed are all near-by stars, but this is surely not a complete list. The second nearest, Proxima Centauri, is not even included in my list. The nearest of all, our Sun, is included.

Note on the 'spectral type' column below: Highly trained astrophysicists know how to get a lot of information about a star just by decoding its spectral type and referring to the appropriate books. On the other hand, I myself have only about a dozen of the appropriate books, most of which are out-of-date.

Note on white dwarfs in multi-star systems: Regardless of the white dwarf's present mass, we can assume that it started out as the most massive component. We know this because the most massive one will evolve faster than all the others.

Note on the 'luminosity' column below: A lot of the light from stars in the red part of the H-R diagram is invisible infra-red light! So listed 'magnitudes' for such stars do not tell us much about the energy output from these stars. Visual observers look at a star's visual magnitude. But astrophysicists usually concern themselves with its luminosity, which includes all wavelengths, from radio, through infra-red, visible, UV, x-rays , and gamma rays. In this write-up, we are mostly interested in the total heating effect on planets, so we use luminosity, not magnitude. This luminosity/magnitude ratio becomes significant in the spectral type K region, and it is huge in type M. At type M0 it's 4 to 1, and at type M8 it's 40 to 1! An astronomer who wants to study red dwarfs needs first of all a good infra-red telescope.

The 'M/L' column shows mass divided by luminosity, giving us approximate main-sequence residence times, relative to our Sun, which as we know is about 11 or 12 billion years. After its residence time expires, the star will either brighten into a moderate-to-low-mass red giant, or dim into a low-mass white dwarf.

For red dwarfs beyond about M3, with mass less than about 0.3 solar masses, **some adjustments have been made** to this M/L rule of thumb, as follows:

First, a sun-like star has a nuclear 'engine' which generates its energy. This core is approximately the inner 25% of the star, by radius. By volume, it's about the inner 1.5%. The stuff down there is very dense, so this small core has about 50% of the star's mass. To change my metaphor a little, the core is the 'gas tank'. When the core starts to run out of hydrogen fuel, the star's main-sequence time has expired, and it restructures itself, into red giant or white dwarf, depending on its mass. (The lightest ones skip the giant stage, and go straight to white dwarf.)

But, note that most stars have an outer convective zone, in which some of the energy is radiated outward, but most of the energy is not radiated outward but instead is convected outward by thermal convection. In the Sun, this convection zone extends from the surface down to the 71% level. In the dwarfs below 0.3 solar masses, it extends down to 25% and below, thus continually mixing fresh hydrogen fuel into the gas tank. So these lightweight dwarfs have access to all of their fuel, instead of only half. This doubles their main-sequence life spans.

Second, below 0.085 solar masses, we have a more important adjustment. These stars have cooler core temperatures, so cool that they cannot fuse ordinary hydrogen. They can, however, fuse deuterium, D (also called H^2 or ^2H, which should not be confused with H_2, molecular hydrogen.) They use the ordinary proton-proton chain, minus the first reaction step of the chain.

When you fuse deuterium to helium in this way, you find that it is not as good a fuel as hydrogen, providing only 88.5% as much energy, atom for atom. But there is a much more important factor than that: Deuterium is a scarce fuel! Only 0.015% of the star's hydrogen supply is the easily-fused deuterium. When you multiply these two numbers, you find that the deuterium supply can maintain the star on the main sequence for a time only 0.000133 as long as the hydrogen supply could, if the star were hot enough to fuse it, which it isn't,

of course.

Are all these lightweight stars brown dwarfs? Various astrophysicists differ as to their definitions of this term. I myself say that a brown dwarf is any object which either now or in the past relied on deuterium burning for most of its fusion energy. So anything between a planet and a red dwarf of 0.085 M0 is a brown dwarf.

Why do only 3 of the stars listed have names of their own?

We have Sirius, Procyon, and The Sun. And that's all. Well, Sirius B and Aldebaran B are wives, who go by their husband's name. Some are named after a constellation, in the Latin genitive case, plus a number or a Greek letter. Alpha Centauri. Tau Ceti. Epsilon Indi. 40 Eridani. So in English we have Alpha of the Centaur. Tau of the Whale. Epsilon of the Indian. Some have the name of the compiler of a star catalog, with the number of its line item. So we have Groombridge 1618. Krüger 60. And so on.

Sometimes it can get complicated, in spite of all efforts to be clear. One of my parents' professors at Yerkes Observatory was referred to (behind his back) as "van B", short for George van Biesbroeck (sometimes mis-spelled van Biesbrook and/or confused with E. Van Biesbroeck). Perhaps the "van B" nickname was a response on the part of his grad students to get even with his notoriously demanding attitude toward his observing assistants. At any rate, the star VB 10, which van B spotted as an interesting object, at one time was the dimmest star known. So VB 10 is short for van B 10, which is short for van Biesbroeck 10. An abbreviation of a nickname! It is also known as BD+4° 4048 B, which of course is the companion star of BD+4° 4048.

Continued on page 31

Some star-like objects which might favor life

Listed in order of mass, most massive first, with solar units equal to 1.00

Lum.	**Mass**	Size	M/L	Temp	Type	Name and Notes
23.5	2.3	2.4	.098	9230K	A1	Sirius A A young star, still on Main Sequence.
7.65	1.4	1.4	.18	6450K	F5	Procyon A **A sub-giant,** not so young.
1.6	1.1	1.05	.66	6030K	G0	Alpha Centauri A
.03	1.03	0.0084	—	27000K	DA	Sirius B **A white dwarf, high mass**.
1.00	1.00	1.00	1.00	5777K	G2	Sun Has used up half of its MS residence time.
.66	.84	.83	1.27	5570K	G8	Tau Ceti

The universe is not yet old enough for any red dwarfs below this line to leave the M.S.

.42	.79	.79	1.85	5250K	K0	Alpha Centauri B
.33	.76	.76	2.30	5250K	K0	40 Eridani A
.15	.67	.68	4.47	4350K	K5	Epsilon Indi
.077	.51	.63	6.62	3850K	M0	Groombridge 1618
.061	.45	.59	7.38	3720K	M1	Gliese 229A
.080	.44	.0136	—	14000K	DA	40 Eridani B **A white dwarf, low mass.**
.045	.40	.55	8.9	3580K	M2	Aldebaran B

Red dwarfs below this line have deep convection zones which double their life span.

.036	.27	.46	15.0	3500K	M3	Krüger 60 A
.020	.16	.39	24.0	3300K	M4	40 Eridani C
.011	.10	.33	38.2	3100K	M5	L726–8A

Many star-counters say the median main sequence star lies just about on this M5 line.

.0053	.10	.27	60.4	2800K	M6	L726–8B
.0025	.10	.22	80.	2600K	M7	Wolf 630C Also called VB 8

BOTTOM OF MAIN SEQUENCE (M = 0.085 M0)

Stars from .060 to .085 M0 can burn only the very small amount of deuterium which they contain. They soon run out of fuel, slowly cool, and end up as massive planets.

.0012	.06	.17	0.013	2200K	M8	VB10 **A brown dwarf,** like all stars in
.0012	.06	.17	0.013	2200K	M8	RG 0050 this mass range.
	.06	.04		2100K	M9	LHS 292 TiO and VO molecular bands
				1900K	L2	Kelu–1 **A brown dwarf.**
				1850K	L4	GD 165B **A brown dwarf.**
				1000K	T	Gliese 229B H_2O and CH_4 molecular bands.
0.00	.00095	.10	∞	170K		Jupiter **A planet.**

Some planet-like objects which might favor life

Listed in order of body diameter, largest first. * = number may not be accurate.

Dimensions are as compared to the Earth or the Moon, as follows:

E = Earth. M = Moon. au = astronomical units. d = days. y = years.

Primary	**Name**	**Diameter**	Mass	Semimajor Axis	Orbital period	Tide-locked rotation?
Sun	**Jupiter**	11.19E	317.9E	5.20au	11.86y	
Sun	**Saturn**	9.46E	95.17E	9.54au	29.46y	
Sun	**Uranus**	4.01E	14.56E	19.19au	84.01y	
Sun	**Neptune**	3.81E	17.13E	30.06au	164.79y	
Sun	**Earth**	1.000E	1.000E	1.000au	1.00y	
Sun	**Mars**	0.533E	0.107E	1.524au	1.88y	
Jupiter	**Ganymede**	1.514M	2.027M	2.784M	7.155d	Yes
Sun	**Mercury**	0.382E	0.055E	0.387au	87.97 d	3 : 2
Saturn	**Titan**	1.482M	1.837M	3.179M	15.945d	Yes
Jupiter	**Callisto**	1.381M	1.469M	4.891M	16.689d	Yes
Jupiter	**Io**	1.047M	1.214M	1.097M	1.769d	Yes
Earth	**the Moon**	1.000M	1.000M	1.000M	27.322d	Yes
Jupiter	**Europa**	0.903M	0.663M	1.745M	3.551d	Yes
Neptune	**Triton**	0.780M	0.291M	0.923M	5.877d	Yes
Sun	**Pluto**	0.667M	0.177M	39.53au	248.54y	to Charon
Saturn	**Rhea**	0.440M	0.025M*	1.370M	4.518d	Yes
Saturn	**Iapetus**	0.414M	0.030M*	9.261M	79.33 d	Yes
Pluto	**Charon**	0.374M	0.020M*	0.051M	6.387d	to Pluto
Saturn	**Dione**	0.322M	0.016M*	0.982M	2.737d	Yes
Saturn	**Tethys**	0.302M	0.009M*	0.767M	1.888d	Yes
Uranus	**Titania**	0.288M	0.059M*	1.139M	8.706d	Yes
Uranus	**Oberon**	0.259M	0.034M*	1.524M	13.46 d	Yes
Sun	**Ceres**	0.259M		2.77au	4.6y	
Sun	**Pallas**	0.144M		2.77au	4.6y	

I have listed Jupiter twice, as both a star-like object and a planet-like object, so that you can see how the listings splice together. With a luminosity of essentially zero, Jupiter has a 'main sequence lifetime' of infinity. Cloud top temperature varies with location on the planet and current weather conditions, so a typical value of 170K is listed.

Note that Jupiter is definitely not a typical brown dwarf / massive planet. Compare Jupiter with LHS 2924, which appears to be a brown dwarf which has run out of its deuterium fuel and now has started its final gradual collapse into a massive planet. LHS 2924 has shrunk to the size of Uranus, but it has 60 times the mass of Jupiter. And it's not a white dwarf, either. A typical low-mass white dwarf weighs 10 times more than LHS 2924, and is considerably smaller.

Jupiter, on the other hand, shows no sign of collapsing. It's perfectly happy the way it is. Jupiter isn't a massive planet. It's just an ordinary planet, a bit on the large side.

The main thesis of this write-up:

Almost all civilization-bearing solar systems will include at least one red dwarf star!

In this regard at least, we do live on a Rare Earth, since we orbit around a Rare Star, the Sun, which exceeds the great majority of stars in both mass and luminosity. In percentile terms, the Sun is at the 92nd and 94th percentile. Our Sun is certainly not a typical star.

What is a typical star?

First of all, let's define typical. We will look at all the light radiated by all the stars in the solar neighborhood. We will rank the stars according to their luminosity. The 'bright' stars will add up to half of the total light, and the 'dim' stars will provide the other half of the light. The 'typical' star will be the one right in the middle: brighter than each 'dim' one, and dimmer than each 'bright' one. OK, I just added up all the light emitted from a sphere 16 light years in radius centered on the Sun. It totals 34.75063 times the Sun. I included the Sun itself. Sirius A's contribution is 23 times the Sun. And that's well over half of the total. So we have only one 'bright' star (Sirius A). Every other star in our solar neighborhood is 'dim' according to our definition! And Sirius A, the brightest one, also qualifies as the 'typical' one!

This absurd result can hardly be a definition of typical. Let's try something very simple now. We just divide the total amount of light, 34.75063 Suns, by the total number of stars, which turns out to be 53. We get an average luminosity of 0.66 Suns. Good. Now we can just point to Tau Ceti, which has that amount of luminosity, and say, "That one there, that G8 star is typical."

Tau Ceti surely is more typical than either Sirius A or our own Sun, but it's still up around the 90th percentiles of mass and luminosity. Not very typical.

I would like to try a third definition. Let's rank the stars as before. But this time we will set aside the luminosity numbers, and only go by the ranking numbers. We will find the star which is exactly in the middle of the rankings. And we will see how bright that star is, and call that typical. OK, we know there are 53 stars in our neighborhood. So we should choose as typical the one which is ranked 27th. And it turns out to be Ross 780, a red dwarf of spectral type M5. It's brighter than 26 stars, and dimmer than the other 26. And it's .0016 times as bright as our Sun. That's a typical star, all right. Finally! So let's go with it.

A typical planet

Suppose we wanted to live on a planet with a comfortable climate, orbiting that typical M5 red dwarf star. Exactly where does that planet orbit? We just take the square root of 0.0016, and we get a semimajor axis of 0.040 a.u. For comparison, in our own Solar System, Mercury orbits ten times farther out, at 0.387 a.u. If Ross 780 should turn out to have a planet at 0.040 a.u. then that planet would have an average temperature similar to our Earth. But there's a catch. It's just too close to its star. This candidate planet would get tide-locked, for sure. If you traveled there in a space expedition, you would probably think its front side was a bit too hot and dry: about 242°F at the subsolar point, according to my rough mental calculation, assuming its atmosphere and albedo were both similar to our Earth. When you went searching for its water, you would find it all on the planet's cold back side, in the form of a gigantic ice cap. An entire Pacific Ocean, almost entirely frozen, perhaps 15,000 feet thick! I'm not a planetologist, but I would not be surprised to learn that geothermal heating, acting over millions of years, could melt significant volumes of this ice, which would occasionally vent out from under the ice cap. This process would be a cross between volcanism, iceberg calving, geyser action, and weather. The pressurized 'lava', made of mineral-rich ice water, might squirt out at speeds of 2 or 3 hundred feet per second, more or less. (That's a guess on my part, not a calculation. In any case, it could kill any person who got in its way.)

Maybe our candidate planet is not so typical as a life-bearing object, after all. Both too hot and too cold. So we want to avoid tide-locked planets.

Let's look at these red dwarf stars

Professors Ward and Brownlee state that the tide-lock phenomenon is enough of a nuisance to eliminate all red dwarfs from consideration as host stars for life.

I take almost exactly the opposite position. I like these low-mass stars. They are useful objects, because they can cause near-by planets to become tide-locked in a harmless way! You will soon see what I mean. Also, they exist in huge numbers. And these stars live forever.

Huge numbers! If I want to show that very hospitable planets exist in very large numbers, I will design solar systems which make use of very common stars. And it does appear that just about half of our galaxy's stars are of spectral types M5 thru M7. Lightweight red dwarfs, to make billions of good planets.

M5 thru M7, forever! Much much longer than the present age of the universe, anyway. Plenty of time for life to develop. Plenty of time for life to evolve from bacteria-like forms into plants and animals. Plenty of time to develop intelligence. Time for low technology, such as shoes for exam-

ple. Time for civilization to develop. Religions. More importantly, time for non-dysfunctional religions!

[We have very recently had a very close call with dysfunctional religion. What if Adolf Hitler had been born just a few years later, and what if his contempt for the Jews had not extended to include "Jewish science" (nuclear physics)? Then the German government suddenly gets very friendly, while the Nazi physicists secretly develop nuclear bombs, all the Jewish physicists being safely locked up in prisons. What then?]

To continue: Time enough to ponder the most sophisticated question of all: What is human consciousness and how does it work? On a simplistic level this is a very easy question, but the more you think about it the harder it gets. For example, a computer can easily say over and over, "I am conscious" but saying it does not make it true. For another example, if you key in the word 'spellcheck' and submit it, it will get flagged as an error. Spellcheck is unaware of its own existence, and so it is clearly not conscious! Now suppose you add that word to the dictionary. Now spellcheck is aware of its own existence. Does that suddenly make it conscious?

And into the future: Time enough for mid-level technology such as Apollo and space shuttles. Time for the terraforming of planets on the million-year scale. (Don't laugh. We have not yet figured out how to make Earth habitable for 1000 years, and certainly not for a million years. And Earth is the easiest planet of all to make habitable.)

And so on. Time enough for a civilization to develop high technology, such as star ships. Billion-year terraforming. Making human society totally sane. At that stage of development it will become feasible to destroy the Earth in less than one year. One all-out war would do it. So the chance of such a war occurring next year must be less than 0.000000001 (one chance in a billion). If we do not achieve this level of societal sanity, we will not have achieved billion-year terraforming.

How will we know that we have achieved sanity? We will have to wait and see. If we go for a billion years without producing one person as insane and as influential as Adolf Hitler, then we have succeeded. Hitler killed himself 75 years ago, so we have 999999925 years to go. We cannot prevent all insanity, so we must instead concentrate on preventing the madmen from achieving influence. We could start now.

Anyway. Enough of the future history of an infinite time span. Back to the low-mass stars.

A quick overview of the main sequence

Let's look at just three attributes of main sequence stars: Their luminosity L, their mass M, and the ratio of the two, M/L. We'll use solar units. One of my astrophysics textbooks lists the brightest of the main sequence O stars as shining at about 800000 L8. Wow! Close to a million times the Sun's luminosity. But the least luminous main sequence stars are probably at about 0.0025 L8, more or less, depending on where we say the main sequence ends. For our present purposes, I terminate the main sequence at M7. Beyond about M7, the stars burn only deuterium, and do not last very long as main sequence stars. Stars do exist way down there in gigantic quantities, but what do you call them? Are they brown dwarfs? Are they massive planets? Maybe we should just call them dark matter, since they are so very dim.

Now look at the luminosity range, from brightest to dimmest: 800000 / 0.0025 = 320000000. Wow again! The one star is 320 million times brighter than the other. It's like the difference between a powerful searchlight versus a penlight with a dead battery.

Next, we compare the stars' masses. That main sequence O star weighs in at about 60 M8, and the M7 dwarf at 0.085 M8. The ratio of those numbers is substantial, 706, but nothing like 320 million.

The third statistic of interest is the ratio M/L. It tells us, approximately, how much time the star can spend on the main sequence before its core runs out of fuel. A car driver will recognize that M is proportional to the size of his gas tank, and L is his rate of gas consumption. Since we are using solar units, M/L = 1.00 will refer to the Sun's life span: approximately 11.8 billion years. (I'm including the Sun's main sequence time plus its gradual sub-giant stage, but not the faster ramp up the Red Giant Branch.)

For the O star, M/L = 0.000075, which normalizes to only 0.9 million years.
For the M7 star, M/L = 34, which normalizes to 400 billion years. That's more or less forever, considering that the present age of the universe is only about 13.8 billion years

A recipe for long life: 2 stars. 1 low-mass, 1 medium-mass

My plan is to use a rather sun-like star as a source of light and heat for a planet chosen to be hospitable for life. We know the Sun itself is useable, but I don't want to use anything more massive than that because such stars will have shorter main sequence life spans. Also, the farther down the main sequence we go, the more stars will be eligible for this job. They will be a little less massive, and quite a bit dimmer.

Of course there's a problem. Eventually the dimmer ones of these light-and-heat stars will need to be so close to their planets that tide-lock will be a likely event, and ultimately a certain event. This will probably start to happen at a semi-major axis somewhere between that of our Mercury (0.39au) and our Venus (0.72au). The corresponding luminosities are 0.622 L8 and 0.850 L8. I want to reassure Ward and Brownlee, since they worry about this.

So to address this tide-lock problem,we will bring in a second star, of much less luminosity and somewhat less mass. Our planet will orbit around this secondary star, close enough so that it will surely tide-lock to the secondary, not to the primary. It will be like Earth's Moon, which is tide-locked to the Earth, not to the Sun. Once it is safely tide-locked thus, all the problems are solved.

I want the functions of these two stars to be clear. That is why I name them differently: The primary is called the light-and-heat star, and the secondary is called the tide-lock star.

Ideally, the tide-lock star would have lots of mass, but no luminosity at all. That is actually feasible. Just use a Jupiter, or a mature brown dwarf which has fully cooled off after burning up all of its deuterium.

Ideally, the light-and-heat star would have lots of luminosity, but no mass at all. That is of course impossible. But we have seen back on pages 3 & 5 how stars can differ a whole lot in their M/L ratios. So we pick one with a favorable ratio.

Moon-Earth-Sun. The topology of the alien solar systems

The Aliens live on their Moon, which orbits around their Earth. None of them live on their Earth. Their Earth in some cases is a lightweight red dwarf, and in other cases it resembles our Jupiter. In all cases their Moon is tide-locked to their Earth. I myself call their Earth by the descriptor 'the tide-lock star'.

The Moon-Earth system orbits around their Sun, which is farther away than their Earth. I call their Sun 'the light-and-heat star'. In a few cases their Sun resembles the human sun, but most of them are red dwarfs.

Humans who find the topology of the alien systems to be confusing, should be reminded that it is identical to the topology of their own moon-earth-sun system, the only difference being that the humans all live on their earth, not their moon.

Often alien children ask, upon learning that the human planet is not tide-locked, "Don't they get dizzy, spinning around on an un-locked planet?"

Can planets form in a binary star system? Yes.

Ward and Brownlee ask this question in their book, and I have at least a partial answer for them: Just count the number of large moons in our own solar system, which is of course a binary of Sun and Jupiter. I count 14. These objects orbit around secondary objects such as Jupiter, Saturn, and Earth, so we might call them S planets. S for secondary. Many people call them moons instead.

Now count those objects in orbits which enclose the Sun but not Jupiter. These orbit the primary star only, so they are P planets. My list on page 3 includes Mercury, Earth, Mars, Ceres, and Pallas, totalling 5. (For some reason I omitted Venus on page 3. Sorry. Also omitted are some fairly large Kuiper Belt objects.)

Finally, count the objects in orbits which enclose both the Sun and Jupiter. These are B planets, B for both, and I count Saturn, Uranus, Neptune, and Pluto. 4 of them.

So our own binary system displays a total of 2 dozen planets, including good examples of all 3 orbital types. The answer for Ward and Brownlee is "Yes, planets can certainly form in binary systems."

I list Jupiter as a planet on page 3, but if we are calling our system a binary, Jupiter is the secondary star, not a planet.

How slowly can a planet rotate and still be habitable?

Ward and Brownlee might say 24 hours is the limit, but I'm not that much of a pessimist. Earth's Moon clearly rotates too slowly for life at present, but if it had a deep enough ocean, it could harbor life. How deep is deep? I would guess 10 meters might be enough, and 100 meters would certainly be enough.

Setting aside the deep ocean issue, I would put the limit, for shallow water, between the day of Titania, at 8.706 Earth days, and Oberon, at 13.46 days. Call it 9 days. 216 hours. Life on dry land would prefer a faster spin than that, but we know that 24 hours works OK.

For many planets with marginal spin rates, the limiting factor would not be afternoon heating, but afternoon weather. I'm anticipating thunderstorms every day, with tornados most days. And maybe snow flurries every night, around dawn, in the high latitudes. By the way, the aliens on many planets, upon hearing about the extremes of Earth weather, are certain that Earth is an uninhabitable planet.

White dwarf stars?

At first, we might consider a white dwarf to be a very hospitable star for Earth-like planets, since it would have a very long and stable life.

But in almost all cases, the formation of a white dwarf is preceded by a red giant stage, which clears away all planets from the vicinity of the future white dwarf. An exception would be a moderately close binary, in which the expanding atmosphere of the primary star gets swept up by the companion star, so that a red giant never forms. We shall not attempt to analyze this unusual case.

The bottom line: Most white dwarfs won't have any planets at all. So they will not have any native life.

But how about non-native life?

Upon examining a diagram of the Sirius binary, I have realized that an alien star ship might be in orbit around the white dwarf Sirius B right now! This hair-raising idea assumes that somewhere in the Sirius solar system some planets have survived through the present white dwarf's red giant stage, either in the system's Kuiper Belt region or in the Oort Cloud or who knows where?

So let's check out this hypothetical. Recently the aliens arrived, maybe half a billion years ago. They took up residence on a Sirius planet, though many of them still live aboard the star ship. When they see a good solar system going by, they will all re-board the star ship and depart.

They had better hurry up. Sirius has a M/L life span of only about 1.2 billion years, and I'm guessing 75% of it may have expired already, so they only have 300 million years left before Sirius A evolves off the Main Sequence. The Sirius system is currently moving toward us at 8 kilometers per second, which is not very fast.

Looking at our system, they have good spectroscopic data on the four brightest planets: Venus, Jupiter, Earth, and Saturn in that order. They can easily see that Venus, Jupiter, and Saturn are totally hopeless. They guess that Earth and maybe a handful of un-discovered moons may be habitable or more likely terraformable. They have observed a few occultations of distant B-type stars in the Milky Way so they know there's a lot of junk out there orbiting our Sun. Asteroids, no doubt. Their most exciting data of course comes from radio. They can hear an inhabited planet that rotates in 23 hr 56 min! The bad news is that's all there is. It seems the aliens (us!) have not founded colonies anywhere.

The whole point, of course, for this little bit of fiction, is that even a solar system like Sirius, which maybe could never have given rise to life might nevertheless be inhabited now, by some space-faring people.

So, jst for fun, disregarding the actual history of the stellar evolution of the two stars, how do the numbers work out, in terms of light? OK, look at Figure 15.2, on page 579 of the excellent Modern Astrophysics text by Carroll & Ostlie. Sirius A's luminosity is about 35L8 (order of magnitude). At periastron the stars are separated by about 9 a.u. Squaring the distance and dividing, I find that the A star's light at the B star's location is 43% as bright as our Sun at our Earth's orbit. Either a planet or a star ship in orbit around the B star will be on the chilly side, unless we provide some additional insolation from the B star. As a trial solution, let's provide 75%. Then at periastron we have 118% and at apastron about 78%. (At apastron the A star is about 32 a.u. away, so its light doesn't add much.) OK, if we add another 3%, we have 121% and 81%. Good.

Now we need to know how near we must be to the B star, in order to get 78% of normal sunlight. Well, it turns out that Sirius B is just about exactly ten magnitudes dimmer than Sirius A. 10.12 magnitudes, actually. Ten magnitudes is a factor of 10000 dimmer. That, in turn, requires a factor of 100 closer. Closer than 9 a.u., so that's .09 a.u. Plus we need another factor of 81%/43%, inverse square rooted. Which all comes out to 0.0656 a.u. unless I have made an error. So for a comfortably warm environment one needs to orbit one's star ship 0.0656 a.u. from the Sirius white dwarf, which has a surface temp of 27000K.

That's pretty scary, or at least I find it so. The light is very very intense, and most of it is UV light. If anything should go wrong with your personal protection equipment, you will probably suffer severe sunburn within seconds. Think arc welder. Way hotter than that, actually. Note that I am not talking about the light from Sirius. This is Sirius B, and it's much worse, because it's so much hotter. It's comparable to the light from the fireball of a nuclear bomb. And it's coming from a tiny speck in your sky. And of course a nuclear fireball cools within seconds. This goes on for ever. Ironically, it doesn't even feel hot. It's just barely hot enough to keep your star ship warm. If you could turn it off, you would soon freeze.

Couldn't we orbit around Sirius A instead?

No, that won't work. If you took up a comfortably warm orbit around Sirius A, that would be fine for 50 years, but then here comes the white dwarf on its 50 year orbit. Its gravity throws your star ship into a hopelessly different orbit.

The real problem with Sirius B: Materials science

What material will you use for your star ship's outer surface? It must withstand nuclear-bomb-class UV radiation, for thousands of years. Oh, you say you are going to re-paint it every year? OK, but I'm not going out there with a brush!

The bottom line: There are really places where you can't go

And white dwarf stars are among them.

Back to red dwarf stars. Let's see some specifics.

OK. We shall continue to plan a search for combinations of heat-and-light star, tide-lock star, and habitable planet. Look back to the list of stars and planets on page 3. Just by coincidence, I seem to have listed 24 stars and 24 planets (and moons). Some of these objects will be more useful than others. So we will do some elimination:

'A' refers to the heat-and-light star.
'B' refers to the tide-lock star. (Or planet)
'C' refers to the habitable planet.

1. Divorce all the multiple stars. Single stars only. They can be used, singly.
2. No white dwarf stars. Don't go anywhere near them.
3. Nothing more massive than the Sun.
4. Sub-Main-Sequence stars can be used only as 'B'.
5. Giant planets used only as 'B'.
6. Add Venus.
7. Eliminate everything smaller than Europa.
8. Allow Earth and Venus as 'B'.
9. Remember that the names, "Europa", "Venus", etc. refer to objects with dimensions and characteristics similar to our own Solar System's Europa, etc. It may help to bear in mind that there is no star which is named M0 or M7. Likewise, the creatures which live on "Europa" do not speak English or Russian. They are aliens. Also, those creatures may not even be plants or animals. We are just looking for life of any sort, not necessarily intelligent life.

We have made some progress. Now we have:

Candidates for 'A' 13 objects From Sun down to M7 dwarfs
Candidates for 'B' 20 objects From M0 down to Venus
Candidates for 'C' 10 objects From Earth down to Europa

We can build a solar system by choosing A, B, and C, and then checking to see if the combination is realistic. Some will be large, bright, and massive; some will be small, dim, and delicate. Some will not be workable at all.

Here's a big one: Sun, Groombridge 1618, Earth. Here an Earth-like planet orbits around the M0 dwarf Groombridge 1618 and is tide-locked to it. That M0 dwarf in turn orbits a sun-like star which supplies lots of light and heat.

Here's a small one: Wolf 630C, Venus, Europa. Europa is tide-locked to Venus, which in turn orbits the M7 dwarf Wolf 630C. Here the primary star is extremely dim. This system could be quite close to our own solar system and go undetected. Suppose by unlucky chance it was aligned perfectly with the globular cluster M13 in our sky, or maybe M15. We might never see it!

A mid-sized one: Aldebaran B, RG 0050, Titan. Now Titan is tide-locked to the M8 brown dwarf RG 0050, which orbits the M2 dwarf Aldebaran B.

Here's one which doesn't work: L726-8A, Gliese 229A, Callisto. I have deliberately selected my 'A' from the lower part of the 'A' range, and my 'B' from the upper part of the 'B' range. The result is that in this particular case 'B' is more than 5 times brighter than 'A'! So the tide-locked Callisto

gets brightly illuminated on the side facing 'B'. Bad! The tide-lock star is supposed to be dim, and the light-and-heat star is supposed to be bright. I failed to verify that this is actually the case for this exact combination of bodies. Had I selected for my tide-lock star a planet with zero luminosity such as Neptune there would have been no problem.

There remain more issues to address

The 'A-B' orbit: Habitable planets want to be distant from their star, so they don't scorch. They also want a circular orbit, so that their seasonal climate contrast is minimized. Unfortunately in the case of stellar binary orbits these requirements tend to be contradictory. Round orbits tend to be very tight, and large orbits tend to be rather eccentric. Siirius has a large, eccentric orbit, for example. This correlation will eliminate most stellar binaries from serious consideration.

I think the best solution is not to get upset with these awkward star-star orbits. If you happen to see one which is both large and round, go ahead and take note of it. But there is no need to search for them. Otherwise, you should think, not in terms of an 'A-B-C' configuration of star-star-planet but rather star-planet-planet. In our own Solar system, we see only one star-planet orbit which is uncomfortably small: Mercury. Also only two which are uncomfortably eccentric: Mercury and Pluto. And of the large moons which I have listed, none has an awkward orbit. If our system should turn out to be typical in these respects, that is all good news. (I don't happen to know the eccentricity of the Ceres and Pallas orbits. But I'm not going to worry about these rather small bodies.)

I assume there is some significant difference between how stars form in binary systems versus how planets form in a solar system. That unknown difference would explain the differences in the resulting orbits.

There's another possibility, namely that almost all solar systems form with crazy, chaotic planetary orbits, and the resulting crazy, chaotic planets either never form life or never form intelligent life. That would explain why our Solar System is orderly and not crazy. We can only live in an orderly environment.

There is a Name for this idea. It is The Anthropic Principle. It is often applied to the Universe as a whole. There may be entire universes out there somewhere, in which everything is chaotic. The laws of physics there don't make any sense. Of course we could not possibly live there, because anything as complex as a human being requires an orderly environment. So we live in this universe, where the laws do make sense.

There are of course scientists who point to the apparent contradictions between Quantum Theory and pretty much the rest of Science. And they say, "Look, the laws of physics here don't make any sense. We do live in one of those crazy universes!"

Anyway, I think the Anthropic Principle probably does apply to the formation of stars and planets. So our own Solar System, at least, must be orderly.