

Focused

The Valley of the Moon Observatory Association Newsletter
(a non-profit science and astronomy education organization)



Winter 2016

Volume XIX Number 1

2015 Was an Amazing Year

By Robert Davis

2015 has been an amazing year for space exploration. We had everything from a flyby of Pluto to a unique map of the entire northern sky in the light of neutral hydrogen. If you knew about that last one I applaud you. We had the Dawn mission go into orbit of Ceres and discover what turned out not be observatory domes. They found 130 bright spots, including the Big One at about 55 miles across. There is still no certainty as to what the stuff is; the smart money is on hexahydrite. If that is the case then that could indicate that Ceres is oozing briny fluids from its interior on to the surface. So the mystery continues. But even if it turns out we found the answer already, the mystery of fluids flowing on Ceres will be mighty intriguing. The European Space Agency's Rosetta celebrated its one-year anniversary at Comet 67P/Churyumov-Gerasimenko. And not only that but Rosetta's lander, Philae, woke up and phoned home. The pair has made interesting discoveries over the past year, such as evidence for a daily ice-water cycle on and near the surface of comets, and first *in situ* detection of molecular oxygen at a comet. The trio made their closest approach to the Sun back on August 13 and the mission continues until September of next year. Japan has managed to put its Akatsuki spacecraft in orbit around

Venus after an engine failure back in 2010 caused it to fly past the planet. In fact, insertion into orbit occurred five years to the day of the failed attempt. ESA has launched LISA. LISA stands for Laser Interferometer Space Antenna, but one wonders how long it took before somebody went "Hey, that rhymes." Anyway, LISA will be testing technologies for detecting gravitational waves and paving the way for a larger, more sensitive detector: eLISA – the Evolved Laser Interferometer Space Antenna.

2015 gave us new results from the world's most sensitive dark matter detector. Who even knew we had the world's most sensitive dark matter detector? I feel so out of touch. It is called LUX, for Large Underground Xenon dark matter experiment, and it is located, in all places, in the Black Hills of South Dakota. No, I'm not making that up – the Black Hills are home to a dark matter detector. In any case, it has not detected anything but it has apparently allowed scientists to eliminate some candidate particles.

The year is coming to a close, it is the holiday season, and I'm feeling a little jovial so let's talk about KIC 8462852. You know, the star with the Dyson sphere - a giant alien megas-

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<http://www.rfo.org>

Public Events at Robert Ferguson Observatory

January 9, Saturday

Public Solar Observing 11 am – 3 pm
Public Observing Night 6 pm

February 6, Saturday

Public Solar Observing 11 am – 3 pm
Public Observing Night 7 pm

March 5, Saturday

Public Solar Observing 11 am – 3 pm
Public Observing Night 7 pm

April 9, Saturday

Public Solar Observing 11 am – 3 pm
Public Observing Night 8 pm

May 14, Saturday - Astronomy Day

Public Solar Observing 11 am – 3 pm
Public Observing Night 8 pm

June 4, Saturday

Public Solar Observing 11 am – 3 pm
Public Observing Night 8 pm

Evening public viewing is \$3 per adult, 18 years or older, plus \$8 per car parking fee. Donations accepted. Dress for cold nights!

RFO Classes (see Page 3)

Night Sky Spring Series

January 12	February 9
March 8	March 29
April 5	May 3

Be sure to check out our website at <http://www.rfo.org> for the RFO weather forecast and other interesting information.

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VMOA Mission Statement

The VMOA is a group of volunteer amateur
and professional astronomers organized as
a non-profit association to provide educa-
tional programs about science and astronomy
for students and the public. To that end,
the VMOA operates the Robert Ferguson
Observatory in Sugarloaf Ridge State Park in
association with California State Parks.

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President's Message

By Robert Davis



2015 has been an amazing year for space exploration. That opening line may sound somewhat familiar but it is ok. I only plagiarize the best. In this case though I'm talking about the exploration of space from RFO. At the last docent meeting, the number of visitors we had to date was right on course for setting a new record. The thing is, many of our public star parties were dominated by the Sonoma Nebula (aka cloudy skies). Visitors still came out.

Maybe they came out to hear one of John Dillon's lectures in his *Astronomy Before Telescopes* series. As a diehard small scope volunteer I was always in the parking lot and didn't get to see any of the star party presentations. John kindly did combined shows for docents on a couple of Wednesday nights but they conflicted with my bagpipe lessons. I play bagpipes (in case you hadn't heard – pun intended). Fortunately, I did get to see his last docent night presentation and it was brilliant. If you would like to see what I'm talking about, and I highly recommend this, go to YouTube and search for "before telescopes". Make sure you have plenty of time because you will want to watch all three installments.

Maybe they come up because they had so much fun last time they came up. Being in the parking lot I don't

really get to see faces but I do hear voices. After a while they become familiar. They may tell me their name, which I will most likely forget, but it is nice to hear a familiar voice and that is what sticks in my head. There have also been times when I don't recognize the voice right away but the speech pattern stands out. In any case, I can say without a doubt that we definitely get repeat visitors.

Whatever the reason, I'm sure it has a lot to do with our service department. I'm speaking, of course, about our docents. A company is nothing if it doesn't have a good service department; and we've got the best. One of my favorite times during a star party is when the crowd starts to dissipate and I end up with a small group of two or three people at the scope. There is time to really talk about what it is they are looking at and answer all their questions. I can hear that other small scopes are having similar conversations and I know the visitors are soaking it up.

I have put the most amazing thing about 2015 off long enough. RFO's new 40-inch telescope has been installed! When I came on board in 2002, the original 40" had already been replaced with the 24" that has been serving us so well for so long. Many thanks to Bill Russell for loaning us such a great telescope. It will be missed. Thinking back over the years, it has been pretty exciting to hear the various progress reports from the Project 40 team. Check out the website for more details (rfo.org/project40.html). I have not had a chance to look through it yet but I can hardly wait. A huge congratulations to the Big Four of Project 40: Larry McCune, Steve Follett, George Loyer, and Mark Hillestad. And a big thanks to all the other docents who have helped out along the way; even if it was just keeping Steve company during a grinding run. It was an amazing effort and it produced an amazing telescope. The

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RFO 2016 Class Schedule Night Sky Classes

Each class includes a lecture on the constellations of the season, their history and mythology, and how to find objects within them. Learn the bright stars and deep-sky objects of the night skies. After each presentation (sky conditions permitting), you will enjoy a review of the constellations in the actual night sky and learn how to find them for yourself. The constellations, and the objects within them, will be viewed through binoculars and telescopes, including the Observatory's 40-inch reflecting telescope, until or beyond 10:30 pm (depending upon interest and enthusiasm). The upcoming Spring Series classes will be held on Tuesday, January 12, February 9, and March 8 at 7:00 pm. Classes continue on March 29, April 5, and May 3 at 7:30 pm.

Fee: \$75 for 6-class series or \$23 for a single class

E-mail: nightsky@rfo.org to reserve a space in this popular class

Look for more information about RFO's Night Sky Classes online at <http://www.rfo.org>

Observing Labs

An intensive telescope observing session after a brief presentation on the night's theme.

Handouts/Observing lists provided.

Attendance limited to 6.

Fee: \$30.

For reservations, email: nightsky@rfo.org

Find more information on upcoming Observing Labs in the next issue of 'Focused' or online at <http://www.rfo.org>

Project 40 Is In the House

by George Loyer

After more than 12 years of effort and many important milestones on the way, we have reached a new milestone on the way to our final destination. The Project 40 telescope is in the west wing of the Robert Ferguson Observatory. In early December 2015, Bill Russell's 24-inch reflector was carefully and gently disassembled and stored in preparation for its new owner – is that you? Larry McCune, Mark Hillstad and Steve Follett then began the process of installing the telescope in its new home.

As we expected, Larry had to do some on site machine work to mate the telescope mount to the piers, drilling holes in the steel mount plates and into the piers to securely hold the telescope in place. Then the re-assembly of the telescope from its recent disassembly began, installing the three rocker bogey wheel assemblies on the mounting plates with positioning sheet between them that holds the centering shaft. On top of that the team dropped the azimuth ring attached to the thick plywood base also carrying the A-frame supports for the altitude bearings. Then the rocker box was installed in the altitude bearings and the struts and secondary cage were assembled on top of that. The primary mirror cell was slid into position and finally the optical elements were installed – the 40-inch primary mirror, recently coated by Viavi (JDSU/OCLI), the 16-inch tilted flat secondary mirror and, in a later session, the final optical assembly consisting of the diagonal mirror, the Paracorr coma corrector in the integrated focuser, and an eyepiece.

At this stage, it was time to balance the telescope and

the team was surprised at how little additional counterbalance weight was required to get the telescope balanced at the two critical positions, with the telescope pointing to the horizon and then pointing to the zenith. As we continue to tune the telescope with the final components, the biggest being a finder telescope, we will go back to this step a number of times.

The image you see of the telescope propped up on a bench was how it looked at that point. Now the team installed the altitude and azimuth drives. Some final adjustments were made to the components, cutting off a bit of excess altitude drive shaft and providing additional bearing supports on that very long shaft. The azimuth drive likewise went in smoothly once we remembered how all the pieces fit together in that very tight space under the telescope. Checks were made for any interference between moving parts, but the work in testing the mount in Mark's shop and driveway seemed to have paid off.

The drive uses servomotors and it measures the rotation of those motors as a way to roughly determine the location of the mount, and then compares that information to digital rotary encoders as a feedback mechanism. All of that is tuned with software supplied by SiTech, the maker of the drive system, in a section called Tick Determination. We took the telescope through that process and everything validated for the altitude drive, but the azimuth drive was showing some problems. The symptoms were that we could hear the azimuth servomotor sounding differently as

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Watching the 2016 Winter Sky

by Jack Welch

Jupiter reaches opposition on 3/8 and is thus the dominant observing object this winter. In *Leo*, it rises around 11pm at the beginning of the year and is up all night by March. Retrograde motion begins on 1/8. At opposition the disk size will exceed 44". The moon will be very near Jupiter around 10pm on 1/27, 8pm on 2/23, and 9pm on 3/21. There will be 5 *double shadow transits*: on 2/26, 3/4, 3/14, 3/21, and 3/28. Details of these and numerous other *Galilean satellite events* can be found in the "What's Up in the Night Sky" link at the rfo.org website.

By watching many of these Jovian satellite events one can note several things. First, before opposition, Jupiter's shadow is west of Jupiter so the satellites disappear into eclipse west of Jupiter. After opposition, they reappear from eclipse east of Jupiter. Jupiter's equatorial plane is tilted so that we are seeing it slightly from the southern side. The tilt is small enough that *Callisto*, which orbits furthest from Jupiter, can still pass in front of ("transit") or behind (be "occulted" by) Jupiter. However, it does so in the polar regions: transiting in the north and being occulted in the south. Finally, very near opposition, the satellites and their shadows transit very close to each other, possibly overlapping. Transits of *Io* on the evenings of 3/5 and 3/12 are the best times to observe this phenomenon, especially on 3/5, which is an RFO Public Star Party night!

Saturn is in the morning sky in Ophiuchus this winter, rising around 5am at the start of the year and around 1:30am by the end of March. Saturn begins retrograde motion on 3/25. The crescent moon is near Saturn (and Venus) around 6am on 1/7, and Saturn and Venus are very close together around 6am on 1/9. Saturn's rings are tilted at an angle of about 26° all year.

Venus continues as the "Morning Star" all winter though it will be low in morning twilight by late March. Besides being near Saturn in early January, Venus is near Mercury in early February with both joined by the crescent moon on the mornings of 2/5 and 2/6. These should be lovely sights for those with low eastern horizons.

Speaking of *Mercury*, it is having a fair evening apparition as winter begins, reaching a maximum altitude of 7° 45 minutes after sunset (or 5:44pm at RFO) on 12/31. It fades from view in the early few days of January but reappears late in the month for a fair morning apparition, reaching a maximum altitude of 7° 45 minutes before sunrise (or 6:32am at RFO) on 1/31. It is near Venus during this apparition and joined by the crescent moon on 2/5 and 2/6.

Mars starts the winter in *Virgo* and moves all the way to *Scorpius* by the end of March. A morning object, it rises

around 2am in early January and around 12:30am by late March. It is approaching opposition in May but remains small until about mid-March, when it reaches a diameter of 10".

The moon will produce *large tides* from 3/9 to 3/12 due to new moon occurring near perigee. This is the first of a 3-month sequence of large tides near the new moon. We have opportunities to see very thin crescent moons on the evenings of 1/10, 1/11, 2/9, and 3/9, and on the mornings of 1/7 (near Venus and Saturn), 2/6 (very near Mercury and near Venus) and 3/7 (very near Venus). See our website for additional details.

The moon is also now in the midst of a sequence of very close encounters with the very bright red-orange star *Aldebaran* in *Taurus*. Several of these encounters will involve *lunar occultations* when we see the moon pass in front of the star. Two are this winter, on 1/19 and 2/16. Again, see our website for details. There will three more occultations of Aldebaran viewable locally this year, in April, August and December. Besides Aldebaran, the moon will occult bright stars on 1/21, 2/15, 2/16, 3/12, and 3/21 (see website).

For avid eclipse watchers, there is a somewhat subtle deep *penumbral lunar eclipse* on the morning of 3/23. The southern half of the moon should dim noticeably for at least 20 minutes before and after eclipse maximum at 4:47am.

The *absence* of the moon helps us observe two additional phenomena this winter. First, we will have a moonless sky for the *Quadrantid Meteor Shower* from about 11:30pm on 1/3 until moonrise at 2:16am on 1/4. This coincides with the predicted peak of the shower at midnight. However, the peak time prediction is very uncertain and can differ by many hours. If it occurs during this dark interval then anywhere from 60 to 200 meteors per hour are typical.

Second, moonless evenings around the equinox are good for observing the *Zodiacal Light* in the west after the end of twilight. The periods this year are between 7:40 and 8:30pm from 2/25 to 3/9 and again between 9:10 and 9:40pm from 3/25 to 4/7. You need to view from a site with a dark western sky that has no light pollution. The absence of bright planets in the west this year is advantageous. Caused by sunlight reflecting off of fine material in the plane of the solar system, it appears as a faint glow roughly equal in brightness to the Milky Way that rises from the west-northwest horizon, passes between the *Pleiades* and the bright reddish star *Aldebaran* then losing itself in the glow of the Milky Way of *Gemini*, exactly following the path of the *Ecliptic* and narrowing as it rises higher.

Continuing from the fall, the winter is a good time to observe the periodic dimmings of the famous “eclipsing binary” variable star *Algol* (“*The Demon Star*”) in *Perseus*. Eclipse minima are listed on our website. Part of a small “trapezium” of four stars, Algol is normally much brighter than the other three. But at eclipse minimum, it is similar to the others. Dimming is evident for about 3 hours before and after each minimum.

The *vernal equinox* occurs at 9:30pm PDT on 3/19 this year, bringing an end to winter.

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the mount was rotated. We spent a couple of night sessions characterizing the details of the way the mount was acting and diagnosed two issues. First, we measured the height of the azimuth ring as it rotated and found that it varied by a tenth of an inch and found that the variation appears to be caused by the mass of the telescope bearing down on the A-frame base and then on the plywood base. Even though there are force-spreading members bridging the A-frame base, the plywood was being bent down on either side, causing a sort of potato chip shape. And second, we were able to identify some “hills and valleys” as we moved the telescope in rotation by hand, and we think that this is caused by one or more of the bogey wheels (there are six, two in each rocker bogey assembly) being flattened or otherwise dinged, since the “hills and valleys” are separated by a single rotation of one of the bogey wheels.

While we think these problems could be causes of the anomalies we are getting in the Tick Determination for the azimuth mount, that won’t be determined for certain until we fix them. The potato chip will be fixed by adding some more steel to the cross member and inserting a shim to counteract the force that caused the shape change of the base plywood. And the bogey wheels will be replaced – they are 6 years old and have, at times, rested for months with the telescope on top of them. We are switching to nylon-filled wheels to see if we can get a slightly harder (but not steel) wheel to resist that flattening.

We decided that we should test the drive system in tracking mode to see if we could continue with testing, training and opening of the telescope despite the errors in the azimuth drive. Over short distances, the drive seemed to be behaving without issues. So on a night when we finally had clear enough sky to see a star or two, we collimated the optical components. This process lines up the components so that they are pointed exactly along the optical axis through the center of their figures and involves making small adjustments to the mirror holders of the primary and secondary mirrors to aim them more precisely as measured with a standard laser collimation tool.

Once collimation was completed and the telescope was aligned with a temporarily mounted Telrad, we pointed the telescope for the first time at two bright stars and synchronized the drive to those two points. With the telescope pointed to one of those stars, we were rewarded with sharp star images that were round inside and outside of focus, the standard star test that validates the correctness of the primary curve and the rest of the optical system. As a bonus, the stars across the field had no visible coma, even though the Paracorr coma corrector had not been fine adjusted. In a fast F/3.6 telescope like this one, you would expect to see coma, star images that look like small comets, at the edges of the field. The coma corrector eliminates those with some carefully designed optics. And finally, we were able to do all of this image evaluation work without once touching the drive controls – the telescope tracked for 20-30 minutes with the star in the center of the field.

Now we were ready for the real test. We impatiently waited for M42, the Orion Nebula to rise high enough to see, in what were really crummy skies. Jet contrails were puffing up in the moist sky into straight-as-an-arrow clouds that would drift over Orion and the rest of the sky, slowly obscuring and revealing the sky to us. We finally couldn’t wait anymore and pointed the telescope at the object, even though the observatory wall blocked half of the mirror aperture. We often tell others about our work here by describing the “Wow!” moment that we give to our visitors when they look through a telescope for the first time. I think I can say that Larry, Steve, Mark, and I had a genuine “Wow!” moment of our own as we saw the Orion Nebula in a way that none of us had ever seen before. The Trapezium was sharp and there were many more stars in that field than I remember ever seeing before. The clouds of the nebula filled the field and we could see color in the field, indicating that there was enough light coming through the eyepiece to trigger the color receptors of our eyes. Using the fine motion controls of the drive we could examine the full extent of the cloud, wandering through that stellar nursery like a walk on a new trail in the park.

Well! Back to work! Docent training will begin in the week between Christmas and New Year. The first public event with the new telescope is scheduled on January 9, 2016, weather permitting. The process of tuning the telescope, the training, and the way we will use this instrument to present the sky to our visitors has just begun.

This milestone, especially that moment when we saw that the images were all that we had hoped for over the last 12 years, is one that we will remember for a long time. But it is a mere stopping point on the longer trail we are on, to

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Hunting for Earth-like Exoplanets with the JWST

By Loren Stokes

The James Webb Space Telescope (JWST) is slated to launch in 2018. The primary mirror is 6.5 meters (21 feet) in diameter and is comprised of 18 hexagon segments folded at launch. The telescope is designed to see the first stars and galaxies that formed in the early universe. Their light is now deeply red-shifted. The telescope's detectors will see only this infrared spectrum, not the visible light spectrum seen by the Hubble Space Telescope.

Although not designed to observe nearby exoplanets, the JWST should be able to investigate the atmosphere of exoplanets transiting their stars. The atmosphere surrounding an exoplanet will absorb specific wavelengths in the infrared as its starlight passes through on the way to the JWST. Water, oxygen, and carbon dioxide all absorb at specific infrared wavelengths. It will be a tough measurement, as only a tiny fraction of the starlight will pass through the exoplanet's atmosphere. The small absorption signals should end as the transit ends.

Ideally, an infrared-sensing telescope should image the exoplanet directly while blocking the exoplanet's starlight with a coronagraph. Currently, this can be done for only a few exoplanets orbiting very far from their star, typically a hundred times further than Earth's orbit. Imaging an Earth-like exoplanet in an Earth-like orbit around a Sun-like star is beyond the JWST's capability.

A future Earth-like exoplanet imaging telescope would need to be at least 12 meters in diameter. That would allow imaging about 30 Earth-sized planets around Sun-like stars found by the Kepler mission. Having a coronagraph block the star's light while imaging the planet in the infrared requires a telescope-pointing stability well beyond that of any space telescope to date, including the JWST.

The resulting direct image of the planet should reveal the planet's temperature and some atmospheric gases like water vapor, oxygen, and carbon dioxide, if present. The combination of apparent temperature (from the infrared spectrum) and strength of atmospheric gas absorption should indicate if liquid water is present on the planet's surface.

Consider what the Earth would look like through an infrared telescope a few light years away. The Earth reflects 30% of the Sun's intensity directly back to space. The 70% that is absorbed averages 240 watts per square meter over the Earth's surface. To be in equilibrium with this absorbed solar intensity, the Earth has to radiate this same amount of intensity back to space. According to thermodynamics, a body with a temperature of minus 18 degrees Celsius (0 degrees Fahrenheit) radiates 240 watts per square meter. So that should be the Earth's surface temperature. Sounds

pretty cold. Even if the Earth absorbed 100% of the Sun's intensity, the surface temperature would be only 5.5 C (42 F), still pretty cold.

As seen by the distant infrared telescope, the Earth does indeed radiate as if its surface temperature was -18 C (0 F). Yet the actual surface temperature, averaged over the globe, is 15 C (59 F). Natural greenhouse gasses (mostly water vapor, carbon dioxide, and methane) trap heat at Earth's surface and warm the surface by 33 C (59 F) compared to an Earth without greenhouse gasses. The greenhouse gasses absorb some heat radiated by Earth's surface, and some of that is radiated back to the surface. About 3 miles above the Earth's surface, where the temperature averages about -18 C, the net radiation to space is 240 watts per square meter.

I detailed the above to make an important point. Earth's natural greenhouse effect is quite strong, raising the surface temperature by 33 C (59 F). If we add to that greenhouse effect by just 10%, such as adding carbon dioxide to the atmosphere, Earth's surface temperature will increase by over 3 C (6 F). The altitude where the atmosphere drops to -18 C will increase by about 0.3 miles. This is the new altitude where the Earth radiates 240 watts per square meter to space. The last time Earth's surface temperature was 3 C warmer than now was 3 million years ago. The sea level was 80 feet higher than today's level.

Back to our infrared telescope peering at the Earth from afar. While we would conclude an average temperature of only -18 C, we would see strong absorption lines of water vapor, carbon dioxide, and methane. We would conclude the Earth has a greenhouse atmosphere that supports liquid water on its surface. Whether that average surface temperature is 15 C or 18 C (or even 10 C, an ice age) would not be determined. But any of these temperatures can support life.

Reference: "The Hunt for Earth 2.0", Alberto Conti and Mark Clampin, IEEE Spectrum, November 2015.

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structure causing the crazy signals being detected by the Kepler mission. A group of high school students came up to RFO a couple of weeks after the Internet became ablaze with Dyson sphere fever. They were from a sci-fi literature class (ok – how cool is that?) and they requested a talk on interstellar space travel and the search for extraterrestrial intelligence (SETI). That sounded like fun so I volunteered to put something together and figured if I didn't talk about KIC 8462852 I would probably get questions about it so I did some poking around and put it in the presentation.

Just to give you some background, the Kepler mission was designed to find extrasolar planets by keeping a close eye on about 100,000 stars and looking for a characteristic dip in the stars light. The dip indicates that a planet may have moved across the face of the star. The signal coming from KIC is anything but characteristic. Nobody knew what to make of it so naturally the mass media went for aliens.

Like I was saying, I did some poking around. There was plenty of information about Dyson spheres. This particular Dyson is not the vacuum cleaner Dyson but a theoretical physicist and mathematician who came up with an idea back in the sixties to harness all of a star's energy. All you have to do is build a sphere around the star and all of that energy is now at your disposal. Clearly this thing is not a Dyson sphere because if it was we wouldn't see any light coming from the star at all. There may be some light signal that could be detected but it would not be what Kepler was designed to detect. So the next best thing is a Dyson swarm. This would not encase the entire star; it would be a vast array of solar energy collecting devices. This megastructure would have to be the size of about 20 Jupiters. That is almost 6 trillion square miles. I'm a fan of Arthur C. Clarke and I like his quote: "Any sufficiently advanced technology is indistinguishable from magic". So could one of these seemingly magical structures be built? Most of the information I gathered said no way. The largest problem is that gravitational tidal force of stars is too strong. There is no material strong enough to stand up to a star and any imbalance in the structure would cause its immediate destruction. I'm a skeptic at heart but most of the engineering problems seemed to be based on human standards. Just because we don't have any materials strong enough doesn't mean science could not develop some in time. Everything else is just implementation details that we don't have the answers to. They are unimaginably difficult but maybe not impossible.

There was one aspect about building a structure on this scale that I was surprised I didn't see anybody address. Even my good friends from Astronomy Cast didn't talk about it. Pamela and Fraser aren't really my good friends. I've just been listening to them for so long it sometimes feels like they are. The thing I was looking for was how long it would take to build. Since nobody provided me with an easy answer I did some calculations of my own. Granted I'm not a mechanical engineer and the most sophisticated thing I've ever built was made out of Tinker Toys. Although I have seen some amazing things made out of Tinker Toys (Google for Tinker Toy computer sometime). Here, for what it is worth, is what I came up with. The largest building complex on Earth is a Boeing 747 factory.

It has a footprint of nearly one square mile. A large portion of that area is open space to store the planes on. It took two years to build. Building one square mile every two years, it would take longer to build the structure than the Universe has been in existence by several orders of magnitude. Maybe they have giant Star Trek like replicators that can just crank out monstrous solar collector panels at the rate of 1 square mile a day. We are still looking at over 16 billion years and still longer than the Universe has been around but we are getting closer.

So the basic conclusion I came to was that the whole idea of a Dyson sphere is to harness the vast energy of a star. But, just for the sake of argument, let's say you have a civilization that can process raw materials on the scale of solar systems (because it would take several planets worth of matter to build something this big). They would also have to have a fleet of interstellar ships capable of hauling that material from distant solar systems to the parent star. I'm assuming one wouldn't mess with one's own solar system, but maybe there is a way to keep your own planet in its orbit while you dismantle the rest of the planets. But then again there is that replicator idea. It would have to convert energy into matter. Einstein showed us that this is possible, but the rate of exchange is the speed of light squared. In other words, the amount of energy needed to create enough matter to make a mega structure energy collector seems self-defeating. In fact, it seems to me that if you have the technology that would enable you to build a Dyson sphere – you don't need to build a Dyson sphere. I think you would have solved your energy problems already. But let's suppose there is a need for that much energy. I still don't see where the time to build it would come from. But then again, Santa Claus makes it around the world, stopping at the good children's houses to drop off presents and eat cookies, in a single night; so what do I know.

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plan is to have it up and running for the first public star party of 2016 on January 9.

So whatever reasons our visitors have had for coming up to RFO, we are about to give them a really big one. Forty monstrous inches of light gathering capability that is sure to give them views of the wonders of the universe they won't soon forget. Season's Greetings and Happy New Year – and what a year it is going to be!

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bring the Universe to our visitors, to enrich the experiences of our docents, and to inspire others to try to do what they are not quite sure they can do. Join us in the coming years to look through this new window to the stars.

Valley of the Moon Observatory Association

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