nightwatch
Newsletter of the Pomona Valley Amateur Astronomers

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President's Address

Well, I just got back from this year's RTMC Astronomy Expo. All the people involved do such a great job putting this event on every year. While there, I picked up a couple of eyepieces for a very good price. Laura Jaoui bought a parallelogram mount and tripod for her binoculars. Bob Griffin was up to attend a workshop on astro-imaging. Joe Hillberg and Craig Matthews were at the annual swap meet looking for bargains and selling off a few things. Jim Bridgewater tried out and purchased a new telescope. I saw Bill Connelly but didn't get a chance to talk with him. Oh, and I won a prize in the drawing, a star pillow, astro-calendar, and gift certificate for one of the vendors.

As far as the observing part of RTMC goes, this was the year of **BIG** telescopes. I have never before seen so many huge amateur telescopes in one place at one time. PlaneWave Instruments brought a 42-inch F/6 CDK [Corrected Dall-Kirkham] telescope out. I got to look at the Sombrero Galaxy through this scope. The design of the 42-inch allows one to observe from the eyepiece using only a four-foot step ladder. Pretty amazing for an F/6. Although I didn't get to observe with either, there was also a one meter scope and a third scope of approximately one meter aperture.

Unfortunately, attendance at the 2010 RTMC was down. Several factors could have contributed to this. The economy and the date change from Memorial Day weekend were perhaps the most significant. But, I believe those who did show up had a great time. I know that I did.

Time is running out to sign up for the Mount Wilson 60-inch scope observing session. The fee is $100 per person. I know that sounds like a lot, but I can't think of anything that costs a hundred dollars and has brought me more pleasure than a night observing with the 60-inch scope. A maximum of 25 are allowed to attend so get your name in soon. You won't want to miss out.

Our speaker in May is Dr. Eric Grosfils. Many of you will remember that Dr. Grosfils has been kind enough to speak to us on previous occasions. He is a professor of planetary geology at Pomona College and will be speaking on the surface of Venus. Actually, he will be in Claremont and his topic will be the surface of Venus. Sorry, I guess I'm still a little goofy from all the fun I had up at RTMC.

Happy stargazing !

Ron Hoekwater

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April General Meeting

Gary Thompson shared with us his experience doing an event for the blind with Project Bright Sky at Joshua Tree State Park. Take a look at the amazing events Club Member Frank Busutil puts on at http://brightsky.pvaa.us/.

Our speaker was member Matt Wedel, teacher of Anatomy at Western University of Health Sciences by day and amateur astronomer by night. We learned of the characteristics of meteor craters, a fairly new science dating only to the start of the 1900s when Daniel Barringer bought land around the crater to be named for him. His searches for a huge iron impactor were futile as were Barringer's hopes of becoming rich from the find as the remains found after meteor impacts left behind much smaller and therefore less valuable chunks of iron ore than he had hoped for. What he may not have predicted was the extreme value some meteorites would come to have due to their rarity and extra terrestrial origin.

Matt then shared his theory that the Chicxulub crater, in combination with the extreme lava flows in India known as the Deccan Traps and the gradual reduction in the size of the Earth's oceans combined to lead to the extinction of the previously most successful group of creatures on earth – the dinosaurs. Thank you a very interesting evening, Matt.

Well, back to an entirely terrestrial subject, some of you know that John and I have been planning to move to the Sacramento area for months now – and the move continues. What has changed is that I've finally started to work out of an office up here, so am spending the majority of my time unpacking the boxes we've been packing up down south. In case any of you have considered a more rural life, here are a few tales of my first weeks in our new home:

Life has been really busy for me lately – can't believe it has only been 1 month since I last took the train to work in El Monte. I'm getting used to the new home, new place to work, and driving a car 80 miles a day…

After a few days packing up the essential items I really needed to life and work up north, John and I drove up in 2 cars Saturday April 24th. We spent Sunday emptying the cars and putting things in place. Reported to work at my new desk Monday morning.

Week 1

Sunday's best news – got an old microwave working so I don't have to cook everything in the oven or in a pot on the stove. Cats are amazed at all the wildlife outside. Finally saw the barn owl we hear hooting outside every night. I did remember my favorite chair so I can sit outside and enjoy the beautiful scenery – once I have time to do so. Did not, however, remember my favorite hairbrush. Fortunately found some thistles and sticks in the yard to use ;)

Monday's big successes – making it to work and back home without needing a map and without driving into the Sacramento River or standing on a corner waiting for a bus or a train to pick me up. Cats still come to house to eat (haven't eaten all the wildlife yet). Found a few others at work who like to walk, so we did on a beautiful sunny day. Monday was animal day – saw a gopher snake (alive) sunning himself on the road, bits of dead rabbit (due to the owl?), and a dead gopher (cat enjoyed for a snack), tons of live birds, and heard bats doing their sonar/radar thing in the bat boxes.

Tuesday's news – It rains here – have a raincoat in case we attempt another walk. Another dead gopher. Who is killing stuff and not eating it? How wasteful! Not fresh though, and I still have some leftovers so…

Wednesday – John left for the South again on Tuesday so I spend some time finding an extension cord in case I need to charge the car's battery on my own. Have no key to the workshop so can't get to the air compressor. Will impose on the one neighbor if necessary, and if he's home. Hello, I live next door – may I borrow a few cubic feet of air?

Thursday – Corn in the field to the north is about 3 inches high. Cantaloupe is to be grown to the south – no sign of it yet. Dead gopher #3 – I now have a brush pile designated the Dead Animal Pile.

Over the weekend - we have 3 bat boxes, located under the eaves of the workshop. We have been hearing squeaks and noises coming from the boxes for days – especially in the evenings. Over the weekend, one got loose from inside the walls near the roof and flew around inside for awhile. Cool to finally see one.

Week 2

Tuesday 5/4 – By email, I alert a friend in El Monte that an asteroid will come close to Earth the next day, but of course CLOSE is a relative term. It will come only 8 Earth-moon distances away, or 2 million miles. He is advised that wearing his aluminum foil hat the next day as it passes by should suffice.

Tuesday night's fun – The Bats come out to feed. John is working outside around 8 PM. Looks up to see about 20 bats come out from one of the bat boxes! Then another bunch – and then another – then from the area around the 2nd boxes. He figures about 100 of them all together. I'm planning to sit outside myself tonight and will see if I can catch the spectacle!

Wednesday night – I go out around 8PM to try and see the bats and I'm in time. Lots of chattering leads up to 6-7 bunches of bats heading out from under the corrugated workshop walls and roofing. Whole show takes place between 8:12 and 8:19. At around 8:25, I discover why bats are such valuable members of our new household. I'd been wearing long pants, shoes and socks earlier in the evening but came outside in just long pants and Crocs for my bat watching. Guess what? There are a few inches of exposed skin between the pants and the Crocs and the mosquitoes have discovered this. I now have two "bite ankle bracelets."

Shopping list addition: More cans of Off and a string for my finger so I remember to apply it EVERY TIME I leave the house around dusk.

That's it for our country tales. I hope to come back soon for a visit when things slow down a bit. Hope you are all well – and be sure to let us know if you are around Sacramento, we'd love for you to stop by!

Claire Stover

The World's Largest Telescopes,

Welcome to the first installment of what will hopefully become a series of mini-biographies of the largest telescopes through history, from the 1.5 cm clear aperture of Galileo's 1609 refractor to the 10-meter-plus behemoths of today. Before we begin, though, I need to explain a few caveats and design decisions.

I intend to start at the present and work backward in time. I know more about the largest telescopes of the 20th and 21st centuries and working back will let my research run ahead of my writing. Also, although the title is "The World's Largest Telescopes", I'm really only considering single-aperture optical telescopes. The second part is easy to explain: most amateur astronomers, whether visual observers or astrophotographers, tend to stick to the visible part of the spectrum, and that's what most people have in mind when they think of the world's largest telescopes—colossal radio telescopes like Arecibo notwithstanding.

The decision to stick to single-aperture telescopes was harder to make and more difficult to justify, but basically it means cutting out telescopes that achieve the greatest effective aperture through interferometry (combining the light from multiple apertures). That's mainly a personal bias--I want to know what is the largest single telescope, not the largest system of telescopes--but it does affect who's in and who's out. Some sources list the Large Binocular Telescope (LBT) on Mount Graham, Arizona, as the reigning world champion, because its two 8.4-meter primaries can work together to produce the equivalent of an 11.8-meter telescope. But the twin 10-meter Keck telescopes can also work together, as can the four 8.2-meter reflectors of the Very Large Telescope, so it's not clear why those observatories should not be considered the "largest" telescopes. I understand the scientific benefits of interferometry--mainly improved angular resolution--but I want to focus on the largest single image forming devices.

Part 1: Gran Telescopio Canarias

Currently, the largest single-aperture optical telescope is the 10.4-meter Gran Telescopio Canarias (GTC) on La Palma in the Canary Islands, which is just slightly larger than either of the 10-meter Keck telescopes on Mauna Kea. The GTC is unusual for more than just its record-breaking aperture. Most large telescopes these days are built by large multinational consortia. The GTC was first conceived in the late 1980s as a joint project between the United Kingdom and Spain, but in 1990 the British elected to pursue the Gemini project with the US and several other countries. Such decisions are not unusual--in the past few decades, many more large telescopes have existed on paper than have come to fruition as working instruments. What was remarkable in the case of the GTC was the decision by the government of Spain to continue on alone rather than scrap the project. Eventually they found international collaborators—the University of Florida and a pair of universities in Mexico each contributed 5% of the project budget in return for 5% of the observing time on the completed telescope. Nevertheless, the GTC is unique among today's monster telescopes in having been funded almost entirely by one country (other than the US).

I can't tell you much about the scientific achievements of the GTC because the world is waiting to see what they will be. Although the telescope saw first light in July of 2007, the scientific instrumentation had a long and troublesome development, and the telescope did not begin regular operations until late in 2009. In terms of light-gathering ability, the GTC is really only rivaled by the twin Keck telescopes, and gathers about a third again as much light as any of the 8-meter telescopes—LBT, VLT, Subaru, Gemini, and so on—currently in operation. Considering the immense scientific output of the Keck scopes over the past decade and a half, expectations for GTC are running very high. It is currently mankind's largest optical eye, and the Spanish can be justifiably proud of having brought it to completion. Stay tuned for more from this world champion—and for the next installment of the World's Largest Telescopes.

To learn more about GTC, visit the telescope's homepage at http://www.gtcdigital.net/. Click the British flag at the top right of that page to read the content in English

Mathew Wedel

Warped Stars Feed Black Holes

by Rachel Courtland

Rachel explains that warped stars feed black holes to fatten them up and gives the reason to the fact that the huge amounts of gases are believed to be the formation of a skewed ring of stars, which would facilitate the flow of gas, by sapping its speed so that it spirals in towards the back hole. It has been a mystery on how enough matter can reach these cosmic gluttons to swell them to such large sizes. The answer seems to be connected to a starry disc at the heart of the Andromeda Galaxy and it is stated that it may be hard to see such discs though they are thought to be common. Black holes are considered millions or billions of times as massive as the sun and reside at the heat of most galaxies. The thought is that the black holes have been flattened by huge amounts of gas, but astronomers don't know how the gas makes it through its final hurdle, migrating the last dozens of hundreds of light years to be eaten by the black hole.

Phillip Hopkins and Eliot Quataert of the University of California Berkeley make the suggestion that there are simulations that show that when there is enough gas present to prompt significant amounts of star formation, the newly formed stars orbit a black hole and align to create an elliptical disc that will stretch out dozen of light years from the centre of the galaxy. This oval structure tugs unevenly on incoming gas, causing different streams to collide. The gas will lose momentum and eventually it will get close enough to the black hole to be swallowed up. It is suggested that in this way the black hole could consume as much as 10 solar masses of gas each year. Hopkins makes the comment that it would be enough to feed galactic black holes at the peak of their gluttony, some 10 billions years ago.

It is believed that evidence may be in our neighboring galaxy. Andromeda sports a "double nucleus", two bright spots at the heart of it, which is thought to be a sign of an oval disc of stars and gas.

Andromeda is not unique in the fact that what they see there is likely to be commonplace and therefore the test would be to see whether other galaxies have this stellar feature found in other galaxies.

John Bratton Sr.

How Does It Work?

Ron likes to see old photons but the question has been raised, "How old are they?" The first bit of information we need is the redshift, the value of "Z." What is it?

Hydrogen is the most abundant element in the outer reaches of any star. It is simply a proton with an electron orbiting it. Quantum Physics has explained that the possible orbits are separated by a fixed amount of energy (quantized). When a photon of that energy is absorbed by the hydrogen, it is absorbed by the electron and the electron is kicked loose from the nucleus. When we look at the spectra of light passing through hydrogen, the wavelengths that are missing are those absorption lines. It is observed that all stars have the same hydrogen absorption lines.

The factor Z is equal to the wavelength shift divided by the emitted wavelength. We can measure the shift. To go from knowing Z to knowing the age of the source, however, is much more complicated. Wikipedia (http://en.wikipedia.org/wiki/Redshift) gives a good explanation. (The photon frequency times the wavelength equals the velocity of light.)

There are three sources for redshift. One source of redshift is gravity. Wikipedia covers this, but the explanation involves an understanding of Special and General Relativity as well as calculus. I leave that as an exercise for the reader.

For distant galaxies, the red shift is caused by the expansion of the universe. It is called the metric or cosmological redshift. As the photon travels through space and time the wavelength is "stretched" as the universe expands. The red shift is thus proportional to the difference in density and 1 + Z equals the ratio of densities. This explains why Hubble observed that the red shift was greater for older sources.

The Doppler effect causes the redshift for nearby sources. Just like the train whistle, the frequency appears to shift depending on whether the source is coming or going. Thus, stars which are going away from us have the hydrogen lines shifted toward the red by an amount which depends on the speed of separation.

Within our galaxy, and nearby galaxies, the density hasn't changed much since the light we see was emitted. The redshift is then a simple measure of the relative motion. Most stars will have very small values for Z. For Andromeda it is only slightly more complicated. The galaxy is moving toward us, so the center shift is blue. For any star within that galaxy the shift is more or less depending on whether the star is moving toward or away from us.

To get the time (age) from the redshift for distant galaxies, we must know the Hubble constant and the relative density of the universe at the time the light was emitted. These two factors, as most club members will recall, have changed with the various models of the expanding universe which have been proposed over the years. The answer depends on which model you pick. But if Z = 7, the age is about 13 billion years. The visible light we see was emitted in the short ultra violet.

Ken Crowder

Club Events Calendar

May 21, General Meeting - Dr. Eric Grosfils,

"Puzzle Resolution in Progress: How Old is the Surface of Venus?"

Dr. Eric Grosfils is a Pomona College professor of Geology and the recipient of the 2001 Biggs Award for Excellence in Earth Science Teaching from the Geological Society of America. At Pomona College he teaches planetary geology. Dr. Grosfils has helped students participate in several NASA-funded investigations of geological processes on Venus and Mars. These efforts have focused primarily on assessing the formation and development of volcanic and tectonic features in order to understand how the complex geological surfaces of the two planets formed and evolved. These research efforts commonly integrate analysis of NASA planetary exploration data with numerical modeling and at times field work.

Dr. Grosfils has often been involved in research projects with colleagues from the Jet Propulsion Laboratory (Pasadena, CA), Smithsonian Institution (Washington, D.C.), University of Notre Dame (South Bend, IN), Lunar and Planetary Institute (Houston, TX), University of Nevada, Reno (Reno, NV), and/or Trinity University (San Antonio, TX). Since starting at Pomona College in 1995 Dr. Grosfils has received two NASA-ASEE Summer Faculty Fellowships (Goddard Space Flight Center; Jet Propulsion Laboratory) and a Part-Time Faculty appointment at the Jet Propulsion Laboratory. He has also spent time in residence at the National Air and Space Museum 's Center for Earth and Planetary Studies (Smithsonian Institution).

June 5, 2010, – Star Party – Mt. Baldy
June 12, – Mt. Wilson 60" viewing
June 17, Board Meeting
June 25, 2010, General Meeting

July 10, Star Party – White Mountain
July 20, Star Party – Ontario Library, Main Branch 7–9 PM
July 23, General Meeting - Bob Eklund and Al DeCanzio
Dialogue on the Galilean Imagination
August 7, Star Party
August 19, Board Meeting
August 27, General Meeting - Dr. Rachael Akeson
on Finding Planets Through Transits
September 4, Star Party
September 16, Board Meeting
September 24, General Meeting

October 9, Star Party
October 12, Star Party – Ontario Library, Main 7–9 PM
October 14, Board Meeting
October 22, General Meeting

November 6, Star Party
November 11, Board Meeting
November 19, General Meeting - Gene Serabyn of JPL

International Space Station Transits the Moon
Captured At Last by RAS Club Members

After months of hunting, several club members finally caught the International Space Station crossing the disk of the moon late last month.

Burton Briggs has been a long time leader of this effort. Some time ago he discovered a website that calculated time and earth surface centerline positions for transits and conjunctions of many satellites, and particularly the Space Shuttle and International Space Station.

One clicks into Calsky.com and inputs the observing position and how far one is willing to travel. Calsky calculates where one needs to be, and when, to observe a satellite crossing the disk of the moon or sun. They include an interactive Google Map of the "centerline." One must be within a few kilometers of the centerline to see a transit. Being on the line increases the chance of witnessing the event and also increases the length of the transit. From that point on, it is simply a case of driving there, and taking a picture of the moon (or sun) at the right time.

Oh, were it in fact that easy! Among the things one must deal with are:

- the rarity of the event (although the ISS goes around about once every 90 minutes, these transits of the moon or sun take place only about once a month in any locale),
- moon phases (you cannot see anything silhouetted against a New Moon or slight sliver),
- clouds (three of our trips were killed off by weather, one while we sat cameras ready),
- off beat locations (Cabazon seems to have more than its share of those nearby),
- middle of the night timing (who needs to catch a transit at 2:00 am?),
- work schedules,
- and equipment snafus.

Just after Christmas, Calsky's email alert system said there would be a transit in Moreno Valley, at 8:30 pm on December 29. So, Alex McConahay contacted the others in the transit chasing crew (Burton, David Morris, and Jim Redfield). Burton had moved up to Idaho. But the others managed to get together beside a dirt road in northeast Moreno Valley. The night of the big show, Alex had forgotten his computer, and so had to run home quickly. Jim's camera had performed beautifully during practice, but timed out and went to sleep as it sat idly awaiting show time. But, all in all, the trio were successful in capturing the shot.

For those who want to take their own shots, the procedure goes something like this:

Go to Calsky, http://www.calsky.com/ and follow along their screen prompts. When you finally get a hit, use the interactive map to find an ideal observing location. Light pollution does not matter much, but it helps to be off main streets and such.

Equipment is flexible. Alex and David both opted for full coverage of the disk, about half a degree. If you want more magnification of the spacecraft, you would have to sacrifice full coverage of the disk. More magnification also means a narrow field, and needs better camera aiming. If the target crosses on one side of the disk, and you are aimed at the other, you will miss it entirely. So, it is important to choose a good combination of sensor chip and focal length to grab your shot. Use whatever camera and scope you have. Video captures many frames. Therefore, you have more frames with images of the space-craft, and enough frames to stack for greater resolution on the disk. Furthermore, one can start a video based system early and let it run, and later isolate the frames that catch the spacecraft. Alex chose a video system, and started a minute and a half early. DSLR's however, like David chose, have much larger chips, a wider field, and potentially higher magnification and resolution. However, they can capture only about 5 frames per second, and that for only a few seconds. So, the timing must be better. And no matter what, if you can get only 5 frames per second, you would be lucky to get more than two spacecraft exposures during the half second long event. Both David and Alex re-calibrated their watches and computers using an internet time service immediately before going out. David read off the seconds loud and clear. It should be noted that the centerline locations and timings from Calsky are not necessarily precise. They depend on orbital and other maneuvering burns and are calculated for sea level. At other elevations, timing and location are different. If you master the timing and location, the imaging is relatively simple. Point the camera at the moon or filtered sun. Use a tracking mount if possible, but a fixed tripod will do. Focus andtake test exposures. And then, just before transit, use a remote control (via cable or computer) to fire away with video or continuous mode DSLR. Practice all this before the big event to avoid surprises (like a camera that times-out after sitting idle waiting for the precise second, or whose buffer fills after only a few seconds of continuous mode). The passage of the ISS is exceptionally quick, less than half a second. It makes for an interesting movie (which is available at http://alexastro.com/Alex%20Home%20Page/SolarS/solarsindex.html). We plan to go on hunting these transits, catch a few against the sun, and maybe with the sun shining on the spacecraft. Perhaps we will be lucky enough to capture the Shuttle on its last flight to the station next month!!! It is challenging and fun. If you would like to join, just contact alexmcconahay@roadrunner.com and get on the list.

Alex McConahay

This six-frame sequence captures the ISS transit of the moon. At fifteen frames per second, the transit took less than half a second. Alex McConahay used an Imaging Source DMK 41, on a William Optics 66 SD, and a Meade LXD 55 mount. Although it looks like the space station is flying above the moon, it is actually very close to the earth. The background moon is a composite of 450 frames taken that night in the minute or so before the transit.

What's Up? Aliens Older Than The Universe?

In the 1990's studies of globular clusters indicated that some were older than the entire universe. While this has to be an error, many may be over 13 billion years old, and that's very old. Other globular clusters are aliens to our galaxy. They have, over billions of years, moved into the Milky Way from neighboring dwarf galaxies. The origin of these sparkling compact spheres of 100,000 to a million stars is ancient and mysterious.

Globular clusters are round groups of stars that orbit their own core. They're stunningly attractive, having been described as piles of glowing diamonds heaped on black velvet. Although they seem like small satellite galaxies, they can range greatly in size from 20 to 300 light years in diameter. There are about 158 currently known in the Milky Way Galaxy. Larger galaxies, such as Andromeda, have as many as 500.

By their very nature, globular clusters have a very high star density. This doesn't create a favorable situation for the survival of planetary systems. An instability of planetary orbits probably rules out any life. Collisions and near-collisions of stars occur more often than in normal star populations. Due to these violent encounters, many exotic classes of stars such as blue stragglers, millisecond pulsars and low-mass X-ray binaries are common. A blue straggler is born from the merger of two stars. It has a higher temperature than its neighbors and thus seems unusually blue and young in relation to an ancient age of most stars in globulars. The cores of some globular clusters are so massive that they may harbor black holes, certainly a concentration of neutron stars or white dwarfs. About 20% of globulars have undergone a process called "core collapse." This happens when the larger stars, slowed in their orbits, fall toward the core creating an intensely glowing center.

Globular clusters slowly orbit in a "halo" around our galactic core. This halo is ball-like and independent of the flatter spiral of our Milky Way. This orbiting of our galaxy's core means that most are between our sun and the galactic center. However others orbit further out, even in regions opposite the center. Some globulars (M79 for example) are suspected to be former members of a remnant dwarf galaxy in Canis Major. This is true of M54, only recently part of the Sagittarius Dwarf Elliptical Galaxy. These oddly placed globulars are typically alien invaders from outside. Many of them are the result of the MilkyWay having "cannibalized" several dwarf galaxies. It's probably true of the most massive and brightest of globular clusters, Omega Centauri. This globular, like the enormous 47 Tucanae cluster far to the south , is so bright (3rd mag) that it was originally classified as a star.

Omega Centauri, along with the great M13 in Hercules, were two of the first "spherical nebulae" to be studied by Edmond Halley as early as 1677. M13 is a favorite of mine because when it passes directly overhead and is easily seen in dark skies. In 1774 Charles Messier first noted that M4 in Scorpio was a cluster made of stars. Messier went on to list 29 globulars clusters. The most visible globulars came under study as larger telescopes, developed by astronomers like William Herschel, revealed them all to be made up of hundreds of thousands of stars. By 1749, Herschel was using the name "globular cluster" in his catalogue that listed 70 of these glittering objects

In 1917, Harlow Shapley published a series of in-depth studies of globulars. Along with Helen Sawyer he categorized them from 1 to 12 according to a degree of star concentration in their core. This created the Shapley-Sawyer Concentration Class system. His studies established that the majority are found in that area near our galactic center. Working at Mount Wilson, Shapley used Henrietta Leavitt's 1912 period-luminosity studies of pulsating Cepheid variable stars to determine the distances of globular clusters orbiting the galactic center. In this way he concluded that our solar system was not in the busy center of the galaxy as many believed, but out in one of the less crowded suburban arms. Our galactic center was correctly located in Sagittarius where the most globulars are found. Unfortunately in 1920 Shapley stated that the Milky Way Galaxy was the entire universe and that both globular clusters and "spiral nebula" where included within it. Edwin Hubble, also using Cepheid variables would soon prove that "spiral nebula" were other far distant galaxies.

Harlow Shapley (1885-1972) had a long distinguished career in astronomy. He stated, that unable to get college classes in journalism, he chose astronomy because it was near the top of the alphabetical list of classes and he couldn't pronounce Archeology. In the 1950's he was accused by Senator Joe McCarthy of being a communist because he had regularly communicated with astronomers in the Soviet Union. He also wrote on ants (myrmecology) which he studied during the day on Mount Wilson. A crater on the moon is named after him.

Easily viewed globular clusters near our galactic center are M22 in Sagittarius which is big enough to be 1st magnitude if it were not dimmed by dust. Southward in Centaurus is the huge Omega Centauri. In Scorpius, M4 can be found close to the red giant star Antares. The 13 billion year old M5 in Serpens Caput, M15 in Pegasus, and M2 in Aquarius will require binoculars to locate. Never forget to view M13 in the "keystone " of Hercules at its zenith. And always remember all the pioneer astronomers who looked deeply into the strange luminous beauty of globular clusters.

Lee Collins