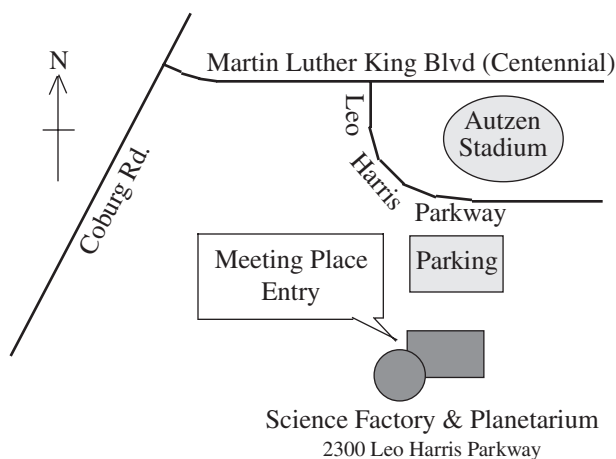# Next Meeting Thursday, March 20th
Planning and Executing an Observing Session
by Mel Bartels, Jon Schwartz, and Jerry Oltion

How much planning do you do ahead of time when you go out observing? Do you make a list of objects to observe, or do you just set up your scope and wing it? Either way, what tools do you use to help you figure out what to look at and how to find them?

Mel, Jon, and Jerry have different approaches to observing, and they have each developed methods that suit their styles. Come learn how they do it and how a little advance preparation can help you maximize your enjoyment out in the field.

We also encourage people to bring any new gear or projects they would like to show the rest of the club. Remember we no longer meet at EWEB. The meeting is at 7:00 on Thursday, March 20th at the Science Factory planetarium. Come early to visit before the program starts.

N

Martin Luther King Blvd (Centennial)

Leo Harris

Coburg Rd.

Autzen Stadium

Parkway

Meeting Place Entry

Parking

Science Factory & Planetarium
2300 Leo Harris Parkway

Next First Quarter Friday: March 7th

Our February First Quarter Friday was cancelled on account of snow. That's twice this winter! Here's hoping March will be a bit milder.

First Quarter Fridays are laid-back opportunities to do some observing and promote astronomy at the same time. Mark your calendar and bring your scope to the College Hill Reservoir (24th and Lawrence in Eugene) and share the view with whoever shows up. Here's the schedule for 2014. Note that we've scheduled some of the star parties a week earlier than the calendar would normally dictate in order to have less moon in the sky.

|		
March 7 (46% lit)	April 4 (29% lit)	May 2 (15% lit)*
June 6 (63% lit)	July 4 (47% lit)	August 1 (32% lit)
August 29 (18% lit)*	September 26 (8% lit)*	October 31 (61% lit)
November 28 (46% lit)	December 26 (31% lit)	

*These star parties are a week earlier than normal to provide less moon glare.

February Meeting Report: Lunar Atmosphere and Dust Environment Explorer (LADEE)

by Rick Kang

At our February 20th meeting, Rick Kang gave a presentation on the Lunar Atmosphere and Dust Environment Explorer, the NASA probe that is orbiting the Moon and analyzing its faint atmosphere of gas and dust molecules.

We're always told that the Moon has no atmosphere, and for all practical purposes that's true, but Apollo astronauts saw streaks of light like crepuscular rays during sunsets and sunrises, and they reported a faint glow at other times as well. We've since learned that there is a tenuous haze of various molecules bouncing around on ballistic trajectories, much like the molecules at the very top of the Earth's atmosphere. Scientists call this a surface-boundary exosphere, where individual particles can move freely over fairly large distances without encountering other atmospheric particles. Many of the solar system's small bodies have this type of atmosphere, so studying it on the Moon can help us understand what's happening in more remote places.
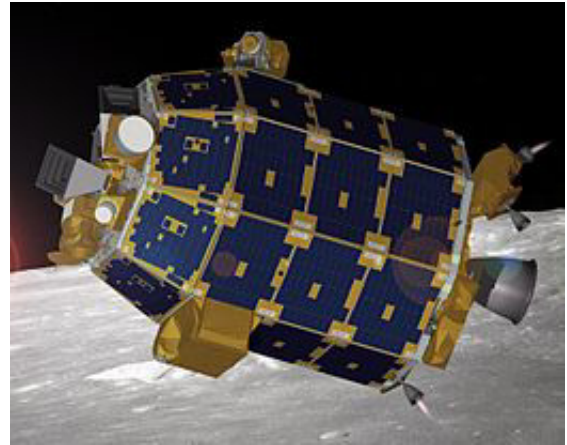
The LADEE spacecraft in orbit around the Moon

These atmospheric particles come from various sources, including the solar wind, thermal liberation of surface dust, and meteorite impacts. LADEE is also searching for evidence of volcanism or other outgassing from the Moon's interior. Analysis has already revealed an increase in sodium in connection with the Geminid meteor shower, as well as evidence of increased light scattering due to dust kicked up by those same meteors.

The spacecraft is also testing a laser communication system that provides much greater bandwitdth for downloading image and other scientific data than traditional radio signals. Tests have set a downlink record of 622 megabits per second (Mbps) from spacecraft to ground, and an upload rate of 20 Mbps from ground station to spacecraft.

The LADEE spacecraft started in a medium-high orbit around the Moon, but will move inward to study various depths as the mission progresses. It will eventually be crashed on the surface in late April of this year.

Thank You Castle Storage

Secondary Shadows and Eyepiece Exit Pupils
by Jerry Oltion

Have you ever looked through a low-power eyepiece during the daytime? If so, you've probably noticed that the center of the field of view is blocked by a hazy black blob. In order to see around it, you have to move your eye off to the side. When you do, the image looks nice and sharp and clear.

Even at night, you'll often see the same thing when you try to photograph something through the telescope using a low-power eyepiece. It's especially bad with camera phones. You've got to move the camera's lens off center to get a decent image.

What's happening?

First of all, this only happens with reflectors. That should offer your first clue. What do reflectors have that refractors don't? Mirrors, of course! Specifically, a secondary mirror casting a shadow on the primary. A shadow that looks suspiciously like the black blob hiding the image in the eyepiece.

You don't see that shadow when you're looking at the stars at night, though, and you don't see it with a higher-power eyepiece even during the day. If it were the secondary shadow, wouldn't it be visible all the time, and wouldn't it look *bigger* at high power?

It might seem so, but a little thought reveals what's going on. Low-power eyepieces have larger *exit pupils*. That's the diameter of the light beam that's coming out of the eyepiece and entering your eye. That light beam does indeed have the shadow of the secondary at its center, but that shadow is proportional in size to the overall light beam. A wide beam has a wide shadow within it; a small beam has a small shadow.

exit pupil

eyepiece

Secondary shadow

During the day, your eye's pupil is constricted, so a wide light beam coming out of the eyepiece is mostly wasted. The outer part falls on your iris, leaving only the shadowed part to pass through your pupil. That's why you see so much secondary shadow: the portion of the light beam that makes it through your pupil is mostly composed of secondary shadow. At night, when your pupil is dilated, the entire light beam makes it into your eye, so you don't notice the shadow as much.

Cameras work the same way. If they're shooting at f/8, most of the light beam is splattering up against the lens's iris, and the camera mostly sees the secondary shadow. Open up the lens to f/2 and the secondary shadow is overwhelmed by the rest of the light beam. Or move the camera off to the side and get it into the brighter part of the light beam. You won't be perfectly on-axis anymore, but for photos of the Moon and planets it won't matter enough to notice.

This shadow effect is one reason why there's a maximum eyepiece focal length for any given telescope. The longer the eyepiece focal length, the wider its exit pupil. Your pupil only opens to about 6-7mm, depending on your age, so an eyepiece that gives you an exit pupil larger than 6-7mm will waste light. Exit pupil is easily calculated: it's the eyepiece focal length divided by your f/ratio. So a 32mm eyepiece in an f/5 scope will give you a 6.4mm exit pupil; just about the maximum. A 50mm eyepiece in that same scope will give you a 10mm exit pupil (50mm divided by f/5), which will waste the outer 3mm of light. And that outer 3mm is carrying most of the image, so you'll see mostly secondary shadow.

To minimize that shadow, match your eyepiece's exit pupil to your eye, or to your camera lens.
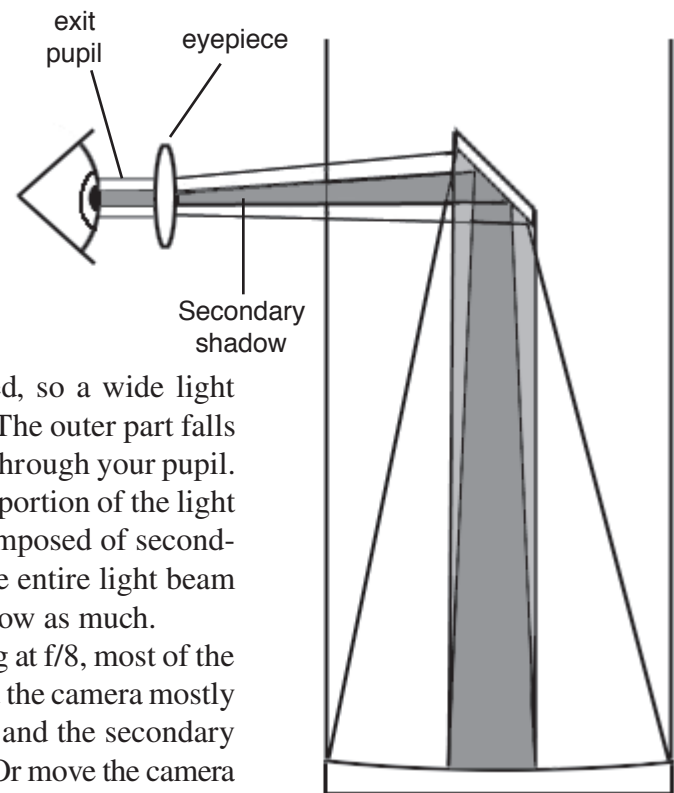
A 6 inch F2.8 telescope
by Mel Bartels

Topsy turvy; that's how my super-fast telescopes look to me. I began amateur astronomy in an era where the major expense and effort was split between the primary mirror (and why I've ground my own optics all these years) and the mounting. Eyepieces were small, lightweight with a medium field of view. Look at my telescopes now; dominated by huge, expensive super wide angle eyepieces and coma correctors.

Having built a 13 inch two degree field of view telescope, I determined to build a scope with even more field. A 6 inch is as small as I wanted to go at f/2.8, considering the increased diagonal size and vignetting caused by the bottom end of the coma corrector intruding into the light path since the diagonal to focal plane distance is so short. I was also worried about the field curvature of a 17 inch focal length mirror causing a differential focus problem between the field of view's center and edge. Luckily, it turns out that none of these concerns are an issue in the field.
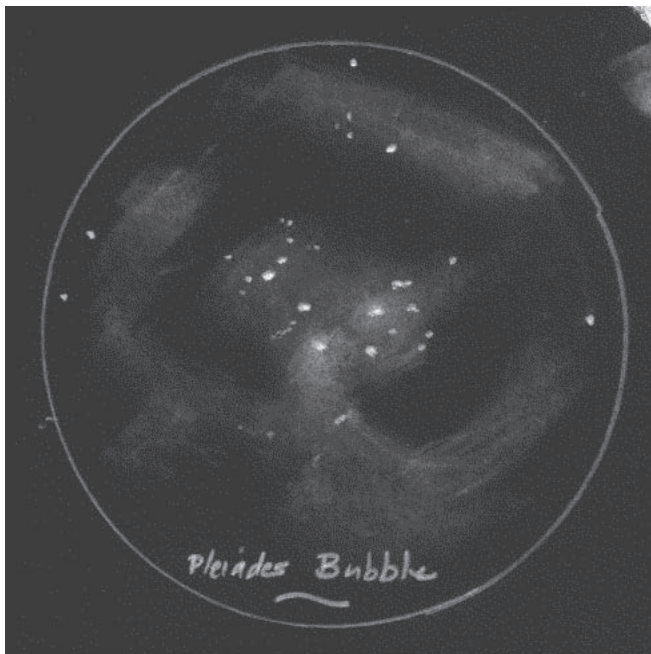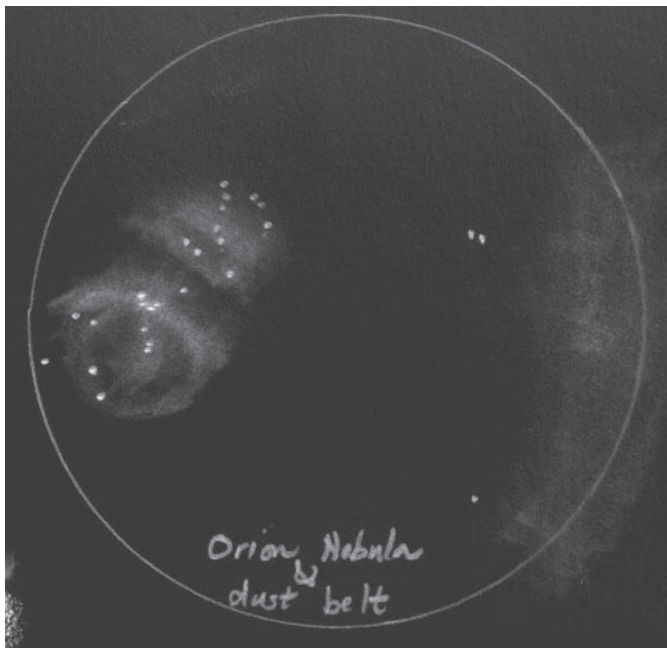
The result is breathtaking. My first night out, on my first object, the Pleiades, *I discovered very faint dust clouds surrounding the Pleiades!* Star images remain perfectly pinpoint from center to edge as they roll through the 4.2 field of view (close to binocular fields); more aperture than I could ever conjure up in my dreams.

The telescope's combination of field and aperture is astonishing. It performs beyond its aperture, showing objects that can be hard to see in larger scopes.

• NGC and IC emission nebulae stand out because they are framed in large swaths of black background. Thanks to the pinpoint star images, I can resolve clusters at surprisingly low magnifications. The individual stars can be seen grouped tightly together as sprinkles of glitter.

• I see larger scale objects in a way not possible before. The Pleiades and the nebulosity that waterfalls off Merope look to be embedded in the dark center of a larger ring of faint nebulosity. The entire Andromeda Galaxy including the extreme side extensions is beautifully framed in the field of view. The
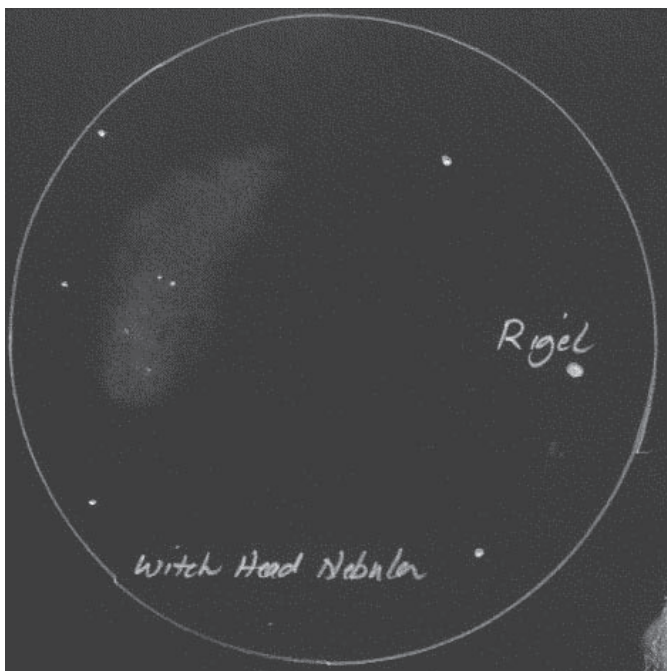
Orion Nebula & dust belt

twist in the Galaxy's outer reaches is obvious. Other dusty areas such as the broad expanse to the west of the Orion Nebula are surprisingly visible along with large scale objects like the Witch's Head.

• Dark nebulae stand out and strands of nebulosity fill the eyepiece as the scope is panned across the Milky Way. Like my other wide angle telescopes, this scope is very sensitive to sky transparency. The views are astonishing in very dark skies. I can pick up the Horsehead Nebula without a filter and even place it in the same field of view as the belt of Orion or M42 on the other side of the field. Barnard's Loop is a nice fit; I can trace it for several fields of view.

• I've gotten quite used to 100 degree eyepieces. Using an 80 degree or worse, 60 degree, eyepiece is

terribly constricting, akin to looking through a soda straw.

• Most of all I forgot about the fast f/2.8 focal ratio and lost myself in the views. Every night I've used the scope I've seen something new, something astonishing, something unexpected.

I discovered that grinding and figuring an f/2.8 mirror is no different than an f/3.0 mirror. The figure is certainly touchy — a few seconds of polishing will subtly alter the star test image at high powers.
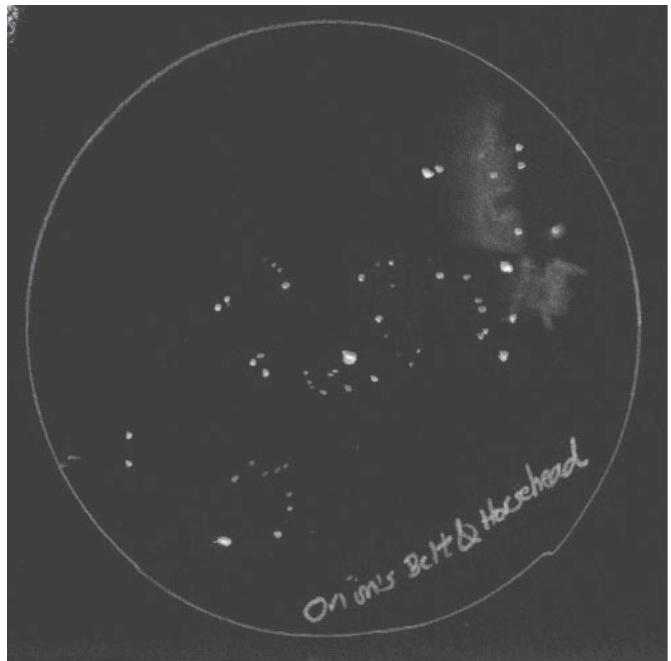
Contrary to received wisdom, my eye's pupil opens up to the 6.4mm exit pupil required when using the 21mm Ethos eyepiece. I test for this by slightly

Orion's Belt & Horsehead

Rigel

Witch Head Nebula

defocusing the star image so that it forms a disc. Since I can see the mirror's edge, I know that my eye's pupil is not truncating the mirror's aperture. However, I must place my eye exactly at the correct location centered and above the eyepiece (the rubber eyeguard helps). Consequently I often use the 17mm Ethos with its 3.4 degree field of view at slightly higher power; my eye doesn't need to stay exactly centered.

I've conducted experiments with slightly oversized exit pupils, that is, the telescope and eyepiece's exit pupil is slightly greater than my eye's maximum opening. I cannot detect an observational difference. For example, let's say that your eye's iris can only open to 6mm, slightly less than the 6 inch f/2.8 with 21mm Ethos combination of 6.4mm. The loss of light

is 0.15 magnitude: not detectable. Remember that the light loss occurs for both object and background, so *an extended object's contrast remains the same.* Another way to put it is that it is equal to the difference between a standard aluminized coating and an enhanced coating (the 6 inch happens to have an enhanced coating). Test by reducing the aperture of a 6 inch to 5.5 inches. It sounds like a lot, but remember the eye works logarithmically, so one must think logarithmically, not in terms of aperture diameter and not in terms of light loss percentage. The light loss is barely detectable. It's the same when you use an eyepiece with an exit pupil slightly wider than your eye's pupil. The practical result is a larger field of view, worth it on those extra-large objects. Try the experiment for yourself and see if you agree with me that the larger field of view is worth the non-detectable light loss.

m78 and Barnard's Loop
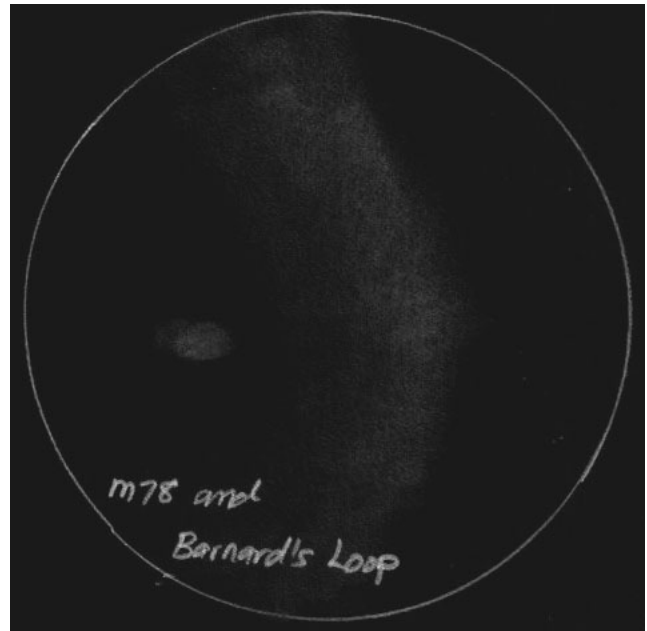
Another concern is vignetting. The diagonal that I use with the diagonal distance to the focal plane means that I have full illumination across much of the field. By slightly defocusing the star's image into a disc and moving it around the field, I can see where the primary mirror's edge begins to be clipped. This matches the calculated edge of the fully illuminated field, meaning that there is no vignetting in the f/2.8 primary to P2 coma corrector to the 21mm Ethos eyepiece stack. Remember that the field I care about is the 1.4 inches of the 21mm Ethos and the 1.2 inches of the 17mm Ethos; most definitely not the full 2 inches possible given the 2 inch focuser.
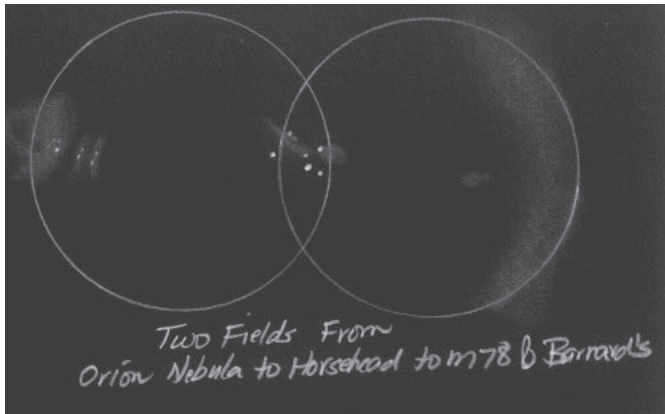
Two Fields From Orion Nebula to Horsehead to m78 & Barnard's

The central obstruction ratio between the diagonal and primary mirrors is about one-third (2.1 inch diagonal), which causes optical quality to drop by about 1/6 wave (not a problem because the optical quality of the 6 inch primary is top shelf). The resolution of stars in globular clusters and open clusters is outstanding with this scope, made compelling because of the dynamic 100 degree apparent field with the Ethos eyepieces.

Based on many years of building scopes and observing with them, I attribute the inky black backgrounds in the eyepiece to good baffling, a smoothly figured mirror surface and a good ion mirror coating. It is thrilling to observe with this telescope.

Club Gains Two New Telescopes

The EAS received a donation of two telescopes this month: a 12" Zhumell Dobsonian and an 8" Celestron Schmidt-Cassegrain. Both are in excellent condition and will go into our telescope lending program. The Zhumell is ready to loan out immediately (well, okay, the primary mirror needs cleaning, but that's easy — right, Brandt?) while the Celestron needs a mount. If anyone has a decent mount for an 8" SCT they'd like to donate to the cause, please let the board of directors know.

How Bright is the Sky?
by Jerry Oltion and Larry Deckman

Larry Deckman asked me a seemingly innocuous question the other day: How do you add the brightness of two stars together? You can't just add their magnitudes — a mag 4 star and a mag 5 star wouldn't add to mag 9, after all. Mag 9 is dimmer than either of the other two. That's because the magnitude scale is a scale of relative brightness that starts with low numbers for the brightest stars and moves to higher numbers as the stars get dimmer. You can't subtract them, either, because the scale is logarithmic. Mag 2 is 2.512 times dimmer than Mag 1, and Mag 3 is 2.512 times dimmer than that, and so on. So to add star brightness you have to convert the magnitude number to a linear brightness, and then add those.

Fortunately, that's easily done if you're game for a little math. See the sidebar to the right if you're feeling adventurous.

After I'd proved my proficiency at adding brightnesses, Larry laughed diabolically and asked the next question: What would you get if you added all the stars in the sky? How bright would they be?

Er...Larry, you do know how many stars there are in the sky, right? The buttons would be worn off my calculator by the time we added them all together. But Larry pointed out that we know how many 1st magnitude stars there are, and how many 2nd, and so on. If we multiply the number of stars times the brightness of each magnitude down to the visible limit, we'll get a figure for each magnitude.

So we did that.

Here's what we got:

Apparent magnitude	Number of stars
-1.0	1
0.0	3
1.0	11
2.0	33
3.0	123
4.0	345
5.0	1,089
6.0	3,198
6.5	4,296
Total =	-4.55 magnitude

How to Add Magnitudes

Since each whole magnitude number is 2.512 times dimmer than the previous one, you can get a linear brightness value by multiplying 2.512 to the -m power, where m is the magnitude. (You have to use the minus because the scale runs backward, from brighter to dimmer.) So for a magnitude 3.9 star, you take 2.512 to the -3.9 power and get 0.0275. If you wanted to add that star brightness to a mag 2.2 star nearby, you would take 2.512 to the -2.2 power and get 0.1318. Adding those two numbers gives you 0.1593. That's not the magnitude of the result; it's the linear brightness value. To convert it back to a magnitude number, you take the 0.1593rd root of 2.512. If your calculator won't do that directly, you can take the log (to the base 10) of 0.1593 and divide it by the log of 2.512. The latter is simply 0.4, so the calculation is simple: Log(0.1593)/0.4=-1.99. That happens to be the combined magnitude of Mizar, whose two individual components we just added together.

You also need to add the brightness of the planets. It turns out they're brighter than all the stars combined, at -5.29. When you add the planets and stars together, you get -5.73. The general glow of the Milky Way will add some more brightness, but probably no more than one magnitude. So the total brightness of the night sky is in the neighborhood of -6.0 to -6.5 magnitude.

How bright is that? It's the equivalent of a Moon that's only 12% illuminated. That's a 3-day-old Moon, a mere crescent. Iridium flares are brighter than that! One Iridium flare can be brighter than all the stars in the sky.

We found out afterward that an astronomer named Abdul Ahad came up with a figure of -6.5 (now called Ahad's Constant), so our calculation is very close to his. Way cool! The math works!
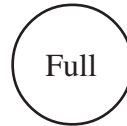
Next time you go out observing, take a moment to consider how much bang for the buck we get. With barely enough photons to rival a crescent Moon, we can see the whole expanse of the Cosmos stretched out for us to admire. A little starlight goes a long way.

Observing in March

New	1st Q	Full	Last Q

March 1	March 8	March 16	March 23
Mercury Rise: 5:47 AM	Mercury Rise: 5:35 AM	Mercury Rise: 6:29 AM	Mercury Rise: 6:25
Venus Rise: 4:30 AM	Venus Rise: 4:25 AM	Venus Rise: 5:19 AM	Venus Rise: 5:15 AM
Mars Rise: 9:47 PM	Mars Rise: 9:17 PM	Mars Rise: 9:40 PM	Mars Rise: 9:04 PM
Jupiter Set: 4:03 AM	Jupiter Set: 3:36 AM	Jupiter Set: 4:05 AM	Jupiter Set: 3:39 AM
Saturn Rise 12:05 AM	Saturn Rise: 11:33 PM	Saturn Rise: 12:05 AM	Saturn Rise: 11:32 PM
Uranus Set: 8:31 PM	Uranus Set: 8:05 PM	Uranus Set: 8:36 PM	Uranus Set: 8:10 PM
Neptune Rise: 6:41 AM	Neptune Rise: 6:14 AM	Neptune Rise: 6:44 AM	Neptune Rise: 6:17 AM
Pluto Rise: 3:51 AM	Pluto Rise: 3:24 AM	Pluto Rise: 3:53 AM	Pluto Rise: 3:26 AM

All times: Pacific Standard Time (Nov 3, 2013-March 8, 2014) = UT -8 hours or U.S. Pacific Daylight Time (March 9-November 1, 2014) = UT -7 hours.

Daylight savings time begins March 9

Date	Moonrise	Moonset	Sunrise	Sunset	Twilight Begin	Twilight End
3/1/2014	06:45	18:58	06:49	18:01	05:13	19:37
3/2/2014	07:18	20:11	06:47	18:02	05:12	19:38
3/3/2014	07:52	21:21	06:46	18:04	05:10	19:39
3/4/2014	08:26	22:28	06:44	18:05	05:08	19:41
3/5/2014	09:02	23:32	06:42	18:06	05:06	19:42
3/6/2014	09:41		06:41	18:07	05:05:	19:43
3/7/2014	10:24	00:31	06:39	18:09	05:03	19:45
3/8/2014	11:10	01:26	06:37	18:10	05:01	19:46
3/9/2014	13:00	03:14	07:35	19:11	05:59	20:47
3/10/2014	13:53	03:58	07:33	19:12	05:57	20:49
3/11/2014	14:48	04:37	07:32	19:14	05:56	20:50
3/12/2014	15:45	05:12	07:30	19:15	05:54	20:51
3/13/2014	16:44	05:43	07:28	19:16	05:52	20:53
3/14/2014	17:43	06:13	07:26	19:17	05:50	20:54
3/15/2014	18:43	06:41	07:24	19:19	05:48	20:55
3/16/2014	19:45	07:09	07:23	19:20	05:46	20:57
3/17/2014	20:47	07:37	07:21	19:21	05:44	20:58
3/18/2014	21:51	08:07	07:19	19:22	05:42	21:00
3/19/2014	22:56	08:40	07:17	19:24	05:40	21:01
3/20/2014	24:00	09:18	07:15	19:25	05:38	21:02
3/21/2014		10:01	07:14	19:26	05:36	21:04
3/22/2014	01:02	10:50	07:12	19:27	05:34	21:05
3/23/2014	02:01	11:46	07:10	19:29	05:32	21:07
3/24/2014	02:55	12:49	07:08	19:30	05:30	21:08
3/25/2014	03:43	13:57	07:06	19:31	05:28	21:09
3/26/2014	04:26	15:09	07:04	19:32	05:26	21:11
3/27/2014	05:05	16:21	07:03	19:34	05:24	21:12
3/28/2014	05:40	17:34	07:01	19:35	05:22	21:14
3/29/2014	06:14	18:47	06:59	19:36	05:20	21:15
3/30/2014	06:47	19:58	06:57	19:37	05:18	21:17
3/31/2014	07:21	21:07	06:55	19:38	05:16	21:18

Items of Interest This Month

Mars starting to look good this month

3/5 Io shadow transit 11:28 PM – 1:45 AM

3/7 First Quarter Friday Star Party. Io shadow transit 5:57 – 8:13 PM. Red Spot visible until ~8:00.

3/9 Daylight savings time begins early AM

3/14 Io shadow transit 8:52 – 11:09 PM. Io transits with Red Spot 7:38 – 9:54 PM.

3/20 Spring begins at 9:57 AM. Europa shadow transit 6:58 – 9:42 PM

3/21 Io shadow transit 10:48 PM – 1:04 AM

3/22 Multiple shadow transit (Io & Ganymede) before sunset. Ganymede shadow continues transit from sunset to 10:26 PM

3/27 Europa shadow transit 9:34 PM – 12:18 AM. Callisto transits ahead of shadow.

3/30 Ganymede and Io's shadow transit near one another from sunset to 9:29. Ganymede's shadow transits 11:08 PM – 2:28 AM (just behind Red Spot).

For Current Occultation Information

Visit Derek C. Breit's web site: http://www.poyntsource.com/New/Regions/EAS.htm

Go to Regional Events and click on the Eugene, Oregon section. This will take you to a current list of Lunar & asteroid events for the Eugene area.

All times are for Eugene, Oregon, Latitude 44º 3' Longitude 123º 06' for listed date