Oberwerk Ultra 15x70

Compared to other 70mm binoculars

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Oct. 15, 2006

Are These All the Same?

The buzz on the street is all about the new "premium" binocular. There are a number of importers/distributors currently offering what appears to be the same binocular. Keep in mind, none of these importers/distributors actually make these binoculars. Oberwerk, Garrett, APM, AP, General Hi-T, TS, AOE, they all import these binoculars, variously referred to as Ultra, Grizzley, Marine, Premium, etc. While there is no positive assurance that we have identified all the originating sources, it is a pretty fair bet to say, there are not seven different manufacturers of these binoculars.

Of course it is nearly impossible to tell if they are all "exactly" the same. We know from experience that any particular model line can be custom made for any distributor. As an example, over the last few years, one of the most commonly available import binocular sizes on the market has been the 15x70. You can pick up a low to mid-priced Barska, Celestron, Apogee, Oberwerk, Garrett, Telescope Service (or some other brand name) and set them on a table next to each other. At least for some of them, by looking at outward appearances you could not tell one from the other. However, are they all the same? Well, often they are not.

We have identified probably as many as a half dozen different things that can be done or not done during manufacture that could make all these brands different. There is a post in the CN binocular forum "Best Of" threads titled "These Look the Same, What Could Be Different?" It addresses not only things that you can readily see, but also some of the differences you cannot see by looking AT the binocular. For instance, you can see when one binocular is FMC and another is not, but no one could ever tell by looking at a binocular if the lenses were produced by a fast machine polish or slow precision polish which is purported to produce a much finer quality lens. No one can tell by looking at a multicoated lens if extreme care was taken to measure the thickness of the coatings to 1/4 wavelength needed for precision premium coatings. And no one can tell by looking at a binocular if the prisms selected for this quality level have passed critical inspection or if they are the prisms that got rejected by critical inspection for some other brand. These are just some of the major production differences which cannot be seen, but would make a huge difference in performance. These are the types of qualities that can only be seen by observing with and comparing the instruments.

We know United Optics and Kunming Optical, both in Kunming China, have had this Oberwerk Ultra style binocular available for a quite a few months, and while no one has come right out and stated positively where they are getting their shipments from, it is possible, and in my opinion likely, that all or at least some of the US and European distributors are getting these manufactured in the same place.

A review of the United Optics website Series 8 binocular models shows what I believe is this binocular and describes the features that are being described by some or all of these distributors.

Kunming United Optics Corporation is a fully integrated design and manufacture enterprise. United Optics was launched in 2001

http://www.united-optics.com/products/products.htm

Also, a review of the Kunming Optical Instruments Company Limited shows these may or may not be a branch of the same company, but they show the same binoculars.

Binocularschina was started in 1998... In Feb., 2001, we formed a second corporation Ufind Optics Co., Ltd. which handles all exports... And, for the last three years, we've been able to control or partly own 11 factories which specialize in different stages of binoculars production...These factories are all based in Kunming...we changed our company name to Kunming Optical Instruments Co., Ltd in Dec., 2003...Beginning from Feb. 1st, 2004, we'll do business in the name of "Kunming Optical Instruments Co., Ltd." thereafter.
http://www.binocularschina.com/binoculars/MS.html

With a binocular of this level of quality, it seems from advertising that none of the current importers are skimping on anything. They all seem to advertise the same degree of high quality lens polish, premium coatings and rugged build quality. It would appear from initial published in-depth reports that is exactly what we are getting. QC from the vendor may be the only variable.

The Oberwerk Ultra 15x70

The Oberwerk Ultra 15x70 Stats and Performance Measures

Incidentals
Objective lens caps are the pop in kind, rather than the slip over old style. The binocular comes in a nice latched and lockable case with form fitted foam. The foam is all covered with a soft felt lining. Included is a padded neck strap and a good rigid L bracket for mounting the binocular on a tripod.

Size - Weight
Well, the Ultra is a heavy 15x70. Weight measures at 5# 5oz. For comparisons, the Fujinon FMT-SX 16x70 weighs 4# 12oz and the Oberwerk LER 15x70 weighs 3# 2oz. Overall length is 10.625 inches or 270mm, almost identical in size to the Fujinon 16x70.

Strengths-Weaknesses
I think what may be the most significant strength of these binoculars is mechanically the apparent ruggedness and optically the apparent fine contrast. A weakness, at least from my point of view, is the need for a little more eye relief for eye glass wearers.

Mechanical Operation
The eyepiece diopter is stiff. It starts out with a little pop when you attempt to readjust it for focus. After that it moves smooth. The main barrel hinge is fairly stiff. It is not going to move once you set it for your IPD. Basically, with the stiff hinge and stiff diopter, once you set this binocular for your own use, you won't need to adjust it again. Nothing moves unless you intend to move it. Fold down rubber eye guards are medium soft and very wide. They are comfortable, but do not block all outside light from the eyes.

Close Focus
One noticeable difference in actual vs specified values became apparent quickly. The specified close focus of this binocular is 10 meters. That's 33 feet. With eyeglasses correct vision, I measured close focus of 120 feet or 36 meters!

AFOV – TFOV
Full field of view spans from Gamma Delphinus, (Y)Del to Eta (n)Del, almost exact. This is 4.35°. This is very close to the specified 4.4°, and it is wider than the 4.0°

Fujinon and about the same as the Oberwerk 2003 15x70. It gives an Afov of 65°.

Exit Pupil
At close focus exit pupil measures approx 4.9mm = magnification 14.2x
Focused on stars exit pupil measures approx 4.68mm = magnification 14.95x
This is perfectly normal and is about expected.

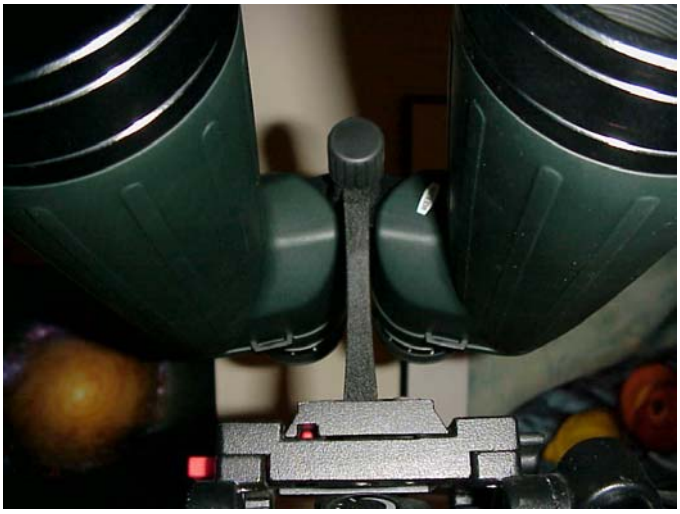
Diopter Adjustment / Focus Speed
With my eyeglasses corrected vision, the eyepieces are both between +1 and +1.5 diopter for focus at infinity. For close focus they are both at +6 dipoters, with no room left to turn when focused at a distance of 125 feet. Eye lens focus rotates thru 325°. Eye lens focus travel is 6mm. Therefore, the eye piece is turned through 54° of turn per 1 mm of in-focus. I would consider that slow focus, a valuable feature to have incorporated into the design.

Exit Pupil Distance / Usable Eye Relief
The eye lens is deeply recessed. With eye guard folded down for eyeglass wearers, I measure 8mm recess to lens and 11mm from eyecup to exit pupil point. With eye guard extended for non-eyeglass users I measure 13mm from outside of eye guard to lens and 6mm from eyecup to exit pupil point. So total exit pupil distance is about 19mm, but maximum usable eye relief is only 11-12mm.

Having the eye lens deeply recessed is good in that it keeps the lens away from both eyeglasses and eyelashes. However, I wish the eye relief were a little longer for us eyeglass wearers. When looking with both eyes, as we intend with all binoculars, I cannot see the outer right edge with my R eye and I cannot see the outer left edge with my L eye, but together with both eyes I can see to both edges. The L eye can see the far right edge of field and the R eye can see the far left edge of field. It seems as though I can see the entire fov, but the field stop is somewhat blurred. When I took my glasses off to have a quick look, I noticed the field stops more distinct. These are similar to how I use and see with the Fujinons. So, I'd estimate that I'm loosing less than 5% of the outer edges of the field of view. Without my eyeglasses, the entire view was seen easily.

IPD
Inter-pupilary range is adjustable from a minimum 56mm to maximum 75mm. However, the minimum IPD with supplied tripod adapter installed is only 58mm.

Tripod and Adapter
The screw slot for the tripod adapter is recessed about 3-4mm in from the body of the prism housing. That means that you cannot use a typical wide flat binocular adapter with these binoculars, it would rub on the housing, marring the rubber coating, or it may not even screw in. In this photo, the IPD is set at 62mm. The thickness of the L adapter is only about 5mm.



A very nice sturdy, Pentax shaped, narrow metal adapter is provided with the binocular. It holds the binocular very stable and secure. However, even it is not narrow enough to allow this binocular to reach the minimum IPD setting. It prevents the binocular from closing to less than 58mm, eliminating the last 2mm of usable close IPD from use. If you have very close set eyes, as some do, you may need to search for the narrowest tripod adapter you can find, similar to the Pentax shaped adapters.

You could handhold this binocular for brief periods, but this binocular really needs a mount. I used this binocular on a variety of mounts including a Bogen 3130 head on a Bogen 3211 tripod, Bogen 501 head on a Bogen 3246 tripod and a Universal Astronomics Unimount Light on a surveyor tripod. At only 5.5# this binocular did not overload any of these mounts.

Light Cutoff
Both prisms completely span the entire prism shelf. There are no edges of prisms exposed. However, the backside of the front prism protrudes slightly into the light path. I could see it in both barrels. This causes one form of what we refer to as prism light cutoff. Even upon close inspection, it was barely perceptible in the exit pupil. Without measurements, I would estimate the cutoff at 1-2%. This is blocking light only from the outer few mm of the objective lens. I considered this minor light blockage inconsequential.

Internal Barrel Reflections - Baffles
The insides of the barrels are fine ribbed matte black/gray. No internal reflections were seen at any time while viewing any objects other than the moon. With the moon just outside the fov, the half moon caused undesirable reflections off the inside of the barrel. This should probably be expected.

Focal Length
Overall length is 10.625 inches or 270mm. Based on my method of calculation for determining focal length, I estimated focal length of the objective lens at 302 to 313mm. Call it F = 310mm. The aperture is an unencumbered 70mm. Therefore this binocular is found to have a focal ratio approx. f/4.4. Eyepieces have a focal length between of 20mm and 21mm. Eye lens = 24.5mm in diameter.

Collimation
Collimation was nearly dead on. Checking numerous times on a 1 arcminute double, I could barely see any degree of minor mis-collimation. Checking to a 1 arcmin double star at 15x, I would easily be able to see even if collimation was off by 20-30 arcseconds. These aren't even off by 15 arcseconds. Images merged completely. The field of view in the barrels overlaps nearly perfectly.

In my Oberwerk BT100, at 62x, I can see it is merged to within just about 20-30 arcseconds separation. At 44x, images merge easily for me. At 25x I can't see any separation in the images at all. Few people would be able to see 15-20 arcseconds miscollimation in a 15x binocular.

Allowable tolerances are wider than many experienced observers can actually put up with. A reasonable (more stringent) tolerance for error would be 15 arcminutes apparent error in vertical step, the worst error. An "apparent error" of 15 arcminutes would be seen if a single star appeared double with true misalignment of 1 arcminute, but viewed magnified by a 15x binocular. Convergence and Divergence, both horizontal errors, allow slightly greater error.

This is not your typical binocular where the end user can simply push aside the rubber and turn conditional alignment screws with a jeweler's screw-driver. Professional investigation reveals there are three collimation screws and that accessing the inside 3rd screw is NOT a job for the layman. This binocular has a tilt-plate arrangement with prisms mounted to a spring-loaded prism shelf. The shelf or plate is adjusted via these three screws. Two of the screws are accessible from the outside of the prism housing. To access the third screw, you must open up the binocular. Not recommended! In fact this would release the nitrogen and the binocular would no longer be waterproof.

The best advice I could give; If this binocular arrives out of collimation, send it back for adjustment.

Resolution

Point Source Resolution

On-axis observation, I could clearly see Gamma Delphinus as elongated and could tell the primary from the secondary, but would stop just short of calling it split. That's 144 arcseconds apparent elongated. From these actual readings it falls right about where I would expect.

The Ultras could clearly see the four components of the Trapezium, but I must admit the two closest could easily have been still touching. Because one is slightly brighter, it was easy to see those as two and not just one. With the closest components at 8.7", that is about the best on-axis resolution I've seen. I would call it suspected at 130 arcseconds apparent.

USAF Resolution Tests

15x70 Oberwerk Ultra actual and apparent readings
actual = easily see 6.82", seen clear 6.08", horz seen, vert suspect 5.4"
apparent = easily see 102", seen clear 91", horz seen, vert suspect 81"

For comparison, here are some values from other binoculars:
actual
16x70 Fujinon FMT SX clearly see 6.08", suspect 5.4", no see 4.83"
15x70 Oberwerk 2003 clearly see 6.82", horz only 6.08", suspect 5.4"
12x50 Nikon SE clearly see 8.61", see both 7.65", no see 6.82"
apparent
16x70 Fujinon FMT SX clearly see 97", suspect 86", no see 77"
15x70 Oberwerk 2003 clearly see 102", horz only 91", suspect 81"
12x50 Nikon SE clearly see 103", see both 92", no see 82"

Just for kicks, with a 2.5x multiplier attached behind the eyepiece of the Ultra, for a modified power of 15x2.5=37.5x, I could see resolution clearly to 3 arcseconds (mono view), and it was seen but just barely to 2.7 arcseconds. I could not see 2.4 arcseconds. For comparison, using the Fujinon 16x70 with multiplier (=40x), to equalize I moved several feet further away from the target and could see the same 2.7 arcseconds resolution, but still no better than that. Essentially, I would say the Ultra has the same limit of resolution as the Fujinon.

Off Axis Resolution Using USAF Charts

From previous testing on numerous binoculars I have found the correlation of photopic USAF resolution : scoptic point source resolution is between 90:155 arcsec and 95:160 arcsec, or approx 1:1.7.

From data previously reported above:
15x70 Oberwerk Ultra actual and apparent USAF readings
clearly see 6.82", horz clear, vert suspect 6.08", see orientation 5.4"
clearly see 102", horz clear, vert suspect 91", see orientation only 81"

USAF off-axis resolution measured
at 50% out from center, see 8.61", for an apparent res of 129 arcsec
at 75-80% out from center, see 13.65", for an apparent res of 204 arcsec

Using the correlation noted above, I can predict apparent point source resolution at 50% out = 219 arcsec res and 347 arcsec at 75-80% out.

Compare this to some actual off-axis point source resolution measured;
100 Herc 14.2" seen clear out to 55% = 213 arcsec at 55% out
Stf 485 Cam 18" seen clear out to 60% = 270 arcsec at 60% out
Theta Ser 22" seen clear out to 65% = 330 arcsec at 65-70% out
The estimated point source resolution based on USAF are not to far off from some of the actual readings that I have.

So, I compare those estimated results to off-axis field sharpness of other binoculars on my charts. 219 arcsec res at 50% out and 347 arcsec at 75-80% out is only met or exceeded by a handful of binoculars; the Obie BT100 (entirely dependant on choice of eyepieces), the Fujinon 16x70, the Pentax 16x60, Nikon SE 12x50, Obie Mariner 10x60 and the WO 7x50 ED. Those are the top of the class on my charts. This seems to place the Oberwerk Ultra in the top group for off-axis sharpness.

Field Sharpness

This is basically a term used to define how sharp or how poor the image gets in the outer field of view, without any attempt to define which aberrations are the cause of the distortions. The use of the word distortion here is not meant as displaced star image, but distorted size or shape of the point image; bloating, elongated, curved, by various aberrations, mostly due to curvature, spherical aberration, astigmatism and coma. This term distortion is what helps define the measure of field sharpness.

Distortion

The Ultra 15x70, GO20x70 and Obie v2003 15x70 were all compared to see the distortion of the image of a star in the outer edge of the field. Using a double star of known separation in the same field of view, or at least near the field of view, so I could pan back to it as a reference scale, I measured the size of the distortion. In this case I used the stars in the head of Draco, choosing a star that would end up near the edge of field of view while at the same time I could also see Nu Draco which is a 62 arcsec double. The spread on the distorted star images was almost exactly the same as the spread in Nu Draco. At approximately 80% out in the field, a bright star was elongated to about a half arcminute in length. At near 90-95% out, the star was elongated to one arcminute in length. There was not a significant difference among the three binoculars.

For comparison, a new pair of Meade 5000 26mm plossls in the BT100 shows approximately the same amount of 60 arcseconds distortion in the image near the edge. The Fujinon 16x70 has about 40 arcseconds distortion at the very edges. A pair of 26mm TV plossls in the BT100 shows about 15 arcseconds of distortion at the extreme edge of field. A pair of 14mm TV Radians in the BT100 shows less than 6 arcseconds distortion at the extreme edges.

Field Sharpness

Five out of my 7 top binoculars (BT100 excluded) with the sharpest pinpoint images in the outer field of view have 52, 51, 51, 50, and 45° AFOV. The only binoculars with a wider field of view that make it into the top seven are the Fujinon 16x70 and the Nikon SE 12x50.

Generally, the wider the Afov of the eyepieces, the more quickly aberrations show up in the outer portions of the fov. This Oberwerk Ultra 15x70 has an Afov of 65°. So, unless it is in a class with the Fujinon FMT-SX 16x70 (65° Afov) or the Nikon SE (60°

Afov), it might not be expected to achieve the rank of having some of the sharpest pinpoint images in the outer edges of the field.

Sharpness in the outer edges of the field of view is reduced by a combination of aberrations from the objective lens and the eyepieces. In the Ultra, stars begin to show minor but acceptable elongation parallel to field edge at 55% to 60% out from center. It begins to get unacceptable about 70-80% out. Significant elongation really distorts stars at 80-85% out.

The 15x70 Ultra can see theta Ser, a 22" double star, at 65-70% out from center. This means at 70% out it has a sharpness rating of 330. The Ultra can still see 16 Cyg at 80% out, therefore the Ultra, at 80% out, has a sharpness rating of 585.

By 70% out the Ultra is still keeping up with the sharpness of the Fujinon. By 80% out the Fujinon pulls away. Between 65-70% out the GO 20x80 has an average sharpness of about 500-600, not as good as the Ultra. By 75-80% out the GO 20x80 drops to 750.

100 Herc 14.2" seen clear out to 55% = 213 arcsec at 55% out
Stf 485 Cam 18" seen clear out to 60% = 270 arcsec at 60% out
Theta Ser 22" seen clear out to 70% = 330 arcsec at 65% out
resolution appears even all the way around, no off center sharpness

Compared to the Ultra 15x70, in all cases the Fujinon 16x70 was able to resolve the pairs 15% to 20% out further towards the edge of field. The Fujinon could resolve both 15 Aql (38") and 16 Cyg (39") right at the very edge of the field stop, 100% out. The Fujinon could resolve theta Serpens (22") at 80-85% out from center. The Ultra could only see theta Ser to 70% out from center. In most cases the Garrett Gemini 20x70, using the average of uneven readings, sharp field closely matches the Ultra out to about 65%. Beyond that it drops off.

Sharpness Across the Field					clear	on	25-35													
Position % of Field >>>	Mag	Afov	Tfov	detect	elong	axis	35	40	45	50	55	60	65	70	75	80	85	90	95	100
Oberwerk 20x80 Standard	20	64	3.20	142	156	174						258		284		440				
Oberwerk 20x80 Deluxe I	20	65	3.23			174									440					
Burgess LW 20x80	20	74	3.70		142										720					
Garrett 20x80 AVG	20.8	60	2.90		125	162				277		295		458		749	811			
Anttler 20(18.7)x80	18.7	69	3.70			180				337		393		533	636	729				
Fujinon 16x70	**16**	65	**4.05**		**118**	**154**						**227**	**288**	**307**	**336**	**352**	**470**		**576**	**608**
Pentax PCF WP16x60	16	45	2.80			154												352		
Oberwerk Ultra 15x70	**15**	65	**4.35**		**131**	**155**					**213**	**270**		**330**	**540**	**585**	**660**			
Oberwerk 15x70/'03	15	65	4.30	130.5	144	194				213			330		585					
Oberwerk 15x70/'02	15	65	4.30			194						330								
Nikon 12x50 SE	**12**	60	**5.00**	**115.2**		**160**				**170**			**216**			**264**	**432**	**432**		
Fujinon 10x70	**10**	**50**	**5.00**			**167**				**184**			**260**							
Oberwerk Mariner 10x60	**10**	**51**	**5.10**		**142**								**290**				**360**			

What I see is this Ultra binocular seems to have a fov sharpness that is not pin-point sharp all across the field, or as some people might say, sharp edge-to-edge. Stars begin to show minor acceptable distortion at 55% to 60% out from center. A 22" double at 65-70% out is a pretty stringent test. At 75% out I could not see a 22 arcsec double as a double star. By 85-90% out that same 22" double is distorted to a size of approx 1 arcmin and cannot be recognized as stars. I would put the usable field at about 75-85%, not as good as the best, but better than many.

Aberrations

True Distortion

True Distortion is related to image scale across the FOV. If you look at a square centered in the FOV, with pincushion distortion, the sides of the square will be bowed inwards. With barrel distortion, the sides will bow out. It is almost impossible to see these in the night sky. However they show up when observing straight lined terrestrial objects. **This binocular displays no detectable pincushion or barrel distortion.**

(In the paragraph above I have addressed true distortion. In all other instances here, the use of the word distortion is not meant to describe displaced image as defined by true distortion. It is used generally to describe distorted size or shape of the point image; bloating, elongation or curving of the point image by various aberrations, mostly due to curvature, spherical aberration astigmatism and coma.)

Field Curvature

With the Trapezium placed at the center of the fov, Stf 747, a 36" double at the base of Orion's sword, is placed at about 50% out in the fov. At 50% out, these are showing some aberration of the point image, but not real bad. The double is still easily seen. Refocusing on this 36" double star at 50% out in the fov (without moving the image in the field of view, so in this case focusing on the image at the 50% out position), shows that nearly all of the aberration in the point image can be removed. However, when you do that, the image in the center is thrown out of focus, so the Trapezium now looks like one blob. This is a telltale sign that indicates field curvature. Curvature is the only aberration that can be focused out. In some instruments it is suppressed by a field flattener lens. **In the Ultra we see that curvature is present and it enlarges or distorts the point image at a location about 50-60% out from center to a size of about 15-20 arcseconds.**

I rarely ever refocus my binoculars. Once I'm focused for precise images at the center of field, I leave it alone. Curvature is an aberration that can be focused out, but not many users would focus it out. Many would just move the binocular if they could to center the object of interest and allow whatever is going on in the outer field to just take place. It becomes a problem when, just as many binocular observers do, you are using the entire field of view to observe an object and re-centering is not an option. Stars refocused at 50% out required turning minus 1 dipoter tic. Stars further out required more. I did not find this an acceptable adjustment.

Beyond 50% out, a few other things start to come into play. Please keep in mind, the variety of aberrations causing image distortions in the Ultra is not really bad at all. I'm just trying to identify which aberrations are present.

Coma

In the outer edges of the field of the Ultra, coma begins to present itself. Stars begin to appear with a brighter point towards the center with a small flared fan shape towards the outer edge. If you could see a ray trace from a single star of all the rays of light formed by the objective, you would see most of the points all hit the same spot. That's the bright point towards the center. But then, some of the rays formed from the outer edges of the objective lens begin to miss the bright spot and get spread out in a fan shape. This results in the classic comet shape. This is fairly typical in binoculars. Seldom do we find a binocular that does not have some coma

present. **In the Ultra coma is present in the outer edges of the fov, but fairly well controlled.** It cannot be focused out.

Astigmatism
In the outer field of the Ultra, we begin to see astigmatism. Astigmatism begins to spread the star point image out in an elongated shape. Refocusing the Ultra on a bright star in the outer edge of the field shows the elongated image flips orientation. You can tell it is astigmatism by racking focus in and out past the point of best focus. If the orientation of the "line" flips 90°, it's astigmatism. **There is a clear indication that astigmatism is present. It was not overwhelming and was not terribly distracting since it was noticed at 80% out.** This is not uncommon in binoculars. Astigmatism cannot be focused out.

Spherical Aberration
It would be very difficult to tell, but with the presentation of the three aberrations noted above, I thought I did not see any spherical aberration. Well, maybe just a little. When I focused out the curvature at 60% out, **the point image at 60% out was not as fine as the on-axis precisely focused point image, so this may indicate a little SA is present. If present, spherical aberration is not easily noticed and soon becomes totally overwhelmed by the other aberrations.**

Chromatic Aberration
I could see some minor CA on Vega, some blue with Vega on-axis. A hint of false blue color was seen on Altair. Sirius shows a blue spike. No color was seen on Deneb. **So while I saw some minor on-axis CA, No off-axis color was seen on any bright stars.** All these very bright stars showed the distinct spiking often seen on bright stars. No other objects viewed throughout the remainder of several night showed any of these affects.

As far as true color, Mu Cephei, Betelguese and Aldebaran all showed up as a distinct orange color. Albireo shows its yellow and blue.

If minimum CA correction is assumed at 1/2000 F, then 1/2000 F = 1/2000 x 310 = 0.155mm. If 1mm of focus travel = 54° turn, then 0.155mm = 8.5° of turn. About one third of a dipoter mark represents the in/out focus of the full extent of the CA correction. It may be possible, since there is a slow enough focus turn, to focus out logitudinal CA.

The near full Moon was so bright I could not look at it without hurting my eyes. I went in and got my sun glasses and that helped a lot.

Careful eye position was required to view the moon on-axis without CA. It was easy, even though the moon was kept centered in the fov, to tilt my view and see a thin band of yellow along the fully lit edge of the Moon. The on-axis view could be easily positioned to completely eliminate CA.

Lateral Color Error
Each color (wavelength) focuses at a different focal length. That means also that **each color results in a very slightly different magnification. Since image scale varies with wavelength, objects off-axis show color fringes because variance in magnification causes color images off-axis to not coincide. In essence, lateral color is a form of distortion.** This is why much more color is seen off-axis than on-axis.

Lateral Color showed up when a partial Moon was moved to a position off axis. With the fully lit edge of the Moon towards the outside edge, the Moon would show a thin green band. With the fully lit edge of the Moon towards the inner fov, then the inner edge (the fully lit edge) of the Moon would show a thin yellow band. Lateral color on the moon is not unusual.

Summary of Aberrations
So, what does this all mean? Well I've already stated the outer field correction in the Ultra is pretty good. I believe **I noted earlier that the combined aberrations show the extreme off-axis star image is bloated to about 1 arcminute, not to bad at all.** Curvature adds 20 arcseconds of bloating to the star point already by 60% out. If coma were not present the star images due to astigmatism would look like long lines, generally running parallel to the field stop, sort of like little sections of arcs of a circle. When astigmatism is combined with coma, the comatic fan shape gets elongated to the classic seagull, the wings grow longer. **While most all aberrations are present, this is not a binocular that is suffering from serious aberrations.** I'm just taking the time to identify what aberrations are present and show about how much they seem to be affecting the image. We should be so lucky to have all binoculars present images like this.

Light Transmission
Total light transmission will be determined primarily by the area of the aperture and the quality of the coatings. Premium fully multi-coated binoculars can transmit 95-96% of the total light gathered. Also important for total transmission is illumination of the exit pupil. That will be discussed later.

Coatings Compared
I checked the coatings by comparing to several other models I own.
The coatings on the Oberwerk Ultra are:
Less reflective than the 2003 Oberwerk 15x70 and Pentax PCF 10x50 WP.
About equally reflective as Oberwerk Mariner 10x60, BT100 and WO 7x50 ED.
Equally or slightly more reflective than the Fujinon FMT-SX 16x70.
The coatings are definitely more reflective than the Nikon SE 12x50.

No binocular I own has matched the non-reflective character if the Nikon SE coatings. This is my top-of-the-line. Held at the same angle you can look into the Oberwerk Ultra or the Fujinon FMT-SX or the Oberwerk Mariner and you can just see your face with variations in light and dark areas. Pick up a Nikon Action Extreme or some moderate quality binocular and you can see detail such as eyes or rims on glasses. Looking into the Nikon SE, you have a hard time even seeing the outline of your head and you cannot see any features on your face at all. **The Oberwerk Ultra coatings are definitely towards the high end in the broad scheme of things.** Out of the 35 or so binoculars that I've tested, among a few just less than the very best, I've selected 4 of maybe the top 5-6 to compare with the Ultra and the Ultra seem to fall right in the middle of that group.

Limiting Magnitude Compared
Limiting magnitude is slightly different from Light Transmission in that LM is also affected by magnification. **Given two binoculars of equal aperture and equal quality, that should have the same transmission, the one with higher**

magnification will have deeper limiting magnitude. A 10% increase in magnification will result in approximately 0.1 mag increase in limiting magnitude.

Over a period of several nights of observations under different sky conditions, I used a variety of binoculars to record numerous readings of faintest stars, or limiting magnitude. These are the best results achieved condensed from those various sessions. I used my detail chart of Cr399, the Coathanger for these readings. Naked Eye Limiting magnitude (NELM) is recorded for each night to show varying conditions.

Some of the binoculars used for the Observing comparisons. From left to right. Garrett Optical 20x80 TWP, Anttler Optics Sky Sweeper 20x80, Fujinon FMT-SX 16x70, Oberwerk Ultra 15x70, Oberwerk LER 2003 15x70. I carefully centered and cut 70mm holes in lens caps so I could use the Garrett 20x80 as a 20x70 in comparison tests. It has been referred to here as the GO 20x70.

NELM mag 5.0, before and after readings. Moon rising.
Ultra 15x70 spotted mag **10.83 and 10.84,** but could not see 10.93.
Fujinon 16x70 saw the mag **10.84 and 10.93**.
Garrett 20x70 spotted mag **10.95**. **Persistence also netted mag 11.02**.

NELM mag 5.4, Milky Way faintly visible. No Moon. Sky conditions very transparent. Oberwerk Ultra 15x70 saw 10.83, 10.84, **10.93, 10.95, 11.02 and 11.04**. Stars of mag 10.4 were seen steady and 10.6 seen most of the time. Mag 10.80 and 10.83 could be noticed pretty quickly. Mag 11.05 could not be seen. I would estimate mag 10.4 seen 100% of the time, mag 10.6 – 75%, mag 10.83 – 50%, 10.95 – 20 to 25%, and mag 11.02 seen only 10% of the time spent looking.
Garrett 20x70 saw **deepest mag 11.02 and 11.04**, but not 11.05.
Oberwerk v2003 15x70 could only see **deepest mag 10.7 and 10.83**.
Nikon SE 12x50 saw mag 10.52 and only to a **maximum faintest mag 10.6**.

NELM Mag 5.4 NELM. two bands of Milky Way faintly visible at zenith. Cr399 was naked eye. Two different mag 5.4 stars were seen, but mag 5.6 could not be seen.
Oberwerk Ultra 15x70 faintest seen **10.95, 10.96, 11.00, 11.02, 11.08**
Fujinon 16x70 faintest seen **10.95, 10.96, 11.00, 11.02**
Anttler 20x80 faintest stars seen mag **10.95, 11.00, 11.02 and 11.05**
Garrett Gemini 20x70 faintest stars seen mag **10.96, 11.00, 11.05 and 11.08**

NELM mag 5.4 again. two bands of the Milky Way faintly visible at zenith. Cr399 was naked eye. Mag 5.6 could not be seen. Conditions identical to previous night.
Oberwerk Ultra 15x70 faintest seen **11.00, 11.02, 11.05**
Burgess LW 20x80 faintest stars seen mag 10.84, **10.95, 11.00, 11.02 and 11.05**
Oberwerk v2003 15x70 faintest stars seen mag 10.6, **10.83, 10.84**

Megrez 80 used this night for comparison to higher powers. Also, I wanted to check some of the other stars I'd been looking for but couldn't see. Yes, they are there.
Megrez 80 SD II with 14mm Radian 36x80 faintest seen **11.63, 11.71, 11.74**

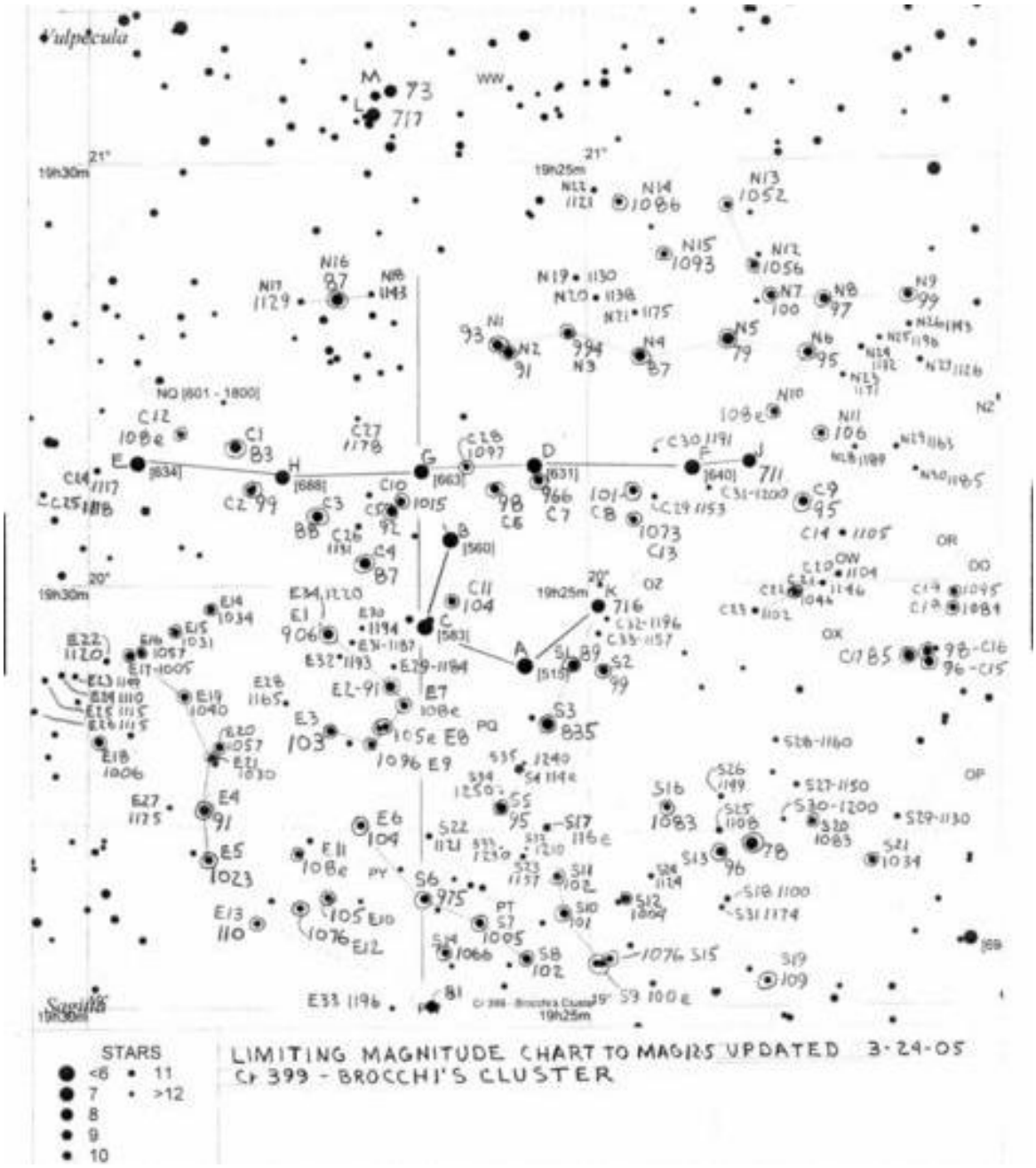
Many readings are taken because sometimes stars are seen and sometimes not. At these limits of visual ability, it is difficult enough to see, let alone see every limit sample every time. More readings give a consistent grouping around the highest value reached for each binocular. There are far more readings, not all reported here, both easier and attempts beyond the limits reached here.

The GO Gemini 20x70 in many tries could not see stars of mag 11.10 or 11.15.
The GO Gemini at full 20x80 in previous tests, best skies, has seen to mag 11.3.
The only two binoculars that saw 11.08 were the Oberwerk Ultra and the GO 20x70.
Most observations were repeated to confirm the stars seen.
The Anttler 18.5x80 saw the 11.05 star only once.
The Ultra glimpsed the mag 11.08 star numerous times.

All stars fainter than mag 10.6 were seen only with averted vision in binoculars, although some of them, mag 10.83, 10.84, could be seen most of the time.
Mag 10.4 and 10.5 stars were all seen fairly constant.
Stars mag 10.95 and fainter were seen maybe only 10% of the time at best.
Mag 11.05 and 11.08 stars were seen maybe only 2-3 seconds at a time.
In the Megrez 80, I could see mag 11.02 direct, but mag 11.5 was definitely averted.

Lim Mag Results best skies mag 5.4-5.5
Megrez 80 with 14mm Radian 36x80 mag 11.74 (mono view)
Burgess LW 20x80 mag 11.05
Anttler Optics Sky Sweeper 20x80 (18.5x80) mag 11.05
Garrett Optical Gemini (20x70) mag 11.08
Fujinon FMT-SX 16x70 mag 11.02
Oberwerk Ultra 15x70 mag 11.08
Oberwerk LER 2003 15x70 mag 10.84
Nikon SE 12x50 mag 10.6

TV85 with 14mm Radian 43x85 mag 11.68 previously in mag 5.2 skies
Garrett Optical Gemini 20x80 mag 11.3 previously in mag 5.6 skies
Fujinon FMT-SX 10x70 mag 10.85 previously in mag 6.0 skies
Nikon SE 12x50 mag 10.8 previously in mag 5.8 skies



Attached here is the chart showing all the stars that were used for testing Limiting Magnitude. Try observing some of these targets with your instruments in your local conditions to find out what your equipment is capable of seeing.

If all quality is equal, then a 20x80 should be able to see about 0.5mag deeper than a 15x70. A 20x70 should be able to see 0.35 mag deeper than a 15x70. Given the sizes, the Anttler, which operates at 18.5x80 should have been able to see nearly the same or slightly deeper than the Garrett masked 20x70. With equal quality, both of those should have been able to see about 0.3 magnitudes deeper than the Fujinon or the Oberwerk Ultra. What we see from the results is the Fujinon 16x70 and the Oberwerk Ultra 15x70 held the positions right at or near the deepest magnitudes seen. This gives an indication of higher light transmission in these two binoculars.

As far as Light Transmission measured by Limiting Magnitude, the Oberwerk Ultra holds right up to or exceeds the mark reached by the Fujinon 16x70, the GO masked to 20x70mm and the other lesser quality 80mm binocs. Premium coatings and better contrast provide greater transmission that allows an instrument to go a little deeper and reach or exceed the performance of lesser quality instruments, even though those other instruments have higher magnification or larger aperture, or both. **The Oberwerk Ultra exhibits crispness in contrast that seems to allow faint light points to pop into view.**

Exit Pupil Illumination

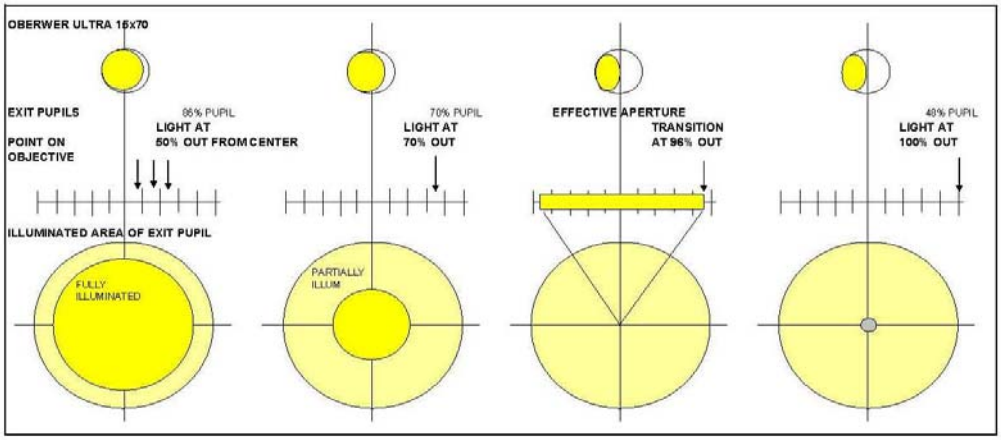
This is one of those pieces of information that cannot be determined by observing, but requires measured testing. It can make a big difference in the image we see. Here is a profile of the exit pupil illumination.

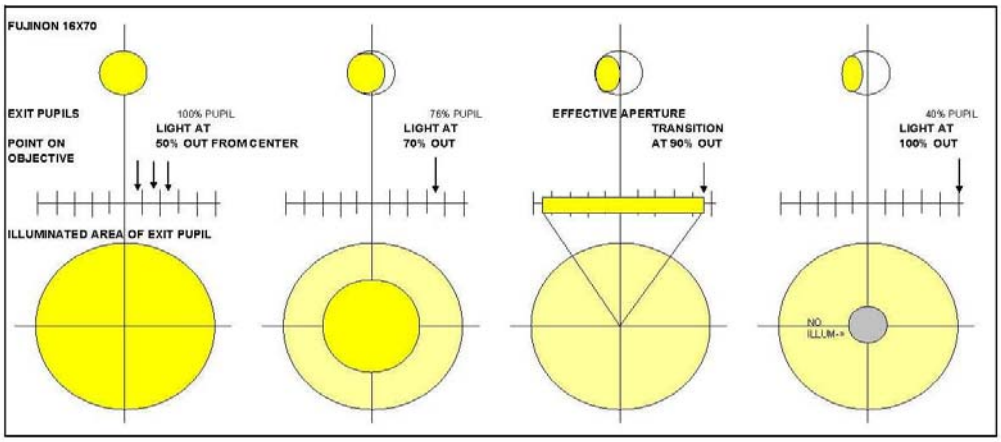
While the outer portions of the exit pupil may not be fully illuminated, some central portion of the exit pupil is fully illuminated by the full aperture. In this central portion of the exit pupil, light gathering and resolution are based on the full aperture. It is fair to say the outer portion of the exit pupil is not receiving light from the entire objective, therefore the effective aperture in the outer portion of the exit pupil is less than the full aperture. Most every binocular blocks some of the light from the outer portions of the exit pupil.

The illumination of the exit pupil is what Roland Christen talked about in some of his comments about this new line of binoculars. How bright the image appears and how well contrast is achieved is due in part to how well illuminated the exit pupil is. This 15x70 has a very well illuminated exit pupil. I included a graphic attachment here showing a comparison of the Ultra 15x70, Fujinon FMT-SX 16x70 and the Oberwerk 2003 15x70. The Ultra lies in between them, but it is much closer to the Fujinon.

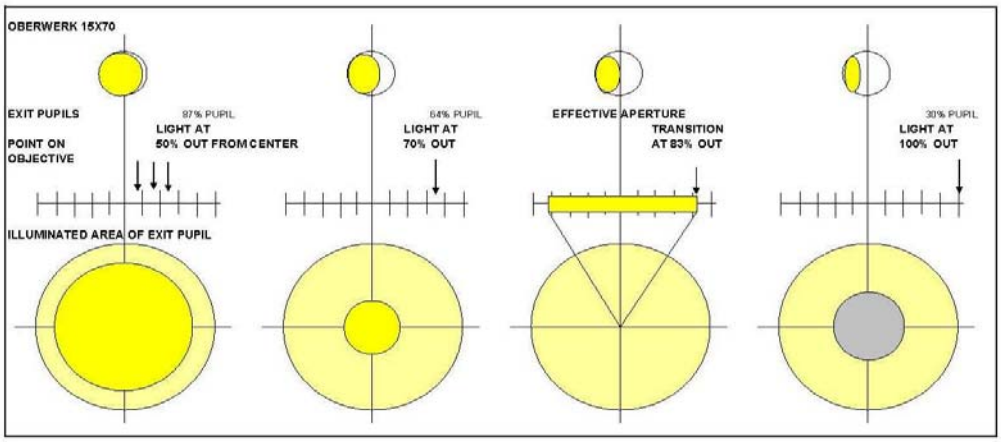
The Fujinon 16x70 comes out on top for all light entering at any point on the objective within the central 50% of the lens. Light entering the objective at 50% out from center illuminates the entire Fujinon exit pupil. In the Ultra, it illuminates about 85% of the exit pupil. However, the Fujinon exit pupil illumination drops slightly as the source light enters further out on the objective lens.

Shortly after a point 70% out from center the Ultra overtakes the Fujinon. Light entering at the very edges of the objective leaves the central 20% of the Fujinon completely dark. In the 2003 Obie 15x70, 40% of the center is left dark. Only the central 4% of the 15x70 Ultra is dark. The Ultra is clearly the winner here.





BRIGHT YELLOW = AREA OF EXIT PUPIL 100% ILLUMINATED FROM POINT ON OBJECTIVE
DIM YELLOW = AREA OF EXIT PUPIL <100% ILLUMINATED FROM POINT ON OBJECTIVE
TRANSITION = EXIT PUPIL = 50% DIA. OF FULL, E.P. ALL PARTIALLY ILLUMINATED FROM POINT ON OBJECTIVE
GREY AREA = AREA OF EXIT PUPIL GETTING ZERO LIGHT FROM POINT ON OBJECTIVE



For each instrument shown in the graphic attached, the top row of circles shows the actual exit pupil image projected on a white board for each position of the entering light beam, that position stated for each image,. Assuming that ep image can be rotated about a central axis point, the large circle shows the percentage of the exit pupil fully illuminated, partially illuminated, or not illuminated at all.

For comparison I include here note data on one of the best performances I have measured, the BT100 with 14mm Radians. I also include the Fujinon FMT-SX 10x70. I found the comparison to the Ultra interesting.

Oberwerk Ultra 15x70
exit pupil is 100% illuminated by light at 45% out from center
exit pupil is 50% illuminated by light at 96% out from center
exit pupil is 48% illum (4% dark) by light from the very edge of the objective

Fujinon FMT-SX 16x70
exit pupil is 100% illuminated by light at 50% out from center
exit pupil is 50% illuminated by light at 90% out from center
exit pupil is 40% illum (20% dark) by light from the very edge of the objective

Oberwerk 2003 15x70
exit pupil is 100% illuminated by light at 40% out from center
exit pupil is 50% illuminated by light at 83% out from center
exit pupil is 30% illum (40% dark) by light from the very edge of the objective

Fujinon FMT-SX 10x70
exit pupil is 100% illuminated by light at 35% out from center
exit pupil is 50% illuminated by light at 85% out from center
exit pupil is 35% illum (30% dark) by light from the very edge of the objective

Oberwerk BT100 with 14mm Radians
exit pupil is 100% illuminated by light at 65% out from center
exit pupil is always more than 50% illuminated
exit pupil is 55% illum (0% dark) by light from the very edge of the objective

The Ultra is clearly providing illumination of the exit pupil that moves it up a class. In addition to premium coatings, simple transmission calculations and limiting magnitude tests, which actually show the Ultra performs better than some equal sized and even some larger sized binoculars, these illumination tests are one more factor that help explain Why it performs better.

Oberwerk Ultra 15x70 Observing Sessions
side by side on various nights with (among others)
Fujinon 16x70, Garrett Gemini 20x70 and Anttler Sky Sweeper 18.5x80.

Contrast Allows You to See More
Magnification improves the ability to resolve because objects are seen at a larger image scale. However, the qualities of contrast and resolution in an optical system are best observed when you have side by side comparisons and the smaller optics are seeing equal to or more than the larger optics. This most definitely cannot be due to magnification. I believe it can be attributed to contrast, the result of better coatings, better illumination and better baffling.

I ordered a pair of 100mm lens caps that fit snuggly over the front end of the Garrett Gemini 20x80. I carefully centered and cut 70mm holes in each so I could use the Garrett 20x80 as a 20x70 in comparison tests. It has been referred to here as the GO 20x70. I also used the Anttler Sky Sweeper 20x80 (which really only has a magnification of 18.5x80) as is. These notes were my impressions of general observing.

I viewed many deep sky objects with the Ultras. Several that were nice to see were M71, a prominent but small hazy patch; M57, still very small but obviously not a star, no dark center; the North America nebula, not distinct, but some areas noticed, an indicator of good contrast; the Double Cluster, the Owl 457 and Stock 2 all pretty sights; NGC 7789, a few suspected resolved, also an indicator of good contrast. Views of M35, M37, M36, M38 were easy. M31 was beautiful. M32 was easy and M110 was a faint glow. The arms of M31 grew with averted vision and I would guess it's extent was about 2°. M78 and M1 were both fairly bright. I easily spotted stars of mag 10.5 to 10.7 in M45 without much effort.

Moon Views
The near full Moon was so bright I could not look at it without hurting my eyes. I went in and got my sun glasses and that helped a lot.

All three binoculars required careful eye position to view the moon on-axis without CA. It was easy in all three, even though the moon was kept centered in the fov, to tilt my view and see a thin band of yellow along the fully lit edge of the Moon.

Lateral Color showed up when the Moon was moved to a position off axis. With the moon towards the right, then the outside edge (the fully lit edge) of the Moon would show a thin green band. When the Moon was moved to an off-axis position towards the left, then the inner edge (the fully lit edge) of the Moon would show a thin yellow band. The Fujinon added a slight purple when towards the left. Lateral color on the moon is not unusual.

None showed significantly greater CA than the other. All three were about equally affected. None were so distracting that I wouldn't use them for moon viewing. In fact, the on-axis views in all three could be easily positioned to completely eliminate all CA. The on-axis detail in lunar features was sharp and clearly defined.

Extended Object Views
I viewed several OC, GC and nebula and noted differences in the views. Some of the objects viewed are listed here:

oc M26 - in GO 20x70, see 1 or 2 stars resolved with faint fuzzy splotch to the north. Both F16x70 and U15x70 see one resolved speck and the remaining fuzzy area was barely seen.

oc 6664 - Both F16x70 and U15x70 detected some very faint averted specks at the correct location. The GO20x70 instantly detected 2 or 3 faint specks. This result is probably more in line with the LM test than with extended objects.

pn M27 - GO 20x70 sees a rectangular shape. Both F16x70 and U15x70 can see the neb is not round, but the shape is less defined. I thought the U15x70 gave the brightest view.

gc M71 - Both F16x70 and U15x70 see M71 as difficult, not bright, sometimes needing averted vision to see at all. The GO20x70 saw more of the diffuse area, and the object was always visible.

gc M13 and M15 - In the F16x70 and the U15x70, both gc showed as a much brighter center with a fainter outer ring. In the GO20x70, M13 and M15 both showed a larger extended area of the outer ring around the core.

en NGC7000 - All the binoculars could see portions of the North America nebula. The Fujinon appeared to provide the best contrast between the fairly bright background and the faint nebula.

oc NGC 7789 - in Cas has many very faint stars and is often seen in binoculars as just a spot of glow. Very good dark nights with clean air allow seeing more. Recently I observed this cluster with my 150mm refractor using a 27mm Panoptic for 44x150. I counted 85 faint and very faint averted vision stars. Last night using binoculars, although they were too dense to count, I suspected seeing about 20 resolved stars with the Garrett 20x70. With the Anttler 18.5x80, I could only suspect seeing 10-15 stars. Both the Fujinon 16x70 and the Oberwerk Ultra 15x70 showed an estimated 10-15 stars clearly resolved. I suspected seeing about 8-10 resolved stars with the Burgess 20x80 and the Obie v2003 15x70. The Burgess and Obie 2003 were about equal on this cluster. The Oberwerk Ultra 15x70 showed a nicer image than either the Burgess or the '03 Obie 15x70.

The continued quest for IC 342

Several nights recently the sky has been pretty transparent. Milky Way has been visible a lot lately. And I've been mixing up my viewing sessions between late night and early morning. This is the record of some early morning attempts at finding an elusive object.

Tues. Sept 26, 06, 4-5 AM Oberwerk Ultra 15x70

I woke early and went out just to observe a different sky than usual. The instant attraction to M42 captured my attention for a brief period. It is just so darned beautiful to look at! The Ultras saw extension forming long wings curved out NW and SE with the little ball of M43 at the head. The Trapezium was clearly visible as 4 components. I scanned around at leisure for a while. Taking note of how nice the sky was, I decided to try again for IC 342 in Camelopardalis.

I didn't have any charts out with me, so I took a crack at this from memory. North of Kemble's Cascade lies the extremely faint surface brightness face on galaxy IC 342. I

thought I saw it immediately. There was clearly a broad diffuse glow located at the location. I suspected seeing it every time I looked at this spot. Could this really be it? I've been questioning my observations of this object for several years now.

Wed, Sept 27, 06, 4-5 AM temp 48° Oberwerk Ultra 15x70
Conditions same as yesterday. I spent a minute or two looking around naked eye and found 3-4 stars all mag 5.5. I didn't try very hard, so I suspect NELM was a bit fainter than that.

I went right for IC 342. Once again, (and without charts, but I know this location very well), I followed the path from Kemble's Cascade pointing north. This time I landed on the spot of IC 342 and immediately saw it. There was no question. The faint glow was quite obvious. This morning for the first time I can definitively state that I was able to see IC 342. That is a face-on galaxy that, IIRC, has a surface brightness of about Sb mag15.0.

The glow of IC 342 (not really a glow, more like a thin gauze) was sort of like the faintest background portions of the North America nebula, not anything near as bright as the Gulf of Mexico portion. When you look at the North America nebula, there sometimes appears to be a very faint extension of the diffuse nebula that extends out north and west of the Gulf of Mexico, up into the region that would be Canada. It's difficult to see where it ends. This is similar in some respects to how IC 342 appears. I think another good example of how faint IC342 appears might be similar to M74, only larger, more spread out. Although some might say these are not difficult objects, that may be true for a mag 6.5 sky. This is a mag 5.5-5.7 sky.

There was no question that a large circular diffuse patch was present in the view. It was not really brighter towards the center, but it was difficult to see exactly where the diffuse edges ended. I would describe it as an evenly bright diffuse patch about 20 arcminutes in diameter. It could be seen looking right at it. It could be seen panning over it. It was seen averted. It was distinctly present in the view no matter what method of viewing was used.

These observations show the position and appearance exactly located where I thought I suspected the presence of an extremely faint diffuse spot several times in previous observations. In the past I have made many attempts to see IC342 with instruments such as Oberwerk 25x100 IF, Oberwerk LER 15x70, Garrett Gemini 20x80 TWP and Fujinon FMT-SX 16x70. I think now that some of those times I suspected the presence of something, I may have actually seen it. Today there was no reason to question or suspect if it was seen. It was plainly visible. I spent an hour scanning the skies looking at clusters and patches of dense star clouds in the Cas-Per Milky Way. I returned to IC 342 at least a dozen times and saw it each time I returned.

Although favorable conditions must be present to see such an object, without a doubt it also requires the use of premium instruments. Only a binocular with excellent contrast could have shown this object. There are a few objects in my observing lifetime that I have seen only in binoculars. All of them were found after many attempts and then only with instruments of better quality. This Oberwerk Ultra is one that exhibits excellent contrast and the ability to show some of the most difficult objects.

Overall Viewing Experience

The Ultra 15x70 always seemed to be showing me just as much as the Fujinon 16x70. There are some notes of objects above that actually show contrary to that supposition, but it didn't seem that way in general viewing. It took a bit of persistence to see those differences. For instance, on one night the Fujinon recorded a slightly deeper LM and certainly the Fujinon has better off-axis sharpness of view. But the natural viewing experience is more often of brighter objects centered in the field, so these limits may not always come into play.

In all cases the larger image scale of the GO 20x70 made a lot of things easier to see. For instance M57 was much easier to see in the GO 20x70 than either of the other binoculars. There was never something that could be seen in the smaller binoculars that couldn't be seen easier in the GO 20x70. However, I'm not sure that would hold true for some very faint or broad extended objects such as vast areas of nebula. Most objects viewed were not at the limits of performance. I never tried for IC342 with the GO20x70.

There were several times that I thought the image appeared brighter in the Ultra 15x70. I doubt that the slight difference in the size of the exit pupil would have made brightness noticeable, although it's possible. At the very least, I think this gives a good indication of the contrast and transmission in the Ultra 15x70. I think the contrast in the Ultra was one of the most notable characteristics.

I like individual focus binoculars for astronomy. A binocular such as this one does not change settings from one session to the next. Just put it on the mount and it is ready to go. There is no fiddling around with this binocular, no tweaking the collimation, no refocusing. Take it out of its case, mount it, and view. It's that easy.

Is It Worth It?

As far as cost, let's look at some of those I've compared it to in this report:

Oberwerk Ultra 15x70 new $349
Fujinon FMT-SX 16x70, about $600 new, about $450 used
Garrett Optical Gemini 20x80 TWP new $269
Oberwerk LER 2003 model 15x70 new $149

As for quality, consider this: Although it may not come out on top as the best, it is being measured here to some pretty tough standards and it doesn't seem to have any serious stumbling blocks. Essentially, I would say the Ultra has the same limit of resolution as the Fujinon. While most all aberrations are present to some degree, this is not a binocular that is suffering from serious aberrations. The Oberwerk Ultra's coatings are definitely towards the high end in the broad scheme of things. This 15x70 has a very well illuminated exit pupil, rivaling the Fujinon. The Ultra's Light Transmission holds right up to or exceeds the mark reached by the Fujinon 16x70 or the GO masked to 20x70mm. In short, this Oberwerk Ultra is a very good binocular. I usually like to refrain from doing so, at least until I've had many weeks and opportunity to try out something new, but in two months from what I've seen and recorded so far, I'd recommend this Oberwerk Ultra 15x70 to anyone.

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