



EQUIPMENT REVIEW

Sometimes, observing is best with both eyes open. /// BY PHIL HARRINGTON

Binoculars under \$100

Maybe you're new to the astronomy hobby and thinking about buying a telescope. More often than not, your best first purchase isn't a telescope, but binoculars. Getting used to the narrow, flipped-around images through a telescope can be daunting. Binoculars are more natural, almost like extensions of our eyes. Every amateur astronomer —

indeed every person — should own binoculars.

Of course, that begs the question: "Which binoculars?" There are many factors to take into account, but the answer often boils down to budget. It probably makes sense to spend as little as possible to fuel a budding interest.

But just as the marketplace is flooded with low-price telescopes, it is also beleaguered with economy binoculars. You can find dozens out there. Which one is best? Decisions, decisions ...

The numbers game

All binoculars are specified by two numbers, such as 7x50 or 10x70. The first

number is the magnification, and the second is the diameter of the front (objective) lenses in millimeters. Light passes through each objective lens, reflects through a prism assembly, and then exits through an eyepiece in the form of a magnified cylinder of light called the exit pupil.

Ideally, the exit pupil should match the diameter of your eyes' pupils. If the binoculars' exit pupils are larger than an observer's pupils, light will be wasted.

If, on the other hand, the binoculars' exit pupil is too small, the view will be a circle surrounded by a black ring. Fully dilated, the eye's pupil expands to 7mm, but this varies from person to person.

The diameter of the exit pupil can be calculated by dividing the objective-lens diameter by the magnification. Thus, in the case of 7x50 binoculars, the exit pupil will measure 7.1mm across.

Traditionalists may argue binoculars with 7mm exit pupils are the best for night viewing. That notion probably dates back to World War II, when the U.S. military issued 7x50 "night glasses."

Today, however, most of us view through light-polluted skies under which our pupils never dilate fully. Furthermore, as we age, our pupils don't dilate to the degree they did when we were younger, regardless of darkness.

As a result, many observers prefer 10x50 binoculars because of their 5mm exit pupils. Also, the slightly higher magnification produces better image contrast (the bright-to-dark ratio) than through a 7x50, and the 10x50 model is still light enough to support by hand.

Some observers prefer larger binoculars because they offer increased light-gathering power. The increased size and



Orion Scenix



Bushnell Legacy



Eagle Optics Triumph

Model	Price	Magnif. (x)	Aperture (mm)	Field of view (°)	Exit pupil (mm)	Eye relief (mm)	Weight (ounces)	Prisms	Coatings
Bushnell Legacy	\$99	10	50	7.2	5.0	9	28	BaK-4	MC
Celestron OptiView LPR	\$100	10	50	7.0	5.0	13	32	BK-7	FC
Celestron SkyMaster	\$88	15	70	4.4	4.7	18	48	BaK-4	MC
Celestron UpClose	\$37	10	50	7.0	5.0	11	25	BK-7	FC
Eagle Optics Triumph	\$99	10	50	6.5	5.0	19	30	BK-7	FC
Nikon Action	\$100	10	50	6.5	5.0	12	34	BaK-4	MC
Oberwerk 8x56	\$100	8	56	6.0	7.0	24	32	BaK-4	FMC
Oberwerk 11x56	\$100	11	56	4.0	5.1	19	32	BaK-4	FMC
Orion Scenix	\$90	10	50	7.0	5.0	12	28	BaK-4	FC
Orion WorldView	\$40	10	50	6.5	5.0	14	29	BK-7	FC
Pentax XCF	\$90	10	50	6.5	5.0	13	31	BaK-4	MC
Swift Aerolite	\$81	10	50	5.2	5.0	13	37	BK-7	FC
Tasco Sonoma	\$60	10	50	6.5	5.0	9	23	BK-7	MC

Coatings:

FC: Fully coated optics

MC: Multicoated optics

FMC: Fully multicoated optics

weight, however, is difficult to support by hand — especially for extended lengths of time — and requires a tripod.

Maximizing light throughput

When evaluating binoculars, it's also important to consider glass and coatings. Although optical glass usually is thought of as transparent, it can reflect up to 4 percent of any light falling on it.

To lessen this percentage and improve image quality, an antireflection coating (usually of magnesium fluoride) is applied to either some or all air-to-glass



Celestron SkyMaster



Pentax XCF



**Orion
WorldView**

all surfaces should be coated, so “fully coated optics” is preferred. “Fully multicoated” optics, where every optical surface has been coated with several microscopically thin layers of magnesium fluoride, is your best choice.

Better binoculars use prisms made from barium crown (BaK-4) glass, while lesser models use borosilicate (BK-7) glass. BaK-4 prisms transmit brighter, sharper images because their design passes all the light that enters — what’s known as “total internal reflection.” Due to their optical properties, BK-7 prisms suffer from light fall-off and, consequently, slightly dimmer images.

Besides their optical qualities, binoculars should be comfortable to look through and hold. You shouldn’t have to hold binoculars far in front of your eyes or scrunch them in close to take in the full field of view.

The distance between the eyepieces and your eyes is called eye relief, and it is usually expressed in millimeters. The binoculars featured here have eye relief ranging from 9mm to 24mm. If you must wear glasses when observing, stick to the high end of the range.

All of the binoculars here have over-the-counter prices of \$100 or less and are readily available from local merchants or by mail order. All come with the same basic accessories, including soft carrying cases, neck straps, and, in most cases, a lens-cleaning cloth.

All are center-focus models. This means when you turn a knurled dial, both eyepieces focus simultaneously, rather than each eyepiece being focused individually.

But what if your eyes don’t come to the same focus? Not to worry. The right eyepiece on each of these binoculars can be focused independently of the center focus mechanism. The table on page 71 summarizes each binoculars’ statistics and features.

Testing with both eyes

To find out if some binoculars are better than others, I tested them head-to-head. I checked for optical aberrations during the day as well as at night.

Field curvature and distortion are checked most easily during the day on terrestrial targets. Distortion causes straight lines to bow or curve, while field curvature causes different parts of the view to focus at different settings.

Viewing celestial objects at night will give you a pretty good indication of binoculars’ image brightness, astigmatism, and contrast.

surfaces of binocular lenses. While a single coating is good, multiple thin coatings are even better at enhancing the unit’s optical performance.

So-called multicoated binoculars, however, typically have only the outer lens surfaces coated. For the best views,

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Oberwerk 11x56



Oberwerk 8x56

Astigmatism, which causes stars to focus as extended lines rather than points, is most noticeable in the periphery (edges) of the field of view.

So, how did they perform? All of the binoculars showed some degree of each aberration but performed surprisingly well considering their low prices.

I judged the Orion Scenix 10x50 (\$90) a cut above the rest for excellent image contrast and brightness. Focusing is smooth and precise, and images are sharp and clear. Distortion and field curvature are evident around the outer 25 percent of the field of view, which is less than most in this price range. The view through the Scenix 10x50 compared favorably to my Orion UltraView 10x50 binoculars, which cost \$70 more.

The Nikon 10x50 Action binoculars (\$100) also are exceptional. Aberrations are well-corrected, as evidenced by a sharp, flat field of view and good image contrast. I also like Nikon's bayonet-style eyecups that twist out rather than fold like all the others. Ergonomically, the binoculars have a sculpted feel that makes holding them easy.

Images through the Bushnell 10x50 Legacy (\$99) and Pentax 10x50 XCF

(\$90) binoculars are as bright as in the Nikon 10x50, although the Bushnell and Pentax models have a bit less image contrast.

Distortion and astigmatism also are more pronounced than through the Nikons, blurring the outer third of each field. Both the Bushnell and Pentax binoculars are easy to hold, however, and focus smoothly.

Tasco's Sonoma binoculars (\$60) also have good image brightness and contrast. Field curvature, however, softened the outer half of the field of view when the inner half was focused, and vice versa. Ergonomically, I found the Sonoma's tapered eyecups to be the most comfortable as well as the most effective at blocking stray light. The eyecups worked well even when I purposely observed near a streetlight. The binoculars I tested had traditional multicoated optics, but many retailers sell a different version that includes ruby-coated lenses. Ruby coatings, designed to reduce glare in bright lighting, are not suitable for stargazing.

Images in the Oberwerk 11x56 binoculars (\$100) also were sharp, although I saw some minor ghosting

(the appearance of faint, duplicate images) around brighter objects. The ghosting is likely an artifact caused by irregularities in the paint inside the barrels of the particular binoculars I tested. Several spots around the internal field stop looked as though they had been touched up with less-than-flat black paint. Focusing, however, was smooth, and the unit was comfortable to hold thanks to conical barrels.

Not only do the Oberwerk 8x56 binoculars (\$100) look the same as the 11x56 model, but the field of view is practically the same. While 6° is a wide field of view for 11x binoculars, it's a bit



Swift Aerolite



Nikon Action



Tasco Sonoma

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Eagle Optics

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Nikon

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Oberwerk

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Pentax Imaging Company

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**Celestron
OptiView LPR**

narrow for 8x. The small field creates a noticeable tunnel-vision effect I found confining. Even though the image contrast is good, and stars are sharp across 80 percent of the field, I preferred the 11x56s for the above reason.

The Celestron OptiView LPR (\$100), Orion WorldView (\$40), and Eagle Optics Triumph 10x50 binoculars (\$99) all produce good image brightness and contrast, although not quite to the level of the previous models. All had sharp images across the inner 75 percent of their fields of view as well as acceptable contrast and sharpness. And here's a twist: Celestron's OptiView binoculars have built-in broadband light-pollution filters. Turning small thumbwheels at the

base of the prism housing swings the filters in and out. Urban stargazers might benefit from this feature, but I didn't see a big difference from suburban or rural settings.

While Swift's Aerolite binoculars (\$81) are comfortable to hold, the thin focus wheel is a little more difficult to use than the focusing wheels on the other binoculars. Contrast is good, although image brightness isn't as high as through some of the other models. The outer third of the field of view also produced soft images due to field curvature. The Aerolites also are the only binoculars I tested without a tripod socket built into the central hinge.

Celestron's 10x50 UpClose binoculars (\$37) are the least expensive in this group. Despite the low price, images are more than satisfactory for someone just starting out. Admittedly, contrast is lower and astigmatism is greater than in some other models. However, providing beginning observers fully coated optics for under \$40 is a great manufacturing accomplishment.

Finally, we come to Celestron's giant 15x70 SkyMaster (\$88), which I left to the end because their size puts them in a different league than the rest. Image brightness, quality, and contrast are all remarkable considering the bargain price. Usually, you should mount binoculars of this size on a tripod to get the most out of them, but I

was able to hold the SkyMaster by hand long enough to enjoy views of many of my favorite sky objects. Although images were a little soft across the outer 25 percent of the field, the overall effect was striking. If you are in the market for giant binoculars at an economical price, I recommend Celestron's 15x70 SkyMaster binoculars.

Indeed, all of the binoculars presented here offer exceptional value for the money. As in the telescope market, binoculars that contain advanced features are readily available at amazingly low prices. The models featured here certainly prove you don't need to break the bank for binoculars that will serve you well for years to come. ■



**Celestron
UpClose**