Exploring the Universe with Binoculars

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Overview

• Why stargaze with binoculars?
• Gear: choosing and using binoculars, specs, things to look for and avoid
• Targets: pretty things to look at in the night sky
• Resources: helpful sources of inspiration and advice
Why stargaze with binoculars?

• It’s easy!
• It’s inexpensive.
• It’s intuitive – you look in the same direction as the instrument, with no mental flipping or rotation required.
• You may see things at a smaller image scale (less magnification), but you will also see more sky (larger field of view).
• Binocular stargazing isn’t inferior to using a telescope, any more than biking is inferior to driving. It’s a different experience.
Choosing Binoculars: When Gear Matters
Bino Basics: Magnification x Aperture

15x70
7x50
10x50
8x42
10x42
Bino Basics: Magnification x Aperture
Bino Basics: Magnification x Aperture
10x50

...means 10x magnification

Higher magnification:
- more detail
- narrow field of view (FOV)
- shakes will be more visible
- image will be dimmer!

Lower magnification:
- larger field of view (FOV)
- brighter image
- shakes will be less visible
- less detail

...means objective lenses are 50mm in diameter

Larger aperture:
- gathers more light
- heavier

Smaller aperture:
- gathers less light
- lighter
The primary function of any stargazing instrument:  
- naked eye  
- binoculars  
- telescope  
is not magnification but *light gathering*.

All else being equal, *aperture always wins*. 
## Aperture and Light Gathering Area

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>42mm</td>
<td>1384mm(^2)</td>
</tr>
<tr>
<td></td>
<td>(x \sim 1.5 =)</td>
</tr>
<tr>
<td>50mm</td>
<td>1960mm(^2)</td>
</tr>
<tr>
<td></td>
<td>(x \sim 2 =)</td>
</tr>
<tr>
<td>70mm</td>
<td>3850mm(^2)</td>
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Bino Basics: Porro Prism vs Roof Prism

Porro prism binos have “shoulders”

Roofs are smooth
Bino Basics: Porro Prism vs Roof Prism

Porros tend to be bigger and heavier (not as good for birders), but they’re less finicky – roofs need phase coating for max light.
Focusing: use the diopter
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Twist-up eyecups

Diopter
Focusing procedure:
1. Close right eye, focus for left eye using center wheel.
2. Close left eye, focus for right eye using diopter.
What to look for: collimation

Close right eye... Close left eye...

If the images match, the binoculars are in good collimation.
What to look for: collimation

Close right eye... Close left eye...

Oops. These binoculars are not in good collimation. Using them for any significant time will give you a headache!
What to look for: interpupillary distance (IPD)

This won’t be a factor for most people, but if your head is unusually narrow or wide (like mine), you may find that some binos, particularly older or foreign models, may not fit your natural eye separation. This has happened to me with vintage Japanese binos – which are otherwise generally excellent.
What to look for: eye relief
What to look for: eye relief

Enough eye relief to observe while wearing glasses...
What to look for: eye relief

...or not?
Exit pupil: how wide and how bright?

The exit pupil is the width of the beam of light that comes out of the eyepiece.
Exit pupil: how wide and how bright?

15x70
4.7mm

7x50
7.1mm

10x42
4.2mm

8x42
5.3mm

10x50
5mm

Exit pupil = aperture/magnification
The average diameter of the dark-adapted pupil in young people is 7mm, but it can be as high as 9mm. As we age, we lose the ability to open so widely, typically by 0.5-1.0mm per decade past the age of 30.
Exit pupil: how wide and how bright?

Exit pupil much smaller than eye pupil – eye could be admitting a lot more light, image may seem dim

20x50 binos
Exit pupil is 50/20 = 2.5mm
Exit pupil: how wide and how bright?

Exit pupil completely fills eye pupil – the eye is admitting as much light as possible, so the image appears maximally bright.

10x50 binos
Exit pupil is 50/10 = 5mm
Exit pupil: how wide and how bright?

Exit pupil larger than eye pupil – extra light falls on iris and is “wasted”. Image doesn’t get any brighter.

7x50 binos
Exit pupil is 50/7 = 7.1mm
Exit pupil: how wide and how bright?

Exit pupil *larger than* eye pupil – extra light falls on iris and is “wasted”. Image doesn’t get any brighter...

BUT these binos may feel very comfortable because the eye can move around within the exit pupil without losing any brightness.
Field of view: how much sky?
Field of view: how much sky?

8X42
6.8°
357ft@1000yds
119m@1000m

Waterproof
Multi-Coated
Bak-4 Prisms
Field of view: how much sky?
Field of view: how much sky?

Many 10x binoculars give a 6° or 7° field of view, which is enough to take in Orion’s Belt and Sword at the same time.
Field of view: how much sky?

Larger 15x binoculars only show about 4.5° at a time – enough for the Belt or the Sword, but not both at once.
Lens coatings: good, bad, and ugly
Lens coatings: good, bad, and ugly

GREEN or BLUE GO!

RED or ‘RUBY’ STOP!
To mount or not to mount?
Tripod mounts: simple, easy, cheap
Parallelogram mounts
Binocular chairs

Homemade stabilizers

Photos by Alan MacRobert, http://www.skyandtelescope.com/
Mirror mounts: keep looking down!

Tech heaven: image-stabilized binos

These are extremely cool – and fairly expensive.
Big binoculars: 20x80 and up
A neat trick for freehanding big binos

Keep hands up here for aiming and focusing...
A neat trick for freehanding big binos

Then move them down here for relaxed viewing.
Which should you choose, and why?
Which should you choose, and why?

DON’Ts
• No zooms
• No ruby lenses
• Nothing so heavy or with such high magnification you can’t hold it steady (recommend: 2-3 lbs, 7-10x)

DOs
• Porros tend to be cheaper and less finicky than roofs of equivalent quality
• Aperture between 35mm and 50mm, for starters
• Magnification between 7x and 10x
• If you can, try before you buy, or buy from a vendor with a generous return policy
How much should you spend?

Celestron UpClose 10x50

Celestron SkyMaster 15x70
How much should you spend?

Celestron UpClose 10x50
Usually run $25-35

Celestron SkyMaster 15x70
Usually run $60-70
Using Binoculars: When Gear Doesn’t Matter

• Anything that shows more than the Mark 1 eyeball is worth using.

• Curiosity, willingness to learn, and experience matter more than gear.

• Your binoculars are probably better than Galileo’s early telescopes, and he managed to discover countless amazing things that you can now discover for yourself.
Observing near and far: the solar system

Solar system targets: the moon
Galileo tracked the phases of Venus (above) and the movements of the moons of Jupiter (left) with a simple telescope that was no better than low-end binoculars today. You can easily see as much as he did!
Solar system targets: the planets

A simulated view of Jupiter and the Galilean moons – Io, Europa, Ganymede, and Callisto - in 7x35 binoculars. My first bino observation!
Observing near and far: double stars

From “Eyes of the Dragon”, Sky & Telescope, August 2017
Observing near and far: OB associations

OB associations are groups of young massive O- and B-type stars that were born together in star-forming nebulae and that have not had much time to separate. Many of the closest ones spans several degrees – think open clusters on steroids. These are wonderful targets for rich-field telescopes and, you guessed it, binoculars.

Orion OB associations posted to Cloudy Nights by Allan Dystrup
Observing near and far: galaxies

Big Fish, Small Tackle
Mathew Wedel

“Ask people who land huge fish with light tackle, why I do what I do,” wrote West Coast observer Jay Reynolds Freeman, in an essay about hunting deeply objects with small telescopes. For amateur astronomers, there are no bigger fish than galaxies, and no lighter tackle than binoculars. There’s something particularly satisfying about catching an object as grand as a galaxy in an instrument small enough to hold in your hands.

In addition to this reward, observing galaxies with binoculars shows you something about the universe. Galaxies are the building blocks of the cosmos, and in binoculars you can see them in their native habitat. Mostly that means they’re isolated by vast gulfs of nearly empty space, but here and there you can find clumps of them. These galaxy groups and clusters are the first steps up a ladder that leads through superclusters, filaments, sheets, and walls composed of thousands or millions of galaxies, to the large-scale structure of the universe.
Observing near and far: asterisms

Observing near and far: asterisms

See “The Serpent’s Fang”, Sky & Telescope, June 2017
Resources for bino observing
The best thing since sliced bread – the Evening Sky Map, a free download every month from Skymaps.com.
Each month the Evening Sky Map has lists of objects to observe with naked eyes, binoculars, and telescopes, all of which are plotted on the sky map – it’s a great way to learn the sky.
Resources for bino observing
Resources for bino observing: atlases
The Astronomical League has loads of observing projects, which you can do whether you are an AL member or not.
Resources: observing projects
Resources: astronomy magazines
Resources: astronomy magazines
Back to basics: all you really need

• All of this knowledge and all of these resources are *nice to have*. But they aren’t *necessary*. They may make your binocular observing easier or more enjoyable, but they don’t make it *possible*.

• Absolutely necessary: binoculars

• Not absolutely necessary: everything else
Back to basics: Matt’s 3-step checklist

• Do you have binoculars?
• Is it nighttime?
• Is the sky clear?

If the answers are all ‘yes’, then **GO!**
Thanks, and clear skies!