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The Galileoscope: The Good, the Bad and the Ugly

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The Galileoscope is purportedly a high-quality, low-cost refracting telescope kit developed for the International Year of Astronomy 2009. Many will be given away to children and adults to learn how telescopes work and operate, and to repeat some of the celestial observations that Galileo made 400 years ago. How well does the Galileoscope work is the subject of this review

The Galileoscope™ is advertised as a high-quality, low-cost refracting telescope kit developed for the International Year of Astronomy 2009. Merrit Models and a group of astronomers, optical engineers and science educators developed this kit (www.galileoscope.org) in conjunction with the International Year of Astronomy 2009. The "Galileoscope" is also a Cornerstone Project of the International Astronomical Union (IAU), the worldwide coordinator of the IYA2009 celebration (www.astronomy2009.org).

Figure 1. The Galileoscope. This low-cost kit enables the user to build a 50-mm refractor telescope. The length of the optical tube including dew cap is about 22 inches.

This kit allows one to assemble a 50-mm (2-inch) diameter, 25- to 50-power achromatic refractor (Fig. 1). Since the IYA2009 marks the 400th anniversary of the first use of an astronomical telescope by Galileo, the manufacturer claims "You can see the celestial wonders that Galileo Galilei first glimpsed 400 years ago that still delight stargazers today."

Promotions state, "The Galileoscope is more than a telescope—it's a strategic initiative to improve math, science and technology literacy worldwide."

The Galileoscope web site also states that not everyone has a telescope, especially in less developed parts of the world. Therefore, to enable more people in more places to personally experience the wonders of the universe, they claim to have developed a remarkably inexpensive, very-high-quality, easy-to-use refractor. With this new instrument,

called the Galileoscope, the developers of this telescope say children and adults are supposed to learn how telescopes work and repeat for themselves the spectacular observations made by Galileo beginning in 1609.

COST

As of August 10, 2009, the kit was priced at U.S. $20 each plus shipping for 1 to 99 units, or U.S. $15 each plus shipping for 100 units or more. This price is obviously much less than most other commercially available telescopes. Is it worth the price? Is this telescope an easy-to-use refractor? I ordered four of these telescopes in March 2009 for evaluation. (The original price was only $15 each plus about $5 for shipping.)

OVERVIEW

The Galileoscope kits finally arrived in August 2009 leaving little time for review before our local museum plans to give away many of these telescopes in September. However, even preliminary inspection of these kits reveals both the good and bad about these low-cost instruments. Potential users of these telescopes should be aware of the attributes of these kits and telescopes before either buying, assembling or supervising others in their construction or operation. While the Galileoscope can give good images of many celestial objects, mechanical constraints limit its usefulness. Like many low-cost telescopes, operating the telescope can be frustrating, especially for beginners. Furthermore extremely poor instructions included with the kit can make proper assembly difficult and baffling although most parts fit together nicely. Fortunately, better on-line instructions are available as a pdf file from the Galileoscope web site (www.galileoscope.org).

The Galileoscope comes as a kit with simple instructions for no-tools assembly, which is claimed to be five minutes or less. Its achromatic optics includes a 50-mm-diameter glued doublet objective lens of focal length 500 mm (giving it an f/10 focal ratio). Also included are six small lenses to make an eyepiece of focal length 20 mm (magnification 25x) and a 2x Barlow lens (yielding 50x). This Barlow lens can also be used as an optional “Galilean eyepiece” giving about 18x although the field of view is extremely small, a normal characteristic for this type of eyepiece. The Galileoscope has a standard 1.25-inch eyepiece barrel so other eyepieces can be used. The telescope also attaches to nearly all standard photographic tripods, another useful feature.

However, a tripod is not included with the kit; you need to supply your own.

Some may try to handhold the telescope but this is ill-advised. Most people have trouble viewing objects with handheld instruments even at 10x let alone 20x or more. However, you can probably glimpse views of daytime scenes with the 25x eyepiece if you have steady hands.

OPTICS

The 50-mm, f/10 objective is an achromatic, glass doublet, a nice feature in such a low-cost instrument. (Galileo’s telescope used a simple, low quality lens that needed to be “stopped down” to produce useable images.) Other parts are plastic except a tripod mounting nut. Most parts fit together nicely and are easy to put together if you already

know how to assemble this product! The tube is baffled and includes a dew cap, another nice feature. Constructing eyepieces, however, requires patience and care. Four small lenses (two positive, two negative) are used to make a symmetrical type 20-mm focal length eyepiece yielding 25x and an inverted image. The remaining two lens (positive and negative) make a negative 2x amplifier ("Barlow") which can also be used to simulate Galileo's negative eyepiece. This gives about 18x along with a very small angle of view (a small fraction of a lunar diameter) but the image is erect.

The good news is the telescope can produce acceptable images for both daytime and night viewing, especially for beginners. Time and weather did not allow for a detailed evaluation of its optical quality, but preliminary tests were sufficient to suggest beginners will be pleased with views of daytime scenes and many celestial objects.

For example, although some chromatic aberration is noticeable, images of the Moon appear crisp and detailed with beautiful views of lunar craters even at 25x. The telescope also splits the double star Mizar in the Big Dipper at 25x. The view of the Pleiades was very delightful at low power since the entire cluster fits within the field of view at 25x. (The field of view with the 20-mm, 25x eyepiece is 1.5 degrees; 0.75 degrees with the 2x Barlow.) Other objects need higher magnification. For example, I had no trouble seeing the Jovian satellites as sharp points and some banding appeared on Jupiter, but this required using the telescope at 50x or more. Some eyepiece lens flare did downgrade the image. Still I could make out the gibbous shape of Venus although this was difficult due to its small angular diameter (14 arc seconds). Using my own 6-mm commercial eyepiece considerably improved the image quality. However, using the telescope at 50x or more may prove very difficult with this instrument, especially for beginners due to mechanical considerations. (More about this below.) Still, many of these sights can easily thrill beginners and children who are unlikely to analyze the images very critically.

ASSEMBLING THE GALILEOSCOPE

Now for some bad news. The instructions included with the kits are unacceptably poor, unclear and incomplete. These instructions are brief and contained on a single double-sided page. Black and white pictures are low quality and provide little help. If the telescope is not correctly assembled, the telescope can fall apart or blurry images will result. Those who give the Galileoscope to family or friends unfamiliar with telescopes or observing may find they may have difficulty properly assembling or using this instrument unless given help. (Fortunately better instructions are available on-line although beginners may still need further guidance. See below.)

The claim that the telescope can be assembled in five minutes is misleading. It will take at least that long just to unpack and check all parts, usually an important step. However, checking all parts in this kit is impossible since the included list of parts is not only incomplete but also contains no identifying pictures! The instructions list only twenty items but thirty-one are included. Omitted from the list of parts are two large O-rings, an eyepiece field stop, two V-block stands (to display or hold the telescope when not mounted on a tripod), a Barlow lens tube, a second small eyepiece clamp ring, two auxiliary eyepiece barrel halves, an auxiliary eyepiece cap, and the Sun-warning sticker. Some

parts (e.g., the large O-rings) are not mentioned in the assembly steps leaving the user wondering what purpose they serve.

Understanding the instructions is a difficult task. Assembling the telescope, especially by people unfamiliar with telescopes, will take more time. Although the parts fit together easily, some may not understand what goes where or may assemble the instrument and eyepieces wrong. If one already knows how to put together the kit, five to ten minutes or so may be adequate. However, one needs much more time understanding how to use the Galileoscope. (The instructions do not include any help on this subject.)

Deterrents that may thwart successfully building this telescope are numerous. For example, the kit includes both small and large O-rings but the instructions do not specify which should be used. Some may use the large rings where small rings are needed. In addition, the instructions never mention using the large O-rings in the assembly process so most people will wonder why the kit includes this second set of rings.

In fact, the large O-rings are intended to help hold the main telescope barrel together since the barrels come in two halves. These rings can be fitted over the main tube to help hold the barrel together but this is not mentioned in the included instructions. Unfortunately, placing the O-rings over the tube is not trivial since they can tear when moved over the sighting posts.

One user wrote that the lens packet had been opened and found that the lenses for the eyepieces were missing. In fact, the 50-mm objective is packed between padded packing material. However, the six small eyepiece lenses are also packed within the same padding material. Many may find the objective lens but never notice the eyepiece lenses are "hidden" within and throw them away! (The instructions say nothing about how the lenses are packed.)

Instructions for assembling the eyepieces are similarly unclear. Not properly identifying all eyepiece components in the packing list adds to the confusion. One can easily select the wrong lenses or assemble the eyepieces incorrectly. The eyepiece lenses are also small and slippery and can be put either in backwards or in the wrong combinatiaons. They should be carefully handled with lens paper or tissue to avoid fingerprints or dirty, blurry images will result. Dexterity may be needed to assemble the lenses in the eyepiece tubes. Children and older people may find it difficult or impossible. It may take five minutes or more just to assemble all eyepiece components.

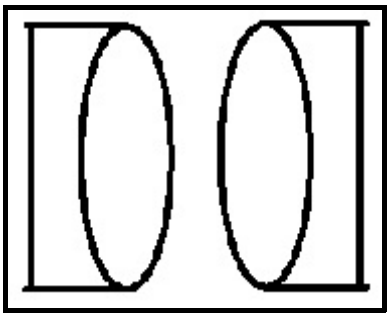

Figure 2. Galileoscope Eyepiece. The kit comes with lenses to make this 20-mm focal length symmetrical type eyepiece consisting of pairs of negative and positive lenses. This eyepiece gives 25x and a wide viewing field when used in the Galileoscope. However, the image is inverted.

The Galileoscope kit contains parts to assemble a 20-mm focal length eyepiece (for 25x) consisting of four lenses—two sets of doublets containing a convex and concave lens with the lens pairs air spaced from each other. (This design is usually known as a *symmetrical* or *Plössl* eyepiece.) Fortunately, the instructions list assembly steps and contain a diagram (Fig. 2) to show their correct arrangement. However, some users may be confused by the

statement to insert the small, thin field stop ring into the eyepiece barrel since this ring is not mentioned in the list of parts and the included picture is not clear.

Additionally, the kit also contains two remaining small lenses to make a Barlow lens (a 2x

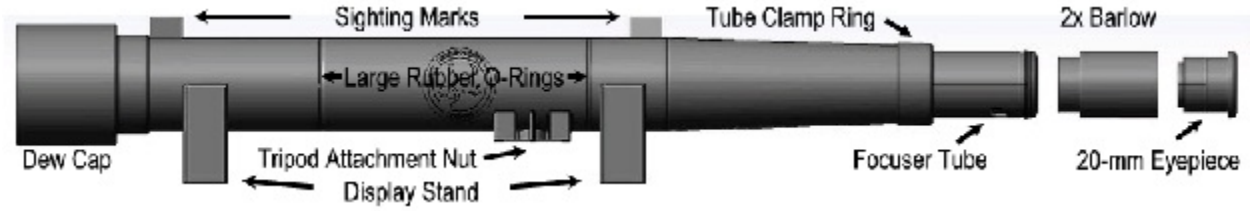

Figure 3. The Assembled Galileoscope. The telescope is shown with the 2x Barlow tube in front of the 20-mm (25x) eyepiece yielding 50x. To make an approximate 18x Galilean telescope, discard the 25x eyepiece and remove the optical barrel from the Barlow tube. Then, attach the auxiliary eyepiece cap to the front of this optical barrel and insert the resulting eyepiece into the focusing tube.

diverging lens system). This component can also be used as a Galilean eyepiece when removed from its "Barlow tube" and an auxiliary eyepiece cap attached (neither itemized in the parts list). See Fig. 3. This feature is not made clear in the instructions, which only show the eyepiece construction in small, cryptic diagrams. Furthermore, the diagrams for the Galilean eyepiece or Barlow do not properly show how the lenses should be assembled. The convex surface of one lens should be placed within and touching the concave surface of the other lens (Fig. 4.) This is impossible to learn from the included diagrams.

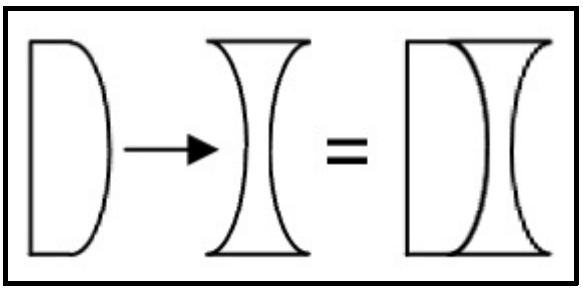

Figure 4. Galileoscope Optics for the Barlow Lens or Galilean Eyepiece. The concave lens on the right should face the narrow or bottom of the eyepiece barrel. The instructions included with the Galileoscope do not make this arrangement clear. When used as an eyepiece, the image is erect but the angle of view is extremely small.

The instructions conclude by stating one should use the included diagrams to create a *Galilean telescope*. However, many will ask what is a *Galilean telescope*? Is not the Galileoscope a *Galilean telescope*? In fact, it is the construction of a "Galilean eyepiece" that makes this telescope simulate the telescopes that Galileo used. Still, no explanation is given for what is a "Galilean eyepiece," or how or why it should be used.

Finally, beginners may be confused that images are upside down when used with the 25x eyepiece and think this wrong! The instructions do not mention this is normal. However, beginners who manage to construct and use the Galilean eyepiece will find the image is erect. This may confuse the beginner even more and imply the 25x eyepiece is defective.

However, views through Galilean eyepieces are extremely narrow and most will find this eyepiece impossible to use for viewing. So, again beginners may conclude they have done something wrong. Moreover, the lenses of this Galilean eyepiece are deep within its holder so the eye cannot be placed next to the lenses. This further reduces the field of view. Using eyeglasses will exacerbate this problem. Again the instructions neither mention this eyepiece has a very small field of view nor point out this is the type of eyepiece used by

Galileo. Still, this eyepiece simulates what Galileo saw although the Galileoscope has much superior optics. The best use of the Galilean eyepiece may be to start a discussion about the difficulty of using early telescopes with type of eyepiece!

Users will probably find the 25x eyepiece gives best performance and is easiest to use assuming the eyepiece is correctly assembled. The instructions do not point out that using the 2x Barlow will reduce the viewing field, dim lunar or planetary images and make the telescope more difficult to point or focus. Unless the telescope is locked firmly on a sturdy tripod, inserting the Barlow lens will probably move the telescope off the object. Then the user will find it difficult to relocate the object again in a reduced field of view. The telescope will also be out of focus which will make locating the object even harder. Focusing the telescope with the 2x Barlow may try the patience of many since the telescope is likely to shake when touched.

Finally, some may find the Galileoscope gives even better performance if they already own good telescope eyepieces. In fact, the use of a good commercial eyepiece will help bring out the good quality of the objective lens. Recall the focusing tube will accept standard 1.25 inch telescope eyepieces.

DETAILED INSTRUCTIONS

The manufacturer should have included clearer and more detailed instructions with the kit.

Fortunately more detailed instructions and color pictures are available on-line as pdf files on the Galileoscope web site (www.galileoscope.org).

This web site also contains various teaching materials. The pdf file consists of a seven-page document with many color pictures and diagrams. These instructions also include a complete list of parts with identifying pictures. Many other figures greatly help understand the telescope's construction.

Downloading and using these more detailed instructions are mandatory for the successful assembly and use of this telescope!

The most worthwhile and important section of the instructions included with this telescope is a statement to *see the Galileoscope web site for more information.* **Do it!**

USING THE GALILEOSCOPE

Using the telescope may frustrate some beginners with little or no telescope experience. Focusing the scope is by draw tube that must be pulled out or pushed in to focus the telescope. Do not focus by moving the eyepiece in or out of the focus draw tube—move the draw tube in or out. Slightly twisting the draw tube as you move it in or out makes this process easier. I found this worked fairly smoothly but the telescope tube can easily oscillate when touched making it hard to focus accurately. In addition, the telescope may shake or move off the object especially at higher powers when touched even when used with a sturdy tripod. The telescope has a long moment arm and is only secured by a single tripod nut. Thus, the telescope is easily subject to the tiniest vibration and may move off

target when switching eyepieces. In fact, focusing while observing may be impossible for some, especially at high powers or by children.

Most users will probably find using the telescope at low power (25x) not too difficult but may find their patience wearing thin when used at higher powers. Both focusing the telescope and keeping the object in view is more difficult with increasing magnification. Remember celestial objects will slowly move across the field of view due to the Earth's rotation. This will require constant recentering of the object, especially at higher powers. Unfortunately, some features such as the banding on Jupiter or Saturn's rings require higher magnifications. For example, I used my own 6-mm eyepiece (about 80x) to see clear bands on Jupiter but inexperienced observers might find this an impossible or frustrating task if they cannot easily focus or keep the planet centered in the eyepiece.

NO FINDER

The telescope has no finder but uses two sighting marks. While not difficult to use on daytime objects or a bright Moon, the sighting marks are almost impossible to see against a dark sky. Thus, placing planets or stars in the eyepiece may prove very difficult for some. Perhaps coating the sight marks with fluorescent paint would help. The instructions should have warned people to use low magnification to find objects. (Unfortunately, a poor tripod may allow the telescope to lose the object due to vibration when changing eyepieces.)

NO STAR DIAGONAL

The telescope is designed for straight-through viewing much like Galileo's original telescope. While this simulates how Galileo used his telescope, it makes observing objects high above the horizon difficult or impossible! The Galileoscope does not include a star diagonal nor can one use a conventional star diagonal to aid viewing. (The Galileoscope will not focus on distant objects if used with a star diagonal.) This can limit or make impossible viewing objects at high altitudes. It also means images seen through the 20-mm (25x) eyepiece are inverted. This is OK for celestial objects but not for daytime scenes.

Use of a conventional star diagonal would eliminate this problem. However, the tube does not have enough back focus to permit the use of a conventional star diagonal that turns the light at a right angle for more convenient viewing. The manufacturer readily admits that the use of a conventional star diagonals will not work. Therefore, the telescope will not focus on a distant object if used with such an accessory. I regard this as a design fault. Allowing for only an extra inch of focusing movement could have eliminated this deficiency.

To avoid craning your neck, the (detailed) instructions suggest using a tall tripod that can extend to at least 60 inches and sitting in a chair. Even so, objects nearly overhead will not be observable since one probably could not get their head under the eyepiece. At the very least, it will be a "pain in the neck." I found objects above about 45 degrees altitude not easy to observe.

NO TRIPOD

In addition, the Galileoscope does not come with a tripod; users must supply their own. Fortunately, one can attach the Galileoscope to most photographic tripods. Unfortunately, many acquiring this instrument will not have either a photo tripod or a sturdy enough tripod and will unlikely to buy a sturdy tripod for a telescope that only costs about $20. Even sturdy photographic tripods may not work well with astronomical telescopes since the Galileoscope has a weak point of attachment (a single 1/4-tripod nut) and a long tube that can shake. Unfortunately, even good many photo tripods usually do not have fine motion adjustments.

Since the Galileo telescope easily shakes if not securely mounted, a sturdy tripod with good locking clamps is advised. Unfortunately, many beginners may not have a good photo tripod and will not want to invest in one. Unfortunately too, even good photo tripods often do not have the smooth motions required for telescope use nor do they have slow motion controls. (Orion Telescopes sells a Precision Slow-Motion Adapter for tripods which makes using telescopes on photo tripods much easier to use. Cost is about $40. See www.telescope.com.)

Thus, mechanical constraints may severely limit the use of the Galileoscope, especially by children or beginners. (The telescope is almost impossible to use without a tripod and still may be difficult for some with a conventional photo tripod.) See also comments on star diagonal and focuser.

CONCLUSIONS

What can you expect in a twenty-dollar telescope? Not much. However, the Galileoscope delivers much more, at least optically, than most telescopes costing five to ten times more. In fact, its optical quality is a bargain for $20. Is it a high quality telescope as advertized? Optically beginners will find the Galileoscope performs reasonably well but its mechanical construction is only fair. Therefore, some may question that the Galileoscope is really an easy-to-use refractor. Even when mounted on a good photo tripod, the telescope suffers from vibration and lack of stability like most cheap “department store” telescopes. Some people may find using this telescope on astronomical objects a daunting task and may only find it useful as a daytime telescope when it is much easier to use. However, images will be inverted unless the Galilean eyepiece is used, which is an almost impossible task due to its small viewing angle.

Still, with proper guidance, instruction and patience, the Galileoscope may help some beginners thirst for better views of the sky. Certainly, low power views of the Moon and the sight of the Jovian satellites should excite. Just remember to download the detailed pdf instructions before trying to assemble the telescope. Proper construction of the telescope should, by itself, be an interesting and educational component of using the Galileoscope.

The Galileoscope was also supposed to be more than a telescope. Its kit should have included better instructions for both assembly and use without requiring use of the Internet. Thoroughly researching the Galileoscope web site is necessary to benefit from building and using this instrument. The telescope may end up being more a conversation piece

about ancient instruments although its optical quality is far superior to the first telescopes. This might help alleviate the frustration some might feel trying to use this telescope. Thus, the Galileoscope's most useful application may be as a teaching tool about telescope design and operation including their use by the first telescope observers. Hopefully, beginners will not lose interest in observing the sky, will better appreciate the difficulties using early telescopes, and eventually move onto something better.

Serious beginners may find investing in starter telescopes such as the Orion FunScope 76mm Reflector Telescope a better deal. (Cost is only $50. See www.telescope.com.) The Orion telescope is much simpler and easier to use while producing good images. In addition, the Orion telescope will less likely turn beginners off from astronomy.

The best thing about the Galileoscope may be the 50-mm glass achromatic, doublet objective, which is probably worth more than the cost of the scope. Some may even find it useful to place this lens in their own mounting cell, optical tube assembly, focuser and star diagonal to make a new and better working small telescope! ¤

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