Instruments and Imaging Section
Technical Tips No. 4
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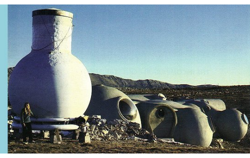

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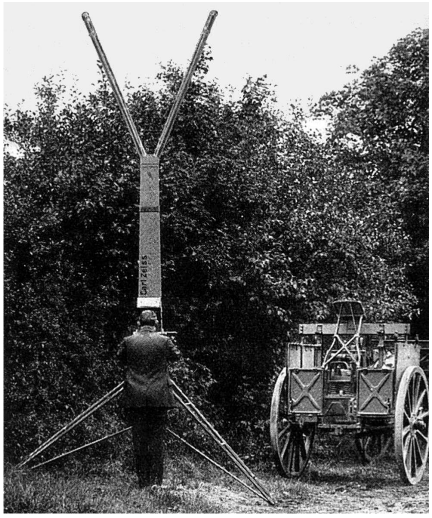
In the previous *Technical Tips* the 'mystery object' is the first Ritchey–Chrétien telescope – a 24-inch, completed in 1927 – accompanied, of course, by George W. Ritchey and Henri Chrétien. From around 1905 Ritchey's ideas for new optical systems were diametrically opposed to George Ellery Hale's obsession with the production of large reflectors of standard Newtonian/Cassegrainian design, culminating in 1917 with the completion of the 100-inch Hooker telescope at Mount Wilson – an instrument for which Ritchey's design had been rejected. For many years Hale actively strove to prevent the advancement of Ritchey's revolutionary ideas, and, being all-powerful in the American scientific community, also blocked and rejected all nominations for awards for Ritchey, who never received any. Ritchey later continued his work with Chrétien in France, and decades later his many years of struggle were fully vindicated. The Hubble Space Telescope is a Ritchey–Chrétien system, as are the instruments in many large, modern observatories.

The facility illustrated at top right is an observatory, and the prize for identifying it correctly is a mention in despatches.

In the February issue of the *Journal*, Stewart Moore published an article on the acquisition of binoculars. It therefore seems an appropriate time to reissue my 'Notes on the use of binoculars', which I first produced as a 4-page A5 leaflet about five years ago.



A Neighbourhood Watch enthusiast

Notes on the use of binoculars

Bob Marriott

Principles

The advantages of binocular over monocular vision are:

- Faint objects are slightly more easily seen.
- Fine detail is more quickly, and sometimes better, seen.
- It is less tiring.
- It produces an increased stereoscopic effect (though not in astronomical work).

Binoculars are described in terms of their magnification and their aperture measured in millimetres: for example, 7 x 50 (m = 7, a = 50 mm). The diameter of the exit pupil (the disc of light in the eyepiece), e, is determined by the aperture of the object glass, a, divided by the magnification, m:

$e = a/m$

As the light level decreases the pupil of the eye dilates, and with complete dark adaption the maximum aperture is about 7 mm (although this decreases with increasing age). If the exit pupil of the instrument is larger than the pupil of the eye, light is wasted; but if the pupil of the eye is larger it can accommodate a larger exit pupil produced by a larger instrument aperture or lower magnification. Binoculars such as 7 x 50 and 11 x 80 are therefore ideal for astronomical work, as they produce exit pupils matching the maximum aperture of the pupil of the eye.

Types and design

Prismatic binoculars – in which the light is twice turned through 180° by right-angled Porro prisms – are, with few exceptions, the only type suitable for astronomical work. The diagrams on the next page show the light paths producing an erect image in a compact instrument. A centre knurled wheel should be available for focusing the eyepieces simultaneously, and there should be independent focusing of one eyepiece. The connections between the tubes should be hinged so that the interpupillary distance can be exactly matched by the separation of the two optical axes.

Testing

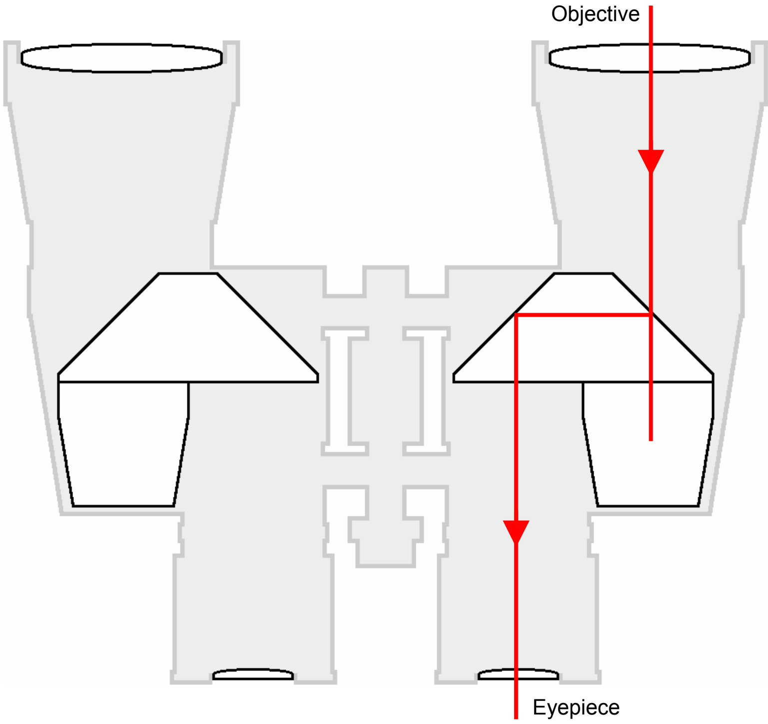
If binoculars are tested in daylight, attention should be paid to the edge of the field. If there is the slightest indication of aberration or distortion, then the binoculars are of no use for astronomical work. The ultimate test of any astronomical instrument is the determination of the quality of star images, which ideally should be perfect over the entire field of view.

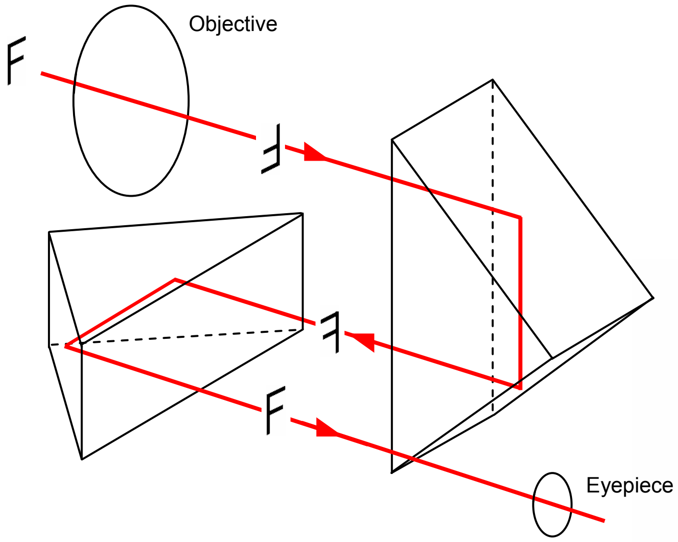
Resolution and magnitude limit

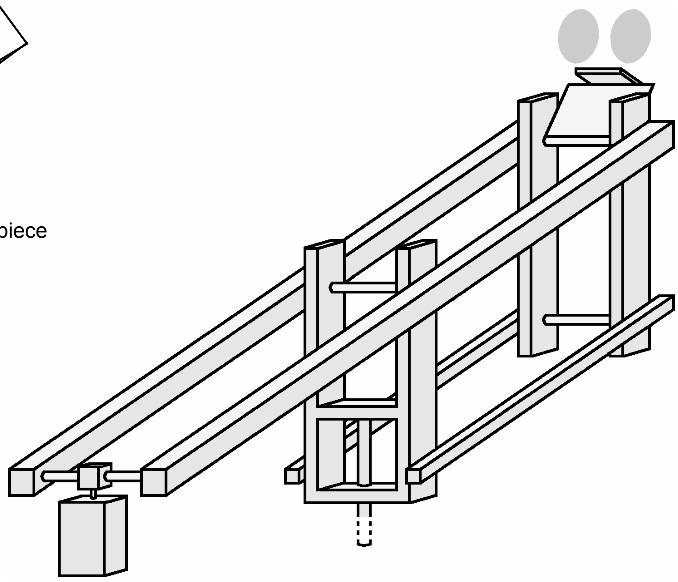
According to Dawes' limit, the maximum resolution of an object glass (or mirror) is 4″.56/d (inches) or 115″.8/d (mm), where d is the aperture of the instrument. Thus 7 x 50 binoculars have a theoretical resolution of 2″.32, although due to the very low magnification this is not attainable in practice. According to Pogson's photometric scale, a 1-inch (25.4-mm) aperture will reach to magnitude 9.2, and 7 x 50 binoculars could be expected to extend to about magnitude 10.5. However, both of these rules, although based on practice, are idealistic, and results are very much dependent on seeing, transparency, light pollution, and the skill and condition of the observer.

Observing techniques

With any instrument used for astronomical work, the slightest deviation from focus or the smallest movement will result in the reduction of perception and detail and the loss of at least a magnitude. The eyes should not be strained to acquire focus, which must be accomplished only with the instrument. The observing position should be as compact as possible, with the binoculars held firmly, the wrists close together, and the elbows against the body. When standing, bracing the body against a wall or solid post ensures a much greater degree of stability. However, when observing objects at high elevation and at the zenith, the constant or repeated bending back of the head reduces the blood-flow to the brain, resulting in inefficient light reception, occasional giddiness, and disorientation. A seated or reclining position is therefore much more satisfactory. At higher magnifications even the heart pulse will be transmitted to produce slight movement, and with a magnification of more than 10 the binoculars should be mounted for best results. A tripod is useful, but is awkward to use when observing objects at high elevation. The diagram at lower right shows an example of a counterbalanced mount with which binoculars can be used comfortably and left in position.







Potential work – casual and useful

Good binoculars can be purchased for less than the cost of the smallest telescope, and their use will lead to a rapidly increased knowledge of the sky. A wide field and low magnification can be an advantage, as many deep sky objects are too large to be contained within a telescopic field, even at low magnification. Sweeping through the Milky Way will provide fine views of star fields, features on the Moon will become familiar, and bright comets can be monitored. A personal record can be of great satisfaction, and observations can be recorded with written descriptions, drawings, or both. The observation of variable stars presents an opportunity to add to the pool of scientific data, and more than 100 of them are included in the BAA Variable Star Section's Binocular Programme.