Part 2

OBSERVING VARIABLE STARS WITH BINOCULARS.

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The construction of a binocular was shown by aid of a cross-section, and basic specifications were explained, as well as the usual problem when using a high magnification, of mounting the device in order to view stable images. A few proprietary forms were described such as a universal L-bracket, or a hinge clamp for fixing via a heavy tripod to the very useful parallelogram (giraffe-like) device, that allows the binocular to be positioned into a fixed position. The latter is an ideal situation when showing others the sky, assuming that someone does not make a grab, shifting the binocular position, hence mis-locating the object which should be on view. The parallelograms require a very sturdy tripod, possibly a surveyor's, rather than a camcorder/camera type. Several other ideas have been used, for example, a garden lounger converted to rest the observer in a comfortable position, and support the binocular at the observers' eyes. Light estimates of a star made with the same hand-held binocular in comparison with a mounted one will differ slightly. Some large sized instruments are available on a customised tripod. These may use angled eyepieces for ease of viewing, and have interchangeable eyepieces to change the magnification and field size. When selecting a binocular for hand use, it would seem sensible to actually handle the binocular, check several aspects of it, before purchasing.

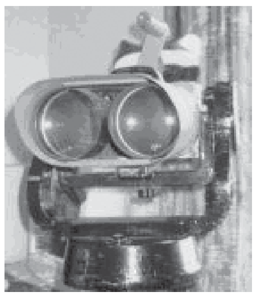


Figure 1: George Alcock's 25 x 105 tripod mounted binoculars.

Several binocular styles relate to optical design, for example, the roof prism, Zeiss porro prism, the terrestrial (straight-through), and Galilean style of opera-glass. Prism quality is also important for the ultimate aim of image quality, with modern BaK-4 type being subtly superior to the BK7 glass. Focussing mechanisms that provide a crisp image are either centre-focus, the most common, or with the eyepieces having their own movement. Though optical distortions, collimation of a faulty instrument and lens coatings were not described in detail, these aspects are worthy of study. In quality binoculars all air-to-glass surfaces are multicoated, which means that ghost images and internal reflections are reduced. The centre bridge, that gives eye access to the eyepieces, should not be too slack, the motion smooth if even a bit rigid. Similarly the focussing action needs to be smooth and not jerky, which would upset the precision required to image stars as near pin-point.

Simple Tests for Binoculars.

Mechanical:

- Check for hinge movement, anything rattling, loose screws, and smooth focussing (central or eyepiece).
- The position of the threaded mounting bush is relevant, as it is either on a barrel, or in line of the centre spindle, and this may dictate how to mount the binocular.
- Each barrel should have its optics collimated, but it is also a matter of importance that the axes of both barrels are parallel in the same plane. If the axes are mis-aligned the field will not appear wholly circular, and it would be like seeing two circles slightly offset to the other. This defect is not good for the observer's eye status, and would affect one's eyesight if used over time.

Condition:

- Check for internal blemishes (mildew or paint flecks on the optics), by turning the binocular around and inspecting the objectives against various lighting angles.
- Personal experience over a plastic carrying strap that became brittle, then broke, instantly presenting me with a monocular and a broken barrel, meant a sturdy (non-plastic) strap was obtained.

Coatings:

- The best coatings can be judged by looking down on the objective, with a hand over the eyepiece, and examining reflections. A totally white reflection means the optical surface is not coated. Multi-coatings reveal reflections that are noticeably fainter.

Exit Pupils:

- Check if round with no grey edges, and if no internal parts visible.

Distortions:

- Check star 'shape' when moved to near the edge of field.
- 'Line' distortions – Try looking at a thin vertical or horizontal element (a radio mast, or aerial) through one barrel at a time. It should display minimal curvature and little false colour to its edges.

Throughout the history of binoculars, image quality and body shape have been improved through a multitude of factors. For example: the hinge, glass quality, achromatic improvement, miniaturisation, anti-reflective properties, and the fairly modern aspect of image stabilisation that gives superb views without the need for a mounting.

For visual observing, one of the important quantities is the size of the observer's pupils under working conditions (dark, or light polluted), since it is important to try to match this to binoculars with the right sized exit pupil (aperture in millimetres divided by the magnification). The writer's 16x70 Swift is showing its exits in figure [2] below. It is wise and economic to match the instrument exit size to the observer's actual working pupil. There is little point in wasting the 7 x 50 (7mm diameter) area, if your adapted pupil is say 5mm, for which a 10 x 50 binocular would be better. There is an approximate relation of 0.35mm reduction in adapted pupil size per 10 years. Sky Publications, market a small device that allows the pupil size to be assessed. Alternatively it may be measured with some experimentation, and the aid of a sequence of tiny holes separated by a variety of millimetres in a thin piece of black, plastic. (A small diameter sewing needle heated to assist creating small holes and handled with pliers is one suggestion.) Dark adaptation takes a long while to be 'finalised', so use a fixed amount of time, say 5 to 15 minutes, before checking the exit pupil size. Several ways of aiding the process are well known but not appropriate to publish openly. Most visual observers will have an assessment of their dark adapted pupil size.

observer's pupil	**suitable binoculars**
5mm	10x50
7mm	9x63 or 10x70
8mm	10x80

Ideally aperture in millimetres divided by the magnification should match the observer's adapted pupil size.

This writer's age, and light-polluted observing situation, is not amenable to anything above a 5mm diameter exit pupil, but in a (rarely used) dark, unpolluted sky this could change to a 6 - 6.5mm. In light-polluted areas, or using a site surrounded by lights that may stray into the aperture, two dew-shields help the situation and assist keeping optics less damp.

Figure 2: 16x70 with its exit pupil, side guard and clamp.

The effective range in magnitude that an instrument will 'see' depends on several factors but the basic specification and simple formula of 2+5logA (mm) gives a check on the faintest star visible. Very few observations should be made near the limit of the optics, with the usual wisdom indicating to choose stars varying in the range about 1 to 4 magnitudes brighter than the theoretical or practical cut-off brightness. (The two criteria are very likely to be different!). My 16x70 under local skies may allow T Coronae Borealis to be seen in its usual state, say about magnitude 10.5, so this binocular is usually honed on objects that vary from about 6.5 to 9.5 magnitudes. An 8x40 with a theoretical limit of about 9.0 will be used on variables varying between about 4.5 to 7.5; this instrument and observer struggle to get magnitude 8.5 stars. (I hasten to note that observing is mainly done under a bright light dome of Wakefield, West Yorkshire, and it is a delight to see fainter in different UK or overseas locations).

In an attempt to suggest improving visual observation, a slide offered a few pointers, but several items were not that serious! The content is reproduced here:

How to improve visual estimation.

Avoid: Cloudcover, mis-identification, date/time mistakes, bias(!), pre-conceived values of comparison star magnitudes, transcribing an incorrect record, very low altitude objects (except in some circumstances, e.g. novae, supernovae), bright (moonlit or twilight) sky, hazy conditions, stepping on pets (the local hedgehog), 'live' electrics, opening fridge door (unless astronomy friendly lit), dropping important things (flask of warm soup, kendal mint cake, chocolate).
Choose and use: (If possible) best quality and state of optics, same optical system for the phase of the object, objects not near limit of observation, consistent use of comparisons of similar colour, and those that are close to variable in distance, comparisons that have a small brightness difference between them, check the optimum line of position angle joining variable and comparison(s), a consistent method of light estimation, an amount of time for dark adaptation, a comfortable posture and warm clothing (obvious?), the frame of mind: i.e. no hurrying, enough down-time after a traumatic day, use anger-management methods in case of local (neigbourhood) circumstances, i.e. the house and garden lighting policy may well be different from the observer!

The importance in recording an accurate time of observation, as well as correct date, possibly by using a radio controlled timepiece was made.

Figure 3.

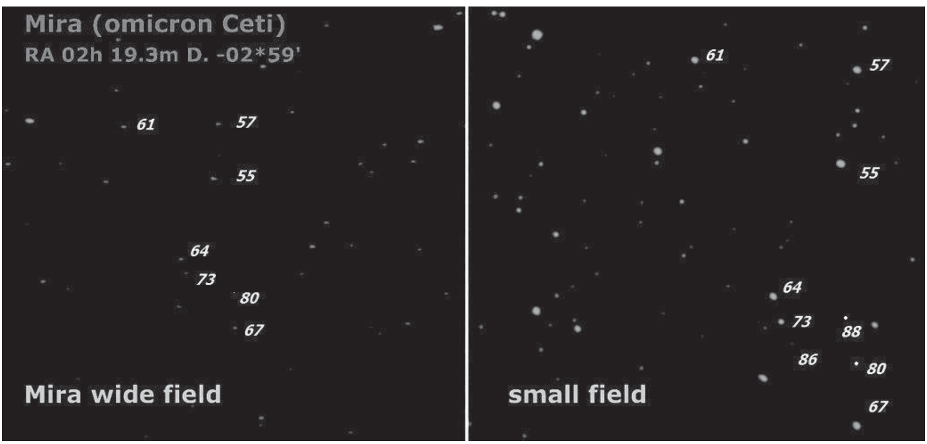
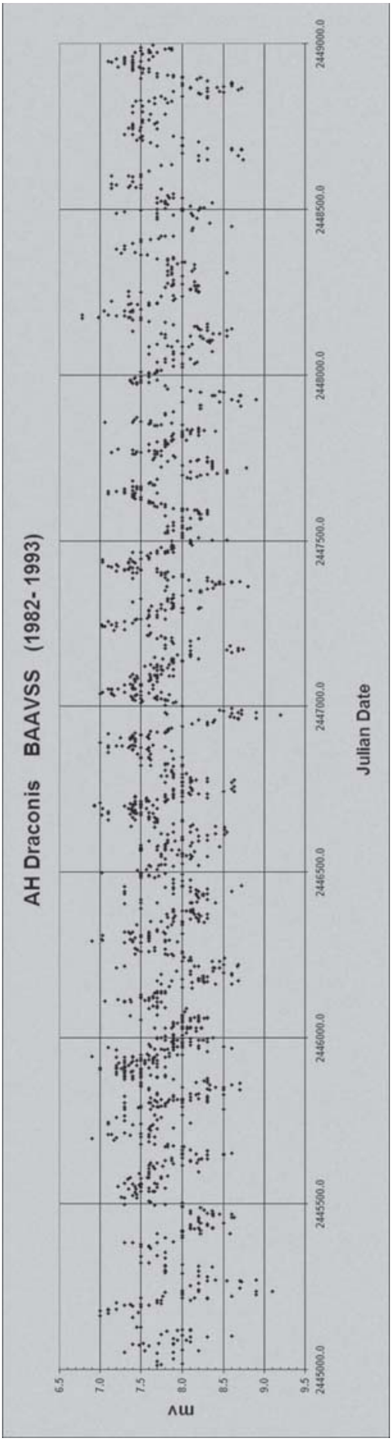


Figure 4.



A method of finding star fields, and positively identifying an object, was highlighted by an example of the visibility, and magnitude of omicron Ceti (Mira) from two different scaled images with implanted comparisons, shown in figure [(3)] opposite page. Relevant VSS charts were also shown in relating the problem of field orientation and size. The VSS charts, drawn mainly by John Toone, are often used in conjunction with larger fields for aiding the initial search area, these being prepared from drawn atlases or planetarium style software. On trips where A4 size charts may be a handicap, the writer has a set of 'abbreviated' VSS charts hand drawn (black permanent ink) to 10cm square and corner tagged for easy use.

The BAA VSS programme of binocular variables was briefly described, with several type stars emphasized either in relation to its field and comparisons, or with a VSS light-curve showing the kind of variation, figure [(4)]. A few programme stars were shown as examples of a variable class to indicate problems like the Purkinje effect, or where comparison stars are well placed in relation to the line joining the variable. It is well known that different estimates are made when these 'lines' are either horizontal or vertical. The case of rho Cassiopeiae the hypergiant which is varying 4.2 to 6.8 magnitudes in extreme, shows large scatter between observers, and individuals may consider their estimate not worth reporting, which is not the case. Please report light estimates as observed with no alteration. Due to perception of coloured stars, some observers try to reduce the hue by expanding the stars into de-focussed discs thence using the fractional method of estimation consistently to make the estimate. Other typical stars observable with binoculars were; AH Draconis, AC Herculis, X Ophiuchi, chi Cygni, TT Cygni, R Scuti, AG Pegasi, R Coronae Borealis, AB Aurigae, and SS Cygni near maximum.

Observers who like to see variations over shorter time scales than the general slower classes, could take on several of the eclipsing binary variables like RZ Cassiopeiae, W Ursae

Majoris, HU Tauri, U Cephei and the easily found VV Orionis. This latter object is near the famous belt stars, but its beta Lyrae type variations are small, about 0.4 and 0.2 mag. amplitude so very near the practical limit for a serious visual observer.