Exit pupil and visual acuity

From Mr David Frydman

Andrew Langley's paper in the 2004 April *Journal* highlights the importance of exit pupil diameter to visual acuity, particularly referring to binoculars. 7×50 binoculars are often recommended as the standard for astronomy, whereas 10×50s or 12×50s are generally superior. 7×50s are easier to handhold for long periods and are less critical with regard to collimation and optical quality. 20×50 binoculars were heavily criticised in the past as being useless for atronomy when, in fact, they can produce stunning views if well made. They are however difficult to use handheld.

The diameter of the exit pupil is only part of the story as regards visual acuity. Andrew Langley uses the 'clearly resolved' criterion, so my findings are not strictly comparable. I can just resolve Mizar (14.4 arcseconds unequal double) in standard 12×45 binoculars, or with more difficulty in a pair of high quality 10×30s. However, Mizar is not resolved in 10×50s, except through fairly thin cloud, which reduces the intensity of the components. Presumably using variable neutral density filters would produce the same result, giving an optimum intensity. The 3mm exit pupil of the 10×30s is superior to the 5mm of cloud-filtered 10×50s, but not by much.

The equal double star γ Arietis, at about 7.8 arcseconds, is just resolved in 30×60 binoculars but not in 20×60s. At these higher magnifications optical quality and stability are more of a problem.

In my twenties I could resolve ε Lyrae from London with the naked eye at 208 arcseconds separation.

I have occasionally found benefit in resolution by placing ×7 binoculars behind good 20×80 binoculars to reveal hidden detail. To my surprise I can handhold 18×50 image-stabilising binoculars with a pair of roof prism 6×18s fitting snugly behind them. Much of the hundred-plus times magnification is empty, but hidden detail is seen on the Moon. To attempt this both binoculars must be well collimated.

Several manufacturers supply ×2 or ×2.5 monoculars that fit behind binoculars or spotting scopes to increase resolution. To me this seems to be the optimum extra magnification. ×6 is far too high, but was the lowest magnification booster that I had available.

I have long advocated 3mm or 4mm exit pupils for binoculars, particularly for middle-aged observers to help correct age-related eye defects, and for those observing from towns. Contrast is also enhanced and the sky darkened. However, there are situations where larger or smaller exit pupils can be useful. The simplest way of providing this is to have several pairs of binoculars of differing specifications.

Incidentally, when choosing binoculars it is important to check that they do not defocus when pointing upwards or when pressed against the face. This point is rarely mentioned, yet some quite expensive binoculars are useless for astronomy because of this fault. Also, eyepiece rocking should be checked. Here, internal focus and object glass focus models score highly.

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Webcam imaging of the planets

From the Director of the Asteroids & Remote Planets Section

Current images derived from small 'scopes and a simple webcam produce pictures to rival those taken by the Hubble Telescope many times larger in aperture. Those images that I have seen have been confined to Mars, Jupiter and Saturn. No doubt some have also been taken of other planets and I wonder whether they can be used to answer some queries on them.

The first is the Schroeter Effect on Venus. Here the observed phase differs from the theoretical one, resulting in observed dichotomy occurring at different times from that which theory states. I have long believed that the observed phase is a function of the observer's visual sensitivity. The terminator is a line that is not sharp since sunlight will strike the atmosphere obliquely, so it will show a gradual brightness diminution as the light penetrates to shallower levels. The recorded phase will, to my mind, depend on how sensitive the observer's eye is to this and how faint he can see. Imaging should be capable of processing to bring out this effect from a single image and it would be interesting to know what sort of variations can be achieved for a range of phases, not only around dichotomy but also at crescent and gibbous ones. We have an opportunity to resolve one of the long held mysteries of the planets in this.

The other query relates to Uranus and Neptune. These planets appear very small and so will present difficult problems, as Uranus' disk appears only 3.5 arcsecond whilst Neptune's is around 2 arcsec. In my report on Uranus published a few years ago I noted that detail when the planet is pole-on to the Earth seems to be illusory, whilst at equatorial aspect the belts drawn seem real. As we are at a mid-aspect now the belts should be seen and images showing them (or whatever detail can be recorded) would be useful as a confirmation. There is no record of detail being detected on Neptune from ground-based observation and so occasional imaging could help with this. These observations will be very difficult as the disk will be small with usual f-ratios and Neptune is still very far south of the equator. However I would suggest that the rewards of successful imaging are potentially so high it is a project well worth trying and perseverance will produce valuable results. The planets are available to view now so a few minutes imaging would be worthwhile. I would be pleased to receive anything that is obtained.

I also wonder what an image of Mercury would show? In Antoniadi's book all that could be seen was albedo features. I assume that the same is true from amateur ground-based imaging though I would expect better size and position information to be achieved. Obviously this would be difficult as Mercury is only at a low elevation when visible and also at a relatively small solar elongation. I, for one, would be interested to know.

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