We may summarize our findings, pointing out that the perceived depth of field of a binocular is strongly dependent on its magnification and the observer's accommodation width, but only marginally dependent on the pupil size diameter (or ambient light). We shall further remind the reader on what has been discussed before in section 4.3: The depth of field does not depend on any additional factors, including the design of its optical layout. If a manufacturer happens to praise the outstanding depth of field of his product, then he is either selling a binocular of particularly low magnification, or trying to deceive the potential customer.

10.9 Depth resolution and cardboard effect

In section 9.3 we have discussed human depth resolution – the ability to distinguish between distances of objects as a result of stereoscopic vision. In combination with the binocular, this ability to view 3-D is improved considerably. First of all, the magnification enhances angular differences between incoming rays by a factor m. The lateral retinal disparities of images, and thus the ability of human vision to perceive depth, are enhanced by the same factor. Additionally, the increase of baseline separation – a result of an axis offset caused by the image reversal system that modifies the separation of the objectives – enhances stereoscopic vision. This is particularly significant with prisms of Porro I type (axis offset: $\sqrt{2}$ times the entrance width w), less so with Porro II systems (equal to w), and marginally so with certain variants of the Abbe-König prism.

As a result, the stereoscopic depth perception of the unaided eye is boosted by the factor

$$K = m\frac{\text{objective separation}}{\text{eyepiece separation}} \ . \qquad (10.41)$$

As an example, the Zeiss 10x50 binocular of figure 5.5 has an objective separation (baseline) of $b' = 140$mm, when the eye distance is set to 65mm, yielding a boost in stereoscopic depth resolution by a factor $K = 21.5$, and the Porro II type Ross 10x50 of figure 5.8 yields $K = 16.9$. Naturally, a roof-prism model without axis offset would offer only its magnification as the corresponding boost factor. Figure 10.18 displays the resulting depth resolution, as computed by equation (9.9), with the following modification to accommodate the performance of the optical instrument:

$$\Delta E = \frac{E^2\alpha'_{\text{min}}}{b' + E\alpha'_{\text{min}}} \ , \qquad (10.42)$$

where E stands for the distance to the far object, and ΔE for the minimum detectable separation between E and $E - \Delta E$, the distance of a second object in front. $\alpha'_{\text{min}} = \alpha_{\text{min}}/m$ is the minimum detectable retinal disparity, after division by the magnification (angles in radian measure, average values amount to $\alpha_{\text{min}} \approx 1.45 \cdot 10^{-4}$rad). At a distance of 100m, the Zeiss 10x50 with an objective separation of $b' = 0.140$m offers a depth resolution of 1m, and at 1000m distance, the resolution drops to 94m. A 10x50 roof-prism binocular would – in absence of any axis offset and an objective separation of $b' = 0.065$m – yield a depth resolution that is inferior by about a factor of two. This fact is certainly among the reasons why the military has commonly relied on Porro prism designs, despite of their disadvantage in terms of bulk.

For naval military applications, binoculars with enhanced stereoscopic vision have occasionally been designed. Figure 10.19 shows the 7x40 RISO-I stereoscopic binocular, made in Japan and applied by the US Navy during the Korean War. In this instrument, planar diagonal mirrors are used to implement an axis offset of a factor of 3.9, so that the stereoscopic boost factor (Eq. 10.41) over the unaided eye amounts to $K = 27$. Mounted rangefinders with baselines of several meters and far superior depth resolution have routinely been employed by