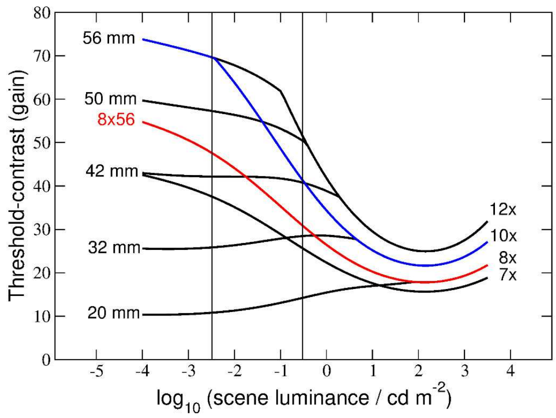
the twilight regime in between. For the computation of these curves, a light transmission of $\mu = 0.9$ was assumed for each binocular, stray light was neglected (by setting $\nu = 0$ and $\mu = T$), and the apparent angle of view was fixed to 60°.

At high luminance levels, the binocular performance is determined solely by its magnification, in close coincidence with the resolution-based efficiency of equation (10.7). In fact, this also follows from Ricco's law (section 9.1.1): The higher the power, the larger the target is seen through the ocular, and the lower its threshold-contrast. Since the eye pupils are well contracted, the exit pupil diameter consistently exceeds the eye pupil diameter, all binoculars are operating in under-magnification mode, and the luminous flux entering the eye from the target is always proportional to the square of the magnification.

The situation is different at very low light levels: Usually, the eye pupil exceeds the exit pupil diameter and the binocular is operating in over-magnification mode. The luminance of the target, as seen through the instrument, is now proportional to the objective diameter. Hence, the contrast-threshold gain is entirely a function of D, once again in close agreement with previous results obtained for the resolution-based efficiency (equation 10.9).

Significant differences between both approaches to binocular performance are emerging in the crossover regime between day and night. In twilight, the 8x56 (red curve) performs consistently higher than the 12x42 (blue curve), which dominates in daylight, but rapidly loses ground when the luminance levels are dropping. This appears to be in close agreement with empirical observations in the field. By contrast, the twilight index of equation 10.11 would suggest a higher performance of the 12x42 throughout the twilight regime. In section 10.4.1 we are going to analyze the reasons for that contradiction.



10.8

Threshold-contrast gain obtained with the same instruments, but for an elder observer (about 60 years of age). The 8x56 binocular (red) delivers a less stellar performance in twilight, and may be replaced with the 10x56 (blue) as a powerful low light instrument.

Figure 10.7 also confirms how poorly a compact 8x20 binocular performs once the light level drops. With its small exit pupil of 2.5mm, it is rapidly drifting into over-magnification mode, in which it produces a reduced contrast and a dull image. This reflects a general trend, observable with larger instruments as well: As soon as the observer's eye pupil begins to exceed the exit pupil diameter, the threshold-contrast gain ceases to grow. The secret behind the performance of a night glass is its large exit pupil, which is shifting that turnover-point deep into the low light regime.

Figure 10.8 summarizes the results obtained with the same binoculars as in Figure 10.7, but for an average elder observer of about 60 years age. Since the eye pupils are no longer able to expand to sufficiently wide diameters, the performances of night glasses with wide exit pupils are not fully exhausted. The