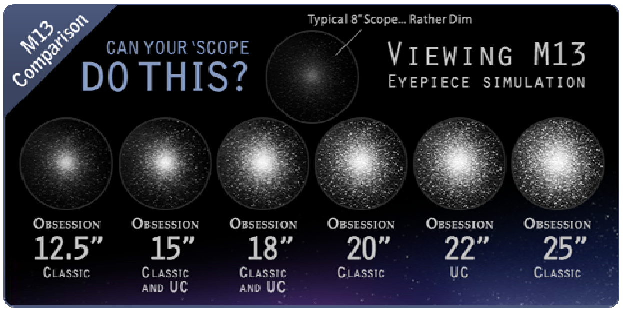
Telescope Light Gathering Ability – Seeing Faint Stars



This figure shows a comparison of the same faint star cluster seen with telescopes of increasing aperture size and LGA. Notice the big change between an 8-inch and am 18-inch!

The human eye is a small lens that lets-in only a small amount of light. This is useful when you are looking at a bright daytime scene, but when you are studying faint stars this becomes a problem.

A telescope has a much larger aperture than the eye and allows more light to be brought to a focus to study. This means that even stars too faint to be detected by the eye can easily be 'brightened' by the telescope so that they are easy to detect and study.

Light Gathering Ability is the property of an optical system that tells you how much brighter things will appear than what the human eye can see. It is the ratio of the area of the objective to the area of the human eye lens.

Problem 1 – A pair of binoculars has a lens with a diameter of 50 mm. If the human eye lens has a diameter of 7mm, how much more light do the binoculars gather than the human eye?

Problem 2 – Star brightness is measured on the magnitude scale where each magnitude represents an increase in intensity by a factor of 2.514. What is the brightness difference between a star with m = +1.0 and m = +6.0?

Problem 3 – The human eye can see stars as faint as m = +6.0. What size mirror will be needed so that stars as faint as +16.0 can be seen?

Problem 1 – A pair of binoculars has a lens with a diameter of 50 mm. If the human eye lens has a diameter of 7mm, how much more light do the binoculars gather than the human eye?

Answer: LGA = $(50/7)^2$ = 51 times more light.

Problem 2 – Star brightness is measured on the magnitude scale where each magnitude represents an increase in intensity by a factor of 2.514. What is the brightness difference between a star with m = +1.0 and m = +6.0?

Answer: The magnitude difference is m = 5.0, so the brightness difference is a factor of $(2.512)^5$ = 100 times.

Problem 3 – The human eye can see stars as faint as m = +6.0. What size mirror will be needed so that stars as faint as +16.0 can be seen?

Answer: The magnitude difference is +16.0 - +1.0 = +10.0, which is a brightness factor of 100x100 = 10,000. You need a telescope that provides a LGA of 10000 so
$10000 = (D/7mm)^2$ and so D = 700 millimeters (27-inches in diameter).