2 BIGGER IS BETTER

THE DOME OF THE 5-METRE HALE TELESCOPE

The elegant dome of the 5-metre Hale Telescope at Palomar Mountain, northeast of San Diego, California, opens up in the early evening to let the huge telescope adapt to night-time temperatures. Astronomers believed it would be practically impossible to construct even larger telescopes for a long time after its inauguration in 1948.

In their quest for ever-fainter objects and finer detail, astronomers have always demanded bigger telescopes. Scientific vision, technical nerve and personal perseverance led to the giant observatories of the early twentieth century. Located on remote peaks and protected beneath majestic domes, these awe-inspiring instruments have revealed an expanding and evolving Universe, populated by a stunning variety of galaxies and nuclear-powered stars that produced the elements in our bodies. A few decades ago the 5-metre Hale Telescope on Palomar Mountain seemed to be the ultimate telescope. But was it?

"How to do better? Think mirrors."

THE YERKES REFRACTOR

Ground by American telescope builders Alvan Clark & Sons, the primary lens of the Yerkes Observatory's Great Refractor, in Williams Bay, Wisconsin, has a diameter of 40 inches (101.6 centimetres). The lens was completed in 1895 and is still the largest ever made.

At night your eyes adapt to the darkness and your pupils widen to collect more light. As a result, you can see dimmer objects and fainter stars. Suppose you had pupils one metre across — that would give you supernatural eyesight, showing stars 25 000 times fainter than those we can see with our eyes! This is where telescopes come in. A telescope is like a funnel. The lens or mirror collects starlight over its whole surface and concentrates the light into a narrow beam that enters your eye. The bigger the lens or mirror, the fainter objects you can see. Another important advantage of a large telescope is its greater resolving power. With a bigger lens or mirror, you can see smaller details, like the surface markings on a planet, the binary companions of stars or the spiral structure in a distant nebula.

So size is everything, and astronomers have always been on a quest for larger instruments. But how big can a telescope be? Not so big if it's a refractor. Starlight has to pass *through* a lens so the lens can only be supported along its edge. If the lens is too large and too heavy it will sag. In contrast, the primary mirror of a reflecting telescope can be supported from the back. It can be much bigger. A mirror has another advantage, too. It only needs to have a perfect reflecting *surface*. A telescope lens, in contrast, has to be of perfect quality throughout. Every bubble or impurity in the glass will degrade the image.

In 1893 the largest refractor in history was presented at the World's Columbian Exposition in Chicago. Four years later it was installed at the University of Chicago's Yerkes Observatory in Williams Bay. Its lens, ground by famous optician Alvan Clark, is just over one metre across; its tube eighteen metres long. Astronomers have used this impressive instrument to study binary stars, stellar motions and distances and the spectroscopic properties of starlight, which have provided important clues to the chemical makeup of stars. But with the Yerkes Telescope, refractor builders had reached their limit.
How to do better? Think mirrors.


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