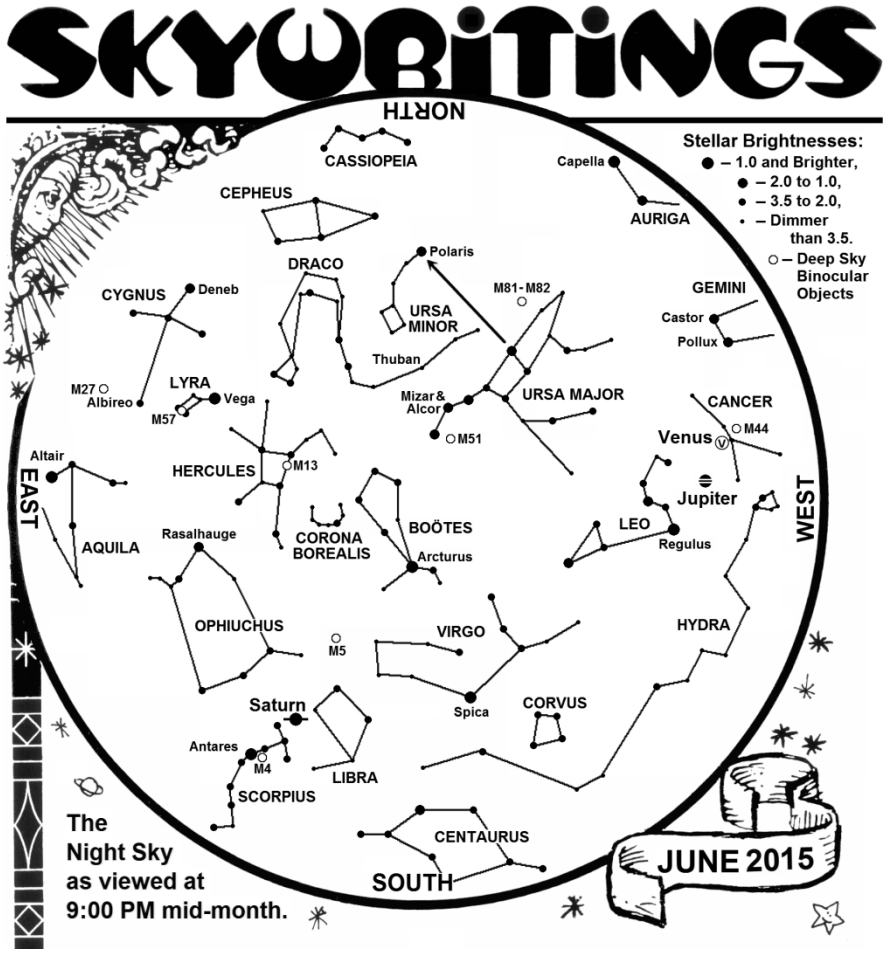
Olbers' Paradox – Why is the Night Sky Dark?

By Barry D. Malpas – Special to the Williams-Grand Canyon News – 2015 June



Why is the night sky dark? Such a question asked of the average person would probably prompt a response like "because the sun has set." Scientifically it isn't obvious why the sky is dark. This oldest and simplest astronomical observation actually tells us something profound about the Universe.

Astronomers agree generally that the Universe is uniformly filled with stars and also infinite in size. Why then don't we see the accumulation of bright surfaces from all the myriad of stars radiating down upon us day, or night? That is, why doesn't the sky appear as bright as the Sun's surface?

For example, let us imagine that we are in the middle of an enormous forest, and no matter in which direction we look, our line-of-sight is eventually obstructed by a tree. Even though the trees are well separated, we are still surrounded by a wall of green. Any gap between near trees is eventually filled by trees further away. By this same argument, one would expect to see a solid wall of star light in every direction, given an almost limitless number of stars distributed throughout the infinite vastness of space, i.e., your line-of-sight would intersect the surface of some star no matter in what direction you observe. Hence, using this logical argument, with the Sun being an average star, the night sky should appear as bright as the Sun's surface.

Noted astronomers such as Johannes Kepler in 1610, Edmund Halley in 1720, J.P. Loys de Chéseaux in 1744, and H. Wilhelm Olbers in 1823, all pondered this problem now commonly referred to as "Olbers' Paradox." Kepler suggested that the Universe of stars extended only out to a finite distance. Once your line-of-sight passes that boundary, it encounters only empty space. But, as far as we can observe, we see stars. Olbers suggested that starlight is gradually absorbed while traveling through space, and this cuts off the light from any stars beyond a sufficiently great distance. However, this doesn't solve the problem, either. Any absorbing interstellar gas or dust would eventually heat up until it reradiated all the absorbed starlight and the energy reaching us would be the same. So where does the argument go wrong?

Surprisingly, the first scientifically plausible proposal was given in 1848 by American author Edgar Allan Poe, who suggested that the Universe is not old enough yet to fill the sky with light, and though the Universe may be of infinite size, there hasn't been enough time since the Universe began for starlight, traveling at the speed of light, to reach us. However, it was not until the mid-20th century, and the acceptance of the Expanding Universe Model, that an explanation of this phenomenon has found resolution. The fact that most everything in the Universe is moving away from us is well documented by both visual spectroscopic, radio telescopic, and other astronomical data. The expansion of stars and galaxies away from one another has two effects on the

light emitted from them. First, the emitted photons have further to travel to reach Earth. Thus their rate of arrival is much less than if the Universe was not expanding. And second, the light waves are shifted by the immense expansion velocities into longer wavelengths which have lower energies due to the Doppler Effect (also known as Red Shift.) Together these effects reduce the intensities of stars, especially since further galaxies are receding from us at velocities approaching the speed of light. Scientists have calculated that for the sky to be bright we must be able to observe stars that are on average 10^{24} (1 followed by 24 zeros) light years away from us. Since stellar lifetimes are relatively short in comparison, and the age of the Universe is only 13.8 billion years old, there hasn't been enough time for the great majority of light photons to reach us.