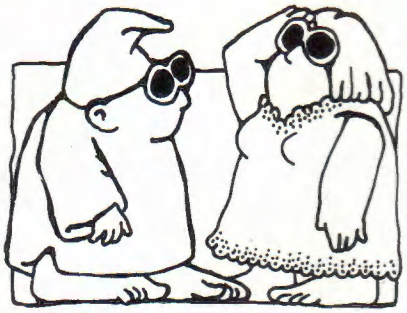
Darkness defined in terms of the finite universe.

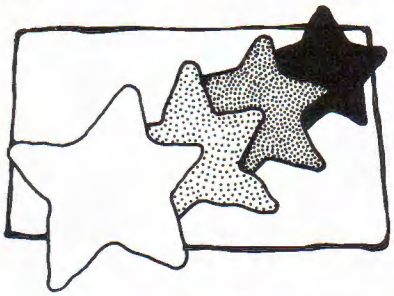
A bright night



Max-Karl Winkler

As winter approaches so does the appearance of the brighter stars that populate our winter skies. To this add clear, crisp evenings and you'd think the sky would appear even brighter than it does. Did you ever stop and wonder how the skies can be so dark with an infinite number of stars out there? Interestingly, this question was asked at least two centuries ago.

The dark-sky phenomenon is known as Olbers' Paradox. Heinrich W. Olbers, a German physician and astronomer, addressed the phenomenon in the early eighteenth century. He was not the first to address the phenomenon, but because of a researcher's incomplete search, he gets the credit for discovering it—the name Olbers' Paradox stuck. The "paradox" is that in an ageless, infinitely large universe, one would see stars everywhere. (If the universe were infinite, and it may well be, a star would certainly lie at every angle from wherever we chose to stand on Earth.) As a result, starlight arriving from every angle would produce a bright sky. Yet at night the sky appears dark and only flecked with stars.



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Disappearing stars

Modern-day cosmologists studying this phenomenon would be quick to point out that Olbers' Paradox is no real paradox, but instead is based upon incorrect assumptions regarding the age of the universe and its change over time. During Olbers' day, the universe used to be considered infinitely old and unchanging.

We now know from Edwin Hubble and other astronomers that the universe is always changing. Through use of spectrographs, devices that divide light into its composite colors, we have learned that light from stars and galaxies moving away from us appears to be shifted toward the red end of the spectrum, due to the Doppler effect. This phenomenon is called the redshift. The further away an object is observed, the faster it is moving away from us, and therefore, the greater its redshift. For very distant objects, which are moving away from us very rapidly, the wavelengths of the light will be shifted into the infrared range, beyond the spectrum that our eyes can detect. Therefore, the light from stars moving quickly away from us is redshifted beyond the color spectrum, appearing invisible to us.

The youthful universe

Until recently, we relied mostly on the expansion-of-the-universe theory to explain Olbers' Paradox. However, it is now suggested that the finite age of the universe, rather than its expansion, is more important in explaining the night sky's darkness. The universe is only approximately 15 billion years old. Furthermore, light travels at a finite, though very high, speed. Therefore, we can observe light from only those galaxies and stars that lie within a distance of 15 billion light-years from Earth. A light-year is the distance that light travels in one year, six trillion miles. Galaxies farther than 15 billion light-years away from us have not existed long enough for their light to reach the Earth yet.

Therefore, the question of why the night sky is dark can be resolved first by understanding the difference between the theoretical, infinite universe and the observable, finite universe. There may be stars and galaxies beyond our observable universe, but our observable universe is not yet old enough for light from these objects to reach us. Simply put, since the observable universe has a finite age and a finite number of sources of light, the night sky is not completely illuminated.

Evening planets

Venus: Sets three hours after sunset.
Mars: Rises approximately at sunset and is visible all night.
Saturn: Sets about four hours after sunset.

Moon phases

December
First Quarter - December 2
Full Moon - December 9
Third Quarter - December 16
New Moon - December 23
First Quarter - December 31

January
Full Moon - January 8
Third Quarter - January 14
New Moon - January 22
First Quarter - January 30

For further reading

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