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The expanding universe of cosmology titles grows larger.

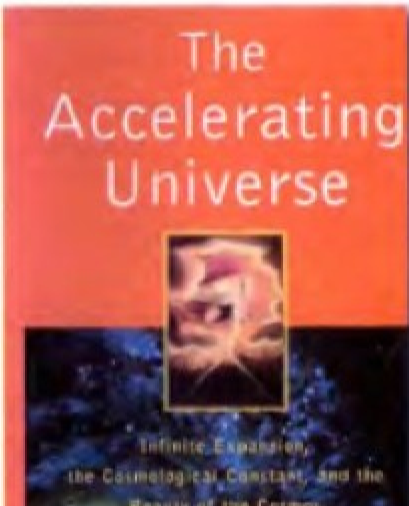
The Accelerating Universe: Infinite Expansion, the Cosmological Constant, and the Beauty of the Cosmos
By Mario Livio
274 pages, John Wiley & Sons, $28

The Runaway Universe: The Race to Find the Future of the Cosmos
By Donald Goldsmith
232 pages, Perseus Books, $25

AS IT HAPPENS, I'm writing this on a midnight in August. A minute ago I stepped outside. A ring of light encircled the full moon. High above the palely lit folds of California hillside, a meteor arced across the black space and the few stars that showed despite the city's lights.

Yet why do I see a starry night at all? If the cosmological principle put forward by Copernicus is true—if the universe is homogeneous, having the same properties everywhere, and isotropic, looking the same from every angle—then a short chain of reasoning leads to the inescapable conclusion that the heavens should be as white as a sheet of paper. Here is the reasoning.

That our universe is uniform is clearly true within the observational horizon of the 10 billion light-years that our telescopes provide. Moreover, if the universe did possess a center, then things would not appear the same in all directions unless you stood at the center (an assumption that Copernicus ruled we cannot reasonably make). Therefore, astronomers have concluded, the universe has no center and no edge. But then, if the cosmos is infinite, wouldn't any line of sight lead eventually to the surface of a star?



German astronomer Heinrich Wilhelm Olbers stated this problem, called Olbers's Paradox, in 1823, but an explanation didn't come until a century later. It grew out of the most astounding discoveries human beings have ever made: that our Milky Way is merely one of millions of galaxies, that the universe is thus much bigger than we had thought, and that it is expanding at a tremendous rate.

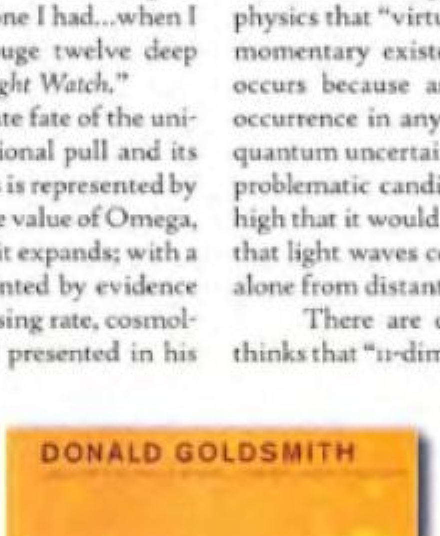
We owe our knowledge of all this to the work in the 1920s of the astronomer Edwin Hubble. He peered into space from the summit of Mount Wilson in Pasadena, California, to measure the distances to galaxies whose spectra were anomalously red. The likeliest cause of such redshifting, Hubble reckoned, was motion away from the observer. The same Doppler effect that raises and then lowers an ambulance siren's perceived pitch as it approaches and then recedes from a listener would compress light wavelengths—making them blueshift—or stretch them out—redshifting them. Yet Hubble found no blueshifting; all the galaxies seemed to be redshifting. Moreover, the shift was proportional to their distance: those farthest from Earth were racing away from us the fastest. The universe seemed to be running away from us.

How can this be? You can liken the cosmos to the surface of a balloon. If we were in a two-dimensional spaceship on that surface, like a dot painted on the balloon, we might travel in any direction, though eventually we'd return to our starting point. Now picture the balloon expanding. Any dots on its surface would recede from each other—the farther apart two dots were, the faster they would recede. And this same effect applies in our three-dimensional expanding universe: although the galaxies aren't getting bigger, intergalactic space itself is opening up between them.

So, if you've wondered why theorists are sure there are other dimensions besides the familiar ones, it's because nothing else explains starry nights. Everything we've learned has validated this picture. If the universe's expansion is traced backwards, for instance, it apparently began in a small point—the big bang—about 14 billion years ago. Detection of cosmic background radiation remaining from the big bang has confirmed this estimated age of the universe. Other mind-boggling revelations have followed since Hubble's. Even learning that all the stars and visible galaxies are only luminous froth comprising between 0.01 and 0.025 of the universe's total mass didn't disconcert most cosmologists. But in 1998, astronomers detected something that did. Two new books with similar titles—*The Accelerating Universe*, by Mario Livio, and *The Runaway Universe*, by Donald Goldsmith—seek to explain this discovery.

Mr. Livio heads the science program at the Space Telescope Science Institute, which conducts the Hubble Space Telescope's programs. In *The Accelerating Universe*, he admits that in 1998, upon seeing analyses of the images of very distant supernovae, he didn't initially believe them. These supernovae, at a range corresponding to about one-half the universe's age, burned less dimly and had receded less than was consistent with the normal Hubble expansion law. After other possibilities were eliminated, the only explanation remaining was that the cosmos had once expanded more slowly than it does today. This finding challenged Mr. Livio's cherished belief in the inherent beauty of timeless physical laws. He writes that it gave him "a feeling in my stomach similar to the one I had...when I heard that somebody had...managed to gouge twelve deep slashes into Rembrandt's masterpiece *The Night Watch*."

Why such distress? Because the ultimate fate of the universe depends on the balance of its gravitational pull and its kinetic energy. The ratio of the two quantities is represented by the Greek letter Ω, or Omega. With a negative value of Omega, the universe contracts; with a positive value, it expands; with a zero value, it remains static. In 1998, confronted by evidence that the universe was expanding at an increasing rate, cosmologists resurrected an idea that Einstein had presented in his paper on general relativity in 1916, but later discarded. Finding that his mathematics implied an expanding or contracting universe and retreating from that implication, Einstein had restored Omega to zero by fudging his equations with a cosmological constant: an energy density in the vacuum itself that would counteract matter's gravitational pull. Following Hubble's discovery, Einstein travelled to Mount Wilson to thank the astronomer personally for delivering him from what he called his "greatest blunder."



But modern particle physics does indicate a vacuum energy density, experiments have proven its existence, and since 1998 cosmologists have uneasily contemplated the probability that it affects cosmic expansion more than all the universe's matter combined. Indeed, their assessment is that currently Omega due to empty space stands at about 0.7, and Omega due to matter, at 0.3. What particularly disturbs Mr. Livio is that this means Omega from matter has only recently in universal history dipped below Omega from empty space, which implies that the human race is living in a singular time—that our vantage point really is special. The entire trend reeks, Mr. Livio complains, of the anthropic principle, which holds that the universe's properties are dependent on our existence.

Mr. Goldsmith is agnostic in *The Runaway Universe*. "Beauty or the lack of beauty does not determine the truth," he writes. "The first order of business remains the determination of the key parameters that describe the cosmos." He's prepared to consider the anthropic principle a possibility. I found Mr. Goldsmith's attitude more agreeable. But his book feels a little like an introductory semester in Modern Cosmology. Mr. Livio's accounts of cosmology, despite his blather about aesthetic principles in the universe's laws, will be more vivid for beginners.

The cosmological constant remains a theory based on a ratio; whatever physical reality underlies it is unclear. Both authors flunk the test of lucidly describing the candidates for that reality. Some theorists have proposed the so-called vacuum fluctuation energy, caused by a requirement of quantum physics that "virtual" particles continually jump in and out of momentary existence throughout space. (Such legerdemain occurs because an absolute zero probability of a photon's occurrence in any given volume of space violates the rule of quantum uncertainty.) But this vacuum fluctuation energy is a problematic candidate: physicists currently give it a value so high that it would accelerate the universe's expansion so much that light waves couldn't make it between us and a mirror, let alone from distant galaxies.

There are other possibilities. Stephen Hawking now thinks that "11-dimensional supergravity contains a three-form gauge field, with a four-form field strength. When reduced to four dimensions, this acts as a cosmological constant." I'm sure my first reaction to this is the same as everyone's—why did it take Mr. Hawking so long to figure this out?

Yet Mr. Hawking can also see no way around the anthropic principle. And the truth is that our universe is in its brief springtime, basking in the big bang's afterglow and with an efflorescence of blue-white stars. Ahead there stretches an eternity—if the accelerating expansion we think we see is real—during which the reds and infrareds of dully glowing galactic clusters will initially fade beyond each others' observational horizons, while their stars will become black holes, white dwarfs, and other stellar remnants. Then even those remnants will evaporate. Given all that and the early universe's turbulence, it would seem that we could have come into existence only when we did—at the singular moment when the universe's properties supported our existence. So something like the anthropic principle is undeniable.

At any rate, we'll know more soon. By year's end, the National Aeronautics and Space Administration will launch its MAP satellite observatory, to be followed, in another seven years, by the European Space Agency's Planck satellite. Both will observe the universe with unprecedented accuracy and depth, furnishing more revelations.

MARK WILLIAMS has heard that the universe itself may be just a quantum fluctuation in the void. He agrees with Woody Allen, who said, if nothing really exists, then he definitely overpaid for his carpet. Write to markred@pacbell.net.