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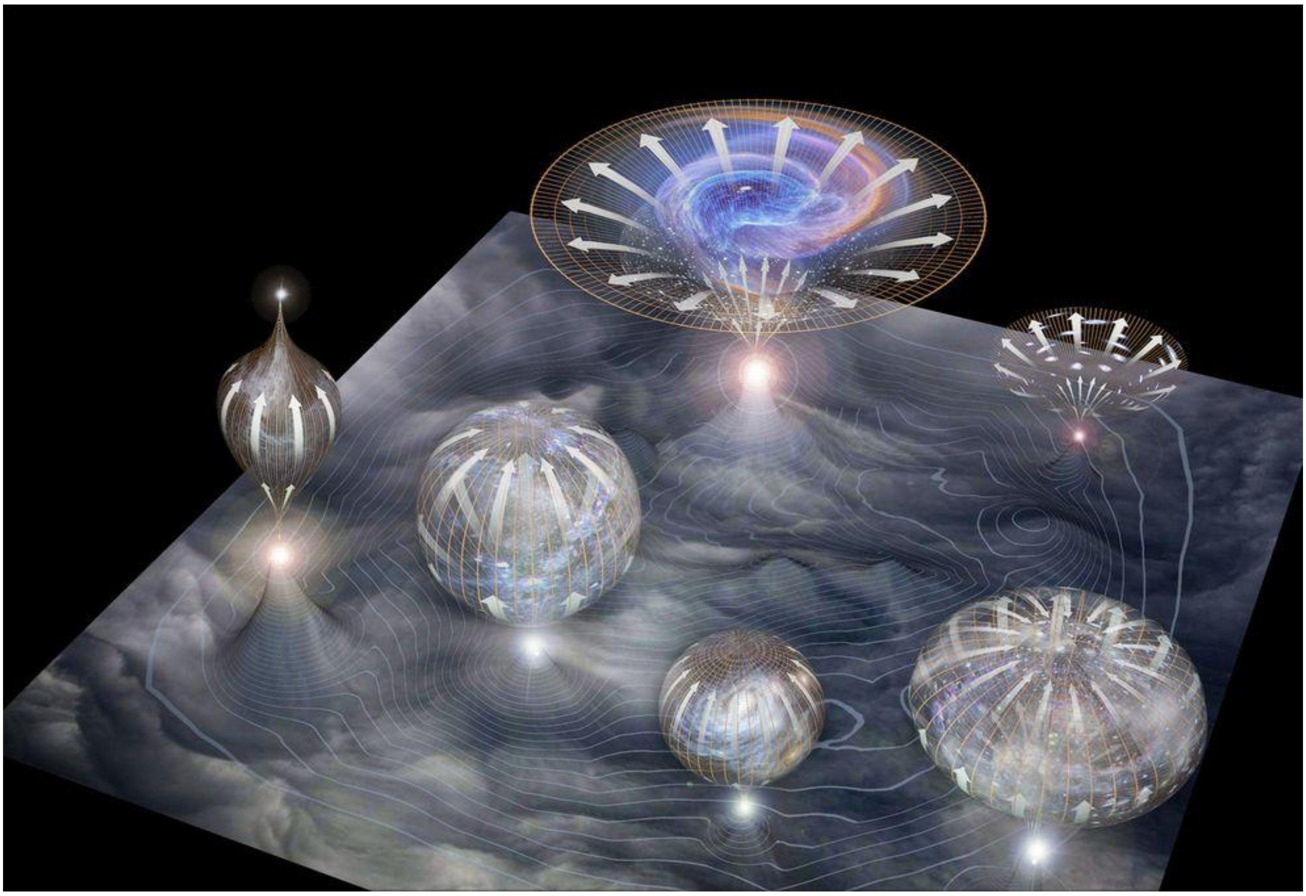
Big Bang Discovery Opens Doors to the "Multiverse"

Gravitational waves detected in the aftermath of the Big Bang suggest one universe just might not be enough.



This illustration depicts a main membrane out of which individual universes arise; they then expand in size through time.

ART BY MOONRUNNER DESIGN

Dan Vergano
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Bored with your old dimensions—up and down, right and left, and back and forth? So tiresome. Take heart, folks. The latest news from Big Bang cosmologists offers us some relief from our humdrum four-dimensional universe.

Gravitational waves rippling through the aftermath of the cosmic fireball, physicists suggest, point to us inhabiting a multiverse, a universe filled with many universes. (See: "Big Bang's 'Smoking Gun' Confirms Early Universe's Exponential Growth.")

That's because those gravitational wave results point to a particularly prolific and potent kind of "inflation" of the early universe, an exponential expansion of the dimensions of space to many times the size of our own cosmos in the first fraction of a second of the Big Bang, some 13.82 billion years ago.

"In most models, if you have inflation, then you have a multiverse," said Stanford physicist Andrei Linde. Linde, one of cosmological inflation's inventors, spoke on Monday at the Harvard-Smithsonian Center for Astrophysics event where the BICEP2 astrophysics team unveiled the gravitational wave results.

Essentially, in the models favored by the BICEP2 team's observations, the process that inflates a universe looks just too potent to happen only once; rather, once a Big Bang starts, the process would happen repeatedly and in multiple ways. (Learn more about how universes form in "Cosmic Dawn" on the National Geographic website.)

"A multiverse offers one good possible explanation for a lot of the unique observations we have made about our universe," says MIT physicist Alan Guth, who first wrote about inflation theory in 1980. "Life being here, for example."

Lunchtime

The Big Bang and inflation make the universe look like the ultimate free lunch, Guth has suggested, where we have received something for nothing.

But Linde takes this even further, suggesting the universe is a smorgasbord stuffed with every possible free lunch imaginable.

That means every kind of cosmos is out there in the aftermath of the Big Bang, from our familiar universe chock full of stars and planets to extravaganzas that encompass many more dimensions, but are devoid of such mundane things as atoms or photons of light.

In this multiverse spawned by "chaotic" inflation, the Big Bang is just a starting point, giving rise to multiple universes (including ours) separated by unimaginable gulfs of distance. How far does the multiverse stretch? Perhaps to infinity, suggests MIT physicist Max Tegmark, writing for*Scientific American*.

That means that spread across space at distances far larger than theroughly 92 billion light-year width of the universe that we can observe, other universes reside, some with many more dimensions and different physical properties and trajectories. (While the light from the most distant stuff we can see started out around 14 billion light-years away, the universe is expanding at an accelerating rate, stretching the boundaries of the observable universe since then.)

Comic Mismatches

"I'm a fan of the multiverse, but I wouldn't claim it is true," says Guth. Nevertheless, he adds, a multiverse explains a lot of things that now confuse cosmologists about our universe.

For example, there is the 1998 discovery that galaxies in our universe seem to be spreading apart at an accelerating rate, when their mutual gravitational attraction should be slowing them down. This discovery, which garnered the 2011 Nobel Prize in physics, is generally thought to imply the existence of a "dark energy" that counteracts gravity on cosmic scales. Its nature is a profound mystery. About the only thing we understand about dark energy, physicists such as Michael Turner of the University of Chicago have long said, is its name.

"There is a tremendous mismatch between what we calculate [dark energy] ought to be and what we observe," Guth says. According to quantum theory, subatomic particles are constantly popping into existence and vanishing again in the vacuum of space, which should endow it with energy—but that vacuum energy, according to theoretical calculations, would be 120 orders of magnitude (a 1 followed by 120 zeroes) too large to explain the galaxy observations. The discrepancy has been a great source of embarrassment to physicists.

A multiverse could wipe the cosmic egg off their faces. On the bell curve of all possible universes spawned by inflation, our universe might just happen to be one of the few universes in which the dark energy is relatively lame. In others, the antigravity force might conform to physicists' expectations and be strong enough to rip all matter apart.

A multiverse might also explain away another embarrassment: the number of dimensions predicted by modern "superstring" theory. String theory describes subatomic particles as being composed of tiny strings of energy, but it requires there to be 11 dimensions instead of the four we actually observe. Maybe it's just describing all possible universes instead of our own. (It suggests there could be a staggeringly large number of possibilities—a 1 with 500 zeroes after it.)

Join the "multiverse club," Linde wrote in a March 9 review of inflationary cosmology, and what looks like a series of mathematical embarrassments disappears in a cloud of explanation. In a multiverse, there can be more things dreamt of in physicists' philosophy than happen to be found in our sad little heaven and earth.

Life, the Universe, and Everything

The multiverse may even help explain one of the more vexing paradoxes about our world, sometimes called the "anthropic" principle: the fact that we are here to observe it.

To cosmologists, our universe looks disturbingly fine-tuned for life. Without its Goldilocks-perfect alignment of the physical constants—everything from the strength of the force attaching electrons to atoms to the relative weakness of gravity—planets and suns, biochemistry, and life itself would be impossible. Atoms wouldn't stick together in a universe with more than four dimensions, Guth notes.

If ours was the only cosmos spawned by a Big Bang, these life-friendly properties would seem impossibly unlikely. But in a multiverse containing zillions of universes, a small number of life-friendly ones would arise by chance—and we could just happen to reside in one of them.

"Life may have formed in the small number of vacua where it was possible, in a multiverse," says Guth. "That's why we are seeing what we are seeing. Not because we are special, but because we can."

Video: http://news.nationalgeographic.com/news/2014/03/140318-multiverse-inflation-big-bang-science-space/?rptregcta=reg_free_np&rptregcampaign=20131016_rw_membership_n1p_intl_ot_c1#