A New Map of the Universe, With Advice From Einstein
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by Dennis Overbye

In his famous 1976 New Yorker cover titled "View of the World From Ninth Avenue," the cartoonist Saul Steinberg presented an unabashedly parochial version of what the world looks like to a New Yorker: streets and buildings in the foreground, the Hudson River and a narrow strip called New Jersey beyond it. Behind that were some small hills–the Rocky Mountains–an even narrower strip called California, and beyond that a Pacific Ocean barely wider than the Hudson and tiny patches labeled China and Japan.

In the same spirit but with mathematical rigor, two Princeton astronomers have now produced what we might call an Earthling's view of the universe. On one very long piece of paper it shows the entire observable universe, from below the Earth itself to the last fiery incandescence emitted by the fading embers of the Big Bang when the universe was only 400,000 years old. It was produced by Dr. J. Richard Gott and Mario Juric, a graduate student, mining a variety of data, in particular the Sloan Digital Sky Survey, a continuing effort to map the locations of a million galaxies.

Like the Steinberg cover, the map is unabashedly parochial. A good half of it is devoted to our own cosmic New Jersey, the solar system. But so what? We do, each of us, live at the center of the universe. That is one of the lessons of Einstein's theory of relativity. Because light travels at a finite speed, to look out is to look back. The center of the universe is everywhere or nowhere. It is the present, and in it each of us is surrounded by concentric shells of the past, history racing in at 186,284 miles per second. The page you are reading, from perhaps a foot away is a nanosecond in the past; the moon you see is history by one and a half seconds; that fading radiation from the Big Bang, the fiery cataclysm in which the universe was born, is about 14 billion years ago. Just as all roads led to Rome, all lines of sight in the Einsteinian universe lead back to the beginning. Our birth in a sense surrounds us.

The function of a map is to know where we are, but the psychological universe we inhabit is not the same as the physical one. Consider that, objectively, we live around a star on the outskirts of the Milky Way galaxy. "You are here," reads the caption on another image popular on T- shirts and posters. It shows a spiral galaxy, one of those swirling petri dishes of stars and nebulae, with an arrow pointing to the end of one milky arm. We know that if the metaphorical camera that took that picture pulled back far enough, other galaxies would crowd into view and then clouds of them until our own was just a speck of dust.

The filigreed pattern of clumps, knots and ribbons traced by that dust, theorists tell us, arose from microscopic, quantum irregularities in space-time left behind by force fields during the Big Bang and then amplified a gazillion times by the expansion of the universe and the slow rumbling of gravity. For a cosmologist, this lordly view of the largest possible scale, in which we can see God's own brush strokes, might be the most fundamental and revealing map of the universe. But that won't do for the rest of us who see everything we know and love and yearn for crammed vanishingly into a single insignificant pixel.

"Objects close to us may be inconsequential in terms of the whole universe but they are important to us," Dr. Gott and his colleagues write in a paper describing their map and posted on the physics Web site at arxiv.org/abs/astro-ph/0310571. How to do justice both to the grandeur and the complexity of the universe? Dr. Gott and Mr. Juric used something like Mr. Steinberg's continuously changing scale to make their map. It shows the objects in a thin swath of space extending outward from the Earth's Equator as they appeared on Aug. 12, 2003, among them some 14,000 asteroids and 126,594 galaxies. In addition, famous objects lying outside this equatorial slice, including the Earth's 8,420 artificial satellites, the Sun, the Moon, planets, bright stars and some galaxies have been "dropped in." The circumference of the Equator is represented by a horizontal line near the bottom of the chart. Distances from the Earth's center increase logarithmically–tenfold with each large tick mark–going up the map. The result is a "conformal map," which preserves the shapes of objects like clusters of galaxies or clouds of asteroids and shows them with the same relative sizes they appear to have in the sky.

A cook's tour of this cosmos is a lesson in humility. It begins at the bottom where the dots for the International Space Station and the Hubble Space Telescope, the loci of current human activities in space, hover just below the gray buzz of artificial satellites, barely off the Earth. So much for the conquest of space. Robots have done better than humans at getting Out There. The Wilkinson Microwave Anisotropy Probe, which studies the radiation emitted by the last moments of the Big Bang and last year produced stunning baby pictures of the cosmos, is perched in an orbit on the other side of the Moon. On the far side of the solar system we find almost to our surprise and pride the lonely emissaries, Voyagers 1 and 2 and Pioneer 10, still trucking outward.

But we have to travel a thousand times farther yet, through the icy gulf known as the Oort cloud, relics left over from the formation of the solar system, before we get to the nearest stars. But by now we are taking truly cosmic strides, and before we know it we are beyond the Milky Way and into intergalactic space. At its distant, ancient end, where the galaxies paint filigreed webs and knots on the sky, the map incorporates the latest results of the Sloan survey. Among them is the largest structure yet discovered, the Sloan Great Wall, 1.37 billion light-years long.

At a distance of about 10 billion light-years (3,000 megaparsecs on the map) is the point where astronomers say a mysterious "dark energy" began to speed up the expansion of the universe. Before then, cosmic gravity was slowing the expansion. The turnaround occurred about five billion years ago, according to recent measurements, but distances in the map have been adjusted so that things are "now," rather than where they were when they emitted the light we now see. Accordingly, those Big Bang embers are now some 45 billion years out. Beyond is whatever you like to think: Platonic forms, God's breath, elephants perched on turtles.

Dr. Gott said that he and Mr. Juric intend to produce a version of their map 22 feet wide by 167 feet tall that could be projected on the side of building. In an e-mail message, Dr. Gott reported, "We haven't gotten the movie of the giant version up on the digital wall yet, but we are working on it!"