



Observations

Requiem for a Revolutionary Space Probe

The Kepler Mission introduced us to a dazzling array of solar systems

By Michael D. Lemonick on November 2, 2018



Artist's rendering of Kepler in space. Credit: NASA

When I was growing up, in the 1960s, astronomers and planetary scientists generally agreed that the Milky Way and the broader cosmos were probably teeming with planets. There was no evidence for this belief except for logic: our galaxy alone contains more stars than you could count in a lifetime, and the visible universe has

billions upon billions of galaxies. It would be absurd to think that our own, otherwise unremarkable sun was the only place where planets had congealed into existence.

In the 1990s, we learned that this assumption was valid: astronomers discovered the first verified exoplanets—first (weirdly), orbiting the burned-out husk of a star that had long since exploded, and then around a reasonably sun-like star, 51 Pegasi. Dozens of similar discoveries followed, but it still wasn't clear whether planets were rare and exotic, or as common as moths flitting around in the glow of streetlights.

But now we know it's the latter, and that is almost entirely due to the extraordinary Kepler spacecraft, which has finally given up the ghost: NASA announced on October 30 that the probe had run out of the fuel it needs to operate.

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When NASA engineer Bill Borucki first conceived of what would become Kepler, back in the 1980s, nobody took him seriously. Borucki suggested that you could find distant worlds by watching for stars to dim as their planets passed in front of them—a phenomenon known as a transit—much as Venus and Mercury occasionally pass in front of the sun. The dimming is infinitesimal, though; even a big planet doesn't block out very much of a star's brilliant light. Most of Borucki's colleagues thought it would be impossible to measure.



NASA headquarters agreed: they rejected his idea, not once but several times, and while he kept re-proposing it, a different way of planet-hunting, pioneered by the Canadian astronomer Bruce Campbell and refined by David Latham, Michel Mayor, Geoff Marcy and others began making actual discoveries (they measured stars' subtle wobbling, caused by the gravitational tug of an orbiting planet).

But in 2001, Borucki finally wore NASA down. The agency gave the go-ahead for Kepler, which launched in 2009 and began gazing, unblinking, at about 150,000 stars (the number would eventually rise to a half million). Most wouldn't dim even if they had planets, since the orbit would have to be edge-on to Earth's line of sight for that to happen. But over the next nine years, thousands of them did—and, extrapolating to account for the number that would have if the orientation had been right, the space probe showed that the Milky Way alone has vastly more planets than it does stars.



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And if you care about life on other worlds (as virtually all planet-hunters do), the results suggest that up to half of stars host planets that are somewhat similar to Earth in size and temperature. They may or may not actually harbor life, but the fact that they exist at all would have shocked and delighted the astronomy-obsessed child that I was (and still am).

That's not all: Kepler also showed us that a type of planet that isn't seen in our own system—a so-called super-Earth, bigger than our own planet but smaller than Uranus and Neptune—is extremely common elsewhere. (The words “isn't seen” are deliberate: astronomers are currently searching for such a world, known informally as Planet X or Planet Nine, that might be orbiting far beyond Pluto).

That, along with the discoveries of so-called hot Jupiters—giant worlds whirling around their stars in orbits much tighter than Mercury's around the sun—and a

finding that solar systems often have less of a spread in planet sizes than ours does, shows that our own solar system is kind of bizarre. Copernicus taught us that Earth isn't the center of the universe. Later discoveries showed that the sun isn't special either. Even the stuff planets and stars are made of isn't special, since the still-mysterious dark matter adds up to five times more mass. Our solar system, by contrast, is evidently special in some ways. This is only a partial list of Kepler's scientific achievements, of course; NASA can tell you plenty more, if you're interested.



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Kepler wasn't the first telescope that found an exoplanet, and it won't be the last: NASA's TESS mission, launched last spring, is just beginning to make its own discoveries—and since it's looking at the 200,000 brightest stars in the sky, that means it's also, unlike Kepler, looking at many of the nearest. When it does identify planets (and by now we know it's when, not if), some of them could be close enough to study with the James Webb Space Telescope (JWST), now slated for launch in 2021, and with the giant ground-based telescopes now under construction in Chile and, soon, in Hawaii as well. NASA is also studying the possibility of launching space telescopes in the 2030s that would be even bigger than JWST and could take pictures of exo-Earths around nearby stars to seek out signs of life. Kepler's galactic census is crucial for that work, since it provides hard evidence that promising worlds are actually there for these multibillion-dollar megascopes.

But Kepler found the most by far, allowing scientists to make broad generalizations at last about the populations of planets that fill the Milky Way. It transformed exoplanetology from stamp collecting into census taking. And like Galileo's first, crude telescope did just over four centuries ago, it also began the transformation of our understanding of the universe.
