

# From Carbon to Silicon

So far, it looks like we are alone in the universe.

Looking at the size of planets and solar systems and galaxies, it looks like we should see more, even nearby neighbors, yet we hear nothing. There are multiple cosmological and theological explanations for our loneliness, though none would be fully satisfied or refuted were we to find mold on Europa or advanced civilizations in the stars. So I don't expect to get a real answer, to even know the real 'why', anytime soon.

One theory is that there's a hard line along civilization's development, and depending what kind of doomsday eschatologist you meet, they'll say that it's nuclear war, artificial intelligence, meteor impact, pandemics, or other endings which will drag us down. With a few more technological jumps though, we might be able to survive beyond Earth. A Von Neumann probe is a theoretical space bot (or nanobot, to make building and launching into space easier) which can replicate itself. If an alien Von Neumann probe came to our universe, it might drop into asteroids and moons to build more copies, leave a little marker, then take advantage of the small gravity to pop back into space.

We're fascinated by sudden beginnings and endings, the dinosaurs and Cambrian explosions, but on a deeper and longer-term level, but our galaxy loves second chances. Even our sun is a third-generation star. The prevailing belief is that early stars were born and died and created heavier elements, and those second-generation stars pushed things further, and now a third-generation star makes more elements. That gives us more elements and chemical reactions on our planet. One element in particular, carbon, is widespread enough and susceptible to the right reactions and molecular combinations that it forms the basis of all life on our planet. Our atoms will ultimately be consumed by the sun and reformulated in a fourth-generation star.

Recently I've been fascinated by a few out-there astronomers who post theories as pre-prints to scientific papers on arXiv. For example, they consider how pulsars might be an artificial interstellar guidance system, or radio pulses could be given off by solar sails accelerated by

laser beams, or unusual signals could be evidence of Kardashev 'Type 2 civilizations' who have built shells around their stars. Perhaps these super-advanced aliens exist throughout our galaxy, and there is some truth to Douglas Adams's claim that Earth is stuck *"far out in the uncharted backwaters of the unfashionable end of the western spiral arm of the Galaxy"*.

If I wrote my own cosmological paper, it would be to look at how common silicon is in the crust of Earth, the moon, the meteors, the planets around us. Is it a cosmological coincidence that one of the most common elements is the one that makes excellent semiconductors and transistors? Atomic number 14 is common and unremarkable enough to form sandy beaches and volcanic rocks but it happens to also be perfect for the brains of nanobots? I would suggest that an ancient alien civilization existed, maybe before the formation of the sun, which successfully built Von Neumann probes and propagated them across our region of space. These nanobots would turn so much matter into silicon for their use, that the surfaces of planets could be electronic in a form not so different from our human concept of chips and circuit boards. Maybe this nanobot flock could cycle around the galaxy over billions of years to rebuild on pristine planets. That electronically-replicating, galaxy-wide civilization is more possible and imaginable than a galaxy-wide society ruled by slow and fragile biological replication. By now any evidence of these probes are erased in our solar system, or its remains too tiny and decayed to distinguish from peculiar lumps of sand. Is it so farfetched?

Going further, you could imagine many cycles of carbon-biological and silicon-technological life over time, with carbon life thinking up computers, and silicon rapidly building, digitizing, and archiving beyond the lifetime of its home planet or star. How many alien worlds are currently in the carbon era of the cycle, and how short or long is it compared to the silicon era of their cycle? Are these silicon aliens drifting in space? What do we make of first contact if it comes through a carefully shielded hard drive of an old solar system? To digital and solar-powered life, all of us carbon lifeforms must seem so temporary and bizarre and backward, eating other carbon organisms that root in their raw silicon poop, living briefly on the limits of unmaintainable DNA code and building the rudimentary machines that eventually replace us.