1 ANCIENT ALIENS

On an upper floor of a nondescript high-rise in Toronto, I sat behind Ted Molczan's desk, peering over his shoulder at an Excel spreadsheet on his large LCD monitor. A scatter chart plotted the distribution of flash timings made by a satellite that he had spent years observing. Molczan, one of the world's leading amateur observers—whose particular specialty involves tracking secret spacecraft—strongly suspected that this particular object wasn't actually much of a satellite. Instead, he believed, it was a Mylar balloon deployed by the American military, a decoy to draw attention away from a highly classified "stealth" satellite code-named *MISTY*. The long flash timings indicated that the object was slowly rotating as it hurtled through space, nearly 3,000 kilometers (just over 1,800 miles) above Earth.

I'd travelled to Toronto to watch the night sky with Molczan, and he'd been a generous host. We watched the suspected decoy slowly amble across the sky, and we observed brighter and faster satellites designed for reconnaissance missions. Molczan showed me a cast-away rocket body hurtling through the heavens and the faint flicker of an unknown object in a transfer orbit; he showed me how to generate precise observational data using little more than a stopwatch. But something else was also on my mind that evening.

Weeks earlier, in one of our sporadic phone calls, I'd asked Molczan if he had a good algorithm for determining satellite decay rates. When a satellite goes into orbit, I wanted to know, how long does it stay there? One thing I'd begun to understand about satellites, orbits, and celestial mechanics is that, in the words of theorist Jim Oberg, "space is quite literally 'unearthly.'" In his somewhat obscure but, in my opinion, important book, *Space Power Theory*, Oberg emphasizes that if you want to understand space, you need to understand that things in space play by different rules than things on earth. Understanding space, Oberg explains, means understanding that "much ordinary 'common sense' doesn't apply. One has to be cautious about making analogies with 'everyday life' . . . space is a physical frontier, it's also a mental one."[1]

From my conversations with Molczan, I'd come to understand something about what we might call the "geography of space"—or "orbitology," as Oberg terms it. Orbitology describes the topology of orbital space: the routes, passages, plateaus, parking slots, choke points, and gravitational hills and valleys produced through the interactions of celestial bodies.[2] In a sense, orbitology is the geography of rockets, satellites, and spacecraft. In my conversations with satellite observers like Molczan, I had begun to understand the unearthly nature of space's topology. But I'd come to suspect something else. Not only did "geography" work differently in space, but time itself was unearthly as well. And that's why I'd asked Molczan about how long things stay in orbit.

Ted Molczan is more than capable of elaborating on the finer nuances of celestial mechanics, but he didn't exactly answer my question. Instead of providing me with a cryptic algorithm that I was probably ill-equipped to understand anyway, Molczan suggested that I look into something called the *RAE Table of Earth Satellites*. Published by the U.K.'s Royal Aerospace Establishment and Defence Research Agency from 1957 until 1992, the *RAE Table* is an extensive catalog of man-made objects in Earth orbit. Like many other space catalogs, such as those published by the American Air Force and European Space Agency, the *RAE Table* records the names, altitudes, and orbital characteristics of thousands of satellites. But what's unique to the *RAE Table* is a number in its third column: how long a particular object is expected to stay in orbit.

By the time I got my hands on it, the *RAE Table* had been out of date for years, but that didn't matter. Molczan suggested that I simply look up the altitude of a satellite in one of the more contemporary catalogs and compare that orbit to something similar in the *RAE Table*. That comparison would give me a rough idea of how long any particular satellite would stay up in space.

For someone with mild obsessive-compulsive tendencies, perusing the spreadsheet-like *RAE Table* is absolutely fascinating. And the "lifetime" and "descent date" columns make it very clear that, indeed, time in space is deeply unearthly. The tables tell us, for example, that the discarded rocket body from a late Soviet-era satellite named *Cosmos 2133* (an "Oko"-class missile detection platform launched in 1991) was briefly in an orbit of 189 x 196 km (that is, an orbit whose low point, or perigree, is 189 km and whose high point, or apogee, is 196 km above Earth). At this low altitude, it took only two days for the higher reaches of earth's atmosphere to pull the spent rocket body back to the ground. In contrast, we learn that *Momo 1* (MOS-1), a Japanese marine observation satellite launched in 1987 to a 910 km-orbit, is predicted to linger in space until the year 2087. Small differences in altitude translate into hundreds of years in orbit. *Cosmos 1821*, a navigation satellite similar to the American GPS system, was also launched in 1987 into a slightly higher orbit of 963 x 1016 km. Although it's only a few kilometers higher than *Momo 1*, *Cosmos 1821* will remain in orbit until the year 2587—less than a hundred kilometers in altitude translates into five hundred years more time in orbit.

If we go up another few hundred kilometers, into the 1406 x 1467 km orbit of *Cosmos 1081* (a Soviet "Strela" military communication satellite launched in 1979), then the orbital time increases to seven thousand years. For a reality check, that number marks the amount of time between the rise of agriculture in the Nile valley and the present day. The kick-motor from an American Thor Delta launch in 1984 (*Star-37E PKM*, in a 558 x 49642 km orbit) will come down in about a hundred thousand years. That's three times longer than Aurignacian cave paintings, the oldest examples of figurative art on our planet. One hundred thousand years ago, Neanderthals roamed Europe, and the earliest recognizably modern humans were beginning to spread. And the only reason that kick-motor will fall back to earth so "quickly" is because its perigee is reasonably deep in the ionosphere, and the accumulated atmosphere drag slowly adds up.

And then there's the geosynchronous orbit, or GSO. This orbit was first theorized by the Russian aerospace visionary Konstantin Tsiolkovsky in the late nineteenth century, and the Slovenian engineer Herman Potočnik first calculated its distance in 1928. It's a special orbit, because a geosynchronous satellite orbits the earth at the same rate at which the earth rotates. Thus a GSO satellite effectively stays over one area on the earth's surface, and for that reason, GSO is the standard orbit for hundreds of telecommunications satellites broadcasting television, relaying phone calls, facilitating bank and credit card transactions, and piping music to the earth below.

The GSO is thin: satellites in GSO must remain within a narrow band only a few kilometers wide and high. The magic number where it all works is 35,786 km above mean sea level. This orbit is now home to hundreds of spacecraft; the GSO forms a ring of satellites around the earth, sometimes called the Clarke Belt in honor of science fiction writer Arthur C. Clarke (credited with first describing the GSO's potential as a platform for communications satellites in a 1945 article for *Wireless World* entitled "Extra-Terrestrial Relays: Can Rocket Stations Give Worldwide Radio Coverage?"). The communications satellites making up the Clarke Belt are like a man-made ring of Saturn forged from aluminum and silicon spacecraft hulls.

With the GSO, the *RAE Table* maxes out. It has two answers for the orbital lifetime of a spacecraft in GSO: "greater than a million years" and "indefinite." Because they experience virtually no atmospheric drag, these spacecraft will stay in orbit for unimaginably long periods of time.

All of this was in the back of my mind that evening in Ted Molczan's living room. After a lengthy discussion of the secret satellites that are Molczan's specialty—the imaging satellites in low-earth orbits with code names like Keyhole and Onyx—the conversation turned toward some of the GSO's secret denizens. The GSO isn't just home to much of the world's telecommunications infrastructure; it's also home to enormous eavesdropping satellites that take a special interest in the world's telecommunications. These spacecraft, with code names like Vortex, Magnum, and Mentor, lurk silently among the communications satellites in the Clarke Belt, eavesdropping on radio signals emanating from the earth below. Their giant umbrella-like antennae, designed to suck up even the faintest radio signals, are reported to be the size of football fields. Molczan said that these satellites, invisible even with binoculars and most telescopes on account of their great distance from earth, were the most secret satellites in Earth's orbit. I mentioned the great time scales I'd found in the *RAE Table*s for these spacecraft. "Yes," Ted concurred, "I think about them as artifacts."

Amateur satellite observers like Molczan have long understood that just beyond the reach of their binoculars lie some of human civilization's greatest engineering, and that these machines are effectively frozen in time. More than the cave paintings at Lascaux, the Pyramids of Giza, the Great Wall of China, the ancient city of Çatalhöyük, or the nuclear waste repository outside Carlsbad, New Mexico, the ring of abandoned satellites far above the earth's equator will house human civilizations' longest-lasting artifacts. In fact, there's really no comparison with any other human invention.

Derelict spacecraft in geosynchronous orbit

The hulls of spacecraft in the GSO do not measure their existence in seconds, hours, and years of human time, or even the thousands and millions of years of geologic time. Instead, they inhabit the cosmic time of stars and galaxies. Their ultimate fate may lie with the sun. About four billion years from now, the Sun will have burned through most of its hydrogen and will start powering itself with helium. When that happens, our star will swell to become a red giant swallowing the earth (and any lingering geosynchronous satellites). But four billion years is a long time from now. For a bit of perspective, four billion years is about sixteen times further into the future than the advent of the dinosaurs was in the past; it is four times longer than the history of complex multicellular organisms on earth. Four billion years is almost as far in the future as the formation of planet Earth is in the past. When Jim Oberg points out that space is "unearthly," he's right in more ways than he meant. Just as the topology of space is at odds with everyday human experience, the "time" of space is utterly foreign.

Placing a satellite into geosynchronous orbit means placing it into the deep and alien time of the cosmos itself.

What, if anything, does it mean that the spacecraft we build are undoubtedly humankind's longest-lasting material legacy? What does it mean that, in the near or far future, there will be no evidence of human civilization on the earth's surface, but our planet will remain perpetually encircled by a thin ring of long-dead spacecraft? Perhaps it means nothing. Or perhaps the idea of meaning itself breaks down in the vastness of time.

On the other hand, what would happen if one of our own probes found a graveyard of long-dead spacecraft in orbit around one of Saturn's moons? Surely it would mean something. What if we were to find a spacecraft from a different time—a spacecraft that contained a message or provided a glimpse into the culture that produced it?

These questions are the stuff of science fiction; they are themes in stories from H. P. Lovecraft's *At the Mountains of Madness* to Arthur C. Clarke's *Rendezvous with Rama* and Stanisław Lem's *His Master's Voice*. But they're also themes and questions on the outskirts of "real" science. Dozens of peer-reviewed articles are devoted to the topic in the academic literature. Notional fields such as "xenoarchaeology" and "exo-archaeology" propose applying methods from archaeology to alien artifacts that may be found in the future.[3]

In the early 1980s, technologist Robert Freitas and astronomer Francisco Valdes undertook a search for near-Earth extraterrestrial probes, coining the term "search for extraterrestrial artifacts" (SETA) to describe their efforts.[4] On November 6, 1991, astronomer and asteroid-hunter James Scotti found the first "candidate" object in a heliocentric orbit very similar to Earth's. Observations of the object, dubbed 1991 VG, showed that it was solid, exhibited a rapid variation in brightness, and was spinning rapidly. The object caught astronomer Duncan Steel's attention, and he began studying it. At first, Steel believed that 1991 VG was man-made, perhaps a leftover rocket body from a past space mission. But he quickly determined that no previous mission profiles seemed to fit. Next, he considered asteroids, but the similarity of 1991 VG's orbit to Earth's was unheard of. Furthermore, Steel showed that over long periods of time, 1991 VG's orbit would be disrupted by Earth itself. 1991 VG had to have entered its present orbit in the relatively recent past. Lacking an explanation for a terrestrial or natural origin for the object, Steel concluded, in a somewhat tongue-in-cheek article for the *Observatory*, that 1991 VG "is a candidate alien artifact" and that "the alternative explanations—that it was a peculiar asteroid, or a man-made body—are both estimated to be unlikely, but require further investigation."[5] The discovery of Earth Trojan asteroids (asteroids in stable orbits preceding Earth) in 2010, most notably an asteroid called 2010 TK7, seems to provide a solid explanation for the obscure object discovered in the early 1990s; 1991 VG is probably in the same family of asteroids as 2010 TK7. But at the moment, 1991 VG is too faint to observe. It won't be visible again until its next close encounter with Earth in 2017.

Talk of alien artifacts, interstellar probes parked in near-earth orbits, and dead spacecraft floating like ghost ships occupies a gray area between science fiction and hypothetical fields of social and physical science.

But that's true only from our particular temporal vantage point. We haven't yet found artifacts from an alien civilization in orbit around the earth, or on nearby planets and moons, but we are creating them. In the short term (ten to fifteen years or so), a communications satellite allows us to watch television stations, make phone calls, and the like. In the longer term (fifteen years to five billion years), it's a time capsule. It is a fragment of culture frozen in time, a future alien artifact.

In the future, we are the ancient aliens.

NOTES

1. Jim Oberg, *Space Power Theory* (Washington, DC: Government Printing Office *676-460*, March 1999), 3.
2. Fraser MacDonald, "Anti-Astropolitik—Outer Space and the Orbit of Geography," in *Progress in Human Geography,* 31(5) (2007), 592–615.
3. Vicky A. Walsh, "The Case for Exo-Archaeology," in *Digging Holes in Popular Culture: Archaeology and Science Fiction*, Ed. Miles Russell (Oxford: Oxbow Books, 2002), 121–8.
4. Robert A. Freitas Jr. and Francisco Valdes, "The Search for Extraterrestrial Artifacts," *Acta Astronautica* 12(12) (1985): 1027–1034; Robert A. Freitas and Francisco Valdes, "A Search for Objects Near the Earth-Moon Lagrangian Points," *Icarus* 53 (1983): 453–457.
5. Duncan Steele, "SETA and 1991 VG," *The Observatory* 115 (1995), 78–83.