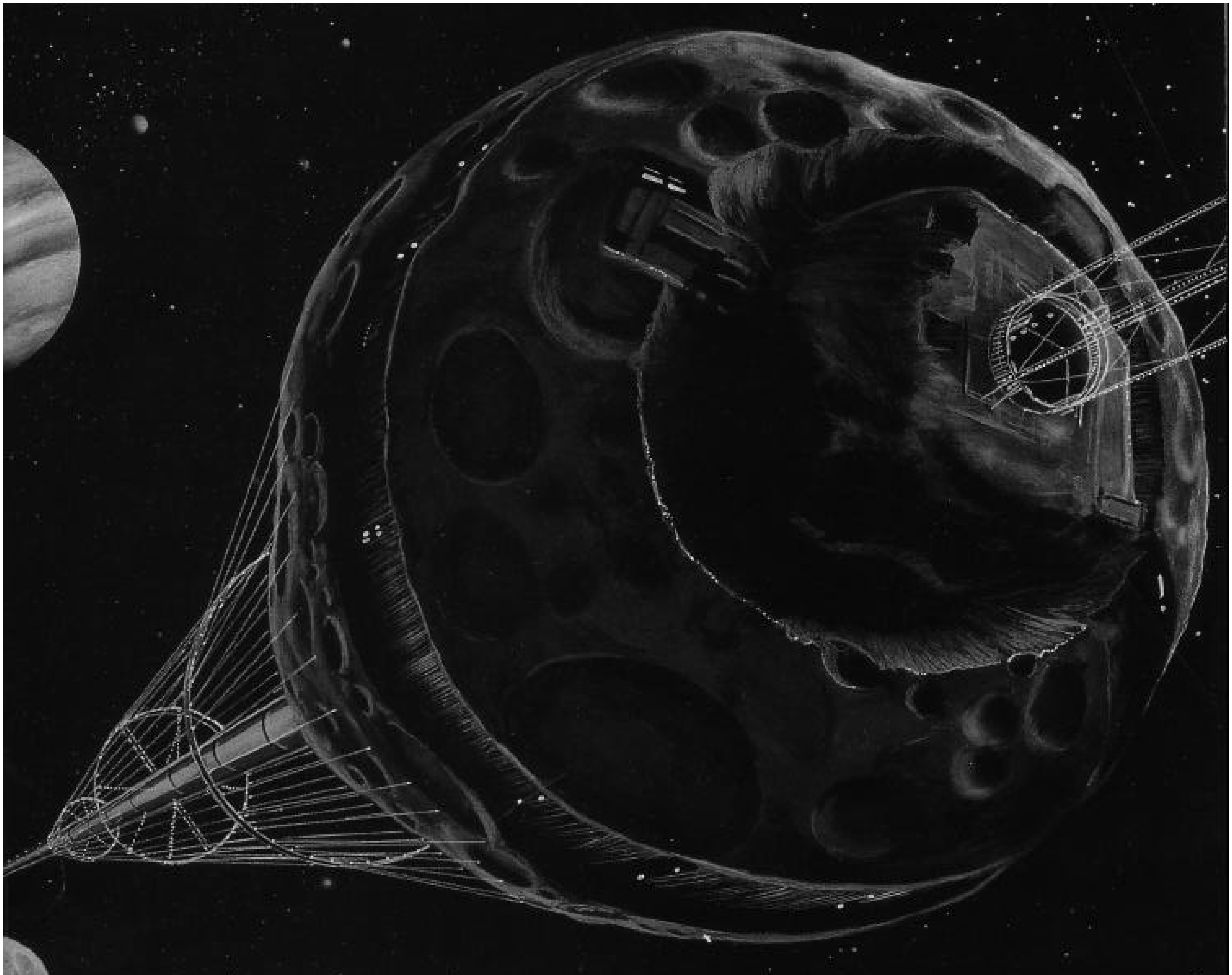

WHEN WILL THE REAL SPACE AGE BEGIN?

by Arthur C. Clarke

AS HAS BEEN WISELY SAID, predicting the future is much harder than predicting the past. Although most of the developments that have occurred in space were described by dozens of science-fiction writers, and such pioneers as Goddard, Oberth and Tsiolkovsky, virtually all estimates of costs and timescales were wildly inaccurate. Remember the backyard spaceships of the 1930s pulp magazines? I recall one eccentric professor who didn't bother to stop at the Moon or Mars on his maiden voyage, but went straight on to Pluto. Those were the days . . .

And this might be a good time to make a belated apology to the Astronomer Royal, Richard Woolley, who, on arrival in England in 1956 to take up his appointment was widely quoted as saying that "Space travel was utter bilge"—and never lived it down after *Sputnik* was launched the very next year.

What the poor man actually said was, "All this writing about going to the Moon is utter bilge—it would cost as much as a major war." With a couple of small alterations—say "ninety percent of" instead of "all," and "minor" instead of "major"—he would have been right on target. He was certainly nearer the bull's-eye than we amateur astronauts of the prewar British Interplanetary Society, who claimed that a rocket to carry three men to the Moon could be built for a quarter of a million dollars.

Even allowing for inflation, that's about three orders of magnitude too low—but I don't regret our naive optimism. Had we any real idea of the cost and complexity of space missions, we'd probably have abandoned hope. Yet in another way we were too pessimistic, for I doubt if any of us really believed that the Moon would be reached in our lifetimes. When I wrote *Prelude to Space*, back in 1948, I put the first Moon mission—with a horizontally launched, fully reusable, two stage, nuclear-powered vehicle—in 1978. But my tongue was firmly in my cheek: I knew perfectly well that so early a date was quite ridiculous . . .

And the very last thing that any of us ever imagined was that, having gone to the Moon, we would quickly abandon it. There is an uncanny parallel here with the history of Antarctic exploration. The South Pole was reached, in 1912, by explorers driven (and funded) largely by nationalistic pride, though of course there were also excellent scientific reasons. Transportation was by the most primitive means imaginable: dogs, ponies, human muscle-power. (Though Scott used ancestors of today's Snocats, the technology was immature and they were a failure.)

Not until some four decades later did we return to the Pole—and stay there. We went back not with dogsleds but with aircraft. For space travel ever to play a really major role in human affairs, something like this scenario will have to be repeated.

Let's be brutally frank: This may not be possible, and even if it is possible, it may never be done. Oh, we will establish scientific bases, visited by human crews from time to time, on all the interesting bodies in the solar system. But permanent colonies on the Moon, Mars, and the Jovian satellites—not to mention the "terraforming" of other planets—may be pure fantasy.

After all, it would be possible to build cities on the seabed, but despite the population explosion I doubt if we will ever do so. Incentive has to precede technology; if the Bureau of Pest Control for this section of the Galaxy challenged us to prove our fitness to survive by reaching Mars, we'd be there in five years—instead of the twenty or thirty it will probably take.

Image: H.A. Weaver (Applied Research Corporation), the HST Comet Science Team, and NASA

The Hubble Space Telescope Wide Field Camera 2 took this picture of Comet Hyakutake on 25 March 1996 when the comet passed at a distance of only 9.3 million miles from Earth.

The recent spectacular bombing of Jupiter by Comet Shoemaker-Levy 9, together with the widely accepted theory that a similar event on Earth 65 million years ago contributed to the extinction of the dinosaurs, has certainly provided one incentive for the development of space technology. Unfortunately, it is very difficult to make any realistic estimate of the danger involved, particularly when we are faced with so many other potential environmental crises. But a survey of the local neighborhood for NEOs (Near Earth Objects) is the least we should do, and the cost would be trivial compared with other scientific (not to mention military) projects. Indeed, much of the work would be done by dedicated amateurs in their spare time.

The spectacle of Comet Hyakutake looming large and ghostly like a misty Moon this March, and, if it lives up to its advance publicity, Comet Hale-Bopp, which will dominate the skies of Earth in the spring of 1997, should certainly focus attention on this problem.

Meanwhile, I am delighted that NASA chose the name SPACEGUARD (from my novel *Rendezvous with Rama*) for the study that Congress requested it to make, and I suggest that future versions open with this Thought for the Day, courtesy of science fiction writer Larry Niven: "The dinosaurs became extinct because they didn't have a space program."

Yet I'm afraid we s.f. writers—especially those slaving in the gilded saltmines of Tinseltown—are responsible for raising expectations that cannot be realized for centuries, if at all. There was an amusing—yet rather sad—demonstration of this at the Smithsonian Air and Space Museum recently. Some young TV addicts were shocked to discover that the Apollo 11 capsule couldn't even manage Warp One—and lost all interest when they heard that Neil and Buzz never said "Beam us up, Mike."

On the other hand, let us give Hollywood its due. The success of *Apollo 13* is one of the most encouraging things that's happened to astronautics for years, as it shows that there is still great public interest in Space. This was further demonstrated by the recent wide media coverage given to the discovery of a (possibly) Earth-type planet of another star.

Yet what I have to say now will, I fear, provide little comfort to my friends in the rocket industry (especially the one who wrote the now-dated but immortal words "I've burned more alcohol in thirty seconds than you ever sold over this lousy bar.") Frankly, I think the rocket has about as much future in space as dogsleds have in serious arctic exploration. Of course, it's the only thing we've got at the moment, so we must make the best possible use of it. (That goes for the remaining shuttles as well, and any other ASPs, SSTOs etc. that may emerge during the next few decades as viable alternatives.)

So what am I proposing beyond, say, 2030—when I hope most of the readers of this piece are still around?

I must admit that when I wrote *The Fountains of Paradise* I considered Yuri Artsutanov's Space Elevator, reaching from the equator up to geostationary orbit, little more than a fascinating "thought experiment." At that time (1978) the only material from which it could be built—diamond—was not readily available in megaton (tera-karat?) quantities. This situation has now changed, with the discovery of the third form of carbon, C_{60} and its relatives, the fullerenes. Dr. Smalley, the leader of the Rice

University team that produced the first tubular variety of C_{60}, claims that it is the strongest material that can possibly exist! If it can be mass-produced, building a space elevator would be a straightforward engineering proposition. As I write these words, I'm waiting for the shuttle *Atlantis* to lower a payload on a long tether—perhaps the first "small step" down towards the equator. (An earlier attempt was only partly successful, but one of my proudest possessions is the copy of *Fountains* the crew sent to me after that mission, when they had signed it in orbit.)

By an eerie coincidence, in 1979 Buckminster Fuller himself wrote the sleeve notes on my 12 inch LP of *The Fountains of Paradise* (Caedmon TC 1606), and drew a sketch of the space elevator reaching up from Sri Lanka to orbit. How sad that he never lived to know of the extraordinary material that would make it possible, and which is now named after him!

What makes the space elevator such an attractive idea is its cost-effectiveness. A ticket to orbit now costs tens of millions of dollars—but the actual energy required, if you purchased it from your friendly local utility, would only add about a hundred dollars to your electricity bill. And a round trip would cost about ten dollars, as most of the energy could be recovered on the way back!

Once it was built, the elevator could be used to lift payloads, passengers, pre-fabricated components of spacecraft and rocket fuel up to orbit. In this way, more than 90% of the energy needed for solar system exploration could be provided by Earth-based energy sources.

"...the best advice I can give to the National Space Society... is this: despite setbacks and false alarms—continue the search for intelligent life in Washington!"

Looking even further ahead, one could see the virtual elimination of the rocket except for minor orbit adjustments. By extending the elevator beyond GEO, it could act as a giant sling, and payloads could be shot off to anywhere in the solar system by releasing them at the correct moment. (See Charles Sheffield's *The Web Between the Worlds* for details.) Of course, rockets would still be required for the journey back to Earth—at least until elevator/slings were constructed on the other planets. If this ever happens, the most expensive component of travel round the solar system would be for life-support and inflight movies.

Though I am now sure that a space elevator could be built on Earth (and much more easily on Mars) there is an obvious problem—the danger of collisions from the hundreds of satellites at lower altitudes. There would have to be a major clean-up job before construction could begin—an excellent idea in any case.

Finally—although this may be a case of Terminal Wishful Thinking, caused by over-dosing on Star Trek—I suspect that the elevator may be bypassed by something far better. Science-fiction writers have long dreamed of a mythical "Space-Drive" that would allow us to go racing round the universe—or at least the solar system—without the rocket's noise, danger and horrendous expense. Until now, this has been pure fantasy, However, recent theoretical studies—based on some ideas of the great Andrei Sakharov—hint that some control may indeed be possible over gravity and inertia, hitherto complete mysteries. A paper by Dr Hal Puthoff and his colleagues suggests that both are functions of the Vacuum or Zero Point Energy that pervades the entire universe, and which is the real residue of the Big Bang. Its magnitude is utterly beyond imagination, but Richard Feynman tried to give some idea of it when he remarked that the energy in a single cubic meter of space is enough to boil all the oceans of the world.

We may already be tapping this in a very small way: it may account for some of the anomalous "over-unity" results now being reported from many experimental devices, by apparently reputable engineers. Physics may be about to face a revolution similar to that which occurred just a century ago: don't be surprised if the fossil fuel/nuclear age comes to a screeching halt in the very near future.

Even if a theoretical basis can be established, the search for a practical "space drive" might be a long one: it took forty years and probably a trillion dollars to get from $E = MC^2$ to Hiroshima. However, the care and feeding of mathematical physicists costs peanuts; it's only when they start digging tunnels in Texas that things get out of hand. If I was NASA Administrator—a nightmare from which, as I told Dan Goldin recently, I sometimes wake up screaming in the small hours—I'd get my best, brightest and youngest (no one over 25 need apply) to take a long, hard look at Puthoff et al.'s equations.*

Meanwhile, the best advice I can give to the National Space Society and similar organizations is this: despite setbacks and false alarms—continue the search for intelligent life in Washington! ✯

* B. Haisch, A. Rueda & H. E. Puthoff, "Inertia as a Zero-Point Field Lorentz Force." Phys. Review A, February 1994.

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