The Pea Shooter

Leaving our solar system was never the goal. Nobody believed it was possible, other than by unreachable theoretical means. The idea of a stable wormhole creates no conflicts within the laws of physics, however generating one requires harnessing the energy of a small sun. Further, there are enough mineral riches in our asteroid belt alone to fully occupy every mining company for centuries to come, supplying all the specific elements that have become in short supply on earth. Thus it is with irony that historians note that the very apparatus meant to enable mining the belt opened a much bigger door.

The first challenge was getting enough material into orbit to do anything meaningful. The inefficiencies of current forms of space travel became readily apparent to those analyzing the economics of asteroid mining. The best rockets could deliver payloads up to three per cent of the overall vehicle weight, with the other ninety-seven per cent being spent on fuel. This approach is suitable for getting a satellite into orbit, but not for building large, interplanetary mining ships. People quickly realized we needed an entirely new way to get material into space on a large scale.

The second issue was propulsion once in space. Systems powered by chemical reactions have a low thrust-to-volume ratio, due to the vast amounts of material required by the reactions. Outfitting a ship with enough fuel to get to the belt and back would result in a giant fuel tank with no room left for a payload. Fusion reactors were briefly considered, but at present none could be made light enough.

The first problem was solved by an industrial accident at the Landon facility in Kansas. The second by a graduate student a decade later, studying nearby.

The Landon Beam Incidence and Collision Center formed a ring thirty miles in circumference that sat two hundred feet below corn fields in eastern Kansas and Nebraska. Fusion provided electricity for the site, as was the case with most of the planet by now. A ready supply of plentiful power had triggered a wave of new scientific exploration, with ever more powerful super-colliders coming online in rapid succession. However, while megawatts might scale up predictably, the surprises from nature do not.

Scientists had made a windfall of discoveries in the first few years that the Landon was operational by colliding more massive particles than was previously possible. On April 27th they discovered how to generate antimatter in large quantities, to their surprise.

A series of tremors was the first indication that something new was happening. Sensors in the main lab, located at twelve o’clock on the ring in Nebraska, started sounding alarms. Detection Chamber Beta went offline. Subsequent aerial photographs showed a crater one mile across, located at four o’clock on the ring, in Kansas, where the chamber used to be.

The scientific community has known about antimatter for decades. It is comprised of atomic particles that are the opposites of normal atoms in our universe. They exist only transiently, since they annihilate on impact with normal matter, releasing all their mass as energy, via a process that is uncomfortably close to that of a nuclear bomb. In previous generations of colliders, the antimatter particles generated as collision by-products would decay almost instantly, or were too small to be of risk. The Landon changed all that. Scientists had scaled up collisions from atoms to entire molecules, and managed to output a thimbleful-sized mass of anti-hydrogen by accident, enough to reduce Detection Chamber Beta to a smoking crater. Once the dust settled the scientific community realized they now had a viable means to propel spacecraft, if they could contain it. That same thimbleful of antimatter, if properly throttled, could propel a large ship across millions of kilometers.

In the meantime, public outcry shut down the Landon until they could figure out a workable safety protocol. Work halted on other large colliders in Europe and Asia. Nobody wanted an antimatter generator in their back yard, so people began to look to space as a possible location for the next collider. Despite the cost there was strong interest to move ahead. Fusion could provide electricity globally, but there is no substitute for elements like Lithium or Tantalum, which power all our electronics and grew rarer by the day. The belt held entire asteroids of rare earth elements, dwarfing our reserves on earth.

Lagrange Point 2, or L2, emerged as the natural choice of location. It sits just under 1.5 million kilometers from earth, on a line travelling directly away from the sun. An object at this location will orbit the sun in exact time with the earth, while always remaining in earth’s shadow. Hiding from the sun in this manner solves a host of issues for living in space, protecting both people and equipment from dangerous radiation emitted by the sun.

Work began almost immediately on a launch facility that did not rely on traditional combustion rockets. The design centered on the use of a railgun, a well-known technology that has been used by the military for decades. Railguns use magnetic fields to pull metal projectiles down a tube, and can accelerate them to astonishing speeds. Magnetic fields can be driven by electricity, which travels through wires at nearly the speed of light. The challenge with a large-scale railgun is throttling down the acceleration so that you do not crush the payload being launched. To solve this problem, they intended to build a track two thousand kilometers long, allowing a vehicle to reach escape velocity without harming live payloads.

The final leg of the journey into orbit for a railgun projectile presented the most daunting challenge. Vehicles exiting one of the twin launch tubes enter into our atmosphere, since we cannot build a structure tall enough to reach space. Transitioning from near-vacuum into a wall of atmosphere at 40,000 kilometers per hour presented an impassable barrier, one that came to be known as the Atmospheric Buffering Problem. The ABP reduced all projectiles into molten slag, rendering the railgun launch facility useless for any payloads other than unformed raw materials.

Construction began without a solution. Given the ten-year build cycle, they gambled that a solution would be found by the time it went online, and had created a sizeable prize for anyone that could design a workable solution. Ginny Okumbe began her first year of graduate studies at Kansas State University during the final year of the build. She had earned her degree in physics the year before in Lagos, Nigeria and had come to Kansas to pursue a master's degree. She and a handful of students were present at the initial test-firings of the launch facility. The first full-sized vehicles shot out of the tubes became compressed into spherical, glowing masses that cooled once in orbit. One of the astronauts remarked that they resembled giant peas, earning the name that has persisted until this day – The Pea Shooter.

Watching the test gave Ginny some ideas about solving the ABP. During her own work with high output capacitors, she noticed by accident that she could charge the air around the device. Once something is charged, it can be attracted or repelled by manipulating the electric field. She used this to repel the air, creating a thin layer of vacuum across the surface of the capacitor. During that moment she realized the tubes for the Pea Shooter did not have to be held in vacuum. The thin layer of vacuum would protect the vehicle from heat buildup that would normally occur due to atmospheric friction, allowing the tubes to be held at ambient pressure. In one move she completely removed the ABP, since there would be no pressure difference between the tube and the outside air upon exit.

However, heat buildup was not the only problem of a thick atmosphere. Escape velocity is many times greater than the speed of sound. Any vehicle travelling at those speeds will produce shock waves, which is manageable in the open atmosphere, but can be catastrophic inside a contained volume. She took apart her noise-cancelling headphones and started writing.

Ginny’s paper won the ABP design prize within a few days of its submission. By the end of that week full-scale wind tunnel simulations were underway. Vehicle designs were quickly modified based on her work, including both the capacitors for generating the vacuum layer and the ‘entourage’ vehicles necessary for the shock waves. These other vehicles consisted of a leader and a follower, both smaller than the payload. They were shaped like long water drops, with their long tails following behind them. These served to generate waves that cancelled those generated by the payload vessel, through a process known as destructive interference. During launch the magnetic coils that run the length of the tubes would vary the distances across the three vessels in accord with their speed, growing farther apart the faster they go. Some energy would still need to be dissipated at full escape velocity, so she designed baffles for the last mile of the tunnels that resembled the silencer devices that can be attached to the end of a rifle and absorb the sound of a gunshot. These baffles would not be in place for the first test, which had been decided would proceed while acknowledging the risk of some tunnel damage. They had to know if this could work.

The facility managers tried to keep the next test firing a secret, wanting to avoid any public relations fiascos if it failed. They need not have bothered, as this was too big to contain. Soon the entire world showed up to watch, and even Ginny’s mother tuned into the stream from Nigeria.

The giant tubes rumbled to life. Electromagnetic charges levitated the three automated vehicles, then began moving them down the line. They disappeared from view in seconds. Several minutes later a bright light shone in the western sky. Ginny held her breath. Once the glow faded, she exhaled, and turned to the monitors. The next observation would come from orbit. If the vehicles survived intact, they would attempt to communicate and coordinate a rendezvous.

Long minutes passed. A mechanical voice finally broke the silence.

“Vehicles Alpha, Beta and Charlie all requesting rendezvous coordinates.”

The room erupted in cheers.