SCIENCE

Fly By Microwaves

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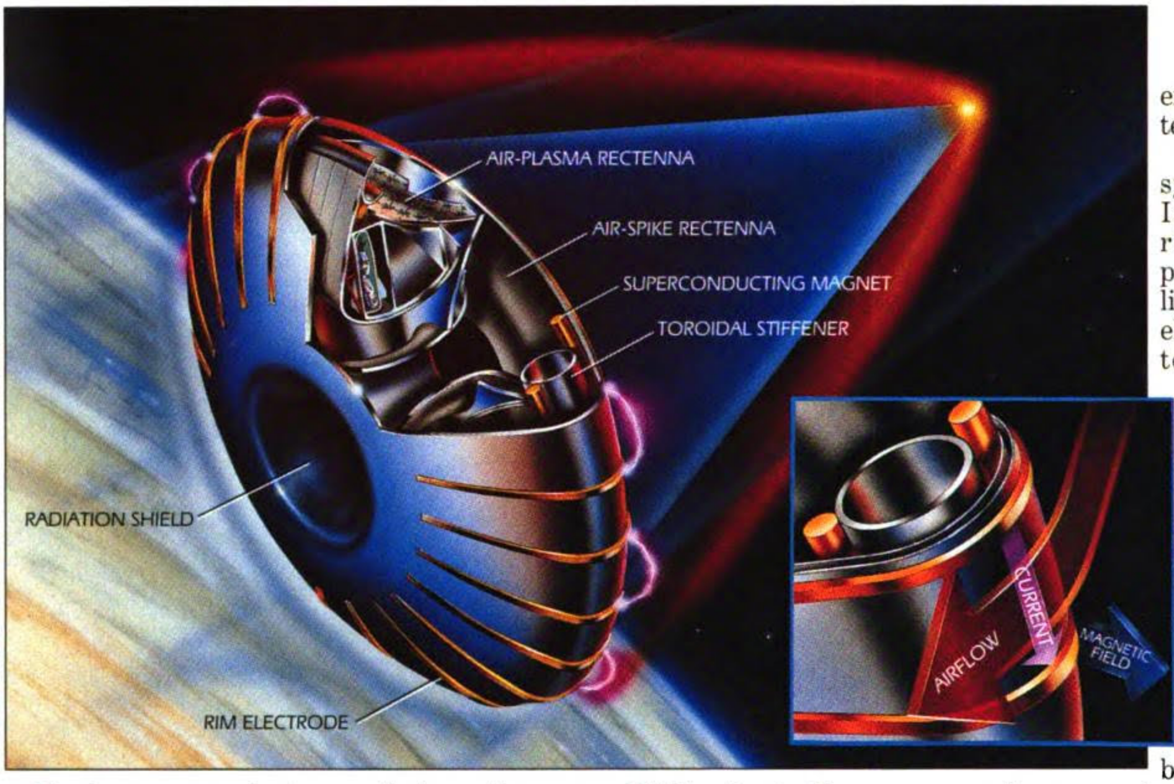

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• Engineers come in two varieties. Some push the envelope from within, squeezing every last advantage out of existing technology. Their insights can turn a desktop computer into a notebook, or a Ford Fairlane into a Taurus. Without them, for sure, we'd be leading poorer lives.

But then there are engineers who perch outside the envelope and stir up trouble. Impatient with the pace of progress, they stretch for undeveloped technologies, mix and match nascent concepts and challenge the world to prove them wrong. They endure condescension while they're working out their ideas. But if their ideas do work out, they're lauded as visionaries.

Put Leik Myrabo into this second category. An associate professor of mechanical engineering at Rensselaer Polytechnic Institute, in Troy, New York, Myrabo is rewriting the laws of flight. But he's not tinkering with jet or rocket engines. Nor is he reformulating fuels or propellants. Instead, he's blueprinting a vehicle that does nothing less than streak into the sky on a beam of microwaves.

For more than a decade, Myrabo has pursued a vision he calls "Highways of Light." The concept began as a means of boosting a spacecraft without burdening it with fuel (see Tech Update, page 21, April '90). Shining up from the ground, a heavy-duty laser would illuminate the spacecraft's lower surface. The barrage of energy would break air molecules into plasma—a blazing vapor of ions, or charged particles. The explosive expansion that accompanied this ionization would shove the vehicle skyward.

In experiments with scale models, the technique proved capable of imparting thrust. But the Strategic Defense Initiative Organization, which helped bankroll Myrabo's research, soon pulled the plug on 100-megawatt-laser development.

Unfazed, Myrabo joined forces with Yuri Raizer of the Russian Academy of Sciences. The Space Studies Institute, in Princeton, New Jersey, picked up the funding. Myrabo recalls the Institute's reasoning: "They said, 'We love your lasercraft, but we're still waiting for the high-powered lasers. High-powered microwave sources are here now—is it possible to design something around them?' "

The switch from laser to less energetic microwave power sent Myrabo and Raizer scurrying for ideas. As is often the case, the wealth of unexploited aerospace theory from the 1950s and 1960s proved a fertile hunting ground. Within weeks, the engineers concocted a fresh design, a disc-shaped vehicle called a microwave lightcraft. Myrabo has since refined the design into one that brims with exciting, albeit untried, technologies.

Take the propulsion system, for example. Instead of simply riding a wave of expanding plasma, the lightcraft would wield electromagnetic forces to whisk the plasma past itself.

The driving force begins as a shaft of pulsed microwave energy. This beam showers the lightcraft from an overhead satellite that converts sunlight into microwaves. The energy hits two rectifying antennas, or rectennas, that lie beneath the vehicle's microwave-transparent surface. These antennas, in turn, convert much of the microwave energy into electrical power. At the same time, they work like lenses to focus the rest to points outside the spacecraft.

Shaped like a shallow, curved lampshade, one of the rectennas rings the craft. This air-plasma rectenna drives the craft at subsonic speeds. It focuses the incoming microwaves into an ignition circle around the vehicle's periphery. There, the microwaves blast air into plasma.

As the plasma expands, it gets caught up in electromagnetic fields from two superconducting magnets that encircle the craft. Their relative strengths being adjustable, these fields can form a magnetic nozzle that propels the plasma downward, imparting lift to the spacecraft.

Futuristic enough? Yet at supersonic speeds, an even more radical propulsion method takes over. In this mode, the other rectenna—located on the lightcraft's upper face—joins in. It focuses part of the microwave beam back ahead of the vehicle, forming a conical reflection known as an air spike. Like the pointed nose of a fighter jet, this cone reduces aerodynamic drag, keeping a shock wave from hammering the vehicle's flat upper surface. Instead, the shock wave arches around the air spike. In addition, the shock wave ushers the airflow to the outer edges of the spacecraft, where a unique air-breathing engine operates.

Here's how the engine works. Around the rim of the craft cling a series of electrodes, between which arcs of current leap. Meanwhile, the two superconducting rings continue to radiate their own fields. And the air-plasma rectenna continues to ionize peripheral air. The confluence of the electrical current and magnetic fields causes the ionized air to accelerate downward, lending thrust to the vehicle.

This engine concept, known as a magnetohydrodynamic (MHD) fanjet, is similar to the submarine-propulsion systems now under development in the United States, Russia and Japan (see "Jet Ships," page 60, Aug. '90). In Myrabo's calculation, an air-breathing MHD engine could deliver unheard-of performance, zipping from Mach 1 to Mach 25 in 10 seconds.

If you think all of this sounds far-fetched, you're not alone. NASA officials see promise in some of the component technologies, but envision no short-term payoff. Even Myrabo admits that microwave lightcraft won't fly for at least a generation.

On the other hand, Myrabo has already put elements of this system to the test. In 1991, at the Naval Research Laboratory, he added a magnetic field to his laser-induced propulsion apparatus to preview the MHD fanjet. It doubled the thrust. And just recently, in an experiment that won attention from NASA and the Air Force, he demonstrated the air-spike concept in a shock tunnel. The equipment consisted of a plasma torch, representing the air spike, mounted on a blunt body that resembled an Apollo-capsule heatshield. Placed in a Mach-10 air blast, the torch triggered an oblique shock wave well forward of the body's flat face.

These tests hint at eventual fruition for Myrabo's work. But they also invite speculation. Remember that the theory behind these technologies was first thrashed out more than 20 years ago. And remember that Myrabo represents the open side of the aerospace establishment. There is also a secret side, well funded and stocked with equally visionary engineers.

Glowing, highly energetic, disc-shaped aircraft with unearthly performance characteristics have long been associated with the secret side. Myrabo's concept may offer a terrestrial explanation for the night-sky sightings that rational people tend to dismiss or ignore. Perhaps. Or perhaps it's just a concept that looks good on paper, or is ahead of its time. You never know with visionaries. PM