fecund than those who don't," he says.

Starks points out that his model, published in the November 13, 2007, *Medical Hypotheses*, is indeed speculative. He hopes, however, his ideas linking increased p53 to reduced cancer risk and increased family size will spark further studies. Paulsen agrees that even if the model is wrong, it is certain to raise interest and is a good thing. "What does provocation do to science?" Paulsen asks. Ideally, "it makes it better. That's what hypotheses are for."

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COMMUNICATIONS

# Aerial Stealth

**Plasma antennas disappear when shut off** BY STEVEN ASHLEY

**ANTENNA VANISHES from radar when the electricity fed to a plasma-filled tube is cut off.**

COURTESY OF THEODORE ANDERSON

Radar uses radio waves to enable aircraft, ships and ground stations to see far into their surroundings even at night and in bad weather. The metal antennas behind those waves also strongly reflect radar, making them highly visible to others—a deadly disadvantage during wartime. A new class of nonmetallic radio antennas can become invisible to radar—by ceasing to reflect radio waves—when deactivated. This innovation, called plasma antenna technology, is based on energizing gases in sealed tubes to form clouds of freely moving electrons and charged ions.

Although the notion of the plasma antenna has been knocked around in labs for decades, Ted Anderson, president of Haleakala Research and Development—a small firm in Brookfield, Mass.—and physicist Igor Alexeff of the University of Tennessee–Knoxville have recently revived interest in the concept. Their research reopens the possibility of compact and jamming-resistant antennas that use modest amounts of power, generate little noise, do not interfere with other antennas and can be easily tuned to many frequencies.

When a radio-frequency electric pulse is applied to one end of such a tube (Anderson and Alexeff use fluorescent lamps), the energy from the pulse ionizes the gas inside to produce a plasma. "The high electron density within this plasma makes it an excellent conductor of electricity, just like metal," Anderson says. When in an energized state, the enclosed plasma can readily radiate, absorb or reflect electromagnetic waves. Altering the plasma density by adjusting the applied power changes the radio frequencies it broadcasts and picks up. In addition, antennas tuned to the right plasma densities can be sensitive to lower radio frequencies while remaining unresponsive to the higher frequencies used by most radars. But unlike metal, once the voltage is switched off, the plasma rapidly returns to a neutral gas, and the antenna, in effect, disappears.

This vanishing act could have several applications, Alexeff reports. Defense contractor Lockheed Martin will soon flight-test a plasma antenna (encased in a tough, nonconducting polymer) that is designed to be immune from detection by radar even as it transmits and receives low-frequency radio waves. The U.S. Air Force, meanwhile, hopes that the technology will be able to shield satellite electronics from powerful jamming signals that might be beamed from enemy missiles. And the U.S. Army is supporting research on steerable plasma antenna arrays in which a radar transmitter-receiver is ringed by plasma antenna reflectors. "When one of the antennas is deactivated, microwave signals radiating from the center pass through the open window in a highly directional beam," Alexeff says. Conversely, the same apparatus can act as a directional receiver to precisely locate radio emitters.

Not all researchers familiar with the technology are so sanguine about its prospects, however. More than a decade ago the U.S. Navy explored plasma antenna technology, recalls Wally Manheimer, a plasma physicist at the Naval Research Laboratory. It hoped that plasmas could form the basis of a compact and stealthy upgrade to the metallic phased-array radars used today on the U.S. Navy's Aegis cruisers and other vessels. Microwave beams from these arrays of antenna elements can be steered electronically toward targets. Naval researchers, Manheimer recounts, attempted to use plasma antenna technology aimed by magnetic fields to create a more precise "agile mirror" array. To function well, the resulting beams needed to be steered in two dimensions; unfortunately, the scientists could move them in only one orientation, so the U.S. Navy canceled the program.

## Signal Clouds

**Having taken heavy casualties, your reconnaissance team is cut off deep within enemy territory. You need extraction fast, but the surrounding mountains are blocking your communications. What do you do? Plasma antenna researchers may have a solution. Several have patented a concept by which antennas relying on plasma gas could transmit and receive signals when more conventional communications links fail. Essentially, explosive charges would propel a jet of plasma high into the air, and the resulting cloud of ionized gas would then strongly propagate electromagnetic signals from a special radio set.**