To the Stars

Zero point energy emerges from realm of science fiction, may be key to deep-space travel

WILLIAM B. SCOTT/AUSTIN, TEX.

At least two large aerospace companies and one U.S. Defense Dept. agency are betting that "zero point energy" could be the next breakthrough in aerospace vehicle propulsion, and are backing those bets with seed money for ZPE research.

If their efforts pay off, ZPE-driven powerplants might enable Mach 4 fighters, quiet 1,200-seat hypersonic airliners that fly at 100-mi. altitudes as far as 12,000 mi. in about 70 min., and 12.6-hr. trips to the Moon.

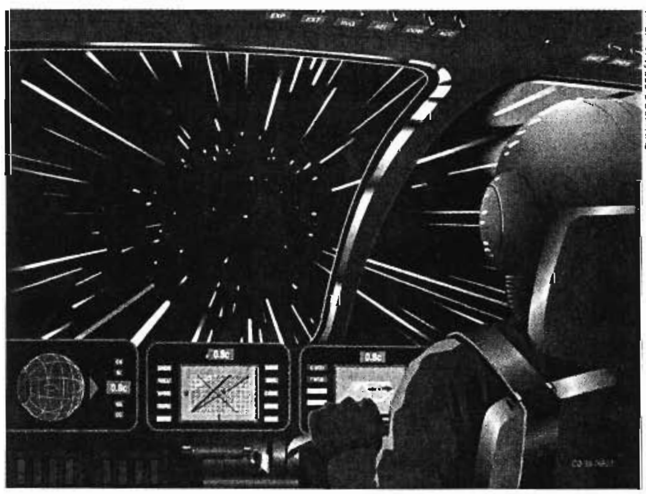
ONE OF THOSE companies, BAE Systems, launched "Project Greenglow" in 1986 "to provide a focus for research into novel propulsion systems and the means to power them," said R.A. Evans, the project leader, in a technical paper last year. Although funding levels have been modest, Greenglow is exploring ZPE as one element of the program's "project-directed research," according to John E. Allen, a consultant to BAE Systems.

At least one large U.S. aerospace company is embarking on ZPE research in response to a Defense Dept. request, but the company and its customer cannot be identified yet. National laboratories, the military services and other companies either now have or have had low-level ZPE-related efforts underway.

The concept of zero point energy is rooted in quantum theory, and is difficult for even the technically minded to grasp. But theories validated by meticulous experiments have confirmed that so-called "empty space" or what scientists call the "quantum vacuum" actually is teeming with activity. Tiny electromagnetic fields continuously fluctuate around their "zero-baseline" values, even when the temperature drops to absolute zero (0 K) and all thermal effects have ceased.

A leading researcher in this realm of new physics, Hal E. Puthoff, director of the Institute for Advanced Studies here, explains zero point energy this way: "When you get down to the tiniest quantum levels, everything's always 'jiggly.' Nothing is completely still, even at absolute zero. That's why it's called 'zero point energy,' because, if you were to cool the universe down to absolute zero—where all thermal motions were frozen out—you'd still have residual motion. The energy associated with that 'jiggling' will remain, too."

For most technologists, quantum theory conjures up images of extremely minuscule particles and field effects. Why would aerospace companies and governments invest in researching "jiggles" that defy measurement? Because those quantum or vacuum fluctuations—the "jiggles" of zero point energy—if tapped somehow, could produce stupendous amounts of energy and enable deep-space voyages that are impossible for today's propulsion methods.



NASA BPP/LES BOSSINAS

Spacecraft capable of interstellar travel will approach the speed of light, and may have to extract energy from the vacuum of space. However, researchers could be years or decades from achieving the breakthroughs necessary to build such a propulsion system.

"Human transportation within the Solar system will only become technologically practical if there is a breakthrough in terms of speed, coupled with an adequate energy/fuel supply," Evans said.

Energy densities (the amount of energy per unit volume) of the quantum vacuum are comparable to those of nuclear energy—or even greater. Consequently, its potential as an energy source is absolutely enormous.

Quantifying the potential of ZPE is difficult, and scientists are reluctant to translate the huge numbers predicted by quantum theory into terms easily grasped. Puthoff's explanation is particularly graphic, though: "It's ridiculous, but theoretically, there's enough [zero point] energy in the volume of a coffee cup to more than evaporate all the world's oceans," Puthoff said. "But that's if you could get at all of it, and you obviously can't. So, when it comes to a practical amount of ZPE [that might be extracted from the vacuum], you're still talking about maybe 10^{26} joules/cubic meter.

"The potential is practically limitless; way beyond what can be conceived. But until we learn what ZPE embodiment to use [an engineering process to extract ZPE], and to what frequency we can effectively extract the energy, it's really hard to make a practical statement about how much you can actually use," he cautioned. "So far, the embodiments are pitifully small. [Experiments] have produced about the same amount of energy as a butterfly's wing—picowatts or so. But the potential is there."

That staggering potential has kept researchers pursuing a "new physics" that some critics classify as near-science fiction. Still, respected scientists and government agencies believe the quest is worth investing time, effort and money. In 1986, the U.S. Air Force's then-Rocket Propulsion Laboratory (RPL) at Edwards AFB, Calif., solicited "Nonconventional Propulsion Concepts" under a Small Business Innovation Research program. One of the six areas of interest was "Esoteric energy sources for propulsion, including the zero point quantum dynamic energy of vacuum space . . . ."

In particular, the late Robert Forward,

ZPE in '12?

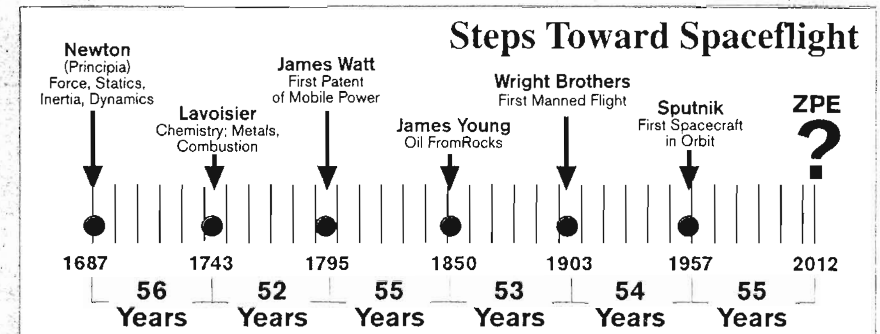
AUSTIN, TEX.

In trying to predict when a scientific breakthrough might unlock zero point energy (ZPE) as a space transportation power source, a few scientists suggest looking for clues in historical cycles.

One of the more enticing is the Kondratieff interval, which was defined by Nikolai Kondratieff in 1924. Often cited in economic studies, the roughly 55-year cycle can be found in a variety of human-event patterns. John E. Allen, a longtime aerospace researcher and consultant for BAE Systems, found that the Kondratieff cycle shows up in key milestones leading to spaceflight (see chart). If the cycle holds true, then mankind is due for another breakthrough in about 2012—which will be 55 years after the launch of Russia's Sputnik, mankind's first satellite, and 109 years after the Wright brothers' first flight.

Hal E. Puthoff, one of several scientists who has spent years trying to "break the code" that would release the tremendous potential of ZPE, quipped, "It's always darkest just before it's pitch black (see p. 50). The most frustrating period is when you know [the answer] is close, but you're not there yet. Certainly, that's where we are now. The fact that major aerospace companies are getting interested in [ZPE] will definitely accelerate the process. But there's no way to predict how long that'll take."

He and other ZPE researchers might look not only to the Kondratieff interval for encouragement, but also to Wilbur Wright's recollection in 1908: "In 1901, I confess that I said to my brother, Orville, that man would not fly for 50 years. Two years later, we made flights. This demonstration of my impotence as a prophet gave me such shock that ever more I have distrusted myself and avoided all predictions."



The Kondratieff interval occurs in a surprising number of human activities. There is a 54-year gap between aviation and spaceflight. But the process seems to be embedded in other evolutions in human thinking. All these quoted were essential to the evolution of aerospace.

Source: John E. Allen, "Quest for a Novel Force: A Possible Revolution in Aerospace," 2003.

a respected scientist consulting for RPL (now part of the Air Force Research Laboratory system), recommended additional research of the "Casimir effect," which had suggested the existence of ZPE decades earlier. This phenomenon is attributed to H.G.B. Casimir, a Dutch researcher, who, in 1948, confirmed the reality of quantum vacuum energy by calculating the value of a small force between two uncharged metal plates.

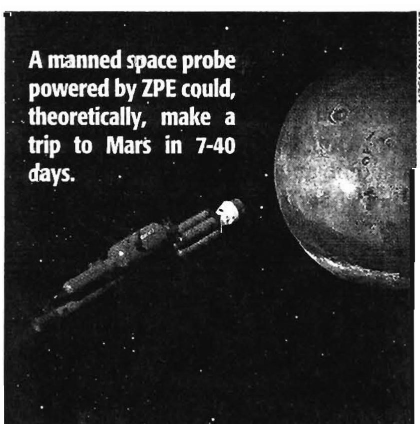
"IF YOU PUT TWO metal plates very close together, they partially shield some ZPE frequencies," Puthoff explained. "That means the energy bouncing back and forth between the plates is less than the energy outside, so the plates get pushed together. Radiation pressure outside the plates is greater than radiation pressure in the somewhat-shielded area between the plates. The plates coming together convert vacuum energy to heat."

In 1997, Steve K. Lamoreaux, a University of Washington atomic physicist at the time, conducted precise measurements of the Casimir effect. His results almost perfectly matched the predictions of quantum electrodynamics theory, according to a peer-reviewed paper in the Jan. 6, 1997, issue of *Physical Review Letters.*

When NASA established the Breakthrough Propulsion Physics (BPP) program in 1996 to research advanced forms of space transportation, it focused on three objectives:

- Propulsion that required no propellant mass.
- Propulsion that attained the maximum transit speeds physically possible.
- Breakthrough methods of energy production to power such devices.

Marc G. Millis, founder and former project manager of the BPP effort, said the program sponsored G. Jordan Maclay, chief scientist for Quantum Fields LLC, was "to look at getting more empirical evidence to flesh-out what this vacuum energy 'stuff' really is." Maclay performed a precise measurement of attractive Casimir forces, and was working to quantify repulsive forces when BPP funding was deleted from NASA's Fiscal 2003 budget (www.quantumfields.com). The BPP program has been on hold since then.



ERIK SIMONSEN

A manned space probe powered by ZPE could, theoretically, make a trip to Mars in 7-40 days.

Through private funding, Puthoff and his team have secured patents based on converting ZPE to "miniature ball lightning—micron-size lightning—using a very small traveling wave tube," he said. "It appeared to demonstrate the principle [of ZPE extraction], but we were never successful in scaling it up to useful levels. We're now working on various engineering embodiments to do that, but we're not there yet."

"As to where we stand on energy exchange [research], the force levels and amount of energy are piddly—real, but extremely small," Millis added. "We're still [asking]: Is there any way to interact with this vacuum energy to create forces without rocket propellant? Can we [develop] a form of propulsion that needs no propellant . . . for very deep-space travel?"

So far, the answers have been "no" or, at best, "maybe." But there are striking and encouraging parallels between the evolvement of ZPE and the history of nuclear energy research. Albert Einstein's equations showed that an infinitesimal amount of mass could be converted to a tremendous amount of energy via nuclear reactions. Initially, scientists insisted something was wrong; the numbers were just too large. They didn't make sense. But the mathematics were incontrovertible.

Then natural radioactivity was discovered, validating Einstein's equations. However, energy releases found in nature were so small that even Einstein believed radiation could never be harnessed as a useful energy source.

"At that time, it looked like [nuclear] fission was going nowhere," Puthoff said. "The big breakthrough came when [atomic physicist Enrico] Fermi did his famous experiment at the University of Chicago. He found that a material releasing lots of neutrons could act as a catalyst and start a runaway reaction. Fission would take off and cause a big effect—eventually the atomic bomb in the weapons [arena] and nuclear reactors in the energy [production] area."

Zero point energy has a similar history. Predictions from quantum mechanics said ZPE existed, but the huge numbers associated with it prompted questions about the mathematics' validity and suspicions of errors in quantum theory. "Then the Casimir effect was found to be a natural embodiment of natural principles," Puthoff said. "The [general] reaction was: 'OK, but it's a small effect. It's never going to be useful for making energy'—just like what was said about nuclear energy. So, we're now at the stage of looking for the equivalent of Fermi's neutron-source catalyst—something that ignites the ZPE process."

If that "catalyst" is ever discovered, and a ZPE powerplant is developed, how would it affect aeronautics and space travel? Allen, a BAE Systems consultant and engineering professor at London's Kingston University, explored that question in a comprehensive paper published last year by *Progress in Aerospace Sciences* (www.sciencedirect.com). Entitled "Quest for a Novel Force: A Possible Revolution in Aerospace," the paper included a "what-if" study, based on "a novel force engine." Allen assumed four sizes of the powerplant, referred to as a "mass-dynamic engine," with thrusts in the 5-500-metric-tons

(11,000-1.1-million-lb.) range. A likely source of energy for them would be ZPE.

Allen is no stranger to cutting-edge projects, having been involved in the preliminary designs of a transonic nuclear weapon (Blue Danube), an early supersonic guided missile (Blue Steel), early space shuttle work, and several advanced fighter and trainer aircraft at Hawker Siddely. "I am familiar with bringing novelties into successful aerospace hardware, and am well aware of the qualities required to make a successful product," he wrote.

Through a systematic process he calls "imagineering," Allen conceived of several air and space vehicles powered by mass-dynamic engines:

- A heavy-lift freighter capable of carrying a 1,000-metric-ton payload more than 20,000 km. (10,792 naut. mi.) at speeds of Mach 0.7-0.9.
- A Mach 4 vertical takeoff/short-takeoff and landing fighter.
- A 600-1,000-seat airliner powered by two 250,000-lb.-thrust engines.
- A Lunar craft that would climb slowly to a 36-km. altitude to minimize aerodynamic effects, then accelerate to a maximum velocity of 10-km./sec. (19,440 naut. mi./hr.) until slowing for a landing on the Moon. "This trajectory provides a flight time of 12.6 hr.," Allen suggested.
- A quiet hypersonic "megaliner" capable of climbing vertically to a 100-mi. altitude, then flying a curved flight path at satellite-like speeds. Allen selected a point-design of 1,200 passengers and a range of 12,000 mi. With upward accelerations limited to 0.5g, flight time would be about 70 min.
- A Mars transporter that could take a 20-person team to the red planet in 7-40 days, depending on the separation distance between the Earth and Mars.

Allen's analyses showed the performance of these craft are within the realm of feasibility, if using a breakthrough powerplant running on fuel with ZPE-like energy densities.

But is harnessing ZPE feasible, and, if so, how soon? If the expectations of cutting-edge scientists are any guide, a ZPE power source with aerospace applications could be in sight.

"I'd say our confidence level [of a breakthrough] is 50% or better. We have some ideas that we're exploring, but we're not ready to talk about them," Puthoff hedged. "The big hurdle is finding an embodiment that will permit scale-ups to useful levels of energy—finding the catalyst for accelerating currently known processes. If our [research] is successful, almost assuredly there'd be no problem with small units—a few cubic centimeters of ZPE—providing enough energy to power spaceships."

As to when a breakthrough might occur, "We're definitely not stumbling around in the dark any more," Puthoff continued. "It's been shown that zero point energy is real and has real consequences. It's definitely a technology that's not ready for prime time, but it's definitely ready for serious scientific investigation."

Based on an historical cycle of breakthroughs in transportation technology, the human race is due for another big leap in about 2012 (see p. 51). Last year, Allen predicted one could occur "within a decade or two. This stage is equivalent to where aeronautics was in the 1890s."

Still, NASA's Millis urges caution. "I really don't want to raise people's expectations too much," he said. "To get overly excited causes more damage [in the field of ZPE research] than skeptics do. We need to make sure we're not extending our claims beyond what the evidence points us to today. To be impartial, I'd say we're not on the verge of grandiose breakthroughs. But we have another embryonic field opening up to us."