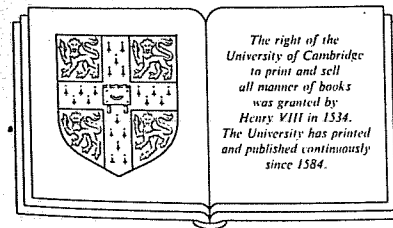


# FUSION

The search for endless energy

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To Paul

doubtful and, he said, referred disparagingly to the effect as a "Wolfie." When Earl Marmor, another MIT researcher, saw it too, they called it a "Marmorism." Both scientists took offense at the jokes, so their supervisor devised a compromise and dubbed the effect a "Marfe." That play on the names seemed sufficient until Marmor and Wolfe submitted a scientific paper on the subject in which they described "Marfe" as an acronym for "multifaceted radiation from the edge." Presented in serious fashion, "Marfe" thus entered fusion's opaque lexicon.

Apart from the mysterious force that rattled around inside their machines, the world's fusion scientists recognized another common adversary: government.

Fusion research had begun in small laboratories with machines that scientists were able to build by hand. But after the first decade, the devices were multimillion-dollar projects, and for that kind of financing the scientists could find only one backer: During the 1980s, world fusion researchers were spending approximately \$1.3 billion annually, nearly all of it government money. The research was in far too basic a stage for commercial industry to take an interest, except in Japan where industry representatives were among the initial planners. Occasionally oil companies and utilities sent their people to fusion meetings, just to keep tabs on the slow pace of research.

No vocal public constituency for fusion existed. By the 1980s, memories of the energy crisis had faded and the environmental movement seemed to have lost the confrontational verve of the 1960s. Only on occasion did the fusion scientists' mission inspire advocates outside its close fraternity. Even then, at least in the United States, it had been a strange melange of fringe characters who rose to advocate a fusion future, often with little or no encouragement from the fusion community.

Bob Guccione, the publisher of *Penthouse* magazine, sank \$16 million into private fusion research, hoping to reap a fortune from an historic technological breakthrough. The presidential candidate, political extremist, and self-styled economist Lyndon LaRouche had a legion of followers who set up tables at airports and distributed leaflets touting fusion energy among his many causes. The photographer

Ansel Adams, famous for his black-and-white landscapes of the American West, was a diehard fusion advocate.

But government was the only natural source of continuing fusion support, even though its enthusiasm ebbed and flowed. Lyman Spitzer, the professor of astrophysics who conceived ground-breaking, secret experiments at Princeton in 1951, had to contend with overzealous bureaucrats who expected fusion immediately. After a subsequent period of government disinterest, a brash energy official named Robert Hirsch forced the Princeton scientists of the 1970s to build a bigger machine than they felt was justifiable. The physicists derided Hirsch as "a young man in a hurry."

"If you don't hurry, you're not going to get to the point where you find out whether you were right or wrong — so you can change course and not waste time," Hirsch said in an interview years later, looking back at the Princeton decision. The first, ardent researchers like Spitzer, Hirsch said, found out that fusion "was horribly complicated." As a result, Hirsch added, "they were embarrassed and forced to go back to basics."

"They developed an attitude and a culture that everything that you do should evolve from an understanding of the basics, as opposed to trying to jump right to the thing that will work. And so the program became a plasma physics program instead of a fusion research program." According to Hirsch, that could not be allowed to happen. Washington had to keep an eye on the physicists.

During the Carter, Reagan, and Bush administrations, government agencies and research labs kept close watch, as well, on fusion developments in other countries and were frequently influenced by events and decisions abroad.

Even though fusion support fluctuated over the years, the scientists never claimed that a lack of government funds was the reason they had not been able to develop a fusion reactor. Bureaucratic conflicts made development more difficult, perhaps even slower, but unlimited financing was not the answer.

The question of money was put to Harold Furth, the director of the Princeton lab. "If the Martians were attacking," he said in his typically droll manner, "if money were no object and the military wanted a working fusion reactor by the year 2000, there is no question we could

administration was offering. People might think the nation's energy problems had been solved by the utopian promise of fusion.

Princeton was forbidden to broadcast its achievement.

But word leaked out. Before government officials vetoed the idea, the Fusion Energy Foundation, an independent advocacy group, had learned from Gottlieb that there would be a news conference. Once informed of the cancellation, the group told a Knight-Ridder newspaper reporter of this unusual turnabout. The reporter was able to confirm from other scientists at the Princeton lab that some sort of breakthrough had occurred – one that the Department of Energy apparently did not want publicized. On a slow news weekend, the Princeton fusion achievement was reported nationwide on the Knight-Ridder news wire and picked up by the television networks and other newspapers. Schlesinger and the fusion division heads were furious. William Bowen, then president of Princeton University, who knew Schlesinger personally, was called in by the lab to help calm down the secretary. Eventually, since word was out anyway, the Energy Department allowed a low-key news conference.

As in the secrecy era and at the Geneva Atoms for Peace conference, fusion continued to be an issue fraught with political overtones. To simply pursue the science and think that it could speak for itself was only inviting trouble. Princeton managed to paper over the bad feelings in Washington this time, but it learned a lesson in political prudence that would affect future announcements.

As important as the Washington reaction was to the political fortunes of the Princeton lab, it had little to do with Princeton's scientific reputation. That was an issue for international colleagues. So with PLT results in hand, Goldston and his mentors set out for the August 1978 Plasma Olympics in Innsbruck, Austria, prepared to claim the world temperature record away from the joint holders, the Oak Ridge lab and the French national lab. PLT had delivered plasmas three times hotter than the previous high, but the very magnitude of the increase led to international skepticism. At Innsbruck, it was Goldston's defense of the Princeton paper on PLT's temperature record that made the young physicist's reputation.

"Fry Rob on one side – flip him and fry him on the other side," was how Goldston remembered the questioning from the multinational

cast of knife-throwers that attended the special night interrogation organized by Roy Bickerton, the scientific leader of Culham lab in England. That same morning, as a courtesy, the sardonic Bickerton had handed Goldston a list of twenty questions he had gathered, all probing the validity of the Princeton PLT experiments and the 5.5 thousand electron volt ion temperatures. "If we came up with three or four . . . okay," said Goldston, "but five and a half? Everyone thought it couldn't be right."

The Princeton mentors rallied around Goldston as fight managers pump up a contender. Through the day Furth and others coached and rehearsed Goldston as he shadow-punched his way through the list of questions. When new questions from different and unexpected angles were thrown out, Goldston defended and counter attacked. After a time, Goldston's mentors pronounced him ready for the evening bout.

There were several hundred people in the audience, but Goldston said he mostly felt the penetrating mind of the eminent Bickerton. Moving through the list of questions, Goldston was able to stay on his feet as the lances fell. They questioned diagnostic methods, calibrations. . . hours went by. Goldston was answering the seventeenth question strongly, but he was worried about the eighteenth. He knew he did not really have a good explanation. As Goldston was about to offer a soft return, Bickerton interrupted. "Look, we're exhausted," the Englishman said. "This has been going on too long. Thank you."

Goldston and Princeton had made it. The community accepted their work. The new temperature record of 65 million degrees would stand. Within the year, PLT would soar to 82 million degrees. Princeton and the international fusion community were ready now for the next, long-awaited step. It was time to stoke up the giant tokamaks and reach for breakeven.

There was at least one spiritual moment on the day ground was broken at Princeton in 1977 for the next-generation of tokamak that might lead to fusion's promised land. Among the ranking dignitaries was Dr. Yasuhiko Iso, a physicist directing Japan's plans for a parallel energy project. Iso's gift to his Princeton friends was a large papier-mache sculpture, a Daruma doll.

first to look and then to photograph. According to Fowler, the second visit was spurred by Lawrence Lidsky's controversial article, "The Trouble With Fusion."

"Ansel called all upset about the article," Fowler recalled. "He viewed all such things as just negativism and asked what 'we' could do about it. I said, 'Well, you take pictures, don't you?'" Adams complied.

One of Adams' efforts to sell fusion was directed at the president of the United States. The photographer had been vituperative in criticizing his fellow Californian, Ronald Reagan, and the administration's environmental policies. After the *Playboy* interview, Adams was invited to meet with the president. The highly publicized meeting took place on June 30, 1983, at the Beverly-Wilshire Hotel in Los Angeles, and it ranged over many environmental issues. Adams made one of his sharpest thrusts in favor of fusion energy. He wrote in his autobiography,<sup>4</sup>

During the visit with Reagan, I suggested he take \$10 billion from his defense program and apply it to a crash program for magnetic fusion development. Reagan raised an eyebrow at my temerity, but I believe it is obvious that once fusion power is achieved, the energy shortage will be past and we will be independent of foreign fuels. In 1902, the automobile was in its infancy and the airplane an insubstantial dream. From the two-cylinder gas buggy to magnetic fusion is a giant stride, but incredibly it can be accomplished during one lifetime.

Unfortunately, Adams' lifetime was not enough. He died in 1984. In his last interview, with *San Francisco Focus* magazine, the eighty-two-year-old conservationist again pushed for the development of fusion energy. "The point I want to make is that fusion development isn't that far down the road," he said. "It's only as far as our leaders want to make it."<sup>5</sup>

Ansel Adams had been the best spokesman the fusion fraternity could have asked for, but he discovered fusion too late in life to have a major impact. The photographs he took of the Livermore fusion machines disappeared into the Adams archives. But by paying attention to the fusion scientists' cause — even just for a year — he had given them heart. His endorsement as a man of stature outside the scientific community seemed in some small way to validate their work. At Livermore, the grateful fusion missionaries mounted portraits of this

cherubic old man with a bristly white beard, lariat tie, and broad-brimmed Stetson where they could see his face every day.

The physicists were delighted to proclaim the support of a giant like Ansel Adams, but they did not know quite what to make of it when they found themselves in the embrace of Lyndon H. LaRouche, Jr.

LaRouche was an ideologically complex character who had a conspiratorial, apocalyptic view of the world. His philosophy had evolved through the years from left-wing Marxism all the way over to archconservatism. Paranoid rhetoric was a mainstay. His criticisms of United States government policy were frequently focused on individuals in a very personal way. Henry A. Kissinger, the former national security adviser and secretary of state in the Nixon Administration, was a favorite object of LaRouche's invective. And, in a 1984 bid for the presidency, LaRouche spent half an hour in a nationally televised advertisement haranguing candidate Walter F. Mondale and accusing the former vice-president of being an "agent of influence" for the Soviet Union.

What's more, Lyndon LaRouche, Jr. believed in fusion.

In 1974, his interest in the technology had prompted him to found the Fusion Energy Foundation. In the early 1980s, whenever candidates spawned by his organization, the National Caucus of Labor Committees, ran for local offices they were likely to mention fusion as a key plank in the platform, an energy source that could build a secure America. Using volunteers from among the LaRouche faithful, the Fusion Energy Foundation solicited funds at airport terminals around the country and continued to spread the word about fusion. Management at several airports tried to throw out the LaRouches, but a string of court decisions preserved the foundation's First Amendment right of free speech.

The leafletting was perhaps the most visible and consistent public relations effort on behalf of fusion energy that the cause had ever seen. But the benefits to fusion's image were questionable. It was hard to know whether the LaRouche brand of salesmanship opened doors or bolted them shut. On February 11, 1982, that point came into sharp focus. Nancy Kissinger and Ellen Kaplan, a Fusion Energy Foundation

worker, scuffled at Newark International Airport. According to court testimony and newspaper accounts, Kaplan walked up to Henry Kissinger as the former secretary of state and his wife, Nancy, were about to board a plane for Boston, where he was scheduled to undergo heart surgery. Kaplan asked a question that the Kissingers took to be offensive, and Mrs. Kissinger grabbed her.

In copious accounts, newspaper, television, and radio reporters across the country identified Kaplan as a volunteer for the Fusion Energy Foundation and an advocate of nuclear power. The incident was described again and again over the ensuing months as Kaplan pressed assault charges. A Newark judge eventually acquitted Mrs. Kissinger, declaring that she had displayed a "somewhat human reaction to an offensive question."<sup>6</sup>

A fringe political group, the secretary of state, an altercation, a fusion volunteer – it was not the kind of image building that the fusion scientists hungered for.

Still, the Fusion Energy Foundation served other, more constructive purposes. In testimony before Congress, it frequently argued the merits of fusion research, and its magazine, *Fusion*, at first espoused the cause in a staidly scientific way. Later, it started advocating some weapons use of fusion technology, and LaRouchian paranoia crept into the magazine. The fusion community cringed. When the foundation presented an award to Mel Gottlieb, Harold Furth's predecessor as head of the Princeton Plasma Physics Lab, colleagues elsewhere questioned the wisdom of accepting it. Gottlieb later regretted any association with the foundation and said he felt "used."

In 1987, *Fusion* magazine was ordered to close by the federal government. U.S. marshalls seized its office and bank accounts in connection with a federal indictment for credit card fraud brought against various organizations operated by LaRouche. In 1988, LaRouche was convicted of trying to defraud federal tax collectors by hiding his income and failing to repay more than \$30 million in loans from his supporters. He was later sentenced to fifteen years in prison.

Thus did fusion lose its most visible private supporter.

Luella Slaner, the philanthropist from Scarsdale, New York, was touched by the fusion bug in 1973, the year of the first Arab oil em-

bargo. By 1975, she had become a one-woman road show, plugging fusion to anyone who would listen. She, too, had become one of fusion's missionaries. Slaner and her husband, Alfred, grew concerned about America's economic security during the anxious months of the oil crisis. "Without energy," said Luella Slaner, "we can't produce anything, and the United States will just become second rate, third rate in everything. The reason we had survived in the past was we'd had an abundance of cheap energy."

The Slaners' patriotic concern was not passive. First they made small sacrifices. Like many Americans, Alfred Slaner started using public transportation instead of his car for the commute to his job in New York City. He was a relatively wealthy man, executive vice-president of the textiles giant Kayser Roth Corporation. Luella Slaner lowered the thermostat in their home so much that dinner guests were forced to bring sweaters.

When Alfred Slaner learned about fusion from a company scientist, his interest was piqued and he dispatched his wife, the daughter of a Columbia University chemistry professor, to find out more about it. What she learned, she said, was that "plasma physics was a very low-key science. It was not very well funded. It had no sex appeal whatever."

She talked directly to plasma physicists and reported to her husband that fusion was worth supporting. The year was 1975. With a bit of seed money from a small family foundation set up to finance charitable interests, Luella Slaner created the Society for the Advancement of Fusion Energy (SAFE).

"I'm an activist, I believe in getting things accomplished," she said.

Over the years, Luella Slaner wrote thousands of letters soliciting funds, hammering Congress and extolling fusion energy. She fed articles to newspapers and sent speakers around the country. She helped produce an educational film on fusion featuring Neil Armstrong, the moon-walking astronaut. In all, the society spent close to \$1 million to publicize fusion – before it fizzled in frustrating failure.

SAFE suspended operations after the oil scare died out and the federal budget blossomed with new military spending in the 1980s. Luella Slaner found that it was almost useless to try to persuade elected officials to support fusion. "No congressman who is in office for two years is going to vote for something that's fifteen years away," she