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PIGS DON'T HAVE WINGS: When Scientists Fool Themselves

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> **"It's all very well to theorize how fusion might take place in a palladium cathode...one could also theorize about how pigs could fly if they had wings. But pigs don't have wings."**
>
> (Steve Koonin, Spring Meeting of the APS, Baltimore, May 1, 1989)

COLD CONFUSION

We are meeting this afternoon on the eve of an important double anniversary. It was ix years ago on March 23rd, 1989, that the University of Utah held a press conference in Salt lake City to announce the discovery of "cold fusion." Six years earlier on March 23rd 1983 Ronald Reagan delivered his "Star Wars" speech to the American people, launching the Nation on a crash program to develop a shield in space to "render nuclear weapons impotent and obsolete."
Coincidence you say, but perhaps not. It could be that Stanley Pons and Nancy Reagan had consulted the same astrologer.

In any case, the Sun warmed Earth on that March 23rd as it had for at least five billion years, by the fusion of hydrogen to form helium. It is a process that will continue for many more billions of years. Fusion, after all, is slow business even in a star.

And yet, Stanley Pons and Martin Fleischmann said they had produced deuterium fusion in a simple laboratory experiment. If they were right, their discovery would spawn an industry larger than any ever seen on Earth, and its creators would be showered with honors, and wealth. But were they right? Comedian Mark Russell may have said it best, "Cold fusion? You can't even get a cold beer in Salt Lake City!"

What can we learn from this episode?

Most physicists were skeptical. The energy released in fusion is carried away by neutrons and gamma rays. At the power levels quoted by the two chemists, their test cell should have emitted about a trillion neutrons and gamma rays each second. Yet, here they are in a press photograph, dressed in jackets and ties, proudly holding what should have been the

most concentrated nuclear source west of Chernobyl. A joke that made the rounds in the Physics Department at the University of Utah asked: Did you hear the bad news about the graduate students in Pons' lab? They are all alive.

RULE I: A PhD in science is not an inoculation against foolishness.

But hundreds of laboratories took the Utah claim seriously enough to try to replicate it. And initial reports looked good for Utah. During the first weeks, laboratories around the world raced to report "partial" confirmations, and a few theoreticians hatched speculative explanations.

RULE II: Because even scientists tend to see what they expect to see, a foolish report by a respected colleague often carries other scientists along on the road to ignominy.

A loose wire, electrode contamination, quirky detectors, calibration errors; they all looked like "partial confirmations" to those who were expecting something to happen. Meanwhile, those who found nothing unusual, figured they had better go back and double check their results. By the first of May, however, at the Spring Meeting of the APS in Baltimore, the second wave of reports began coming in -- and they were overwhelmingly negative.

Everyone seemed to agree on just one thing: if there was fusion taking place, whatever the mechanism, there must be a huge buildup of helium in the lattice of the palladium cathode. Pons and Fleischmann, under great pressure to back up their claims, finally agreed to have their cathodes assayed for helium.

The University of Utah scheduled a press conference for the 6th of June to announce the results of the helium assay. I called the VP for Research at Utah, John Brophy, on the 6th to get the results. Unfortunately, he said, the press conference had to be cancelled. Stanley Pons, who ten weeks earlier had trumpeted his claim to the world without the benefit of peer review, had now decided that without peer review it would be improper to release the assay report. It has not, in fact, been made public to this day!

What began as wishful interpretations of sloppy and incomplete experiments had turned into suppression of contrary evidence and deliberate obfuscation. We had arrived at the "cover-up" phase.

RULE III: It's a thin line between foolishness and fraud.

Of course, the capacity for self-deception should not be underestimated. There is no reason to believe that, in the beginning, Pons and Fleischmann were not sincerely convinced they had produced fusion. But they long since seem to have adopted the O.J. defense: create a residue of doubt. And they have a lot of people willing to help.

RULE IV: Over time, foolish ideas develop a constituency that would prefer that the

issue never be quite settled.

Scientists whose reputations would be tarnished, university administrators who had bet the reputations of their institutions, gullible politicians who had squandered the taxpayers dollars, lazy journalists who had uncritically accepted every press release, all now had an interest in making it appear that the issue had not been settled. Their easy corruption was one of the most chilling aspects of this episode.

To be sure, there are even today true believers among the cold fusion acolytes, just as there are sincere scientists who believe in alien abductions, psychokinesis, creationism and the Chicago Cubs.

RULE V: Most screwy sounding scientific claims -- are screwy.

Not all, of course. When first discovered, superconductivity and radioactivity, to name just two, seemed to violate known laws of physics. Science is interesting precisely because of its power to surprise us. But if a discovery appears to violate the second law of thermodynamics, you want to insist on strong evidence.

Cold fusion, of course, was not the first promise of free energy. Free energy is perhaps the most recurrent myth in physics.

THE CASE OF THE BACKWOODS GENIUS

When James Randi pulls a rabbit from a hat, the people in the audience may not know where the rabbit came from, but unless they are hopelessly naive, they know it isn't magic. As scientists we know that to be true because magic would be a violation of the second law of thermodynamics. When an inventor claims to have built a perpetual motion machine, for example, there is no need to examine his machine. Such devices are often complex and the source of energy cleverly concealed. The enormous power of thermodynamics is that it is independent of the details of the system. It is enough to know that the machine would violate the second law of thermodynamics.

A claim that clearly violated the second law was made in 1984 in the tiny backwoods hamlet of Lucedale, Mississippi. A local mechanic with a grade school education, named Joe Newman, announced that he had invented an "energy machine" that produced more electricity than it took to operate it. Put one in your home, he said, and you will never have to pay another electric bill.

The U.S. Patent Office, however, informed Mr. Newman that it does not patent perpetual motion machines. Exercising his constitutional rights, Newman sued the patent office.

Joe Newman's case might have gone unnoticed, but CBS news decided to cover it as a "human interest" story. It is, after all, the sort of story Americans love: backwoods wizard makes a discovery that confounds the scientific world. Alas, pompous members of the

paper," headlined the New Energy News, which comes out of--where else?--Salt Lake City. The lead author was named the "New Energy News theorist of of the year," which seems rather modest recognition for the paper of the century. Science Magazine carried a feature story about the theory, emphasizing that it had been published in the prestigeous, peer reviewed journal Physical Review A.

In fact, it followed by one year another article by the same author with a more revealing title: "Extracting energy and heat from the vacuum." Well, that's pretty good if you can do it. One is left to wonder, however, how something with that title got published; it's one case where the editor should have rejected it on the basis of title alone. The article contends that energy can be extracted endlessly from the ubiquitous Casimir effect, which, for example, exerts a force between parallel plates due to vacuum fluctuations. He seems not to realize that there is also a gravitational force, but you can't make an engine out of that either.

The author of these papers, and others along the same lines in Physical Review D and E, is no less than Harold Puthoff. So who, I can hear you asking, is Harold Puthoff? He is today the director of the Institute for Advanced Study--no, not the one in Princeton, the one in Austin. He is, I believe, the entire technical staff of the Institute, which is endowed by the fried-chicken king of San Antonio. But in 1972, at SRI, Puthoff, along with his colleague, physicist Russell Targ, were promoting psychic spoon-bender Yuri Geller.

Five years later, they published "Mind Reach," a book about remote viewing that inspired the CIA to invest in psychic espionage. Remote viewers at CIA headquarters in Langley, VA reportedly got to the point that they could see documents lying on desks in the Kremlin, but never quite succeeded in reading them. Puthoff himself was more interested in what remote viewing could do for pure science, and once sent his mind to explore the surface of the planet Mercury.

This connection between the free-energy crowd and the parapsychologists is just one example of the curious network that seems to link all the loonies. They must have a secret handshake by which they recognize one another. They are characterized by a sort of absolute credulousness when it comes to accepting each other's weird pronouncements. They inhabit a world in which weird things are going on all the time.

Does it really matter that the free-energy wackos get to crow a little over publication of an article in Physical Review? Consider what has happened at NIH.

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WITH ALARMING FREQUENCY

When James Randi pulls a rabbit from a hat, the people in the audience may not know where the rabbit came from, but unless they are hopelessly naive, they know it isn't magic. As scientists we know that to be true because magic would violate the second law of thermodynamics. When an inventor claims to have built a perpetual motion machine, for example, there is no need to examine his machine. Such devices are often complex and the source of energy cleverly concealed. The enormous power of thermodynamics is that it is independent of the details of the system. It is enough to know that the machine would violate the second law of thermodynamics.

You don't have to know where the rabbit came from.

Consider the widespread concern over claims that 60Hz magnetic fields from power lines are linked to cancer. I have neighbors who moved their daughters bed to the middle of the room, so it wouldn't be near any wall outlets. In Houston, 11 families in which children have developed cancers are suing Houston Lighting and Power for "fraudulent concealment" of the carcinogenic nature of fields that have "secretly and silently invaded their homes." The suit charges that 60 Hz magnetic fields as weak as 1 milligauss are known to cause cancer. One milligauss? You would have to stand in the middle of an open field to get below one milligauss! Yet, there are similar suits all over the country. Allan Bromley, when he was Science Advisor to the President, figured the total cost in mitigation, litigation and lost property value at $24B.

Yet, a pretty strong case can be made that such an effect would violate the second law of thermodymnamics. One consequence of the second law is "Johnson noise," generated by thermal fluctuations of charge density in any material. It doesn't matter what material. All you need to know is the temperature. Since humans operate at just one temperature, there is a well-defined "thermal noise limit" that must be exceeded if external fields can be said to produce an effect.

Bob Adair at Yale has pointed out that the electric fields induced in the body by power line fields of a strength that might reasonably be encountered in daily life, fall about four orders of magnitude short of the thermal noise limit. And that's just the limiting case. The fields produced by the normal electrical activity of the body are many times stronger than the Johnson noise!

Does this mean that biological effects from weak 60 Hz fields are impossible? Well, maybe not quite. In principle, the masking effect of thermal noise can be made arbitrarily small by choosing a sufficiently narrow pass band.

In other words, any biological effect from weak 60 Hz fields would seem to require a

resonant interaction. Could we have been so unlucky as to select for our electrical power system in the US a frequency that precisely matches a natural resonance of our cells? And could there be another resonance at 50 Hz that affects Europeans the same way?

That may seem wildly improbable, but in fact, not even such an amazing coincidence would be enough to coax a coherent effect out of the Johnson noise. It would require a Q of 2000 -- and power companies don't control the frequency of their generators that closely. 60 Hz is just the average frequency maintained over a 24 hours period. Indeed, at peak demand the frequency often drops as low as 58 Hz.

Does the Waving of the Trees Make the Wind Blow?

What then is concern over power lines based on? The evidence comes from epidemiology. Epidemiologists look for patterns in the incidence of a disease that would indicate a link with environmental factors: the relationship between smoking and lung cancer, for example, or between dietary sodium and hypertension.

But epidemiology cannot establish cause and effect, only a link. An epidemiologist, for example, studying the relationship between body weight and health would find that pronounced weight loss is often followed by death. Does that mean losing weight is dangerous? Of course not. It simply reflects the fact that chronic illness wastes the body. Chronic illness in this case, would be a "confounding factor."

In 1979, a Denver epidemiologist, Nancy Wertheimer, and a physicist, Ed Leeper (there is always a physicist!), reported that the incidence of childhood leukemia was doubled for homes near high-current power lines. Almost overnight there were reports of frequent miscarriages among women who use electric blankets, increased suicides by people living near high tension lines, a high rate of cancer mortality among electrical workers and mental disorientation of people who sit all day in front of computer terminals. I have personally experienced the disorientation that comes from sitting all day in front of a computer terminal, but it hadn't occurred to me to relate it to EMF.

The Wertheimer-Leeper study, however, was not blind. The epidemiologist started with a list of addresses of victims of childhood leukemia, and checked to see where the power lines were. There was every opportunity for unconscious bias. Even so the statistics were poor. Above all, no effort was made to confirm whether the location of the power lines actually corresponded to higher magnetic fields. The parallels with cold fusion are striking. A report of great potential importance based on sloppy and incomplete research. It is followed by even sloppier work by opportunists wanting a piece of a major discovery.

The statistics in the initial confirming studies were appalling. I was reminded of the story of the farmer who reported to his Grange meeting on his tests of a new chicken feed: "Thirty three percent of my hens laid more eggs," he said, "thirty three percent died; and the other one ran away."

Wertheimer and Leeper are the Pons and Fleischmann of EMF; their study is now regarded

scientific establishment conspire to deny him the just rewards of his genius.

CBS interviewed only Joe Newman and his tiny circle of admirers. That circle, however, included a PhD physicist, who informed the world on the Evening News with Dan Rather that Newman's energy machine was "the most important scientific discovery in history."

RULE VI. It seems unlikely that there will ever be an idea so crazy that a PhD physicist cannot be found to vouch for it.

Joe Newman became an instant celebrity; he appeared on the Johnny Carson Show and filled the Superdome in New Orleans with people who paid two dollars each to see him demonstrate his energy machine. Half-a-dozen private relief bills were introduced in Congress to force the patent office to issue Mr. Newman a patent for an "unlimited source of energy." He was given a full hearing before the U.S. Senate. I found the hearing room packed with men in $600 suits. They turned out to be representatives of major corporations who were concerned lest they be left standing on the platform when the gravy train pulled out.

In court, however, things had not gone as well. The judge directed the National Bureau of Standards to conduct a thorough test of the machine, over the protests of Newman who complained indignantly that it would be an affront to the "scientific experts" that had vouched for his machine. At a cost of $150,000 dollars to the taxpayers, NBS found the machine to be a crude motor-generator.

The widows and pensioners who had invested in Newman's machine, watched their savings turn to vapor. They were outraged--but not at Newman. Newman, who by now had a full-time legal staff, announced he would sue the National Bureau of Standards. And his investors cheered him on.

RULE VII: When a charlatan is exposed, the outrage of his victims is most frequently aimed at the one who strips away the mask.

And so it was with Joe Newman's energy machine. But in time, people began to notice that Joe Newman's house was still connected to the power lines.

NOT THE PHYSICAL REVIEW?

Joe Newman is forgotten today, and cold fusion is confined to an annual seance attended by a dwindling number of true believers. But the free-energy cult is actually growing world wide.

And to learn the most recent revelations of its leading prophet, you need only to read the Physical Review. One year ago an article appeared in Physical Review A with the titlle "Inertia as a zere-point-field Lorentz force." "The Century's most important theoretical

as hopelessly flawed--but it no longer seems to matter. Epidemiological studies with sufficient statistical power are expensive and time consuming, particularly for rare diseases such as childhood leukemia. By the time the larger and more careful studies began coming in, an entire industry had grown up around this non-effect. Lawyers, researchers, lobbyists for the power companies, fear mongering writers, all with an interest in keeping the controversy alive.

When studies were finally done that do not rely on proximity to power lines, but to the actual monitored fields, the effect almost disappears. But the argument is made that proximity to power lines must be a better indicator of exposure than the measured level of the field!

In 1993, a study of utility workers in Southern California found that a tenous link between EMF and leukemia and brain cancer almost disappeared if exposure was based on actual monitored levels. But because Southern California Edison participated in the study, the results were discounted. (This has really turned out to be a Catch-22 for power companies. If they don't undertake such studies they are accused of a cover up. And if they do, they will only be believed if they confirm a hazard.)

Meanwhile, however, an even larger study was undertaken of utility workers in Canada and France. The result? No excess brain cancer, and the overall rate of leukemia was normal. But wait! If leukemia was broken down into five subcategories, a possible link was found to one extremely rare form. Indeed, a total of 30 cancer types were included in the study. Since the standard for statistical significance is the 95% confidence level, one out of 20 would be expected to exhibit a false positive. With 30 types, it was better than even money that one would show a false positive correlation!

Recommendation? Do an even larger study. Well, the results are in: The largest study yet, involving utility workers across the U.S., found no association with leukemia, but a slightly elevated risk of a rare form of brain cancer! Oops! That's just the opposite of what they found in Canada.

How is it, you may be wondering, that the uncertainty is always just enough to require more research? It's easy, and this is how it's done: First, you don't compare utility workers with the rest of the population. If you did you would find they have a consistently lower cancer mortality. Instead, compare workers with "low" exposures to those with "high" exposures. But where should you draw the line between "low" and "high"? Simple, just adjust the boundary to maximize mortality in the "high" category. This works best on rare forms on cancer where statistics are poor. Then apply for another grant.

This has not stopped the sale of "mitigation" devices. Catholic University is marketing a special computer keyboard, invented by physics professor Ted Litovitz, that blocks the harmful effects of coherent fields by generating EMF noise. Meanwhile, a California firm, Clarus Environmental Systems is selling a simple plug in device to protect you from EMF that relies on eliminating noise. Clarus relies on advice from William Tiller, former chair of Stanford's Materials Science Department. Despite the seemingly contradictory

approaches, I can give you my personal guarantee that if you use either device you will suffer no ill effects from EMF.

The article on EMF litigation in the Journal of the American Bar Association, concluded with a chilling prediction: "The alleged hazards of EMF exposure almost certainly will be resolved not in the scientific laboratory, but in the courtroom."

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THE MALLARDS ARE MIGRATING

A couple of weeks ago Senator Tom Harkin (D-OH) hosted a press conference in the Dirkson Senate Office Building announcing the release of a report laying out research goals for the NIH Office of Alternative Medicine. It was Harkin, three years ago, who fathered legislation mandating creation the OAM, to the profound dismay of the medical profession. The American people, Harkin declared, cast their vote for alternative medicine by spending $14B a year for alternative therapies.

What is "alternative medicine"? It is by definition any medical therapy that lies outside mainstream practice. That can be harmless enough, it includes herbal medicines and mother's chicken soup. Moreover, at some point every medical advance is outside the mainstream until it becomes accepted. But alternative medicine also includes quackery.

Remember laetrile, the concoction of apricot pits that promised to cure cancer? Scientists at the Food and Drug Administration steadfastly refused to approve this "wonder drug," discovered by a salesman with no medical training. Cancer victims, desperate for any straw, were furious at the FDA, and public pressure eventually forced the agency to conduct clinical trials. When the trials revealed no efficacy, there were charges that the trials had been rigged. Bills were introduced in Congress to force the FDA to release laetrile. Meanwhile, laetrile clinics sprang up across the border; cancer patients traveled to Mexico in droves and gave grateful testimony to laetrile's life-saving power. Until, one by one, they fell forever silent.

The Government in the laetrile case saw its responsibility as the protection of an unsophisticated public against medical quackery. The FDA stood its ground, even in the face of intense public pressure.

"Alternative Medicine: Expanding Medical Horizons" is crammed with quackery--and you don't have to be Jonas Salk to spot it: Lakota medicine wheels; mental healing at a distance; laying on of hands; biofield therapeutics in which the hands don't even have to touch the patient, oriental qi which seeks to balance the energy between different parts of the body; Bioelectromagnetics, but this is not the "bad" EMF that causes cancer, this is the EMF that heals. It seems to be a matter of getting the frequency and waveform just right.

And then there's homeopathic medicine--the water that remembers. You all rember the "infinite dilution" experiments of Jacque Benveniste, who found that you could dilute a substance far beyond the point at which a single molecule might remain--and the water is nonetheless undiminished in its bioactivity. This brings up one of those wonderful linkages between nutty ideas of the sort that I described earlier. Benveniste has recently found that

exposing his homeopathic water to 60Hz magnetic fields erases the memory, reducing it to ordinary stupid water. This provides a mechanism for the deliterious effects of powerline fields on humans. Their bodies are left with amnesiac water.

Fourteen billion dollars a year on this bunk? Even a decade ago, that would have generated demands for new regulations to protect an unsophisticated public from these dangerous quacks. Now we have a freeze on regulations, and the quacks have their own branch of NIH. Why this increased tolerance of quacks!

But perhaps I should explain what a physicist was doing at a press conference on alternative medicine. In the first place, the report devotes an entire chapter to "Bioelectromagnetic Applications in Medicine." But this is not the "bad" EMF, this is the EMF that heals. It seems to be a matter of getting the frequency and waveform just right.

In the second place, when things get really weird, and they do that a lot in this report, the explanation is assumed to lie in quantum mechanics. After all, what could be weirder than quantum mechanics? Going back to Rule VI, there are always physicists that be counted on to lend these ideas support--some with Noble prizes; and I can tell you that a Nobel prize is not an innoculation against insanity either.

It is in the area of Mind-Body Interventions or "mental healing at a distance" that quantum mechanics is invoked most strongly. "Physicists have repeatedly documented that non-local phenomena occur in the subatomic quantum domain...Nobel prize-winning phyicist Brian Josephson of Cambridge University has suggested that non-local events occur in the biological world as well. He proposes that human ways of knowing, particularly the human capacity to perceive patterns and meanings make possible direct interconnections between spatially separted objects."

The Physical Review--Again!

And temporally separted as well it seems. In 1989 Steven Weinberg, a Nobel laureate physicist, who is certainly no wacko and who has zero tolerance for mysticism and fuzzy thinking, investigated the consequences of introducing "slight" non-linearities into quantum mechanics. It was an interesting and bold idea, but Gisen showed a year later that even a slight violation of the superposition principle could lead to violations of causality, that is, information could be transmitted faster than the speed of light.

Now theoretical physics is about testing assumptions. When you make an assumption that leads to a non-physical result, you abandon it. In his book "Dreams of a Final Theory," Weinberg sees little prospect for any fundamental change in quantum mechanics.

But for physicist Henry Stapp at Lawrence Berkeley, the acausal aspects of non-linear quantum mechanics were anything but a disadvantage. He went a step further and proposed using a non-Hermitian Hamiltonian. That tensy change opened up great new possibilities: according to Stapp, that makes it possible for an observer to influence events that have

already taken place! Moreover, he published his theory in Physical Review (PRA **50** (1), 18, (1994)) with the title, "Theoretical model of a purported empirical violation of quantum theory."

What "purported empirical violations of quantum theory," --and who purported them? Well, let me describe the experiment, which involves psychokinetic effects on prerecorded random events. The random events are radioactive decays, which are detected by a Geiger counter and recorded on a floppy disk. Now to those working on the frontier, mental influence of random events no big deal. They do that sort of thing all the time.

What's different here, is that the subject turns his brain off while the decay events are being recorded. He waits until later, as much later as you like, but in the meantime--and this is critical--nobody looks at the recorded data. Days or even months later, the data is played back and the subject tries to control the recorded events! By now you have guessed the result. He is just as successful with the recorded decays as with the real time events. I would have been astounded had it been otherwise

What's wonderful about this is that just such an experiment was initially proposed as a double blind test of the experiments of Robert Jahn on mental control of random number generators. The subject and the tester would both be unaware of whether the subject was attempting to influence events as they happened or was futilely trying to influence events that were history. If the subject does as well with the later as the former, there must be some hidden bias.

Not so in Stapp's quantum mechanics: "No reduction of the wave packet occurs until some pertinent mental event occurs...the detection of a radioactive decay remains in a state of 'potentiality' until some pertinent mental event occurs." So the recorded data hasn't really happened until someone (a human someone apparently) observes it. No one can check, because that would collapse the wave packet. Apparently, recorders are not observers. What does qualify as an observer? Would a chimpanzee suffice, or a stupid human? Can an idiot collapse a wave packet? These profound philosphical questions are beyond the scope of this presentation.

And who, you may wonder, conducted these experiments? Well, you would never guess from Henry Stapp's paper. He references a review paper by Helmut Schmidt, But as Jon Dowling pointed out to me, if you looked up Schmidt's paper in the Journal of Parapsychology would you learn that Stapp himself was a a co-author on the work in question.

Now I confess some feelings of guilt over this episode. to my knowledge, not a single person submitted a comment on Stapp's paper. Is it possible that no one read it? With the growth of Physical Review, that seems entirely possible. In which case, I may have unwittingly collapsed its wave packet. I may be guilty of delivering Stapp's paper from its state of potentiality!