Reality of cold fusion can no longer be denied

Japanese non-fiction author Fujio Nakano reports on the scientific breakthroughs that some people, strangely, would like to suppress: excess heat production and 100% repeatability.

The September issue of the Japanese mass-circulation magazine Bungei Shunju *carried a major feature on cold fusion research which appears below in translation. The article contains a lively report on some exciting new research in Japan, but it is also of great interest for its description of the political environment for scientific research in that country.*

Just as in the United States, cold fusion has been the subject of attack by other scientists and in the press. But whereas researchers Martin Fleischmann and Stanley Pons have been literally driven out of the United States, in Japan the anti-science forces are not hegemonic, and, as this article shows, the two scientists have many vigorous supporters.

The appearance of the Bungei Shunju *article is a sign of the far more open environment for science which now exists in Japan. Many people believe that at the Third Annual Cold Fusion Conference, to be held in Japan in October 1992, the results of this will be seen in an array of breakthrough results in the field, which will come out of Japan.*

This translation from the Japanese is courtesy of Jed Rothwell.

Alchemy was both an art and a science, which attempted to change commonplace base metals into silver and gold. It was practiced before the founding of ancient Babylon, and continued until the modern era in Europe. That long, futile search led to the founding of metallurgy, chemistry, and the theories used to manufacture materials. Alchemy also led to research in medicine, and even promoted the growth of philosophy. It gave rise to a host of ideas and concepts. Even a child can learn this from an encyclopedia.

In Japan, the word "alchemy" has no hint of its original academic meaning. Think of "alchemy," and what comes to mind are things like Investment Advisory Letters, inside trading, corrupt "special deals," and so on, which are 180 degrees away from the original sense of the word. I am afraid that the group that opposes "cold fusion" thinks that word has the same connotation as "alchemy." That point of view seems to have soaked into their very bones. If you tell them that cold fusion reactions exist, and they generate heat, the only way the opposition knows to respond is to say, "It is too good to be true." They deny any possibility that cold fusion is real, and refuse even to look at reality.

Of course, this "alchemy allergy" is seen in other countries as well. Perhaps it is more pronounced in Japan because of our authoritative academic traditions. Professors here announced theories rejecting cold fusion before they had even studied the problem. The negative point of view was amplified by other opinion-makers, perhaps only because they like to "stick with the winner" and "join the biggest crowd."

But all that is no longer open to discussion. Cold fusion experiments and replication left those levels of doubt a long time ago, and entered a more concrete stage of development. Anyone who still says, "Such nonsense, it can't be!" is simply not looking at reality.

'We got tritium!'

It happened on the morning of Feb. 23, not even a month after I submitted my last article, "Nuclear Energy from Water," which appeared in our [*Bungei Shunju*] March issue. I got an excited call from Dr. Tadahiko Mizuno of the University of Hokkaido Nuclear Engineering Department.

"We got tritium! It was there all right! Even if you measure it conservatively, we are getting 10,000 times over background."

Heavy water is the so-called "fuel" of a cold fusion reaction. To determine whether or not a reaction is taking place, you have to look for a number of different effects. One of these is the evolution of tritium. If tritium appears, you have a fusion reaction. As I wrote in my last article, Dr. Mizuno began his experiments in late March 1989, soon after the announcement of cold fusion was made in the U.S., at the University of Utah. After two and a half months, early in June, he became the first researcher in Japan to replicate the cold fusion experiment. At this time, the conclusive evidence that fusion was occurring was the detection of neutrons. Now, in 1991, he had detected tritium.

On the afternoon of Feb. 12, Mizuno finished one of the many experiments he had been conducting in the basement lab ever since the Utah announcement. He carried the fusion cell from the basement up to his lab on the third floor of the engineering building.

A "cell" is a stainless steel flask that is the core of the cold fusion device. Now, from the term "nuclear fusion" you might imagine that a cell is a great big complicated device. Actually it is nothing more than a steel test tube. It is a flask, about 8 centimeters in diameter, and 20 centimeters tall. It holds about 800 cubic centimeters—about a quart. It is a lot heavier than, say, a household juice pitcher, because the flask walls are a centimeter thick all around. The inside of the vessel is coated with teflon. You fill the vessel half-way with 400 cc of heavy water mixed with salts and other chemicals. The solution that Mizuno puts in his device is a yellowish liquid, the color of whiskey mixed with water, or salad oil. The top of the device is also made of thick stainless steel. It has two electrodes built into it, one made of platinum and one of palladium, as well as a temperature sensor terminal, and so on. You lower the electrodes and the sensor into the liquid, and then firmly bolt the top on, and then wrap the device all around with heating wires. This is the design of Mizuno's experimental device—his cell.

When he got back to his lab, he took the top off the cell, and removed about 50 cc of the liquid, a little at a time, with a pipette. He transferred this to a glass test tube. This was to be measured for the presence of tritium. While he had measured the tritium in the liquid before performing the experiment more than 100 times, this was actually the first time he would measure it after the experiment. Mizuno, and his colleague Akimoto, had been the first researchers in Japan to succeed in detecting neutrons, thereby establishing that a nuclear reaction was taking place. But Mizuno felt bothered by the fact that he had not detected any excess heat at all, whereas "enormous amounts of excess heat" is the main effect reported by Drs. Pons and Fleischmann. He felt a nagging doubt: "We are definitely detecting neutrons, which can only mean that fusion is occurring. But can we be certain. . . ?" Even though he had exhaustively measured neutron radiation, he felt he had not paid enough attention to the problems of tritium, or, of course, heat.

Mizuno felt it was about time to "give it a try," as he gave the glass test tube to Dr. Kazuhisa Yasuzumi from the chemistry department. He did not seriously expect dramatic results.

Ten days after the experiment finished, at 1:00 on the afternoon of Feb. 22, Yasuzumi called from the chemistry building. "Dr. Mizuno, it's unbelievable! I'll bring the data over right away!" A few minutes later he came running into the lab, sweating and out of breath.

"What do you think of this?"

No matter how conservatively you measured it, Yasuzumi's data clearly showed an enormous increase in tritium. The results clearly showed that the experiment had evolved tritium to a level at least 10,000 times higher than it had been before the experiment.

U.S.-Japan joint experiment at Kamioka

Let me start by repeating some of what I wrote in my previous article. Nuclear fusion means, literally, that two atoms stick together and fuse into one atom. But, in reality, the story is not that simple. For example, a hydrogen atom has neither a positive nor a negative electrical charge. Atoms consist of electrically positive protons and negative electrons, so the positive and negative balance out.

When you try to stick two hydrogen nuclei together—in other words, when you try to squeeze together a proton with another proton—since they both have a positive charge, they repel one another. It is like trying to squeeze together the north poles of two magnets: They refuse to come together.

The same thing happens with heavy hydrogen. Heavy hydrogen (deuterium), like regular hydrogen, is composed of a proton and an electron. However the deuterium nucleus is different. The hydrogen nucleus contains one proton, whereas the deuterium nucleus (called "deuteron") contains a proton and one other particle with about the same mass, the neutron. This gives the deuteron the additional mass of the neutron. In short, it makes it heavy. Two hydrogen atoms combined with one oxygen atom make water: H_2O, which weighs about 100 grams per 100 cc. In contrast, two deuterium atoms combined with one oxygen atom make heavy water: D_2O, which weights 111 grams per 100 cc—more than 10% heavier, because of the extra mass of the neutrons.

Although deuterons are slightly different from regular hydrogen nuclei, when two deuterons are pushed together, they repel each other magnetically, just like hydrogen. Under normal conditions they do not fuse together. However, while the nucleus of an atom is similar to a magnet, it is not exactly the same. If you overcome the repelling energy and push nuclei close enough together, when they reach a certain point, they suddenly pull together with an awesome strength. They collide and fuse together. At that moment a large amount of energy is released. This atomic fusion energy appears in the form of heat.

It is thought that with cold fusion, the reaction is a "D-D" reaction; that is, a reaction combining a deuteron with another deuteron. Remember, a deuteron is the nucleus of the heavy hydrogen atom. So, two nuclei come together, each containing a proton and a neutron. However, the resulting atom cannot hold all the particles; it cannot have two protons and two neutrons. Two fusion reactions can occur, with equal probability. In the first reaction, two protons and one neutron can fuse to form another element called helium-3, and the remaining extra neutron is thrown out. In the second possible reaction, one proton combines with two neutrons, forming tritium, and the extra proton is thrown out.

With the former reaction, a neutron is thrown out, so this is called the "neutron branch"; the latter reaction that creates tritium is called the "tritium branch." The D-D reaction, or D-D nuclear fusion, consists of these two different branches.

Mizuno, at Hokkaido University, in his experiments up to now, had already made steady repeated observations of neutrons, so we can confirm the neutron branch. Now that he has also detected amazing masses of tritium, we can also confirm the "tritium branch." Of course, we cannot be 100% certain of the tritium branch on the basis of only one observation, but clearly this result adds greatly to the growing evidence that D-D reactions are occurring in his cell.

He gathered these results together in a manuscript to submit to an electrochemical journal, and went only so far as to tell a small group of his close associates and some newspaper reporters. On March 20 he set to work repeating the experiment.

Two or three days later, something happened elsewhere. You might say that the Japanese press is negative toward cold fusion, or at least, very cool toward it. A report appeared in the media that a U.S.-Japan joint cold fusion research project was starting up in the underground Tokyo University Cosmic Ray Laboratory in Kamioka. Here is a part of the report that appeared on March 23, in the evening *Yomiuri* newspaper (Tokyo edition):

> Today, it has been exactly two years since cold fusion appeared on the scene, but it has still not been determined whether the theory is valid or not. In the middle of next month, a joint group of U.S. and Japanese researchers plan to test the theory in the Kamioka underground observatory located in Kamioka City, Gifu Prefecture. They will use the gigantic water tank there.
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> The tank is located 1,000 meters underground, where it is not affected by cosmic radiation. This allows the scientists to perform the world's most accurate search for neutron radiation. If neutron radiation is found, it will prove that nuclear fusion is occurring. Because of this, the experiment is attracting worldwide attention. . . .

This joint U.S.-Japan experiment began on April 17; on the U.S. side were Dr. Steven Jones of Brigham Young University and Dr. [Howard] Menlove of Los Alamos National Laboratory; on the Japanese side, the experiment was to be performed by a group led by Dr. Youji Totsuka of the Cosmic Ray Laboratory.

The Kamioka Underground Observatory is in the middle of the mining region of Gifu Prefecture, where the largest lead and zinc mines in Japan are found. It is located 1,000 meters underground, near the mine belt. It is a huge open space, an underground room, 19 meters in diameter, 22.5 meters tall. The room is equipped with a large tank with a capacity of 1,500 tons of water. In the tank are filters and resin ion exchangers designed to keep the water free of all types of impurities and extraneous matter. This enormous pool of water, along with the 1,000 meters of solid rock overhead, was intended to keep any unwanted cosmic rays from sneaking in and getting in the way of the observations.

Our daily living environment is filled with various subatomic particles from outer space, called cosmic rays, as well as electromagnetic waves from radioactive minerals, and all kinds of other particles. Scientists call all these things lumped together "background," which is to say "noise" or "static." Neutron radiation is also part of this background, of course, which means, for example, if you want to measure the neutrons coming from a cold fusion experiment, the background neutrons get in your way. The basement lab in Hokkaido University, where Mizuno has installed his cell, is 5 meters underground. It is surrounded by thick concrete walls, and the entrance door is made of lead 3 meters thick.

Even with all these precautions, cosmic rays get in anyway. So, before he performed his experiments, Mizuno spent several weeks measuring the energy of the background neutron radiation. Then, after several weeks performing his experiments, he spent about the same amount of time measuring the background again. He wanted to verify that the "noise level" was the same after the experiment as it had been before. He succeeded in verifying this, so he subtracted the neutrons caused by cosmic rays—in other words, the "static" from the total level of neutrons detected during the experiment. This is how he determined the actual number of neutrons.

The Kamioka Underground Observatory is 1,000 meters underground, and the thick solid rock keeps almost all static out. Even if a neutron should be lucky enough to get through the solid rock, it would probably be stopped by the enormous 1,500-ton volume of water. The neutron is almost certain to run into one of the hydrogen protons in the water, which stops it dead. A neutron manages to penetrate through the 1,500 tons of water to strike the detectors in the center of the tank only once very 14,400 seconds on average; in other words, once in four hours. So, the device allows extremely accurate experiments and measurements.

This observatory is also called the Kamioka Neutrino Detection Experiment. It has the best neutrino observation equipment in the world. A neutrino particle, like a neutron, has no electric charge, either positive or negative. So it cannot be forced out of its path to the left or right with an electromagnet; it flies straight past, unaffected. A neutrino is incomparably smaller than a neutron. So the chance of a neutrino hitting a proton in the water is much smaller than the chance of a neutron hitting a proton. Even if a neutrino hits one, it is likely to bounce off it in another direction, and keep working its way through the water.

The Kamioka Observatory became famous in February 1987. When neutrinos from a super-nova explosion in the Great Magellanic Cloud reached Earth, they were detected and measured in the Kamioka observatory with incomparably greater precision than at any other facility on the planet. The incident showed just how excellent the facility really is.

Jones and Menlove performed their experiment with this fantastically accurate measuring device. But, they did not make much progress. On May 27, the *Yomiuri* newspaper began a report:

> Cold Fusion Proof Not Found. Several Months Needed to Analyze Data. Joint U.S.-Japan Underground Experiment at Kamioka Gifu Prefecture.
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> Researchers from the U.S. and Japan performed experiments to verify that cold fusion exists. The experiments began on the 17th of last month in the underground pool observatory in Kamioka, Gifu. The joint experiments continued until the 22nd, but ended without clear proof that cold fusion reactions had occurred.

The article says "data will take several months to analyze," yet it declares that the experiment had failed. It makes me wonder what they have in mind—since this was printed in the morning paper five days after the experiment ended, not "several months" later—but I guess I will let that go. In any event, the first joint experiment at Kamioka misfired.

'Heat' found

Just before the *Yomiuri* newspaper article appeared, a very strange phenomenon occurred with Dr. Mizuno's device at Hokkaido University. Mizuno set up an experiment on March 20. He ran electricity through the platinum to the palladium electrode for 650 hours, up to April 22. Then he turned off the electricity and terminated the experiment for the time being. It was the same routine he had always followed. Then, three days later, on the morning of the 25th, he went to the basement laboratory. He reached out to touch the cell. He was astonished to find that it was extraordinarily hot. Far too hot to handle.

Usually, the experiment ends when the electricity is cut. The heater that is wrapped around the cell is left on for a while. This is done to measure the background neutron radiation. The electricity going into the heater is controlled by a thermostat that keeps the cell temperature at 90°C at all times. However, just by holding his hand near the cell, Mizuno could easily tell that the temperature was way over 90°C.

He could not decide what to do. It was clear that the heat was originating from inside the cell, but there was no electricity flowing through the electrodes, so he did not know what could cause the heat, nor could he control the heat. If he left it as it was, there was nothing to stop it from becoming dangerously hot. He turned off the heat wrapping.

Yasuzumi called from the chemistry building. "Dr. Mizuno, it's unbelievable! I'll bring the data over right away!" A few minutes later he came running into the lab, sweating and out of breath. "What do you think of this?"

The temperature in the basement laboratory is maintained at 20°C year round. Until now, whenever he turned off the heater, the cell would slowly cool down, until, in about 20 minutes, it would cool down enough to be handled with bare hands. But not this time. He waited an hour, then two hours, but it stayed far too hot to touch. Mizuno ran around the engineering labs, gathering towels. He wrapped the cell in a bundle of towels and carried it up to the third floor lab. He warned everyone there, *"High Temperature Do Not Touch,"* put the cell in a corner of the lab, and waited for it to cool.

Two days later it was the long holiday weekend. He was the only one in the lab. As the weekend had begun, the cell had cooled down to room temperature. He set to work opening it up and examining it. There was nothing unusual. It was just as it had always been.

"Where in the world was all that heat coming from?" he wondered.

He had not seriously expected to find excess heat, just as he had not expected to find significant amounts of tritium. He had been the first person in Japan to detect neutrons; later he became the first to succeed in detecting increased levels of tritium, so he was already completely convinced that he was looking at a fusion reaction. "There is no room left for doubt," he said, but somehow he still felt a nagging uncertainty.

Mizuno went back to have another look at the experimental records of temperature. Until now he simply did not believe he would find anything, so he had only spot-checked the temperature records occasionally. He had never looked at the entire record at one time; he had never examined the big picture. Now, as he carefully examined the detailed record, he found that very strange temperature changes were appearing. The experiment had run for 650 hours, when he turned off the electricity and terminated the reaction on April 22. Then the temperature and pressure within the cell fell rapidly. At 655 hours, the temperature and pressure lines stabilized, and continued horizontally. Around hour 670, the temperature began to climb. It fluctuated only slightly, as it continued to increase. By hour 705 it reached a peak 15°C above the 90°C background temperature set by the heater. Moreover, the temperature declined only slightly over time, continuing until April 25, the day Mizuno removed everything from around the cell including the electric heater.

Mizuno examined the temperature record and computed the heat output. For the 55-hour period starting from hour 670 up to hour 725, when he removed everything and brought the cell upstairs, the reaction had output an average of 4 watts per hour. Therefore, it put out a total of 220 watts during the 55 hours. Heat is usually expressed in joules; if we convert watts to joules, we can say that the total heat radiated over the 55-hour period was 792,000 joules.

How much heat is this? You can compare it to the heat put out by one of these body warmer plastic bags filled with chemicals called "Hotto Kairo" that people take to football games and on camping trips. A "Hotto Kairo" contains powder made from iron that is oxidized to generate heat. One mole of iron (55.8 grams) oxidizes at a temperature of 25°C, outputting 162,000 joules of heat. Different manufacturers put different amounts of iron powder in the "Hotto Kairo" bags; but let us say the typical bag holds at least 20 grams. The total output heat from that comes to about 58,000 joules. The total heat from the cold fusion cell was 792,000 joules, 13.7 times greater than that. Therefore, over the 55-hour period, the cell output as much heat as 13 or 14 "Hotto Kairo" bags.

You might be thinking, "That is not so much heat," but remember, this amount came out *after* the electricity was completely turned off and the experiment was terminated. It is impossible to say how much more heat would have come out of the device if it had not been turned off.

The fact is, the phenomenon occurred *after* the electricity going into the electrodes was cut off, which makes it even more astonishing and inexplicable. At the time this happened, Mizuno was in a hurry to finish up a paper he was scheduled to deliver at the Nuclear Physics Society meeting. He only made a brief note at the end of the paper describing this latest discovery. He did not state his view of what the phenomenon might be, and did not draw any conclusions. He had encountered enough skepticism when he reported observing the neutrons; he heard comments like, "That could not happen" and "You must have made an experimental error" from every corner. If he was also going to claim he had observed "excess heat," in a miraculous, unnatural form after turning off the electricity, it was clear that he would be exposed to a flood of criticism.

'Possible proof' may have been there all along

On June 19, as Mizuno was adding the final note to his report, a sensational headline appeared on the science page of the *Asahi* newspaper: "Neutrons Indicate Possible Experimental Verification of Cold Fusion." The data from the experiment performed from April 17 through the end of May by Jones and Menlove in the Kamioka Underground Observatory had been analyzed. It now appeared that neutrons had been detected. Five days after the experiment, the *Yomiuri* newspaper had reported "Cold Fusion Proof Not Found"; now the *Asahi* was reporting "Possible Verification."

The article reported that they checked for neutron emissions every two-thousandth of a second. In six cases, more than two neutrons were observed; four was the greatest number counted. This is a wonderful result, because this took place in an environment where one neutron enters every four hours, every 14,400 minutes; because this is the most "static free" environment on Earth.

This article is written in a weird fashion. It says "more than two" neutrons were detected six times. Well, in that case, how many times was "one neutron" detected during a two-thousandth of a second measuring period? This is not explained. Do you suppose that "one neutron" was only detected only once every four hours? Are single neutron events that rare, when two neutron events occurred "more than six times"? What exactly went on here? Did the Kamioka staff report how many times a single neutron was detected? If so, did the newspaper reporter leave that information out of the article?

Other parts of this article bother me:

> It was reported that a slight possibility of experimental error still exists, due to factors like radioactive uranium contamination in the device, or electrical noise (static) that might be mistaken for neutron radiation.
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> Dr. Jones said that in his view, the neutrons measured in this experiment, "were caused by cold fusion." However, Dr. Totsuka said that "we cannot assert this at the present stage."

The Kamioka Observatory is the most accurate and precise in the world when it comes to observing neutrinos. So why, in the case of this experiment, are the researchers so suddenly concerned about radioactive contamination and electrical noise? This device is reputed to be the most accurate in the world, not just in the country; is the vaunted "Kamioka Observatory" really so unstable?

If this kind of experimental error is possible now, it must have been possible in the past as well. In that case, what has been going on all along? Are all these previous experimental observations similarly in doubt?

The president of Tokyo University was one of the early opponents of cold fusion. In late March 1989, the month Pons and Fleischmann made their announcement, he stated, "If cold fusion is as easy to get as they say, I will quit physics, shave my head, and become a Buddhist priest." I do not suppose that anyone connected with the experiment has allowed those words to color their reporting. But I wonder how to explain their inclination to disclaim and disavow their own experimental results.

A statement was circulated claiming that someone in the MIT group had altered the data from the cold fusion replication experiments in 1989. Members of the group are among the most powerful of the scientists who have come out against cold fusion.

The Kamioka experiment now being conducted by Jones, Menlove, and a Tokyo University Cosmic Ray Institute professor is due to be repeated in July, and the final results will be reported this fall. I guess it will be fun to see the results, but I also feel somewhat anxious. The reason is, I watched Jones prepare his experimental device on NHK [national television], and to be honest, I was surprised at how slipshod the device looked, and how carelessly he was handling it. I have seen devices at Hokkaido University, Texas A&M, I saw Jones's setup at BYU [Brigham Young University]; to me, the device at Kamioka does not look like it is up to the usual standards. Why didn't he bring one of his devices from Utah? I cannot go along with what is happening.

What really floors me is the way Jones handled the device. When I watched the Mizuno work at Hokkaido, and when I watched the experiments at Texas A&M, I saw that they handle the equipment very carefully. They take pains never to touch the electrodes with bare hands, since sweat or oil from the skin can cause oxidation. Well, as far as I could see on television, when Jones was preparing the device, he had his hands all over it. I wondered if it would work; and if the experiment failed because of his rough handling, I wondered if it wouldn't delight the anti-cold fusion gang. This may be none of my business, but it bothers me.

This is getting off the subject, but, on June 14, five days before the "Possible Verification" article appeared in the *Asahi* newspaper, an incident occurred in the American cold fusion community, at the Massachusetts Institute of Technology (MIT).

A statement was circulated claiming that someone in the MIT group had altered the data from the cold fusion replication experiments in 1989. Members of the group are among the most powerful and dominant of the many hot fusion scientists who have come out against cold fusion. When the Pons and Fleischmann paper came out, one member of the group discovered a defect in part of it and wrote a scathing article in *Nature*, ripping apart the Pons and Fleischmann paper. The MIT group began replication experiments in March 1989 soon after the Pons and Fleischmann announcement. Then they announced their experimental results: "No effect was seen." However, it seems that they should have announced instead: "We have decided we are not going to see any effect." I must protect the name of the person who revealed this, but some of the data in the group's report has been fudged. I can say that I have in my hand a blurred copy of a fax with the notation:

> Experimental records from July 10, 1989 almost certainly show excess heat evolution. However, when these data were published on July 13, 1989, the contents had been changed. It is clear that the data shown in the graph published on July 13 have been altered.

When the altered data were revealed, the group leader began offering weak, irrational excuses, claiming he "did not have enough time" or "did not have the budget." Suppose you did not know about these backstage maneuvers; you did not know it was a sloppy experiment performed with slipshod equipment; you did not know that the results were tampered with. In that case you would accept the results at face value. When an MIT professor announces an experiment, nobody doubts that it is true—because, after all, it is labeled "MIT."

100% repeatability

Let us return to the U.S.-Japan joint experiment at Kamioka. It is not clear why the "U.S." side is represented by Dr. Jones from BYU and Dr. Menlove from Los Alamos. Why didn't the original discoverers, Drs. Pons and Fleischmann, participate? I would like to have seen Pons and Fleischmann come, since it was their device that generated such a spectacular amount of heat—at one point it even melted. Perhaps they could not come.

The ostensible reasons they did not come were: Fleischmann had to return to England to be hospitalized for an operation to remove a tumor; Pons had his funding cut off from the cold fusion research center; he had been locked out. Not only that, but he supposedly sold his house and disappeared. In Japan not only the mass media, but the anti-fusion scholars repeated rumors about Pons like: "It was as if he absconded in the night; apparently he went overseas" or "he was under pressure to reveal his experimental results, so he pulled up stakes and fled." So, supposedly, although he had been invited to Kamioka, there was no way he could come.

I would like to outline what has actually happened to them, in order to set the record straight and defend their integrity. It is true that Fleischmann did have to return to England to have a tumor removed. However, he is already out of the hospital, and he is fit as a fiddle. It is also true that Pons sold his house. However, he left because he was fed up with pestering and hectoring mass media reporters, who were usually out to find flaws and write negative articles about him. A long time back, both Fleischmann and Pons bought other houses somewhere in Utah.

Phenomena like cold fusion and high-temperature superconductivity that totally overthrow previously held principles are rare in the history of science. Japan ought to put more value on this chance to participate in a brand new field of research starting from the ground floor.

The reports about the Cold Fusion Institute established at the University of Utah have also been filled with mistakes. Originally, the two had paid for all the experiments out of their own pockets, without depending on university funding. When the university found out that their research might lead to a cold fusion energy revolution in the future, it bent every effort to snag the credit for the research, and caused all kinds of confusion. For example, in 1989 Fleischmann, Pons, and Jones had all promised to make simultaneous announcements of the discovery of cold fusion. The university administration's machinations messed up the plans and pushed Fleischmann and Pons to announce a day earlier than Jones.

Later the university obtained funds from the state to establish a Cold Fusion Research Institute. Common sense would lead you to suppose they would pick the head of the Chemistry Department, Dr. Pons, to run a new facility like that; however, the university brought in Fritz Will, an electrochemist working for a corporation. Then they began pressuring Fleischmann and Pons to gather up and hand over all the data they had collected so far to the institute. Perhaps the University of Utah judged that if they got hold of all the data, they could get along without Fleischmann and Pons. There is no doubt that if cold fusion becomes a practical, commercial form of energy, the profits from patents will be enormous. I suppose they were thinking they could install a corporate researcher as head of the institute, work together with the corporations, and somehow get their hands on all those fat profits.

Naturally, there was no way Pons and Fleischmann would go along with this. Of course they refused to hand over the data. Furthermore, they needed to complete their own research; they were not about to let someone else do it instead. They could not reach a settlement with the research institute, so Fleischmann returned to England for the time being, and Pons took an "extended leave of absence."

The institute found it could not get their cooperation, and it could not loot and plunder their data, so it had nothing else to do. From the day it opened, the institute went nowhere. Naturally, the State of Utah audited the project and ordered it axed when it ran out of funds on July 30, 1991. Fleischmann and Pons are hard at work in an undisclosed laboratory, in an undisclosed country. They continue to advance the research, and collect data.

Let me make one more point clear, in defense of Pons and Fleischmann. After they had supposedly "absconded in the night, because they were under pressure to publicly reveal details," Dr. Wilford Hansen of the University of Utah examined the articles they had published and the data they had made public. In April, he reported publicly that "there is no mistake in Pons and Fleischmann's work." No mention of that statement appeared in the Japanese mass media. There is no question that when Pons and Fleischmann made their first announcement on March 23, 1989, they were criticized for not revealing detailed information about the discovery. Because of that, sensational reports aimed at amusing the readers have appeared, saying that Pons and Fleischmann have "absconded, rather than reveal details." The impression these reports have left has made it all the harder to seriously evaluate this important scientific phenomenon.

Early this summer, from June 20 to July 4, the Second Annual Cold Fusion Conference was held in Como, Italy. Two hundred workers came from around the world—America, Japan, the Soviet Union, China, and so on. There were 20 Japanese participants, including Dr. Hideo Ikegami from the National Institute for Fusion Science in Nagoya. I waited for Dr. Ikegami to return, then sped to Nagoya to hear about the meeting. What he told me, and the material from the meeting that he showed me, left me utterly astonished.

To verify the phenomenon of cold fusion, four problems have had to be cleared up. One was the detection of the neutrons and tritium; second, to confirm that the output heat energy is greater than the input—that is, greater than the electrical energy fed into the electrodes; third, to reproduce the results at will—to ensure what is called "repeatability." Fourth, it is necessary to clarify the connection between the fusion process and the heat. In other words, to deduce the entire mechanism, and produce a theory that explains everything, including whether the heat is caused by nuclear processes.

The first of these points, the presence of neutrons and tritium, was settled a long time ago by experiments performed by Mizuno and others. This problem has been settled beyond argument. The second problem, excess heat, was also cleared up a long time ago, as report after report of excess heat measurements came in from researchers all around the world.

What amazed me was the progress that has been made in the third problem of repeatability. Detailed data were presented at the Como meeting by workers who are able to replicate the phenomenon 100% of the time, at will. They can control the level of fusion, heating water to the boiling point, or boiling it away completely, at will. Furthermore, more than one group has achieved this level of control; not only have Pons and Fleischmann achieved this control, but so have other American groups, starting with one from the University of Utah.

The thing that Ikegami told me that really surprised me was about the Stanford Research Institute, Inc. group, from California. They have developed an experimental method more precise than that of Pons and Fleischmann, and they are able to generate a maximum of 250% more output energy than they input, over an extended period. It is fair to say that their excellent results reflect the difference in commitment between the SRI group, which is putting its full, undivided effort into the research, and the Japanese groups, which are performing "weekend experiments," in their spare time.

Dr. [Michael] McKubre of SRI mentioned at the end of his presentation, "For the first two, long years after I undertook this research, I got no excess heat at all. I don't know how many times I thought about giving up. But, now at last I am getting 250% output heat. With this goal finally at hand, I feel keenly just how long and hard I have struggled."

Ikegami comments: "Of course, cold fusion is a strange phenomenon. You have to keep changing the way you do the work, and the materials you use; you have to suffer terribly, until you finally get it right. If you could get cold fusion from a simple, ordinary experiment, somebody would have explained it ages ago."

Forming a theory to explain cold fusion

As I wrote in my last article, cold fusion occurs when deuterium nuclei are jammed into the crystalline structure of palladium, evidently. The research at SRI, Inc. indicates a key point to this phenomenon. The reaction begins when the ratio of deuterium atoms to palladium atoms reaches at least 0.9. Stanford has developed a method of ensuring that the ratio reaches 0.9 or better; however, the details of this method have not been released because of patent considerations. The point is, at the Como meeting, SRI made it clear that they have conquered the third great problem of cold fusion—repeatability.

Reports on the progress of the conference appeared in the Italian newspapers, of course. These reports included graphs from Dr. Pons's presentation. One of the graphs showed a line indicating the temperature of the cold fusion device. It remained at the ground level until the fourth day of the experiment. Then suddenly, in one jump, it went up to the boiling point of water.

Only one brief mention of the meeting appeared in the Japanese press. This treatment is hardly enough to cover the extensive information reported at the meeting. The article was based on an interview with some Japanese researcher who had not even attended the SRI presentation. He was a skeptic who wrote off the whole thing, case closed.

There is only one major unresolved issue left in cold fusion research: the mechanism. Scientists still have to explain the theoretical basis of this queer phenomenon. That means that cold fusion is in exactly the same stage of development as superconductivity; it does not have a theoretical basis yet. When superconductivity was still studied only under extremely cold conditions, it was thought to be understood in terms of what was known as the BCS theory. Then, as scientists found superconducting materials that worked under hotter and hotter conditions, the domain of that theory was exceeded, and the BCS theory fell by the wayside. At this point, there is no commonly accepted superconductivity theory. One must be devised before experiments can be carried much further; without a theory, scientists have no idea what elements to include in their formulas, or what sort of tests to perform.

Consider this: Have Japanese scientists ever really participated in the earliest stages of research? Do they know what it means to start from zero and grope through the darkness step by step to build a new theory? From the Meiji Restoration (1868)—actually even before that, from the Edo period—we have imported our science ready-made from Europe and America, each piece with a complete, accepted theoretical basis already finished. As a result, we lightly dismiss all the difficulties inherent to building a theory from scratch, and all we look for in science is the decisive conclusion. When we are confronted with an incomplete, unknown phenomenon, instead of jumping in and researching it, we have gotten into the habit of withdrawing and waiting for someone else to figure it out and issue a conclusive theory. We seem to have developed a kind of contempt for the groping, early stages of scientific discovery; our attitude toward alchemy is a reflection of that contempt. To those who smugly claim that "cold fusion is nothing but alchemy," I would ask, "Do you understand the historic significance of alchemy? Do you realize what it produced?" The age when a professor can maintain his authority simply by importing knowledge from the West and reselling it to his students is drawing to a close. In postwar Japan we think of "new science" as something you import from the West and immediately apply to practical, profitable enterprise. This way of thinking has come to a turning point.

Phenomena like cold fusion and high-temperature superconductivity that totally overthrow previously held principles are rare in the history of science. Japan ought to put more value on this unique chance to participate in a brand new field of research starting from the ground floor. If we pursue this kind of research tenaciously, Japan will secure many invaluable treasures, both material and spiritual.