It was at this point that they extended the pulses from 4.5 to 19 minutes. After a fluctuation, the neutron rates settled into a ratio of 1.15 to the background level, with a maximum rate of emissions after 180 hours of about 15 neutrons/second/cm^3 of palladium.

Fifty percent of the neutrons which they measured fell within the high-energy 3-7 MeV bandwidth. Under the given conditions, the expected energy level of the neutrons would have been 2.45 MeV for deuterium-deuterium fusion, 14.1 MeV for deuterium-tritium fusion, 3.76 for tritium-tritium fusion, 10.1 for tritium-helium-3 fusion, and similarly different values than were found for deuterium-lithium fusion. Takahashi's conjecture is that there is a compound reaction going on. First, three deuterons fuse to produce a deuteron traveling at 15.9 MeV kinetic energy, and a fast-traveling alpha particle (a helium-4 nucleus) is also emitted. Then the fast deuteron slows down in the lattice and fuses with another deuteron, to produce the requisite fast neutrons in the 3-7 MeV range. At this point in their cold fusion experimental effort, Takahashi and his associates believed that his theory accounted for the observations of excess heat and anomalously high tritium-to-neutron ratios that had been found by other experimenters, but they themselves had only succeeded on the level of producing neutron emissions. Not content with merely fielding a theory, they continued their experimental program, despite a certain amount of frustration.

In a repeat of the B-series experiments, as before, they made careful checks against background radiation. They found that neutron bursts were correlated with the appearance of high-energy neutrons. Whereas in the beginning of the experiment, 2.45 MeV neutron emissions predominated, between 500 and 600 hours into the experiment, the higher energy peak was dominant. When they changed cathodes, they were still able to repeat the experiment.

Takahashi himself admits that his three-body model is problematic, in that it supposes an occurrence even more improbable than deuteron-deuteron fusion at room temperature—i.e., that three deuterons can overcome the Coulomb barrier simultaneously. His explanation includes quantum excitation of the deuterons resident in the octahedral sites and the existence of free electron clouds (plasmons) around tetrahedral sites, which help to enhance the barrier penetration probability. Further, according to his theory, at a certain point, the existence of three-body fusing clusters of deuterons will exclude the continuation of two-body deuterium fusion.

Proceedings of Como conference released

On Jan. 31, Martin Fleischmann and Stanley Pons presented one of their first cold fusion cells to the Leonardo da Vinci Museum of Science and Technology in Milan, Italy, at a press conference which was attended by 250 people. The occasion was the release of the book-length proceedings of the Second Annual Cold Fusion Conference in Como (see *EIR,* Aug. 16, 1991 for our report on the conference).

The press conference was opened by Dr. Fontanesi, a physicist and director of the museum, who made a strong statement on the importance of research such as that into cold fusion: "Science is not made of absolute truths. We are constantly modifying, we are constantly learning. We are proud to host this press conference because we believe that the scientific dialogue in search of the truth must continue. No one today can simply ignore the work done in the area of cold fusion, and I am one who has spent most of my professional years working on hot fusion."

Como conference organizer Dr. Emilio Del Giudice of the University of Milan emphasized why the title given to the proceedings was "The Science of Cold Fusion"—because cold fusion is no longer a phenomenon or curiosity; it is a new area of science, which must be seriously investigated.

"There is a story," Del Giudice continued in a humorous vein, "of the fellow who discovered boiling water, and explained to his astonished colleague how he went about lighting a fire under a pot of water, and how this soon began to produce bubbles and vapor. His colleague tried to 'repeat' the experiment by taking a large pot of water and lighting a match under it. He concluded that the experiment was not repeatable, and that the first scientist was a fraud. To put the matter simply, certain conditions must be satisfied in order to achieve a positive result."

He summarized the basis for believing that the Fleischmann-Pons experiment is a true example of a fusion reaction. "We hypothesize that there are various nuclear reactions being observed, because some people see tritium, others neutrons, and others observe heat. When a significant amount of heat is observed we also see helium-4 and gamma rays; and these are always in a quantity proportional to the heat. This is a key reaction. You can say that it is the smoking gun in the hand of the assassin."

Martin Fleischmann and Stanley Pons both spoke. Fleischmann described how he and Pons were led to their historic discovery. Describing himself as a "scientific archeologist," he explained that he had knowledge of re-

Only in his C-series of experiments was Takahashi actually able to observe tritium along with the neutrons that he produced. He did so by taking weekly samples of the electrolyte. These results were reported in the summer of 1991 at the Como cold fusion conference, where Takahashi elaborated his theory to incorporate Giuliano Preparata's superradiance theory to explain how the Coulomb barrier is overcome (see box).

At Como, he also suggested that a number of subsidiary fusion reactions might also be occurring, such as accelerated tritium fusion with deuterium to produce a very fast neutron and helium-4. It was only in this series of experiments that Takahashi and his associates were able to detect tritium. In this C-series of experiments, he also used a cubic geometry for his electrode, which was actually a cubic centimeter in diameter.

In this experiment, which also utilized alternating six-hour sweeps in high- and low-current mode, Takahashi's team found that neutron emissions increased over time, with the largest excess neutrons occurring over a 1,050-second period—approximately three sweeps. In general, higher neutron emissions occurred for the high-current intervals than the low-current intervals, and for both modes over time. These appeared to be correlated with the production of tritium, which also increased over time. It was in another experiment in this C-series, during early autumn in 1991, Takahashi first used a plate configuration. A similar neutron spectrum was emitted from the plate, along with tritium in the C-series; however, they did not get excess heat from this plate.

Japanese scientists are now exploring the hypothesis that it is possible to load a palladium lattice at the tetrahedral as well as at the octahedral sites. Tetrahedral sites are deep-potential well sites, and can only be loaded with difficulty over time. It is now believed that the alternation of low and high current causes the octahedral sites in the lattice to unload and reload—but on each reloading, a certain percentage of tetrahedral sites are already filled. These tetrahedral sites, unlike their octahedral counterparts, will tend to remain filled, even as the current is shifted. Since there are double the number of tetrahedral to octahedral sites, filling both could give a 3:1 loading ratio of the deuterium to the palladium.

Whatever the specific details of Takahashi's theory prove to be, it is likely that the conditions which he identifies with the alternation of two-, three-, and four-body fusions (and possibly even higher) are identified with phase-shifts of the loading with the palladium lattice of the cathode.

According to Takahashi's theory, the high heats that he is now seeing come from four-body fusion in which deuterons from three surrounding octahedral sites are excited and "fall into" the tetrahedral site (central to the tetrahedron formed by four octahedral sites) in which a deuteron may also be located. In experiment D there are indications that, as excess power density neared 100 watts/cm^3, there was a falloff of neutron emissions which was negatively correlated to the increase in power generation.

Already in the C-series, Takahashi believes that two-, three-, and four-body fusions were occurring, with the latter two beginning to play major roles. In experiment D, he explains the high heats as the prominence of four-body fusion.

In the two-month period from January through February, according to his original preliminary estimates, the total input energy was approximately 250 megajoules; the total ouput energy was 730 MJ. This gave an excess energy total of 480 MJ. Power input on average was 50 watts, and excess power was about 96 watts, which would scale to approximately 200 watts/cm^3. After 40 days, Dr. Takahashi and his collaborators tried to terminate the experiment. They stopped electrolysis while it was in the low mode for about 10 minutes, but as we noted above, to their horror, they found that the cell temperature began to slowly increase. Fearing an accident such as occurred at SRI, they resumed electrolysis. They have been steadily decreasing the current since then, and now believe that the experiment is sufficiently under control so that they can bring it safely to an end, and move on to new tests of their theory.

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search done in the early part of this century, which indicated the possibility of such a reaction.

Contrasting "cold" to "hot" fusion, he said: "We were before a high-concentration plasma, in an ordered state. This plasma has a low temperature but a high energy, as opposed to the disordered state which we find in hot fusion. Well, you have a choice when you observe something like this. You can say it is inconvenient and ignore it, or you can investigate it. We were skeptical, so we were not surprised by the skepticism of others. The leading opinion of many at the time was that, as the experiments improved, the phenomenon would just disappear. Instead, evidence has increased in favor of cold fusion."

Stanley Pons continued with the same theme, remarking that the skepticism came from the fact that the observations contradicted "modern theory," and therefore scientists believed the experiments to be wrong. "This," he said, "is the antithesis of modern science, which is based upon the observation of phenomena. When we observed one watt per cubic centimeter, we had an interesting scientific curiosity, but today, with one kilowatt per cubic centimeter of energy produced, which has been observed in various labs, we have something with technological implications. Now we have to see if we can contain and sustain this. This will be a hard road, but we cannot say that it will not happen."—*Carol White*