Preface

This Preface has five main sections:

Background. The development of the field, which was originally called "cold fusion" and is now known by various other names, is discussed here.

Terminology - What name do you give this discovery? A review is given of the diversity of terms and motivations for their use to describe the field.

The International Conferences on Cold Fusion – A statistical history. This conference series has been the primary venue for exchange of scientific information in the field. Locations, dates, and the numbers of attendees, countries represented, papers, and authors, are tabulated along with other data and comments.

Strategies for ICCF-14 and These Proceedings. A deliberate strategy was developed to set the location and the agenda for ICCF-14. This section gives an overview of the main parts of the conference, and provides the motivations for why they were scheduled as they were. It also explains the character of introductions written specifically for each section of these proceedings in order to make them intelligible to a wider audience.

Summary of the Field. Presents an overall summary of the field, organized by what is not known and what is known.

Background

Truly unexpected experimental results, which seem beyond explanation by well-developed physical theory, became increasingly rare at the end of the twentieth century. After World War II, physical scientists sought, with significant success, to work out the implications of electromagetism, relativity, nuclear and elementary particle processes, and even superconductivity, all within the context of the various flavors of quantum mechanics.

The last time such confidence had existed in natural science was around 1870. By 1870 the crisis of Newtonian mechanics was seemingly resolved with the theoretical prediction of a new planet, its orbit and mass, and the subsequent observation of Neptune. The integration of electricity and magnetism by Maxwell in the 1860s set the foundation for all subsequent thinking about this class of effects. This confidence began eroding in the mid-1870s. The experimentally driven revolutions of the last twenty-five years of the nineteenth century, notably "x-rays", "radioactivity", and "charged corpuscles" (electrons), delivered to the twentieth century science a wealth of change that seemed mostly under control by the 1980's.

Thus, two unexpected announcements in the late 1980's, high temperature superconductivity and "cold fusion", echoed the disruptive experiments of the end of the nineteenth century. Bednorz and Mueller discovered high temperature superconductors in 1986 and were awarded the Nobel Prize in Physics in 1987. In 1989, it was reported that the metal palladium, when densely loaded with hydrogen, particularly the mass two isotope deuterium, produced so much heat that known chemistry could not explain the observed energy. This immediately led to speculation that nuclear processes had to be responsible for the anomalous heat production, a potentially even more amazing discovery. These discoveries share a common property: they occur in complex solids operating under conditions not normally found in nature. They are so-called many-body systems, whose complexities are legendary. An unusually readable and scientifically superb account of superconductivity is available from Herbert Frohlich "The Theory of the Superconductive State", Reports on Progress in Physics, Volume XXIV(1961).

The discoverers of what they called "cold fusion", Martin Fleischman and Stanley Pons, set off a scientific firestorm by speculating that chemical systems can control nuclear processes. Their 26 April 1989 testimony before the Committee on Science, Space, and Technology of the US House of Representatives included a speculation that, if deuterium was indeed the fuel in their experiments, then they had measured a process that produced at least eight times as much energy as was required to operate the "reactor", which would burn that fuel. This claim was incredible to those who had labored intensely for 40 years trying to build machines that would burn deuterium by simulating the conditions found in the sun. But, they had yet to demonstrate they could produce enough energy to sustain operation of their "hot fusion" reactors. The experiments had even not reached "break-even." Even more incredible to those versed in nuclear physics was the absence of harmful levels of ionizing radiation or neutrons. Furthermore, the Fleischmann-Pons experiment seemed simple and cheap, which it was in terms of equipment, but not in terms of the physical processes involved.

In retrospect, the Fleischmann-Pons Effect (FPE) experiments, which showed that the chemically impossible amounts of energy generated by deuterated palladium, were anything but simple. They involved the complexities found in materials science, nuclear physics, electrochemistry, and other disciplines, plus the analytical challenge of trace element detection and quantification. The majority judgment made in the Department of Energy's November 1989 Report of its Cold Fusion Panel, part of the Energy Research Advisory Board, asserted that the large quantity of measured heat was an experimental artifact. The Panel's report is a marvel of bureaucratic civility and correctness. It delivered with finesse a door-closing end to further serious consideration by the general science community. The tension between the panel members and the co-chairman, Prof. John Huizenga, is captured in the line from the Executive Summary: "The Panel also concludes that some observations attributed to cold fusion are not yet invalidated." But, true to the threat that a new mouth to feed would be added to the nuclear and particle physics research table, the following was produced: "The Panel recommends against the establishment of special programs or research centers to develop cold fusion. However, there remain unresolved issues, which may have interesting implications. The Panel is, therefore, sympathetic toward modest support for carefully focused and cooperative experiments within the present funding system." To our knowledge, all LENR proposals from non-DOE laboratories have been rejected for funding by the DOE. Interestingly, Prof Huizenga promoted his provocatively entitled assessment of the matter in his 1993 book Cold Fusion: The Scientific Fiasco of the Century. Professor Huizenga had been Chairman of the National Academy of Science Committee on Nuclear and Radio Chemistry that was in place in the late 1980s. His unyielding vigor in lobbying colleagues on the committee for the narrow interests of his field of specialty was noteworthy. He attended ICCF-4 in 1993, but found no compelling evidence in what was presented there. As late as 1999, in an interview during press conference on the tenth anniversary of the FPE, Huizenga was holding to his position: "It's as dead as ever."

Most of the essential elements of the DOE Panel critique of the FPE heat discovery have been extensively examined and addressed in the literature, particularly as to the presence of an effect. However, there does not exist at this time a "simple" experiment with a clear theoretical explanation, which comes with the two-body scattering models that have been the bread and butter of the nuclear physics world. There are strong experimental indications that some nuclear processes are modulated by the environments inside solids. Notably, the enhancement of fusion cross-sections in metals and compounds containing deuterium has been measured in diverse experiments.

Despite the very limited amount of work done on the FPE compared to the complexity of the problem, research has been supported by the US Department of Defense, government funding agencies in Japan, Russia, Italy, France, and China, and a number of private investors and closely held corporations. Because some of the investigations do not require large capital investments there is a hardy band of researchers who have independently added important understanding about the FPE. This demonstrates that the industrial science model of post WWII in physics is not the only approach to science. Just as the chemists and biologists have joined forces to dominate late twentieth century science, the FPE offers the opportunity for important results to be obtained by individuals and small groups.

Terminology – What name do you give this discovery?

The field of this conference has been called cold fusion since Fleischmann and Pons speculated that their heat production could only be explained by non-chemical processes, that their fuel was deuterium, and that it wasn't "hot fusion." The term cold fusion was already in use to describe muon-catalyzed fusion, an understood physical mechanism in which fusion of two deuterons occurs at relatively high rates in the presence of muons. In 1989, the term "cold" for the new and mysterious effect, was meant to contrast deuteron fusion at room temperature with known fusion processes in plasmas, which have temperatures of millions of degrees K.

As time passed during the 1990s, processes other than fusion of two deuterons were reported. These transmutation reactions involved and produced isotopes of nuclei with moderate and high atomic weights, and not only two light nuclei undergoing fusion. Because of this, and to emphasize their viewpoints, some researchers in the field sought other names for the effect announced by Fleischmann and Pons. A tabular summary with the various names applied to "cold fusion" follows, plus our comments on the strengths and weaknesses of the various names.

Table 1. Names given to the study of "cold fusion" since 1989

Terminology	Comments
Cold Fusion	Original and recognized name, but incomplete
Low Energy Nuclear Reactions	Low is a relative term and unclear
Lattice Enabled Nuclear Reactions	Clear and specific, but very new and little known
Lattice Assisted Nuclear Reactions	Also accurate, but little used
Chemically Assisted Nuclear Reactions	Many chemists like this
Cold Fusion Nuclear Reactions	Little used
Cold Nuclear Transmutations	A Russian favorite
New Hydrogen Energy	A major Japanese program
Metal Deuterium Energy	A current program in Japan
SANER	SAfe Nuclear Energy Release
Fleischmann-Pons Effect	Clear and encompassing

Table 1 shows most of the titles given to the study of "cold fusion" over the 20 years since its announcement. The field is now widely considered to be part of "Condensed Matter Nuclear Science."

None of these names has gained universal acceptance. In the minds of some workers in the field, they suffer from various shortcomings. For example, "cold" and "low" are relative terms without precise meanings. The variety, and indeed confusion, over terminology is also promoted by the lack of a clear understanding of the basic mechanism (or mechanisms) active in this field. The overall terminology situation was not aided by the foundation of a software company called Cold Fusion, which often shows up in internet searches.

In 2002, a new and broader name was introduced, namely "Condensed Matter Nuclear Science" (CMNS). "Condensed matter" is a term that has been employed by the American Physical Society for a few decades to embrace both solids and liquids. CMNS was meant to focus on the science of nuclear effects in systems involving solids (always) and liquids (often). It is an appropriate description for the current and continuing science of the field, but it will fail to embrace anticipated engineering work based on that science. The International Society for Condensed Matter Nuclear Science was founded in the U.K. in 2003 (www.iscmns.org). It is the primary intellectual scientific society for the field.

At present, given all the problems with the name of the field, many people are simply and clearly referring to the mechanism(s) active in the experiments that followed from the 1989 announcement as the "Fleischmann-Pons Effect" (FPE). That effect is the production of heat and other products in a metallic system under unusual circumstances of very high densities of hydrogen or deuterium. It is interesting to remember that, in the Fleischman-Pons patent application, light water and nickel, as well as other hydrided metals, were included in their claims. Although much of the focus has been on deuterium and palladium, there are credible Italian papers reporting heat being produced from light water and nickel.

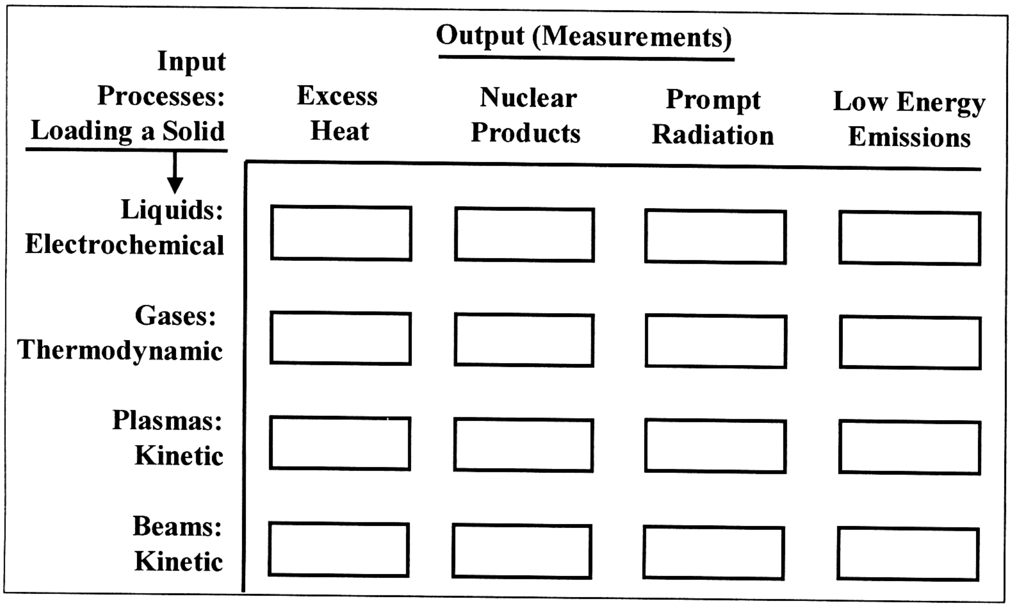

Figure 1. The means of loading protons or deuterons into lattices, and the types of measurements made to prove the existence and determine the properties of LENR.

It is known experimentally that the amount of heat produced per reaction can be over 1000 times the energy released by any known chemical reaction. The power densities (measured in watts per cubic centimeter of the metal) occasionally exceed those in fission nuclear power systems. Associated with this heat in many experiments is the production of helium-4 at levels that account for the heat, if each atom of helium is associated with about 24 million electron volts of energy. Small amounts of tritium, the mass-three isotope of hydrogen, plus other nuclei, energetic particles and photons, and low energy quanta, such as infrared radiation, have been reported for many experiments. Figure 1 shows one way to organize the four means of loading hydrogen isotopes into lattices and the four classes of measurements just mentioned. This arrangement served as the organizing principle for the conference and, hence, for these proceedings.

History of the International Conferences on Cold Fusion

While this sequence of conferences has been the major venue for presentation of results on the FPE effect, its continuation and evolution are subject to much current discussion. The characteristics of past conferences provide a basis for that consideration. The rest of this section presents some statistics on the ICCF and discusses trends over the almost 20-year history of the series. The conferences have generally rotated across three continents, North America, Europe and Asia. The next table is a summary of the dates, locations and the numbers of attendees, papers in the proceedings and authors of those papers. It is based on the proceedings of each conference and other materials, which we have acquired from our attendance at each of the ICCFs.

The number of attendees can be estimated in different ways, all of which have problems. The first method is from the lists published by conference organizers. These commonly contain more names than people who actually attended the conference, so they tend to give high numbers. The second way to estimate the number of attendees is from the official conference photo. The photos usually had some people missing, though they included administrative personnel. Hence, the numbers from the photos are generally low. The last count of attendees is the number given in the proceedings. The reported and published numbers are commonly rounded off. For example, ICCF-2 was said to have >200 attendees. Numbers from the provided lists, from counting faces in conference photos and from the proceedings are given in Table 2. The large discrepancies in the numbers of people attending ICCF-3 and -13 are indicative of the problem of accurately counting attendees. It is likely that the numbers published in the proceedings are most accurate. It must be noted that, in general, not all of the attendees were present for the entire conference.

Table 2. Summary of the dates, locations, attendees, papers and authors for the ICCF conferences

General Information			Attendees				Proceedings	
	Date	**Location**	**List**	**Photo**	**Proceedings**	**Countries**	**Papers**	**Authors**
1	1990	Salt Lake City UT USA	296		>200		35	90
2	1991	Lake Como Italy			>200		57	294
3	1992	Nagoya Japan	324	223	346	18	102	320
4	1993	Lahaina, Maui, HI USA			242	12	65	164
5	1995	Monte Carlo Monaco	207		228	15	76	91
6	1996	Lake Toya Hokaido Japan	175		179	17	110	288
7	1998	Vancouver BC Canada	218		206	21	*89	
8	2000	Lerici La Spezia Italy	145		145	18	68	176
9	2002	Beijing China	113	111	113	17	87	193
10	2003	Cambridge MA USA	135	98	>150		93	170
11	2004	Marseilles France			170	20	74	164
12	2005	Yokohama Japan		58			63	158
13	2007	Sochi Russia	75	52			93	
14	2008	Washington DC	180			15	**97**	

*The ICCF-7 Proceedings have 76 papers presented at the conference, plus 13 additional papers, which were not presented.

The number of papers can be obtained more confidently by simply counting the papers in the proceedings. But not all of the presented papers or posters result in proceeding publications. Similarly, papers that were not presented at the conference are sometimes inserted into proceedings. The author index in the proceedings gives the numbers of people with their names on the published papers. These were counted and tabulated

Given the incompleteness and uncertainty of the number of attendees, it is difficult to be very specific about attendance trends. But the general picture is evident. For the first seven meetings during 1990-1998, attendance was somewhat in excess of 200. ICCF-3 and ICCF-6, both in Japan, were the exceptions in this period. For ICCF 8 through 11, attendance was usually closer to 150. For ICCF-12 and 13, the attendance dropped significantly to well below 100. ICCF-14 had 180 attendees from 15 countries.