On the 30th Anniversary of the Discovery of the Cold Fusion Phenomenon

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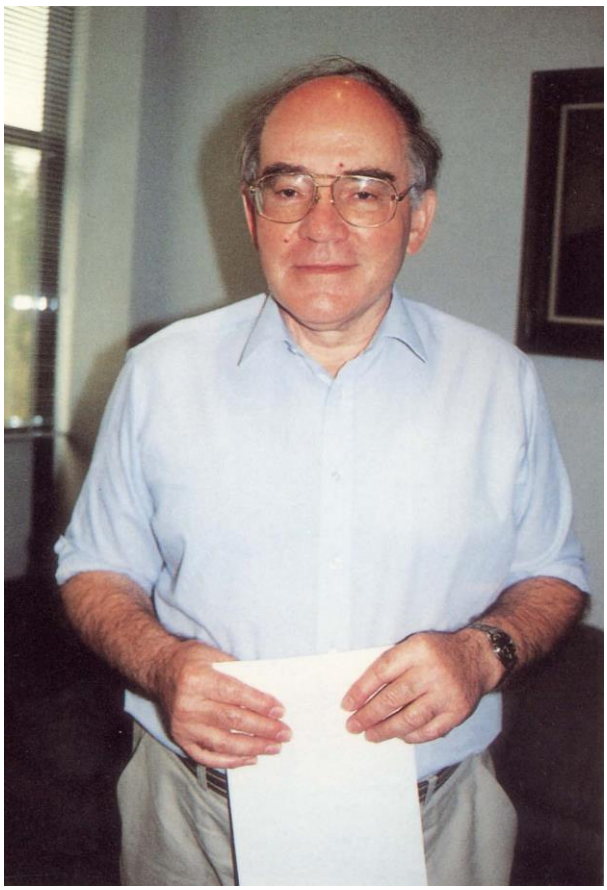
March 23 is the birthday of the cold fusion phenomenon (CFP). On this day 30 years ago, the existence of the nuclear reactions in a solid at near room temperature was declared by Martin Fleischmann at the press conference held in the University of Utah, USA. This event, right or wrong, is the start of the open researches on the CFP lasted 30 years since then and has given a specific destiny to the research field we have had involved in it. Anyway, the investigation on the physics of the CFP has lasted without interruption and is developing day by day now.



Martin Fleischmann (March 29, 1927 – August 3, 2012) on April 7, 1995 at his office in IMRA S.A. Science Center, Sophia Antipolis, Valbonne, France. (Photo by H. K.)

I would like to recollect the history of the cold fusion research from my point of view focusing at my research activity kept about 30 years from the beginning of this science.

First of all, it is necessary to recollect the great pioneering works accomplished by Martin Fleischmann. We give a brief survey of Fleischmann's work in *Section II* focusing on his mental phase of the cold fusion research. It is interesting to notice the motivation of the scientist who discovered the new phenomenon – nuclear reactions in transition metal deuterides and hydrides at around room temperature – with an inappropriate premise on the nuclear reaction between two deuterons. In *Appendix A*, we cite several sentences on this point from writings by Martin Fleischmann.

Here, we give a short comment on the words "*Cold Fusion Phenomenon*" we used to call the events observed in CF materials, i.e. materials where the CFP has been observed.
We notice the words "*Cold Fusion*" and "*Cold Fusion Phenomena*" are used in the titles of several Fleischmann's papers (c.f. Appendix A). In the words "*Cold Fusion*" he had given a special meaning as we see in Section II where we survey his mental process resulted in the discovery of the CFP.

"*Cold Fusion Phenomena*" used by Fleischmann means whole events resulting from nuclear reactions occurring in materials composed of host elements (Pd, Ti) and deuterium. In the progress of researches in this field, we know now that the nuclear reactions occurs not only in deuterium systems but also in protium systems. Furthermore, we know the observables related to the nuclear reactions in this field ranges not only to excess energy but also to transmuted nuclei including tritium, ^{4}He, and neutron. We can guess that the events producing these products in such various materials had been called as "*phenomena*" by Fleischmann. He would has used "*Cold Fusion Phenomena*" to express whole research field he explored and developed since 1989 combining the "cold fusion" in his mind from the beginning and "phenomena" containing various events observed. Borrowing his terminology partially, we would like to use the "*Cold Fusion Phenomenon*" to call the whole events thus occurring in the CF materials where occur nuclear reactions at around room temperature without acceleration mechanisms for participating particles.

I. My Research on the Science of the Cold Fusion Phenomenon

I have published two books and many papers on the CFP.

The books are;

1. H. Kozima, *Discovery of the Cold Fusion Phenomenon – Development of Solid State-*

Nuclear Physics and the Energy Crisis in the 21st Century –, Ohtake Shuppan Inc., 1998, ISBN 4-87186-044-2. [Kozima 1998]

2. H. Kozima, *The Science of the Cold Fusion Phenomenon*, – *In Search of the Physics and Chemistry behind Complex Experimental Data Sets* –, 1st Edition, Elsevier, Amsterdam, 2006, ISBN-13: 978-0-08045-110-7. [Kozima 2006]

These books give monuments of the progress of my research;

Book 1 had shown effectiveness of the phenomenological approach with the TNCF model (trapped neutron catalyzed model). This is also understood an evidence of the participation of neutrons on the nuclear reactions in materials composed of host elements and hydrogen isotopes (CF materials) where occurs the CFP.

Book 2 had shown that the premises assumed in the TNCF model have been explained using the quantum mechanics where a new feature of nuclear interactions between nuclei of host elements at lattice sites (lattice nuclei) and hydrogen isotopes at interstitial sites (interstitial protons/deuterons) works effectively to realize a new interaction between lattice nuclei not notice before. In addition to the possible new interaction between lattice nuclei, the effect of complexity on the CFP has been investigated in relation to various experimental data.

It should be mentioned here about an elaborate work by Ed Storms who compiled and published an extensive list of papers until 2007 [Storms 2007]. This work is very useful to contemplate the total image of the CFP.

I-1 The Subtitle of "The *Discovery of the Cold Fusion Phenomenon*"

The subtitle of the Book 1 is suggestive to the history of the cold fusion research;

Development of Solid State-Nuclear Physics and the Energy Crisis in the 21st Century.

The first half of this subtitle is reflected in the papers I have presented at JCF 19 held on October 2018;

H. Kozima, "Development of the Solid State-Nuclear Physics," *Proc. JCF19,* **19-15** (2019) (to be published), ISSN 2187-2260. [Kozima 2019c]

In this paper, the essential contents of the solid state-nuclear physics have been systematically surveyed. The complexity in the process of formation of the CF materials and the novel features of the interactions between host elements and occluded hydrogen isotopes have been extensively investigated.

Key concepts developed in our theory are;

(1) Complexity in formation of the metal-hydrogen superlattice

(2) Super-nuclear interaction between neutrons in different lattice nuclei

(3) Neutron energy bands and neutron drops in them
(4) Nuclear interactions between neutrons in the neutron bands and nuclei at disordered sites

The second half of that subtitle "*the Energy Crisis in the 21st Century*" has shed various light on the cold fusion research. This problem is discussed below in Sections II and III.

I-2. The Subtitle of the book "*The Science of the Cold Fusion Phenomenon*"

We now take up the subtitle of the Second Book

– In Search of the Physics and Chemistry behind Complex Experimental Data Sets –.

We have noticed many characteristics of the CFP observed in metal-hydrogen systems and carbon-hydrogen systems as pointed out in our papers [Kozima 2006, 2016a]. It should be noticed here the chemistry of the CFP which seems a key factor to form the CF materials in the electrolytic systems [Kozima 2000b (Sec. 4)]. It was noticed a characteristic of the CF materials in the electrolytic systems; the preference of a cathode metal and an electrolyte:

"It should be emphasized here that there are preference for combination of a cathode metal (Pd, Ni. Ti. Pt, Au, etc.), an electrolyte (Li, N, K, or Rb) and a solvent (D_2O or H_2O) to induce CFP." [Kozima 2000b (p. 45)].

The physics of the CFP seems to be the fundamental factor for the occurrence of the nuclear reactions in the CF materials. Main efforts to explain the nuclear reactions in CF materials at near room temperature without any acceleration mechanisms have been endeavored as follows [Kozima 2004, 2006, 2013, 2016b, 2019c]. To give a unified explanation of these complex experimental data containing such characteristics, we have struggled with successive trials given below arrived at our final image summarized in the paper published in 2019 [Kozima 2019c].

We follow the history of our research chronologically below;

1. Observation of neutron emission from Pd/LiOH+H_2D/Pt electrolytic system [Kozima 1990].
2. Proposal of the TNCF model (trapped neutron catalyzed model) assuming quasi-stable neutrons in CF materials [Kozima 1994].
3. Publication of Book I compiling experimental data analyzed by the TNCF model [Kozima 1998].
4. Proposal of the ND model (neutron drop model) assuming formation of the cf-matter containing neutron drops ${}^{A}{}_{Z}\Delta$ composed of Z protons and $(A - Z)$ neutrons [Kozima

2000a].

5. Publication of Book II compiling experimental data analyzed by the TNCF and ND models [Kozima 2006]
6. Explanation of the neutron energy band (one of central premises of the ND model) by a quantum mechanical verification of the super-nuclear interaction between neutrons in different lattice nuclei [Kozima 2009].
7. Compilation of three laws in the CFP induced from experimental data sets [Kozima 2012].
8. Explanation of the formation of the metal-hydrogen superlattice and the nature of the three laws in the CFP by complexity inherited in the CF materials [Kozima 2013].
9. Justification of the phenomenological approach using the TNCF and the ND models to the CFP by inductive logic and the meta-analysis [Kozima 2019c].

II. Martin Fleischmann – A Great Scientist who discovered the Cold Fusion Phenomenon

In this section, we follow the Fleischmann's idea which lead to the discovery of the cold fusion phenomenon (CFP) through his papers.

We know that *anyone can't be omnipotent*. Even Martin Fleischmann is, regrettably, not its exception. He had been uncomfortable in the $d - d$ fusion reactions at several points* but remained there without stepping over its conceptual barrier to a mechanism applicable not only to deuterium systems but also to protium systems.

*There are several sentences showing his insight into new mechanisms for the CFP. Followings are some of them cited from his papers referred in this paper.

"*The most surprising feature of our results however, is that reactions (v) and (vi) are only a small part of the overall reaction scheme and that the bulk of the energy release is due to an hitherto unknown nuclear process or processes) presumably again due to deuterons)*." [Fleischmann 1989 (p. 308)]

"*In the development of any new area of research (and especially in one likely to arouse controversy!) it is desirable to achieve first of all a qualitative demonstration of the phenomena invoked in the explanation of the observations. It is the qualitative demonstrations which are unambiguous: the quantitative analyses of the experimental results can be the subject of debate but, if these quantitative analyses stand in opposition to the qualitative demonstration, then these methods of analysis must be judged to be incorrect.*" [Fleischmann 1991 (p. 476)]

"*An important key to the understanding of the system is given by the strange properties*

of D (and of H and T) in such lattices. We must ask: how can it be that D can exist at a ~ 100 molar concentration and high supersaturations without forming D_2 in the lattice? How can it be that D diffuses so rapidly thorough the lattice (diffusion coefficient > 10^{-7} cm^2s^{-1} greater than that of either h or T!) whereas He is practically immobile? The answer to the last questions, of course, that deuterium is present as the deuteron whereas ^4He does not form α-particles." [Fleischmann 1991 (p. 485)]

In *Appendix A*, we have collected several sentences showing Fleischmann's ideas on the CFP; there are his interesting ideas from the original simple one resulted in the paper published in 1989 to later ones speculating possible mechanisms for various experimental data obtained in the progress of the science in this field. Short explanations are given for each sentences from my point of view at present by an afterthought.

III. Problems related to the "*the Energy Crisis in the 21st Century*"

In this section, we focus on the financial phase of the scientific research in modern society which has given enormous effects on the cold fusion research.

The financial support to scientific researches has been a fundamentally important problem to promote the research programs in the modern society. We have given a short investigation on this problem [Kozima 2017].

In the discovery and development of the CFP, there are shadows of this problem from the first up to present. The financial faces of the CF research until 1990 had been written in the DOE Report I published in 1989 [DOE 1989] and also written by Taubes [Taubes 1993] and by Huizenga [Huizenga 1992]. The same problem after 1989 until 2004 appeared in the DOE Report II published in 2004 [DOE 2004].

III-1. DOE Report I [DOE 1989]

The shortcomings of the DOE Report I were discussed in my book published in 1998 [Kozima 1998 (Sec. 1.2 DOE Report), 2016a (Sec. 2 DOE Reports 1989 and 2004)] as follows;

"*The Committees in the Department of Energy had been composed of experts in relevant fields to the CFP and their technical opinions should be esteemed. It should, however, be pointed out limitations imposed on them by their duty different from the researchers in this field. Their duty binds them to confine their sight and also their expertise limits their investigation of the data of the CFP inside their field preventing extension of their sight*." [Kozima 2016a (p. 163)]

""*Let us point out mistakes in the DOE report.*

Conclusion (1) is based on Conclusions (2) ~ (5), and it has no basis if Conclusions (2) ~ (5) are incorrect. The issue of excess heat and fusion products discussed in Conclusion (2) has significance only when D + D reaction is assumed as the main process. This assumption was adopted by the majority of the scientists at that time, including those who discovered cold fusion.

If there is some other mechanism governing the process, this argument is no longer valid. If you are searching for truth, whether one assumption made by a scientist is correct or not has no importance. You should search for the truth based on the fact that the phenomenon did occur. From this point of view, we will show, in Chapters 11 and 12, that it is possible to explain the results of cold fusion experiments without any inconsistency.

Conclusion (3) was based on the fact that the cold fusion phenomenon presented poor reproducibility. However, the reproducibility of a phenomenon is determined by the condition of the entire system, in which the process takes place. Simple analogy from other physical phenomena should not have been used to draw a conclusion. We will also show the reasons for the poor reproducibility and the way to improve it in Chapters 11 and 12.

Conclusion (4) only shows that the interpretations of the discoverers of cold fusion were not appropriate, and it has nothing to do with the truth. It is hard to believe that board members have made such an elementary mistake. It was found later that inside solid, such as Pd or Ti, with a combination of various factors, complex phenomena can occur. There is always such possibility in science. Today, it is quite obvious to everybody. The board members might have forgotten for some reason that natural science is built upon the fact.

Conclusion (5) is similar to Conclusion (4). If any new findings had been denied only because they were contradiction with the existing knowledge, there would have been no progress in science and there will not be any progress in the future.

The discussions expressed in the DOE Report remind us Procrustes' bed. As Procrustes used his bed as an absolute standard to measure heights of his captives, the critiques against the cold fusion used d – d reaction as an inevitable standard to judge anomalous events." [Kozima 1998 (pp. 3 - 7)]

It is difficult to evaluate scientific works without a right point of view even if he/she has enough knowledge about the theme of the works.

III-2. DOE Report II [DOE 2004]

Almost 15 years since the DOE Report I, several scientists in the U.S.A. asked their

Department of Energy to reconsider the evaluation issued in 1989.

The DOE Report 2004 [DOE 2004] has a different character from that of 1989. The new *Report* was issued according to the request presented by several CF researchers as a document [Hagelstein 2004].

"'*The Department of Energy's (DOE) Office of Science (SC) was approached in late 2003 by a group of scientists who requested that the Department revisit the question of scientific evidence for low energy nuclear reactions. In 1989 Pons and Fleischman first reported the production of "excess" heat in a Pd electrochemical cell, and postulated that this was due to D-D fusion (D=deuterium), sometimes referred to as 'cold fusion.' The work was reviewed in 1989 by the Energy Research Advisory Board (ERAB) of the DOE. ERAB did not recommend the establishment of special programs within DOE devoted to the science of low energy fusion, but supported funding of peer-reviewed experiments for further investigations. Since 1989, research programs in cold fusion have been supported by various universities, private industry, and government agencies in several countries.*' [DOE 2004]"

According to the limited evidences given to the DOE as clearly written in the above *Abstract*, the material is confined to the "*The experimental evidence for anomalies in metal deuterides"* and does not include the data obtained in the protium systems. Therefore, the material given to the DOE is necessarily an incomplete one to show the cold fusion phenomenon as a whole. However, the Report [DOE 2004] had merit to evaluate positive phases of the CF researches after the DOE Report 1989 [DOE 1989].

"Conclusion of DOE is cited as follows;
"*While significant progress has been made in the sophistication of calorimeters since the review of this subject in 1989, the conclusions reached by the reviewers today are similar to those found in the 1989 review.*
The current reviewers identified a number of basic science research areas that could be helpful in resolving some of the controversies in the field, two of which were: 1) material science aspects of deuterated metals using modern characterization techniques, and 2) the study of particles reportedly emitted from deuterated foils using state-of-the-art apparatus and methods. The reviewers believed that this field would benefit from the peer-review processes associated with proposal submission to agencies and paper submission to archival journals." [DOE 2004]

It should be cited one of the positive comments in the Report as follows;

"*It is now clear that loading level and current density thresholds are required in order to observe excess heat in these experiments. The values are consistent regardless of the approach used and the laboratory where the experiment was conducted. Early failures to reproduce the heat effect were, in part, due to not meeting these requirements. It has also been found that thermal and current density transients, which are thought to effect the chemical environment such as deuterium flux, can trigger heat "events". SRI has published an expression for the correlation between excess power and current density, loading, and deuterium flux. These discoveries have led to a better understanding of the phenomena and more reproducibility*." (Reviewer #9)" [Kozima 2016a (pp. 164 – 165)]

Even if the nuclear transmutation in the CFP was excluded from the investigation by experts in the *review team* of DOE, the partial positive evaluation given in their Report was encouraging to the cold fusion society.

III-3. Two Books by Huizenga [Huizenga 1992] and Taubes [Taubes 1993]

The unpleasant episodes about the financial support around researchers described by Taubes in detail in his book [Taubes 1993] and the movement in the State of Utah to establish the National Cold Fusion Institute described by Huizenga [Huizenga 1992 (Chap. X)] had made the atmosphere around the cold fusion research dark or even black. These episodes had given very strong negative influence about the CFP on scientists all over the world.

Some examples of the negative influence are seen in book reviews for these books. The scientists wrote these reviews by only reading the books by Huizenga [Huizenga 1992] and Taubes [Taubes 1993] without reading original papers and contemplating experimental data written there. Even if a scientist is trained in one of established branches of modern science, it is not easy to understand the pioneering work in a truly novel field of researches if he/she don't use his/her scientific spirit for the field which is alien to him/her.

It should be remembered that there is a scientist in the Cold Fusion Panel in the U.S. Department of Energy who insisted to add several words on reservation to deny the existence of the cold fusion events making the preamble as follows;

"A. Preamble

Ordinarily, new scientific discoveries are claimed to be consistent and reproducible; as a result, if the experiments are not complicated, the discovery can usually be confirmed or disproved in a few months. The claims of cold fusion, however, are unusual in that even the strongest proponents of cold fusion assert that the experiments, for unknown reasons, are not consistent and reproducible at the present time. However, even a single short but

valid cold fusion period would be revolutionary. As as a result, it is difficult convincingly to resolve all cold fusion claims since, for example, any good experiment that fails to find cold fusion can be discounted as merely not working for unknown reasons. Likewise the failure of a theory to account for cold fusion can be discounted on the grounds that the correct explanation and theory has not been provided. Consequently, with the many contradictory existing claims it is not possible at this time to state categorically that all the claims for cold fusion have been convincingly either proved or disproved. Nonetheless, on balance, the Panel has reached the following conclusions and recommendations" [DOE 1989 (V. Conclusions and Recommendations, A. Preamble, p. 36), Kozima 1989 (Sec. 1.2 DOE Report), 2016a (Sec. 2)]

IV Conclusion

The history of the CF research in these 30 years since the observation of a part of the CFP induced by nuclear reactions in a CF material is a typical story of discovery of a new science. There had been no framework to put the events in it and we had to treat them by trial-and-error. In the processes of trial-and-error, there were many unintentional errors which might be, regrettably, supposed intentional. The social condition for scientific activity in modern times has been severe asking shortsighted success for investment which is not fit with science.

I have endeavored to give a unified scientific explanation for the complicated variety of experimental data obtained in various CF materials. Fortunately, the phenomenological approach using a model with the trapped neutrons in CF materials could explain experimental data qualitatively and sometimes quasi-quantitatively. As summarized in Section I, our trial on this line developed to enclose whole phases of the CFP. I hope that my system of explanation for the CFP thus established may be, at least, a tiny step to establish the solid state-nuclear physics even if I remember in my mind a sentence I wrote above *anyone can't be omnipotent*. However, I would be behind the words "*to err is human; to forgive, divine*."

Appendices

Appendix A.

Martin Fleischmann on the Cold Fusion Phenomenon

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[**Fleischmann 1989**] M, Fleischmann, S. Pons and M. Hawkins, "Electrochemically induced Nuclear Fusion of Deuterium," *J. Electroanal. Chem*., **261**, 301 – 308 (1989), ISSN: 1572-6657.

[**Fleischmann 1990**] M. Fleischmann, "An Overview of Cold Fusion Phenomena," *ICCF1 lecture* (March 31. 1990, Saturday), *Proc. ICCF1*, pp. 344 – 350 (1990).

[Fleischmann 1991] M. Fleischmann, "Present Status of Research in Cold Fusion," *Proc. ICCF2, Addition to the Conference Proceedings,* pp. 1 – 10 (1991), ISBN 88-7794-045-X.

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[Fleischmann 1998b] M. Fleischmann, "*Cold Fusion: Past, Present and Future,*" *Proc. ICCF7*, pp. 119 – 127 (1998). ENECO Inc., Salt Lake City, Utah, USA.

[Fleischmann 1989]

Martin Fleischmann had considered the realization of the dream F. Paneth dreamed 70 years ago that deuterons will fuse in a palladium metal where they are occluded with a very high concentration.

"*A feature which is of special interest and which prompted the present investigation, is the very high H/D separation factor for absorbed hydrogen and deuterium. This can be explained only fi the* H^+ *and* D^+ *in the lattice behave as classical oscillators (possibly as delocalised species) i.e. they must be in very shallow potential wells. In view of the very high compression and mobility of the dissolved species there must therefore be a significant number of close collisions and one can pose the question: would nuclear fusion of* D^+ *such as*

$^2D + {}^2D \rightarrow {}^3T\ (1.01\ MeV) + {}^1H\ (3.02\ MeV)$ (v)

$^2D + {}^2D \rightarrow {}^3Te\ (0.82\ MeV) + n\ (2.45\ MeV)$ (vi)

be feasible under these conditions?" ([Fleischmann 1989 (p. 302)]

However, it is interesting to notice following sentences in the same paper:

"*The most surprising feature of our results however, is that reactions (v) and (vi) are only a small part of the overall reaction scheme and that the bulk of the energy release is due to an hitherto unknown nuclear process or processes) presumably again due to deuterons)*." [ibid. (p. 308)]

His motivation to this experiment published as a *preliminary note* in the *Journal of*

Electroanalytical Chemistry was printed in his later article [Fleischmann 1993a].
The controversial contents of this paper in addition to other data obtained following few years had been consistently analyzed by the TNCF model [Kozima 1997].

[Fleischmann 1990]
"- - - *We, for our part, would not have started this investigation if we had accepted the view that nuclear reactions in host lattices could not be affected by coherent processes. The background to this research has been presented from the point of view of the behavior of* D^+ *in palladium cathodes since this has been our exclusive concern. A somewhat different account would be relevant to the behavior of deuterium in titanium, the other system which has been the subject of intensive research following the description of the generation of low levels of neutrons during cathodic polarization*." [Fleischmann 1990 (p. 347)]
"*It is now also essential to broaden the base of the research to include both the quantitative evaluation of the effects of the many variables leading to the control and optimization of particular outputs (compare*[46] *) and the extension of the range of systems showing the various effects. For the Pd-D system the central conundrum, the disparity of the excess enthalpy generation and of the expected nuclear products according to reactions (i) and (ii) however remains unsolved. It is clear that there must be other nuclear reaction paths of high cross-section and that these will only be discovered by a careful search for products on the surface and in the bulk of the electrodes (as well as in the solution and gas spaces*)." [ibid. (p. 348)]

[Fleischmann 1991]
He seems to have had realized the nature of the CFP and necessity of qualitative approach which had been elucidated in our recent paper [Kozima 2019b].
"*In the development of any new area of research (and especially in one likely to arouse controversy!) it is desirable to achieve first of all a qualitative demonstration of the phenomena invoked in the explanation of the observations. It is the qualitative demonstrations which are unambiguous: the quantitative analyses of the experimental results can be the subject of debate but, if these quantitative analyses stand in opposition to the qualitative demonstration, then these methods of analysis must be judged to be incorrect.*" [Fleischmann 1991 (p. 2)]

He was persisting in the $d - d$ fusion reactions;
"The most rudimentary measurements of the generation of tritium and of the neutron flux

(or rather the lack of it!) show that the nuclear reaction paths

$^2D + {}^2D \rightarrow {}^3T$ (1.01 MeV) + ^1H (3.02 MeV) (i)

$^2D + {}^2D \rightarrow {}^3Te$ (0.82 MeV) + n (2.45 MeV) (ii)

which are dominant in high energy fusion (and which have roughly equal cross-sections under those conditions) contribute to only a very small extent to the observed phenomena.

We reach the conclusions:

i. The lattice has an important influence on the nuclear processes;
ii. The observed processes are substantially aneutronic;
iii. The generation of excess enthalpy is the main signature of these new nuclear processes." [Fleischmann 1991 (p. 4)]

He was aware of the correlation between the super-diffusivity of D in Pd and the CFP in it.

"*An important key to the understanding of the system is given by the strange properties of D (and of H and T) in such lattices. We must ask: how can it be that D can exist at a ~ 100 molar concentration and high supersaturations without forming D_2 in the lattice? How can it be that D diffuses so rapidly thorough the lattice (diffusion coefficient > 10^{-7} cm^2s^{-1} greater than that of either h or T!) whereas He is practically immobile? The answer to the last questions, of course, that deuterium is present as the deuteron whereas ^4He does not form α-particles*." [Fleischmann 1991 (p. 9)]

This point has been explained in our recent paper [Kozima 2019c].

[Fleischmann 1998a, 1998b]

He explained his basic concept of his experiment on the CFP done before 1989.

"*In 1983, Stanley Pons and I posed ourselves the following two question:*

i) Would the nuclear reactions of deuterons confined in a lattice be faster (and different) from the fusion of deuterons in a plasma?

ii) Could such nuclear reactions be detected?" [Fleischmann 1998a]

He was adhered to the *d – d* fusion reactions and looking for a mechanism to realize them in solids. He considered the Q.F.T (quantum field theory) is the savior for his expectation:

"- - - *The scientific importance lies in the fact that whereas the Bohm-Aharanov Effect is a clear demonstration of the need to replace the C.M. (classical mechanics) by the Q.M. (quantum mechanics) paradigm, the Coehn-Aharanov Effect (indeed, "Cold Fusion" in general) is a demonstration of the need to go one step further to the Q.F.T. (quantum field theory) paradigm*." [Fleischmann 1998b (p. 123)]

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(On March 23, 2019 at the 30th Anniversary of the Discovery of the CFP)