The Science of Low Energy Nuclear Reaction: A Comprehensive Compilation of Evidence and Explanations about Cold Fusion by Edmund Storms. Singapore: World Scientific Publishing Co. Pte. Ltd., 2007. 312 pp. $71.00 (hardcover) ISBN-13978-981-270-620-1.

"Cold fusion" refers here to the claim that by simple electrolysis of heavy water with some electrolyte, the deuterium ions (deuterons) that accumulate inside palladium or some other metal can be made to fuse. This surprising claim was made by Fleischman, Pons, and Hawkins (1989) and, almost concurrently, by Jones et al. (1989). Much has been said about this subject, which has become a scientific "affair" of sorts, with most mainstream scientists refusing to accept the reality of cold fusion, and a smallish band of researchers continuing work and indeed publishing their findings. The present author began to collect a bibliography (hereafter, the Bibliography) of the literature in 1989 (see http://www.chem.au.dk/~db/fusion), including only papers in refereed journals, and the present count is 1367. As many as 30 books have been published on the subject. Of these, not all are notable, some being hasty productions or having clear weaknesses, but some stand out. Some of these were written by proponents of the phenomenon, and some by skeptics. Most of the books were written by people who have not themselves worked on the phenomenon, some being science journalists or enthusiasts without a scientific background.

Two books written by adherents of cold fusion stand out in that they were written by people active in "normal" science, with solid research records, and who have themselves done research on cold fusion. One of them was by T. Mizuno (1997), an electrochemist, and the other by radiochemist Edmund Storms, whose book is the subject of this review. It must be recalled that the claim of cold fusion is astonishing to anyone with a smattering of knowledge of physics. The fusion of deuterons is resisted strongly by electrostatic forces keeping these positively charged particles apart. Fusion can be achieved by heating a plasma (hot fusion), and theoretical studies of the expected rate of fusion at low temperatures, as obtains in an electrochemical cell, predict rates so low that nothing will be detected. There are, then, good reasons for being skeptical of cold fusion claims. A book such as this one, however, makes a strong case for cold fusion, not only by the results presented, but also by the impression the reader gets of the writer. Storms is a working scientist, and this shows clearly in the book. He begins with a clear statement that he is convinced of the reality of cold fusion (preferring to call it low energy nuclear reaction or LENR). He is not—like some proponents of the phenomenon—oblivious to the weaknesses of many claims, that is, he shows the proper critical attitude of a normal scientist and will (mostly) not accept unsound evidence. Much shoddy work has been done in the field, but after eliminating this, some evidence remains that leaves the skeptic in a quandary; the phenomenon is unlikely to be real for many reasons, but there is much evidence nevertheless that it may be. Storms does his best to point out such evidence based on his own work. The book contains an interesting account of his own work, and to a practising scientist, he conveys a true picture of science as it is done; it rings true to someone who is a working scientist.

The book is divided into ten chapters and six appendices. It begins with an overview, a brief history of the field and (Chapter 3) a description of Storms's own work. The book's strength lies here, and the scientific reader will feel at home. Chapter 4 outlines what is known or believed; Chapters 5 and 6 focus on where cold fusion might occur and how perhaps to affect or even initiate it by means of experimental parameters. Chapter 7 considers fusion products and their detection, and, in the last chapters, Storms looks at some theories, the future of the field, and, in Chapter 10, provides a brief summary. Each chapter has its own bibliography, with Chapter 4 having a massive 646 citations.

The claims by Fleischman, Pons, and Hawkins and of Jones *et* al. immediately engendered an embittered controversy between the "believers" and the "skeptics", with arguments and evidence not always strong on either side. In general, one should be wary of blank pronouncements by scientists that something is impossible, and as Storms points out, although there is as yet no good theory of cold fusion, the experimental evidence is not easy to dismiss (in his view, it proves the phenomenon real beyond doubt). As mentioned above, the Bibliography has over 1300 entries. Compared with other fields that appeared around the same time, such as high temperature superconductivity, however, this is not a large number. The Bibliography also shows that the publishing rate rose sharply initially, but fell roughly exponentially thereafter, similar to the polywater affair (Franks, 1981), a curve that has been likened to the course of an epidemic (Bennion & Neuton, 1976). Many journal editors flatly refused papers on cold fusion, and some referees probably rejected papers not so much on the basis of the evidence presented, but on the basis that cold fusion simply must be an error. It must also be said that many cold fusion papers submitted (and published) have been of poor quality and deserved to be rejected. Storms agrees with this. The result has been that in recent years, although some work is still appearing in mainstream serious journals, most work now appears in enthusiast journals, where refereeing probably is not very strict. If these articles were counted (which they are not in the Bibliography), then several thousand papers have been published. Storms himself has published some of his work in these journals, no doubt tired of unfair rejections by the normal journals.

When two deuterons fuse (against a strong electrostatic barrier), there are three branches along which the reaction can proceed, two of them the most probable. One branch leads to tritium and a proton, the other to helium-3 and a neutron, and the third branch, normally occuring with a frequency of only 10^{-7} that of the other two, to helium-4 and highly energetic gamma emission. In all cases, the end result is particles carrying extra energy corresponding to lost mass to be dissipated in various ways. This all happens in "normal", that is, hot, fusion. Skeptics argue that all emissions must be present, while prononents point to one or two of them as proof, or they say that the process may not be the fusion of deuterons, but some "hitherto unknown nuclear process" (Fleischman Pons, & Hawkins, 1989). They insist that experimental observations are paramount, and the lack of theory will be made up later. Storms takes this view, hence his use of "LENR".

Storms' own work concentrates on tritium production and "excess heat". Storms was ideally placed at the Los Alamos National Laboratory (LANL) to detect tritium. When a solution of an electrolyte in heavy water is electrolysed at length, deuterium gas is given off but also some tritium, contained as an impurity in the heavy water (and perhaps also in the palladium). Storms is careful to account for these sources. His findings are interesting: excess tritium appears first in the electrolyte, not in the effluent gas, indicating that it is produced at the palladium electrode. Storms was careful to perform control experiments aimed at eliminating environmental effects (at LANL, there might occasionally be tritium in the air) and convincingly shows that they were indeed accounted for. Similar results were obtained by Will, Cedzynska, & Linton (1993), equally competently obtained, and the skeptic is hard put to reject these results.

Excess heat is measured with a calorimeter. There is current passing through an electrochemical cell, with a voltage across it, producing an input power, and the electrolysis reaction absorbs some of this power at a well-known rate. Effluent deuterium and oxygen might carry off some heat, and heat is both radiated and conducted away from the cell. To keep track of all this is not trivial, and Storms became expert in calorimetry over the course of years, as problems were found, some of them by skeptics and addressed by him, carefully doing control experiments to assess the magnitude of interference effects. One of them is the way the temperature inside the cell is measured. There may be temperature gradients inside the cell, and this problem can be overcome by a better calorimeter design, as was done by Storms. If in the accounting of the known input and the measured output powers there is an excess, this indicates the presence of some phenomenon producing heat. One problem is the irreproducibility of the effect; only some electrodes show it and not all the time. This is one of the strong points that skeptics make. A new effect must be reproduced by others, and this has not been done to the skeptics' satisfaction, even after almost 20 years. Reproducibility can only be achieved, however, when we understand all the factors at work, which is not the case here, so irreproducibility itself does not invalidate cold fusion. Needless to say, Storms tried many different variables: various sources of the palladium, how best to vary current with time, how best to load the palladium with deuterium, what loading degrees are needed, and surface treatment of the metal before the experiment. The results do not yet give a very clear picture.

So the book makes a good case for cold fusion. There are some weaknesses. Some of the figures are poorly done, and the text is often awkward. Some expert criticism of Storms' calorimetry (Shanahan, 2006) is not mentioned, and there is some imbalance in attribution: to some extent, The work by Jones's team is deemphasised in favour of that of Fleischman and Pons's team. Storms is not good especially with foreign names, mangling some of them, and Kirk Shanahan, one of his staunch critics, appears as "Kurt Shanahan" in the Index. Storms suggests the fusion of up to six neutrons with some nuclei, which will surprise many. The term "enthusiast" applies to Storms. The word "amazing" is seen six times in the book, and his critical attitude does seem to lapse at times. For example, he appears to accept what has been called "biological fusion" (Kervran, 1972), which is even less likely to be real than cold fusion, and even suggests that it might be behind spontaneous human combustion; and he also accepts claims by Mills & Kneizys (1991) of electron orbitals of the hydrogen (or deuterium) atom below the ground level, although here Storms appears to be a little skeptical, admitting that there is a lack of theory (which can equally well be said of cold fusion). In Chapter 9, he writes "... the skeptics went to war—a war they have now lost". In the Preface, he writes that cold fusion has now been proved. Many would disagree and remain unconvinced. So, the book is not neutral on the subject. Nevertheless, these weaknesses are comparatively minor and do not detract from the major message of the book, the rather solid experimental evidence of some exotic process taking place, from a careful and self-critical researcher.

What then is the bottom line? This writer is still agnostic with respect to cold fusion because even a thorough worker like Storms has not succeeded in demonstrating the effect at will. This is not to say that we can dismiss cold fusion but simply that we must wait for evidence so convincing that even skeptics must accept it as real. If it indeed is real, then it is subject to parameters that as yet elude most workers in the field. Other newly discovered phenomena have been irreproducible for some time (albeit rarely for 18 years as here) and this alone does not prove it to be false. We shall have to wait and see. The Storms book certainly is recommended reading, for both skeptics and proponents.

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The Megalithic Monuments of Britain & Ireland by Chris Scarre. Thames & Hudson, 2007. 160 pp. $19.95 (paper). ISBN 0-5002-8666-3.

This nicely illustrated book is an up-to-date survey of what is currently known and speculated about the people who settled the British Isles and built the monuments whose icon is Stonehenge and whose construction sometimes demanded massive effort and remarkable organization. What pre-history nowadays learns from applications of science is illustrated by isotopic analysis of human bones, which has revealed, for instance, that in the West of Scotland the Neolithic transition was marked by a sudden change of diet from marine to terrestrial food sources.

The separation of Britain from the Continent after the last Ice Age is sketched. In the Mesolithic, they were still connected by land. The beginnings of agriculture and use of domesticated livestock came after the English Channel had formed around 6500 B.C. Were these Neolithic developments owing to cultural assimilation or to replacement of populations? Increasingly detailed evidence suggests that there may be no single answer for the whole of what is now Britain and Ireland.

That the Channel was no insurmountable barrier is obvious: domesticated animals and plants must have been brought across the water. Agriculture arrived around 4000 B.C, apparently simultaneously with the construction of monuments. However, some scholars believe that at least some of the types of monuments in Britain are homegrown. Their density in some places invites the inference that an aim was to mold or model the landscape, perhaps an insight into a contemporary worldview. That train of thought is followed in such works as *The Archaeology of Natural Places* (Bradley, 2000) and is not necessarily at odds with the huge literature that considers possible astronomical correlates of various megalithic constructions (e.g., Ruggles, 1999).

The famous sites like Stonehenge, Avebury, and Newgrange (in Ireland), which required the efforts of many workers, are numerically a tiny minority; the vast majority of the circles and cairns could have been built by extended families