Radioactivity Reborn

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Before 1896 or maybe 1895, it would have been absolutely unthinkable to suggest that invisible, though still somewhat controversial "atoms," which were imagined to constitute matter, might disintegrate spontaneously. "Disintegrate into what?" might have been the first question, had anyone been so bold as to suggest that matter could decay.

Then came the experiments of Antoine Henri Becquerel (1852-1908) in France, which were inspired by Wilhelm Konrad Roentgen's (1845-1923) remarkable discovery of X-rays in the closing months of 1895. Becquerel had been interested in the phenomenon of fluorescence—as had been his physicist father, Alexandre—but the news of X-rays early in 1896 inspired him to try to discover whether there was a relationship between X-rays and the light from fluorescence. Perhaps fluorescence contained X-rays, he reasoned. It was a logical progression, because the discovery of the astonishing material-penetrating X-rays had come about when Roentgen observed a bright spot on a fluorescence screen that had been placed near a covered, electrified cathode ray tube (electron "cathode rays" had not yet been identified as charged "particles").

So in February 1896 Becquerel placed a fluorescent crystalline material (potassium uranyl sulfate) on a photographic plate that had been covered with paper to exclude light, even ultraviolet light, and exposed it to sunlight to provoke fluorescence. Upon developing the plate, he found that something had fogged it. Perhaps, he thought, the agent was x-radiation. Then a spate of overcast weather intervened, which serendipitously helped him make his remarkable discovery. He had placed the uranium-containing crystalline material on a photographic plate in preparation for sunny weather, but his frustration with the wait for a period of intense sunlight led him to develop the plate before then to see if remnant fluorescence, building up over time, had had any effect on the plate. He was greatly surprised to find that instead of weak fogging, the plate had been strongly affected, even though the compound had not been exposed to bright sunlight. This led him to an intense period of experimentation in which he determined that the uranium compound was giving off a continuous stream of material-penetrating radiation; it was as though X-rays, or something like them, were emanating from the material and it did not require stimulation from sunlight. He found that the rays, like X-rays, could also ionize air. These became known for a time as "Becquerel rays."

It was Marie Curie who in 1898 named the phenomenon "radioactivity," and a new scientific era was in full swing. Albert Michelson's famous statement of 1894 about the "end of the discovery of grand underlying principles" was thereby falsified. He had said: "While it is never safe to say that the future of Physical Science has no marvels even more astonishing than those of the past, it seems probable that most of the grand underlying principles have been firmly established and that further advances are to be sought chiefly in the rigorous application of these principles to all the phenomena which come under our notice." With this episode as background, it is quite amazing that less than a century later, physicists of the caliber of the late nuclear physics professor at MIT, Herman Feshbach, could utter such dangerous sentiments in reaction to evidence coming from the cold fusion field in its early days: "I have had fifty years of experience in nuclear physics and I know what's possible and what's not!" He blurted this out in 1991 to this writer. The more things change, the more they stay the same. . .

Research into the nature of radioactivity, before and after the turn of the century (1900), became a central focus of physics, which led to discoveries that radioactivity encompassed many different kinds of radiations—what would become known as alpha rays (helium nuclei), beta rays (electrons), and gamma rays, etc. It was an intense period of discovery that, in retrospect, looks very similar to the enormous number of discoveries provoked by the "cold fusion" announcement in 1989, but with one major difference. In the early twentieth century, there was no reigning nuclear physics dogma that could tell anyone that any new observation was "impossible." But after the nuclear model emerged from Ernest Rutherford in 1911 with his seminal experiments with gold foils bombarded with alpha particles, a dogma began to set in about radioactivity. The previously unthinkable decay of atoms became known as a phenomenon whose rate could not be changed by any outside influences, such as temperature changes or chemical reactions. The constancy of radioactive decay—the constancy of the so-called half-life, in which one-half of any initial number of radioactive atoms will decay—assumed the mantle of an infallible clock-like system. We recognize this today in the use of radioactive carbon dating, uranium or thorium decay dating, etc. within the fields of archeology and geochronology.

Later this constancy of radioactive decay would supposedly be "explained" in statistical, probabilistic terms by the emerging formalisms of the quantum mechanics revolution. The general idea is this: since charged particles, in particular, would find it impossible, from a *classical* perspective, to penetrate the confining nuclear forces within the atomic nucleus and its surface and then depart as radioactive emissions, there had to be posed the notion that the statistical properties of particle wave functions would allow the particles to "tunnel" through such a strong barrier. This explanation of radioactivity was, by the way, the other side of the coin of the *hot* fusion probability dogma that also eventually set in. This was the assumed necessity to employ the high energies of many, many charged particles bombarding a bare nucleus in a plasma to raise the *probability* of a fusion reaction.

The strength of the constancy-of-radioactivity dogma can be judged from a statement by Rutherford in a lecture in Cambridge, England in November 1936—in those quaint days prior to the discovery of nuclear fission. Here is an extract of his lecture, with the key statements *italicized* by me:

> Suppose in imagination we could obtain a substantial quantity, say a kilogram, of radium emanation [Editor's Note: what we would today call an initial daughter product element.] and introduce it into a heat resisting bomb. At the end of 2 hours, heat would be liberated at a rate corresponding to 20,000 kilowatts and the bomb would be melted unless it were cooled very efficiently. . .
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> While we can predict with certainty the consequences of such an experiment as I have outlined, we are quite unable to realize it in practice, for it would require about 200 tons of radium to supply a kilogram of the emanation, while the total amount of radium so far isolated is probably under 1 kilogram. We may all be thankful too that an experiment on such a scale cannot be actually tried, for the intense emission of energy in the form of penetrating γ-rays, escaping from the bomb, equivalent to 1000 kilowatts, would certainly be dangerous to the health of those in its neighborhood.
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> I hope, however, that such an imaginary experiment may serve to bring home to you the enormous emission of energy in radioactive changes, as well as the striking nature of the transformations which result in the ultimate change of the emanation to helium and uranium-lead. *These radioactive transformations are spontaneous and uncontrollable. Neither intense heat nor extreme cold has the slightest effect on this natural process. We can only watch and study these wonderful changes without being in any way able to alter them.*
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> This process of radioactivity is shown to a marked extent in the two heaviest elements, uranium and thorium, and only in a very feeble degree by a few other elements. The majority of the elements normally show no trace of radioactivity, *so we may justifiably conclude that the atoms of these elements are permanently stable under ordinary conditions in our earth.* During the last few years we have discovered methods not only of changing artificially one element into another, *but also of producing many new radioactive elements which break up according to the same laws as the natural radioactive elements.* This knowledge has only come as a result of intensive research over many years, and the development of new and powerful methods of attack on this most fundamental of problems in Physics.

In light of the low-energy nuclear reactions (LENR) revolution precipitated by the 1989 announcement of "cold fusion," we can now begin to understand how the central radioactivity dogma—so evident in Rutherford's lecture—began to be propagated. Following the ensuing World War, the development of nuclear weapons, and so forth, it was all too easy for physicists to fall into the trap that had befallen their late nineteenth century brethren *before* the discovery of radioactivity. Today, one can consult any modern physics text and find remarkable statements like these: "The constant λ is one of the most important characteristics of each radioactive nuclide: λ is essentially independent of all physical and chemical conditions such as temperature, pressure, concentration, chemical combination, or age of the radioactive atoms." (p. 1145, *The McGraw-Hill Encyclopedia of Physics*, 1993) The same article on radioactivity mentions only a small loophole, by inference to be thought of as unimportant, the example given involves niobium: "There are a few cases where measurable effects are observed for different chemical combinations. One of the largest observed is a 3.2% change in λ for the 24-s isomer in ^{90}Nb."

Now we come to the landmark papers of Otto Reifenschweiler, which we are proud to publish in this issue. The first and shorter one has been posted on www.lenr-canr.org, following its initial submission to *Infinite Energy*. The second, longer paper, "Further Evidence of the Decrease of Tritium Radioactivity by a Thermodynamic Evaluation of a Heating Experiment," sets forth compelling chemical equilibrium arguments that some fraction of radioactive tritium atoms in the experiment must have had their decay constant, λ, brought to zero—*that is, their radioactive decay stopped by the thermal conditions*—while another fraction of the present tritium atoms retain their normal decay rate. These conclusions are based on very puzzling data that Reifenschweiler obtained in the late 1950s at the Philips Research Laboratories, Eindhoven, The Netherlands, in the course of studying Geiger-Müller counters. Reifenschweiler had known how challenging were his observations that heating could alter the apparent decay of tritium atoms. He first published his work in 1994 in the prestigious European journal *Physics Letters A* ("Reduced radioactivity of tritium in small titanium particles," Vol. 184, pp. 149-153). He published a more extensive account in *Fusion Technology* in 1996.[1] It took the uproar over cold fusion research to prompt him to return to his original data and ponder their implications. He was led to the hypothesis that the pairing of tritium atoms could somehow reduce the decay constant of the inherent radioactivity. He further suggested that this bore some relation to the underlying mechanisms of the alleged cold fusion of deuterium.

It should be no surprise to readers of *Infinite Energy* that his devastatingly heretical 1994 paper fell upon deaf ears in the physics community. It created quite a stir in the cold fusion community, however, but I have noticed that since then little reference to it has occurred. It is as though this startling phenomenon may not be secure enough to be admitted as a full-member of the House of LENR and discussed regularly as one of the defining boundary conditions of the LENR phenomena. Perhaps this is because the mainstream cold fusion theorists know how potentially dangerous this work is to their rather narrowly channeled conceptions of metal lattice-induced nuclear reactions. After all, a nuclear reaction per se is supposed to result in an outcome of fixed products, but Reifenschweiler showed in 1994 that the heating of the titanium-tritide compound resulted in first a drop in the decay rate by an astounding 40%, and then a rise back to the original levels of decay as the temperature further increased! This is definitely not "mainstream" cold fusion material. Reifenschweiler emphasized in his 1996 paper, however, his strong suspicion that the two phenomena were related: "For the present we have two different effects: cold D-D fusion and a decrease in tritium radioactivity. However, there is a strong suspicion that the same or a related fundamental principle underlies both effects: Atoms (nuclei) of hydrogen isotopes are bound in suitable metals, and nuclear properties are changed in a manner not understandable." In still later papers,[2,3] Reifenschweiler examined independent evidence gathered by others, connected with much heavier atoms than tritium—zinc, nickel, and strontium. He concluded that additional strong anomalies in radioactive decay were being induced by chemical and thermal effects. However, the experimenters involved found it too difficult to suggest that something more fundamental might be at work, which is not surprising at all. In my view, related anomalies of element changes and isotope anomalies permeate a great deal of modern chemistry and physics experiments—and possibly biological ones too; they are not recognized because the paradigm stretch would be too large for more conventional researchers to accept.

Ponder the possible implications for vaunted quantum mechanics from the original Reifenschweiler work alone, as far as QM's stochastic dogma tries to apply itself to the atomic nucleus. What possible explanation can QM experts, even the relatively open-minded ones within LENR, offer to the idea that the possible chemical and thermal environment of tritium atoms can somehow radically distort—in an on/off fashion, no less!—the supposedly inexorable statistics of instability of the tritium nucleus, not to forget the evidence that Reifenschweiler assembles for heavier nuclei? It may be that all these experiments are more radically profound than even Otto Reifenschweiler has been willing to imagine.

The implications are staggering: a possible glaring flaw in quantum mechanics, revealed in simple thermal experiments with decaying nuclei; possible foundational flaws in the Second Law of Thermodynamics (Reifenschweiler uses the Second Law as a constraint in his formulations); possible/probable large error sources in archeological and geochronological dating methods; and potential astrophysical anomalies of all manner coming under the umbrella of chemi-thermal changes to radioactivity. The 1890s experiments that launched twentieth century physics on its path were no more profound than the alchemical-like experiments within LENR today, and the thermal-related anomalies that Reifenschweiler has so well documented and assessed.

We are evidently far from understanding all that we need to know of the inner working of nuclei in order to develop New Energy sources that transcend conventional fission and hot fusion schemes. Rutherford in his 1936 lecture[4] said this: "We are far from understanding the structure of a complex nucleus and why it breaks up under certain conditions. While wave mechanics is adequate to explain the outer electronic structure of the atom when electrons are well separated, the theory cannot be applied with confidence to a complex nucleus when there is such an extraordinary concentration of massive particles in a very small space." Later there emerged an era of arrogant satisfaction with textbook nuclear models that could prompt a Feshbachian know-it-all attitude, although as late as 1961 a textbook author could write humbly about the nucleus[5]: "Despite great progress in recent years, the nature of the forces acting between its various parts is not completely known. Furthermore, it is not even certain that quantum mechanics will provide a completely adequate technique for evaluating the effects of these forces when they are finally known. . .An unavoidable consequence of this is that a discussion of the nucleus must lack much of the coherence which characterizes discussion of the atom. On the other hand, it is just the fact that everything about the nucleus is not yet understood that makes the subject particularly interesting." In point of fact, neither atomic theory nor nuclear theory as they are now constituted are likely to survive the coming upheaval.

Otto Reifenschweiler has long since retired from Philips Laboratories, and has been pursuing his work on radioactivity independently since then. Fortunately, his mind is active and he even took time during the preparation of his *Infinite Energy* paper to go skiing in Switzerland. I trust and hope that he will live long enough to see the fruits of his work affect the world of physics in a big way as radioactivity is, indeed, reborn.

References

1. Reifenschweiler, O. 1996. "Some Experiments on the Decrease of Tritium Radioactivity," *Fusion Technology*, Vol. 30, November, 261-272.

2. Reifenschweiler, O. 1997. "About the Possibility of Decreased Radioactivity of Heavy Nuclei," *Fusion Technology*, Vol. 31, May, 291-299.

3. Reifenschweiler, O. 1998. "Solid State Environment Effects on Radioactivity," *Radiation Physics Chemistry*, 51, 4-6, 327-334.

4. Rutherford, E. 1937. *The Newer Alchemy: Based on the Henry Sidgwick Memorial Lecture Delivered at Newnham College Cambridge, November 1936*, Cambridge University Press.

5. Eisberg, R. 1961. *Fundamentals of Modern Physics*, John Wiley & Sons, New York, p. 559.

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