A New Theory for Important New Technologies

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This paper responds to two of the 2010 NPA Conference offerings: **1)** a presentation concerning the current status of 'Cold Fusion', and **2)** a paper discussing the properties and behavior of 'Brown's Gas'. The objective of the present paper is to provide a unified theoretical understanding of the experimental facts from both of those technologies. The basis for this theoretical understanding has been developing for about ten years, with most of the foundational ideas having been introduced at earlier NPA conferences, and then presented in a variety of other venues, under the general title 'Algebraic Chemistry'. The experimental facts of Cold Fusion and of Brown's Gas appear to be consistent with the theoretical framework provided by Algebraic Chemistry. That framework now promises to offer practical guidance on matters such as choosing materials, conditions, *etc.*, to maximize the efficiency of the new technologies.

1. Introduction

The 2010 Conference of the NPA featured a good number of new technologies in its written papers, oral presentations, and laboratory demonstrations. The motivation for this report to NPA arises from two of those technology reports [1,2]. Those works discussed some fascinating technology developments in the production and storage of energy.

Ref. [1] deals with 'cold fusion' (CF). Despite unremitting derision from mainstream science, CF technology has been nurtured and developed over several decades with support from the US government, administered through the US Navy. From that effort, we can conclude that CF indeed exists, and that it can eventually be exploited. But it isn't fully explained yet.

Ref. [2] deals with 'Brown's gas'. Brown's gas involves a meta-stable, un-polarized, linear isomer of the water molecule, which, upon impact with a metallic target, reverts to the normal bent sate of the water molecule, and delivers a jolt of energy sufficient to accomplish some cutting or welding jobs. But what actually goes on in this process is not yet very well known, at least publicly.

I believe these two technologies are related, in that a linear isomer of heavy water should enable cold fusion to occur. The reason why is that the linear isomers have a different configuration of electrons than the usual tetrahedral isomers have. The linear isomers leave naked protons, or deuterons or tritons, in exposed positions where they can encounter each other without interference from electrons. The heavy ones are thus encouraged to fuse.

In developing this argument, I am applying research about which I am currently writing a book for Nova Science Publishers [3]. This NPA paper will be the basis for one of the book Chapters. The research area is characterized as 'Algebraic Chemistry' (AC). AC is a computationally convenient approach to the study of atoms that an appropriately updated Special Relativity Theory (SRT) can support. I have reported about the on-going research at several earlier NPA meetings [4-7]

Because AC is really all about electron configurations, it is very well positioned to comment on the developing technologies discussed in [1] and [2].

2. History Leading to Algebraic Chemistry

At the turn of the 20th century, it was believed that a fundamental incompatibility existed between Newton's theory of mechanics and Maxwell's theory of electromagnetism. One theory seemed to require Galilean transformations between different observers, whereas the other theory seemed to require Lorentz transformations between different observers. The newer apparent requirement was selected for fulfillment, and that choice set us on the path to Special Relativity Theory (SRT), and then General Relativity Theory (GRT).

However, at practically the same moment, Quantum Mechanics (QM) was born. A new incompatibility was immediately created. QM is a rather holistic theory, featuring spatially extended systems, with instantaneous statistical correlations. SRT is a rather reductionist theory, featuring point particles, communicating only by light-signal 'bullets', which always travel at finite speed c.

At the present time, QM is considered the best foundation from which to approach Chemistry. So we have Quantum Chemistry (QC). QC is, however, not very easy to use. The calculations involved are complex and computer intensive. That situation invites development of additional approaches that could be equally insightful but less computationally demanding. AC is one such additional approach.

In the early 20th century, the Hydrogen atom was the prototype for the development of QM for all atoms, and hence for QC. Today, the Hydrogen atom is also the basis for AC. Both theories suppose that the basic ingredients of any atom are a positively charged nucleus and a negatively charged population of electrons.

But from there on, QC and AC diverge, at least in method, if not in final conclusions.

In the Hydrogen atom, there is just one electron, which at the beginning of the 20th century was viewed as a point particle; *i.e.*, localized. In QM, it quickly became de-localized. Particles be-

came waves, and waves were described by the Schrödinger wave equation. There were multiple solutions, corresponding to different 'single-electron states' (SES's). To deal with trans-Hydrogenic atoms, QC puts together multiple SES's.

By contrast, AC hangs on to the idea of localization. We suppose that the electron population of any atom is, at any given moment in time, somewhat localized in space. We treat the whole electron population as a sub-system, with overall attraction to the nucleus, plus some internal interactions whose details we do not know a great deal about, but whose consequences we can nevertheless predict based on patterns in available data.

This approach has worked quite well so far. That means we may have in hand some good clue about what Nature inevitably does, and can use that knowledge to try to explain some aspects of the emerging technologies.

3. Patterns in Available Chemistry Data

Here I want to recall the particular data that I have presented in increasingly better form in [1-4], and am here preparing for [5]. The information concerns ionization potentials (IP's) of atoms, and the numerical patterns that they adhere to.

IN AC, the electron population as a whole is regarded as an orbiting body, albeit a sub-system kind of body, with Z individual parts, where Z is the nuclear charge number, equal to the electron count for a neutral atom.

The proposed localization of the electron population suggested to me that a pattern, if one existed, would emerge when the raw data on ionization potentials were scaled by M/Z, where M is the nuclear mass number. The rationale was that M/Z scaling would convert raw ionization-potential data from being element-specific into being population-generic. After scaling the raw data by M/Z, I went looking for a pattern in the data about ionization potentials.

Figure 1 depicts the behavior of the M/Z-scaled ionization potentials, called 'IP's', for all elements (nuclear charge $Z=1$ to $Z=118$ shown). It includes not only first-order IP's, but also IP's of higher ionization order, IO, up to 7, the limit for readily available data. That being the limit, Fig. 1 has less than 400 out of approximately 5000 desired data points. Now and always, I welcome any additional data that readers might possess or know about.
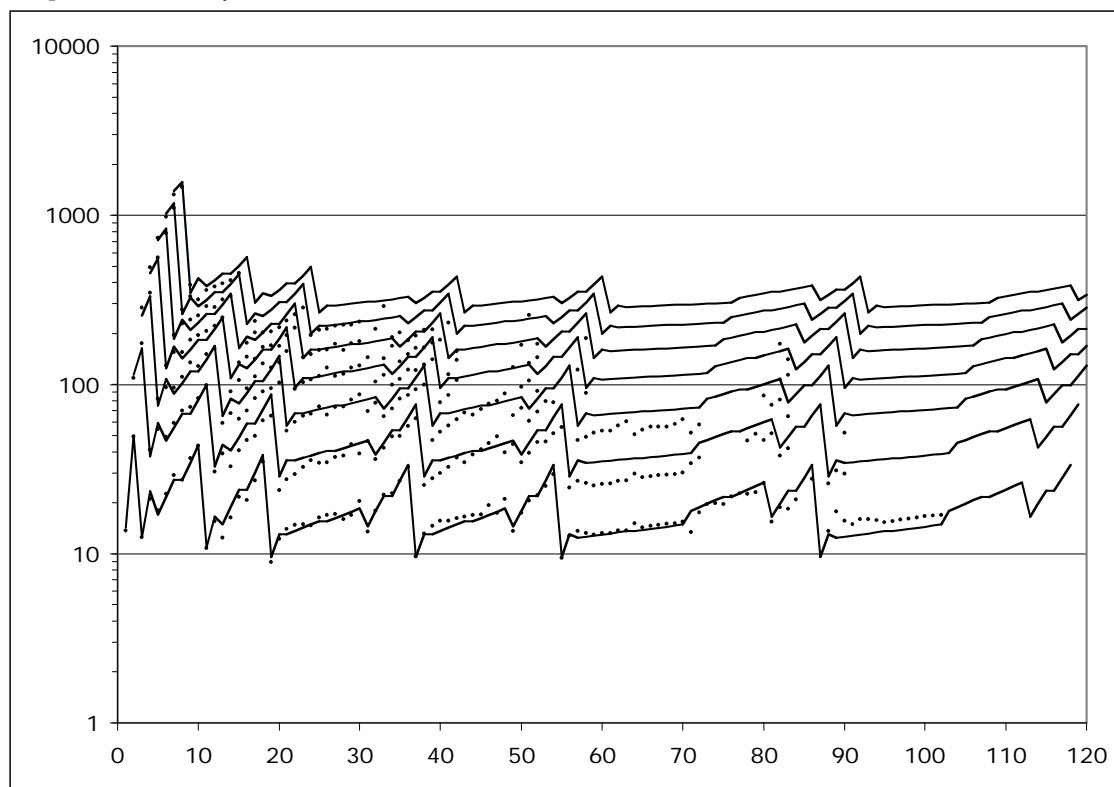

Figure 1. Ionization potentials, scaled appropriately and modeled algebraically.

The most striking fact revealed by Fig. 1 is that, apart from its first point, the curve for *any IO* is quite like the curve for *IO* = 1, but shifted right by $IO-1$ elements, and muted in amplitude, more and more muted as IO increases. This shift behavior means that each successive element reveals one additional bit of information about *all* subsequent elements. This fact speaks to the universality of chemical information: basic information about any one element can be inferred reliably from basic information about other elements.

The Hydrogen-based model used here invites the division of each ionization potential $IP_{1,Z}$ into two parts, one being $IP_{1,1}$ for the generic Hydrogen-like collective interaction with the nucleus, and the other being the increment $\Delta IP_{1,Z} = IP_{1,Z} - IP_{1,1}$ for the element specific electron-electron interactions. Figure 2 uses these entities to relate the IP's of higher ionization order, with $IO>1$, to the first-order IP's, with $IO=1$.

$$IP_{IO,IO} = 2 \times IP_{1,1} \times IO^2$$

$$IP_{IO,IO+1} = IP_{1,1} \times 2 \times IO^2 + \frac{1}{2} \times IP_{1,1} \times IO + \frac{1}{2}\Delta IP_{1,2} \times IO$$

$$IP_{IO,IO+2} = \frac{1}{2}IP_{1,1}(IO^2 + IO) + \frac{1}{2}\Delta IP_{1,3} \times (IO^2 + IO)$$

$$IP_{IO,IO+3} = \frac{1}{2}IP_{1,1}(IO^2 + IO) + \frac{1}{2}\Delta IP_{1,3}(IO^2 - IO) + \Delta IP_{1,4}IO, etc..$$

$$\Delta IP_{1,3} \to \Delta IP_{1,IO+N} \text{ at } IP_{IO,IO+N} \text{ for } IO + N = 11, 19, 37, 55, 87$$

Figure 2. Behavior of higher-order IP's.

The '*etc.*' means that the pattern established at $IP_{IO,IO+3}$ continues from there on. Indeed, even $IP_{IO,IO+2}$ is a special case of the general pattern revealed in $IP_{IO,IO+3}$. The first term in $IP_{IO,IO+3}$ is universal. The second term is period specific. The third term is element specific.

Now knowing empirically what all these terms apparently are, we can pause for a moment and study them. The facts seem to be trying very hard to communicate a story! Presumably, the story is not just *what* the facts are, but *why* they are what they are. The following paragraphs try to capture that story.

Observe that the leading terms representing any IP are proportional to IO^2. This dependence suggests that the physical process generating the data involves removing IO electrons all at once, and not removing just the single electron left after $IO-1$ other electrons have already been removed, or possibly just skipped over and left in place. This distinction about removing IO electrons all at once, *vs.* any scenario that removes just one electron, is obvious from the mathematical factor IO^2, but it is not obvious from a description by a typical text phrase, such as 'third-order ionization potential', for example. So when reading the existing literature on ionization potentials, always watch out the possibility of confusion arising from inadequate language.

The secondary terms representing any arbitrary IP are linear in IO. These terms implement the 'shift right' behavior seen in Fig. 1. They also determine the numerical pattern that the period rises follow. For $IO \equiv 1$, the period rises are *all* $7/2$. For all $IO > 1$, all but the first period are the same, but less than $7/2$, gradually approaching unity as IO increases. The formula for the period rises can be determined by looking at the ratio $IP_{IO,IO+10}/IP_{IO,IO+2}$:

$$\frac{\frac{1}{2}IP_{1,1}(IO^2 + IO) + \frac{1}{2}\Delta IP_{1,3}(IO^2 - IO) + \Delta IP_{1,10}IO}{\frac{1}{2}IP_{1,1}(IO^2 + IO) + \frac{1}{2}\Delta IP_{1,3} \times (IO^2 + IO)}$$

Here $\Delta IP_{1,3} = -\frac{1}{8}IP_{11}$ and $\Delta IP_{1,10} = \left(\frac{7}{8} \times \frac{7}{2} - 1\right)IP_{1,1} = \frac{33}{16}IP_{1,1}$. From these values, one finds that period rises, except for the first one, follow the simple formula $(IO+6)/(IO+1)$, which reduces to $7/2$ for $IO = 1$.

The exception for first-period rises when $IO > 1$ demands an explanation. To begin developing the explanation, note the factor of 2 in the formula for $IP_{IO,IO}$ for $IO > 1$:

$$P_{IO,IO} = 2 \times IP_{1,1} \times IO^2$$

Why does this formula not come out, as it must for $IO \equiv 1$, simply $IP_{IO,IO} \equiv IP_{1,1} \times IO^2$? A possible explanation is that, unlike first-order ionizations, these *total* ionizations are *not* best characterized as 'removal of electrons from the atomic system'; they are *better* characterized as 'removal of the *nucleus* from the atomic system'. Note that electrons have a lot of kinetic energy; on average, an amount equal to half the magnitude of their (negative) potential energy in the atomic system. By contrast, the nucleus has almost *no* kinetic energy. So removing the nucleus from the atomic system takes essentially *twice* the energy that removing all of the electrons *together* from the atomic system would take. But the fragility of the electron subsystem probably prevents the latter scenario.

Next, consider the formula for the scenario that starts with $IO + 1$ electrons, and ends up with 1 electron:

$$IP_{IO,IO+1} = IP_{1,1} \times 2 \times IO^2 + \frac{1}{2} \times IP_{1,1} \times IO + \frac{1}{2}\Delta IP_{1,2} \times IO \quad .$$

The first term, $IP_{1,1} \times 2 \times IO^2$, is identical to the formula for starting with IO electrons and ending up with no electrons. So this part of the scenario looks like the blow-the-nucleus-out scenario, but not with just the nucleus alone; instead, this nucleus takes one electron with it, so that what is blown out is a nucleus-plus-electron system that is like a nucleus with charge IO instead of $IO + 1$. That leaves an electron system with IO electrons still to dispose of.

The second term, $\frac{1}{2} \times IP_{1,1} \times IO$, defines what it means to 'dispose of' IO electrons. Each electron is blown away with enough energy, $\frac{1}{2} \times IP_{1,1}$, so that any pair of them has energy $IP_{1,1}$, sufficient to keep them away from each other.

The third term, $\frac{1}{2}\Delta IP_{1,2} \times IO$, suggests a possible structure for the system of IO electrons. If the system is a ring, or several rings, it takes IO binary cleavages to destroy the system. So there is the factor of IO multiplying $\Delta IP_{1,2}$. But why is there also the factor of $\frac{1}{2}$ multiplying $\Delta IP_{1,2}$? Well, consider that when every electron gets energy $\frac{1}{2}\Delta IP_{1,2}$, then any pair of them has enough energy, $\Delta IP_{1,2}$, to resist reuniting as a pair.

Next, consider the scenario that starts with $IO + 2$ electrons, and ends up with 2 electrons. We have:

$$IP_{IO,IO+2} = \frac{1}{2}IP_{1,1}(IO^2 + IO) + \frac{1}{2}\Delta IP_{1,3} \times (IO^2 + IO)$$

The first term, $\frac{1}{2}IP_{1,1}(IO^2 + IO)$, contains $\frac{1}{2}IP_{1,1}IO^2$, which is quite different from the $IP_{1,1} \times 2 \times IO^2$ seen in the cases of IO and $IO + 1$: it has the overall factor of $\frac{1}{2}$ instead of 2. This means that there is no blowing-out of a nucleus-like system consisting of the nucleus plus two electrons, which would have charge IO instead of $IO + 2$. Instead, IO electrons are blown away from the atom, leaving the nucleus-like system behind. The factor of

$\frac{1}{2}$ on $\frac{1}{2}IP_{1,1}IO^2$ mean the nucleus-like system and the blown-away electron system have between them enough energy, $IP_{1,1}IO^2$, to keep them away from each other.

The first term here also contains $\frac{1}{2}IP_{1,1}\times IO$, which was present in the $IO+1$ case as the second term there. The $\frac{1}{2}IP_{1,1}\times IO$ means the same thing here: each electron is blown away with enough energy, $\frac{1}{2}\times IP_{1,1}$, so that any pair of them has energy $IP_{1,1}$, sufficient to keep them away from each other.

The second term here, $\frac{1}{2}\Delta IP_{1,3}\times(IO^2+IO)$, is actually negative, because $\Delta IP_{1,3}=-\frac{1}{8}IP_{11}$. The second term scales down the energy increments recommended by the first term as being necessary to keep away the IO electrons, either as a group (the IO^2 term), or as individuals (the IO term). The scale-down reflects the fact that an electron system consisting of just two electrons by themselves is the most stable electron system seen anywhere in Nature: like a hundred dollar bill – too big to break!

Next, consider the scenario that starts with $IO+3$ electrons and ends up with 3 electrons. We have:

$$IP_{IO,IO+3}=\frac{1}{2}IP_{1,1}(IO^2+IO)+\frac{1}{2}\Delta IP_{1,3}(IO^2-IO)+\Delta IP_{1,4}IO \quad .$$

The first term is the same as it was in $IP_{IO,IO+2}$, and has the same meaning here. The second term, $\frac{1}{2}\Delta IP_{1,3}(IO^2-IO)$, differs by the internal minus sign from the second term $\frac{1}{2}\Delta IP_{1,3}(IO^2+IO)$ in $IP_{IO,IO+2}$. That minus sign on the already negative $\Delta IP_{1,3}$ effectively adds to the energy requirement to keep individual electrons from coming back.

The third term, $\Delta IP_{1,4}IO$, further raises the energy needed to keep individual electrons from coming back, inasmuch as $\Delta IP_{1,4}$ is positive. The message is: three electrons is a really an unstable situation; having an extra electron is like having extra small change in your pocket: it is just waiting to be left somewhere!

The weakest area for the IP model fit to data is in the IP's for $IO=2$ and $IO=3$ elements in the sixth and seventh periods. The existence of this weak area may mean that the model needs further development. If deemed needed, the most promising area for further development lies in establishing a theoretical justification for the numerical values of the $\Delta IP_{1,Z}$ for $Z=3,11,19,37,55,87$. But the existence of the area of weaker fit may just mean that the experimental data are difficult to obtain there, or confusing to interpret. For example, observe that the reported second-order and third-order IP's there are very close to 2 and 3 times the corresponding first-order IP's. It is possible that the physical process that produced those data points was coincident production of multiple atoms each singly ionized, instead of production of a single atom multiply ionized, as witnessed everywhere else by all the IO^2 factors that fit the data available.

Figure 3 characterizes the overall pattern of first-order IP's in terms of simple integers and ratios thereof. Multiple routes

through the periods are available; bold font indicates the route actually taken in constructing Fig. 1. The most startling fact is that the rise on *every* period is the same: total rise $=7/2$.

$_1$H,	$IP_{1,1}$	$\rightarrow \mathbf{7/2} \rightarrow$	$IP_{1,2}$,	$_2$He
7/8 $\downarrow$		$\leftarrow \mathbf{1/4} \leftarrow$		$\downarrow\downarrow$ 7/8
$_3$Li,	$IP_{1,3}$	$\rightarrow \mathbf{7/2} \rightarrow$	$IP_{1,10}$,	$_{10}$Ne
7/8 $\downarrow$		$\leftarrow \mathbf{1/4} \leftarrow$		$\downarrow\downarrow$ 7/8
$_{11}$Na,	$IP_{1,11}$	$\rightarrow \mathbf{7/2} \rightarrow$	$IP_{1,18}$,	$_{18}$Ar
7/8 $\downarrow$		$\leftarrow \mathbf{1/4} \leftarrow$		$\downarrow\downarrow$ 7/8
$_{19}$K,	$IP_{1,19}$	$\rightarrow \mathbf{7/2} \rightarrow$	$IP_{1,36}$,	$_{36}$Kr
1 $\downarrow$		$\leftarrow 2/7 \leftarrow$		$\downarrow$ 1
$_{37}$Rb,	$IP_{1,37}$	$\rightarrow \mathbf{7/2} \rightarrow$	$IP_{1,54}$,	$_{54}$Xe
1 $\downarrow$		$\leftarrow 2/7 \leftarrow$		$\downarrow$ 1
$_{55}$Cs,	$IP_{1,55}$	$\rightarrow \mathbf{7/2} \rightarrow$	$IP_{1,86}$,	$_{86}$Rn
1 $\downarrow$		$\leftarrow 2/7 \leftarrow$		$\downarrow$ 1
$_{87}$Fr,	$IP_{1,87}$	$\rightarrow \mathbf{7/2} \rightarrow$	$IP_{1,118}$,	$_{118}$??

Figure 3. First-order IP's: map of main highways through the periods.

Figure 4 quantifies the detailed pattern of first-order IP's. On each period rise, there are sub-period rises keyed to the traditional 'angular momentum' quantum number l, and to a non-traditional parameter N that goes $1,2,2,3,3,4,4$ for periods 1 through 7, and gives the number of elements in a period as $2N^2$. For any sub-period, we have:

$$\text{incremental rise} = \text{total rise} \times \text{fraction} \quad ,$$
and
$$\text{fraction} = \left[(2l+1)/N^2\right]\left[(N-l)/l\right] \quad ,$$

(The value l is always the nominal one; some 19 'peculiar' elements depart from nominal in their actual electron population.)

At present, this detailed characterization of the behavior of first-order IP's has to be regarded as purely empirical. It is revealed by, but not explained by, the scaling of the ionization-potential raw data by the factor M/Z. Nor is it explained by any other theory-generated idea. Nevertheless, it reiterates the same point that the study of higher-order IP's made before: there exists a certain universality of chemical information. Basic information about any one element can be inferred reliably from basic information about other elements.

4. Extrapolations Based on the Patterns

Recall that we separated $IP_{1,1}$ and $\Delta IP_{1,Z}$. For first-order ionizations, the IP's scale with Z/M. This means that the constituent parts, $IP_{1,1}$ and $\Delta IP_{1,Z}$, both scale with Z/M too. But for an already ionized atom, the modifications to Z/M will be different for the two parts, $IP_{1,1}$ and $\Delta IP_{1,Z}$.

The M appropriate for an $IP_{1,1}$ remains the nuclear mass M. And the M appropriate for a ΔIP is also the nuclear mass, even though ΔIP's are about electron-electron interactions, and NOT electron-nucleus interactions. Why? The reason is as fol-

lows. $\Delta IP_{1,Z}$ is the minimum energy required to take an electron just outside of the electron subsystem. The $\Delta IP_{1,Z}$ depends on both the natural radius ΔR of the electron sub-system, and on the radius R_0 at which the electron subsystem center orbits in the $1/R$ potential well created by the nucleus. The energy required to take the electron out of the electron subsystem scales as $\Delta R/R_0$, and the R_0 is linear with M.

In general, the Z appropriate for either an $IP_{1,1}$ or for $\Delta IP_{1,Z}$ is not the nuclear charge Z_n. Instead, the electron count Z_e is involved in some way. The electron count Z_e and the nuclear charge Z_n are the same Z only for a neutral atom.

The formulae are essentially the same for every element, so let us use the symbol '$_Z E$' for an arbitrary element, so we can write the formulae in a symbolic way.

First consider the transition $_Z E \rightarrow _Z E^+$. It definitely takes an energy investment of $IP_{1,Z} \times Z/M_Z$, where the factors of Z and $1/M_Z$ restore the population-generic information $IP_{1,Z}$ to element-specific information. This energy investment corresponds to a potential 'wall' to be gotten over. It has the two parts, $IP_{1,1} \times Z/M_Z$ and $\Delta IP_{1,Z} \times Z/M_Z$. The transition $_Z E \rightarrow _Z E^+$ may also consume some heat, or generate some heat, as the remaining $Z-1$ electrons form new relationships, not necessarily instantaneously. That process amounts to the 'rock pile', or the 'ditch', on the other side of the potential wall. It is represented by a term $-\Delta IP_{1,Z-1} \times (Z-1)/M_Z$, where the factors of $(Z-1)$ and $1/M_Z$ restore the population-generic information $-\Delta IP_{1,Z-1}$ to element-specific information tailored for $_Z G$. Thus altogether,

$_Z E \rightarrow _Z E^+$ takes:

$$IP_{1,1} \times Z/M_Z + \Delta IP_{1,Z} \times Z/M_Z - \Delta IP_{1,Z-1} \times (Z-1)/M_Z \ \text{eV's} \ .$$

Now consider removal of a second electron, $_Z E^+ \rightarrow _Z E^{++}$. Being already stripped of one of its electrons, the $_Z E^+$ system has less internal Coulomb attraction than neutral $_Z E$ has. So the factor of Z multiplying $IP_{1,1}$ for $_Z E \rightarrow _Z E^+$ has to change to something smaller. Since Coulomb attraction generally reflects the product of the number of positive charges (here Z) and the number of negative charges (here $Z-1$), the reduced factor is $\sqrt{Z \times (Z-1)}$. Given this factor,

$_Z E^+ \rightarrow _Z E^{++}$ takes:

$$IP_{1,1} \times \sqrt{Z \times (Z-1)}\big/M_Z$$
$$+\Delta IP_{1,Z-1} \times Z/M_Z - \Delta IP_{1,Z-2} \times (Z-2)/M_Z \quad \text{eV's} \ .$$

Observe that putting the steps $_Z E \rightarrow _Z E^+$ and $_Z E^+ \rightarrow _Z E^{++}$ together, the terms involving $\Delta IP_{1,Z-1}$ cancel, leaving that altogether

$_Z E \rightarrow _Z E^{++}$ takes:

$$IP_{1,1} \times Z/M_Z + IP_{1,1}\sqrt{Z \times (Z-1)}\big/M_Z$$
$$+\Delta IP_{1,Z} \times Z/M_Z - \Delta IP_{1,Z-2} \times (Z-2)/M_Z \quad \text{eV's} \ .$$

This reduction to just two terms involving ΔIP's is typical of all sequential ionizations, of however many steps.

Observe too that in the cumulative, we have *two* terms in $IP_{1,1}$, $IP_{1,1} \times Z/M_Z$ and $IP_{1,1}\sqrt{Z \times (Z-1)}\big/M_Z$. If we went further in stripping electrons, we would have IO terms in $IP_{1,1}$. This feature is somewhat reminiscent of the higher-order IP model, which had terms linear in ionization order, IO.

From the above, it should be clear how to proceed with stripping however many more electrons you may be interested in removing.

For another example, think about adding an electron to $_Z E$. The problem is similar to removing an electron from $_{Z+1} E$, but in reverse. So,

$_Z E \rightarrow _Z E^-$ takes:

$$-IP_{1,1} \times \sqrt{Z \times (Z+1)}\big/M_Z$$
$$-\Delta IP_{1,Z+1}(Z+1)/M_Z + \Delta IP_{1,Z} Z/M_Z \quad \text{eV's}$$

Going one step further, the problem of adding another electron to $_Z E^-$ is similar to removing an electron from $_{Z+2} E$, but in reverse. So,

$_Z E^- \rightarrow _Z E^{--}$ takes:

$$-IP_{1,1} \times \sqrt{Z \times (Z+2)}\big/M_Z$$
$$-\Delta IP_{1,Z+2} \times (Z+2)/M_Z + \Delta IP_{1,Z+1} \times (Z+1)/M_Z \quad \text{eV's}$$

Observe that putting the steps $_Z E \rightarrow _Z E^-$ and $_Z E^- \rightarrow _Z E^{--}$ together, the terms involving $\Delta IP_{1,Z+1}$ cancel, leaving that altogether

$_Z E \rightarrow _Z E^{--}$ takes:

$$-IP_{1,1} \times \sqrt{Z \times (Z+1)}\big/M_Z - IP_{1,1} \times \sqrt{Z \times (Z+2)}\big/M_Z$$
$$+\Delta IP_{1,Z} \times Z/M_Z - \Delta IP_{1,Z+2} \times (Z+2)/M_Z \quad \text{eV's}$$

From the above, it should be clear how to proceed with adding however many more electrons you may be interested in adding.

For future reference, here is a summary of formulae for the example element $_Z E$:

$$_Z E \rightarrow _Z E^+: IP_{1,1} \times Z/M_Z$$
$$+\Delta IP_{1,Z} \times Z/M_Z - \Delta IP_{1,Z-1} \times (Z-1)/M_Z \quad \text{eV's,}$$

$$_Z E^+ \rightarrow _Z E^{++}: IP_{1,1} \times \sqrt{Z(Z-1)}\big/M_Z$$
$$+\Delta IP_{1,Z-1} \times (Z-1)/M_Z - \Delta IP_{1,Z-2} \times (Z-2)/M_Z \quad \text{eV's}, \textit{etc.,}$$

$$_Z\mathrm{E} \to {_Z}\mathrm{E}^-: -IP_{1,1} \times \sqrt{Z \times (Z+1)}\big/M_Z$$
$$-\Delta IP_{1,Z+1}(Z+1)/M_Z + \Delta IP_{1,Z}Z/M_Z \quad \mathrm{eV's},$$

$$_Z\mathrm{E}^- \to {_Z}\mathrm{E}^{--}: -IP_{1,1} \times \sqrt{Z \times (Z+2)}\big/M_Z$$
$$-\Delta IP_{1,Z+2} \times (Z+2)/M_Z + \Delta IP_{1,Z+1} \times (Z+1)/M_Z \quad \mathrm{eV's}, \text{ etc.}$$

5. Water in Brown's Gas *vs*. Normal Water

Chris Eckman [2] quoted George Wiseman to the effect that Brown's gas is produced in a process "designed to electrolyze water and not separate the resulting gasses." In other words, it is presently a secret process. That is the case because water as a fuel has important technological implications.

The key ingredient of Brown's gas is thought to be a linear isomer of water. Therefore, the study of water molecules is an interesting application for the formulae developed in the last Section.

The development of the relevant information about Hydrogen goes as follows:

Write Formulae:

(Note: $\Delta IP_{1,1} \equiv 0$, and $\Delta IP_{1,0}$ does not exist)

$_1\mathrm{H} \to {_1}\mathrm{H}^+$: $IP_{1,1} \times 1/M_1 + \Delta IP_{1,1} \times 1/M_1 - \Delta IP_{1,0} \times 0/M_1$ eV's

$_1\mathrm{H} \to {_1}\mathrm{H}^-$:

$-IP_{1,1} \times \sqrt{1 \times 2}\big/M_1 - \Delta IP_{1,2} \times 2/M_1 + \Delta IP_{1,1} \times 1/M_1$ eV's

Insert Data (eV's):

$_1\mathrm{H} \to {_1}\mathrm{H}^+$: $14.250 \times 1/1.008 + 0 - 0$ eV's

$_1\mathrm{H} \to {_1}\mathrm{H}^-$:

$-14.250 \times 1.4142/1.008 - 35.625 \times 2/1.008 + 0 \times 1/1.008$ eV's

Evaluate Formulae:

$_1\mathrm{H} \to {_1}\mathrm{H}^+$: $14.1369 + 0 - 0 = 14.1369$ eV's

$_1\mathrm{H} \to {_1}\mathrm{H}^-$: $-19.9924 - 70.6845 + 0 = -90.6769$ eV's

The development of the relevant information about Oxygen goes as follows:

Write Formulae:

$_8\mathrm{O} \to {_8}\mathrm{O}^+$: $IP_{1,1} \times 8/M_8 + \Delta IP_{1,8} \times 8/M_8 - \Delta IP_{1,7} \times 7/M_8$ eV's

$_8\mathrm{O}^+ \to {_8}\mathrm{O}^{++}$:

$IP_{1,1} \times \sqrt{8 \times 7}\big/M_8 + \Delta IP_{1,7} \times 7/M_8 - \Delta IP_{1,6} \times 6/M_8$ eV's

$_8\mathrm{O} \to {_8}\mathrm{O}^-$:

$-IP_{1,1} \times \sqrt{8 \times 9}\big/M_8 - \Delta IP_{1,9} \times 9/M_8 + \Delta IP_{1,8} \times 8/M_8$ eV's

$_8\mathrm{O}^- \to {_8}\mathrm{O}^{--}$:

$-IP_{1,1} \times \sqrt{8 \times 10}\big/M_8 - \Delta IP_{1,10} \times 10/M_8 + \Delta IP_{1,9} \times 9/M_8$ eV's

Insert Data (eV's):

$_8\mathrm{O} \to {_8}\mathrm{O}^+$: $14.250 \times 8/15.999$
$+13.031 \times 8/15.999 - 13.031 \times 7/15.999$ eV's

$_8\mathrm{O}^+ \to {_8}\mathrm{O}^{++}$: $14.250 \times 7.4833/15.999$
$+13.031 \times 7/15.999 - 7.320 \times 6/15.999$ eV's

$_8\mathrm{O} \to {_8}\mathrm{O}^-$: $-14.250 \times 8.4853/15.999$
$-20.254 \times 9/15.999 + 13.031 \times 8/15.999$ eV's

$_8\mathrm{O}^- \to {_8}\mathrm{O}^{--}$: $-14.250 \times 8.9443/15.999$
$-29.391 \times 10/15.999 + 20.254 \times 9/15.999$ eV's

Evaluate Formulae:

$_8\mathrm{O} \to {_8}\mathrm{O}^+$: $7.1254 + 6.5159 - 5.7014 = 7.9399$ eV's

$_8\mathrm{O}^+ \to {_8}\mathrm{O}^{++}$: $6.6652 + 5.7014 - 2.7452 = 9.6214$ eV's

$_8\mathrm{O} \to {_8}\mathrm{O}^-$: $-7.5577 - 11.3936 + 6.5159 = -12.4354$ eV's

$_8\mathrm{O}^- \to {_8}\mathrm{O}^{--}$: $-7.9665 - 18.3705 + 11.3936 = -14.9434$ eV's

Summarize for Convenience:

$_8\mathrm{O} \to {_8}\mathrm{O}^{++}$: $7.9399 + 9.6214 = 17.5613$ eV's

$_8\mathrm{O} \to {_8}\mathrm{O}^{--}$: $-12.4354 - 14.9434 = -27.3788$ eV's

Water is known to dissociate into the naked proton H^+ and the hydroxl radical OH^-. The hydroxyl radical has to be the combination of ions $\mathrm{O}^{--} + \mathrm{H}^+$, the formation of which takes $-27.3788 + 14.1369 = -13.2419$ eV's; there is not an alternative form using H^-, because then O would have to be neutral.

So it is natural to consider $\mathrm{H_2O}$ as $\mathrm{H}^+ + \mathrm{OH}^-$, or equivalently $2\mathrm{H}^+ + \mathrm{O}^{--}$. Forming water as $\mathrm{H}^+ + \mathrm{OH}^-$, or equivalently $2\mathrm{H}^+ + \mathrm{O}^{--}$, takes $14.1369 - 13.2419 = +0.8950$ eV's, or equivalently $2 \times 14.1369 - 27.3788 = +0.8950$ eV's, a slightly positive energy.

This result is interesting. It being positive means we have just described a form of water molecule that stores energy. So this form of water can serve as a fuel; it can deliver a jolt of energy. **This molecule is apparently the linear, un-polarized, metastable isomer of water in Brown's gas.**

What then is *normal* water? A clue about the nature of normal water lies in the data about Helium. The development of the relevant information about Helium goes as follows:

Write Formulae: (Note: $\Delta IP_{1,1} \equiv 0$)

$_2\mathrm{He} \to {_2}\mathrm{He}^+$:
$IP_{1,1} \times 2/M_2 + \Delta IP_{1,2} \times 2/M_2 - \Delta IP_{1,1} \times 1/M_2$ eV's

$_2\mathrm{He}^+ \to {_2}\mathrm{He}^{++}$:
$IP_{1,1} \times \sqrt{2 \times 1}\big/M_2 - \Delta IP_{1,1} \times 1/M_2 - \Delta IP_{1,0} \times 0/M_2$ eV's

$_2\mathrm{He} \to {_2}\mathrm{He}^-$:
$-IP_{1,1} \times \sqrt{2 \times 3}\big/M_2 - \Delta IP_{1,3} \times 3/M_2 + \Delta IP_{1,2} \times 2/M_2$ eV's

$_2\mathrm{He}^- \to {_2}\mathrm{He}^{--}$:
$-IP_{1,1} \times \sqrt{2 \times 4}\big/M_2 - \Delta IP_{1,4} \times 4/M_2 + \Delta IP_{1,3} \times 3/M_2$ eV's

Insert Data (eV's):

$_2\mathrm{He} \to {_2}\mathrm{He}^+$: $14.250 \times 2/4.003$
$+35.625 \times 2/4.003 - 0 \times 1/4.003$ eV's

$_2\mathrm{He}^+ \to {_2}\mathrm{He}^{++}$: $14.250 \times 1.4142/4.003$
$+0 \times 1/4.003 - 0 \times 0/4.003$ eV's

$_2\mathrm{He} \to {_2}\mathrm{He}^-$: $-14.250 \times 2.4495/4.003$
$-(-1.781) \times 3/4.003 + 35.625 \times 2/4.003$ eV's

$_2\mathrm{He}^- \to {_2}\mathrm{He}^{--}$: $-14.250 \times 2.8284/4.003$
$-9.077 \times 4/4.003 + (-1.781) \times 3/4.003$ eV's

Evaluate Formulae:

$_2\mathrm{He} \to {_2}\mathrm{He}^+$: $7.1197 + 17.7992 - 0 = 24.9189$ eV's

$_2\text{He}^+ \rightarrow {}_2\text{He}^{++}$: $5.0343 + 0 + 0 = 5.0343$ eV's

$_2\text{He} \rightarrow {}_2\text{He}^-$: $-8.7198 + 1.3347 + 17.7992 = 10.4141$ eV's

$_2\text{He}^- \rightarrow {}_2\text{He}^{--}$: $-10.0686 - 9.0702 + -1.3347 = -20.4735$ eV's

Summarize for Convenience:

$_2\text{He} \rightarrow {}_2\text{He}^{++}$: $24.9189 + 5.0343 = 29.9532$ eV's

$_2\text{He} \rightarrow {}_2\text{He}^{--}$: $10.4141 - 20.4735 = -10.0594$ eV's

The message is: it is very difficult (24.9189 eV's) to break a pair of electrons apart, leaving just a single electron in place, and it is rather difficult (10.4141 eV's) to add a third electron to a pair of electrons. But it is very easy (-10.0594 eV's) to add a second *pair* of electrons to a pair already present. In short, electrons just *love* to be in pairs!

This realization suggests an alternative ion content for normal water. Instead of $2\text{H}^+ + \text{O}^{--}$, consider $2\text{H}^- + \text{O}^{++}$. The transition $_1\text{H} \rightarrow \text{H}^-$ takes $-19.9924 - 70.6845 + 0 = -90.6769$ eV's, and the transition $_8\text{O} \rightarrow {}_8\text{O}^{++}$ takes 17.5613 eV's. So making H_2O as 2H^- and O^{++} takes $2 \times (-90.6769) + 17.5613 = -163.7925$ eV's. This *is* way more energetically favorable than making H_2O as $2\text{H}^+ + \text{O}^{--}$, at $+0.8950$ eV's. **This molecule *must* indeed be the normal state of water.**

Does this vision of normal water help explain why the molecule is bent to an angle that recalls a tetrahedron? Indeed it does help. Imagine the heavy O^{++} ion with four satellites around it: two H nuclei (protons), and the two 2e subsystems (electron pairs). The two protons go to two corners of the tetrahedron, and the two electron pairs go to the other two corners.

There is another interesting feature about normal water: unlike just about anything else, it expands upon freezing. Does the vision of normal water as $2\text{H}^- + \text{O}^{++}$ in a tetrahedral arrangement help explain that? Indeed it does help with that issue too. The electron pairs have to orbit their respective protons, and being identical, they orbit in synchrony. That makes the whole tetrahedron spin about an axis that is the tetrahedron edge connecting the two protons. A tetrahedron spinning on an axis that is an edge is a lop-sided occupier of space. It sweeps out a volume that is larger than itself, shaped like two Hershey kisses, melted bottom-to-bottom. When the water is liquid, the spinning tetrahedrons can tolerate other spinning tetrahedrons temporarily invading their temporarily vacant space: they can bounce, or otherwise adjust. But when water is frozen, adjustments are not possible. Each spinning tetrahedron needs to have sole ownership of the volume of space in which it spins.

And what of snowflakes? Why do they have their obvious hexagonal symmetry? The Hershey-kisses image helps with that question too. Imagine Hershey kisses arranged bottom down on a horizontal mirror, so one sees the sweep volumes of tetraheda. Obviously, the most efficient packing arrangement for them is one-surrounded by six; *i.e.*, hexagonal.

Note too that the center of mass of the H_2O molecule is near the oxygen nucleus, and the two protons are outboard. So not only must the tetrahedron spin, but also it must translate: the spin axis must traverse a path that sweeps out a cylinder around the molecular center of mass. This means the polarization vector of the molecule spins in the plane of the Hershey kisses, *i.e.* the horizontal mirror surface. It is always in that plane. That is why a snowflake nearly always turns out planar.

And there is yet another interesting feature about normal water: it is very stable, containing only a fraction on the order of 10^{-7} in the form of dissociated ions. This fact is consistent with the vision of normal water as $2\text{H}^- + \text{O}^{++}$, and not as $2\text{H}^+ + \text{O}^{--}$ = $\text{H}^+ + \text{OH}^-$. The water molecule does not contain the same two ions that it dissociates into. That is, water does not 'live' in the same ionic state from which it 'dies'!

6. Comments on Cold Fusion

Publishing a discussion about CF is risky business, so we should all the thankful to NPA for allowing it! Here I wish to comment on some beliefs that are commonly articulated, and might be wrong, and some other ideas that haven't been articulated before, and may deserve some study.

Those who are skeptical about CF have often pointed to its meager generation of neutrons, which are common byproducts of many of the more familiar nuclear fission processes. But there is a flaw in this sort of objection. **When we study the Periodic Table, we see that the proportion of neutrons in stable isotopes increases with atomic number.** That means fission reactions typically start with elements that have more neutrons than the daughter elements will need for stability. So the excess neutrons are liberated in the fission process. By contrast, fusion reactions do not occur between the abundant isotopes of input elements because those isotopes do not have enough neutrons to make a stable isotope of the product element. Fusion reactions need some heavy isotope(s) as input. And even then, the neutrons provided may be too valuable for any to be liberated. Observe that the chemical/nuclear reactions

$$2\text{DHO} \rightarrow \text{He} + \text{H}_2 + \text{O}_2 \text{ and } \text{H}_2\text{O} + \text{THO} \rightarrow \text{He} + \text{H}_2 + \text{O}_2$$
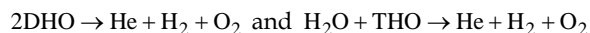
can produce energy without producing any neutrons at all - although no other reactions seem able to do exactly that.

So take note: the fact that neutrons are absent from, or at low concentration in, the environs of a purported CF experiment does <u>not</u> mean there is no fusion going on.

Those who are proponents of CF know they need input water that is enriched with Deuterium, and maybe even Tritium. If this heavy water is not developed in-house, but purchased from a vendor, the CF experimenters may not fully understand how hard it is to make, or exactly what the vendor has actually provided. For example, suppose the process starts with seawater, and uses boiling to remove normal H_2O, and/or centrifuging to increase the concentration of heavier species, which include DHO and D_2O and THO and TDO and T_2O. In what proportions do these heavier species occur? Who knows! But my guess is that DHO is the dominant heavy-water species available, not D_2O (and certainly not anything involving T), and that significant ordinary H_2O is still left in the sample. But it doesn't matter.

Those who are interested in the theory of CF, like myself, are obliged to justify the occurrence of any nuclear reaction at all in

circumstances so modest as a CF cell provides: no high temperature, no high pressure, no magnetic confinement, no regular-fusion big hardware. As noted in my Introduction, I believe the explanation is that the conditions of the CF cell produce a heavy version of Brown's gas, including not only the linear isomer of H_2O, but also linear isomers of DHO and THO, and possibly D_2O and DTO and T_2O. The full set of linear isomers puts not only naked H's, but also naked D's and naked T's, in exposed positions, unshielded by electrons. Nuclear reactions are then possible: two D's, or one T and one H, can fuse to make a normal ^4He nucleus, or two D can make a T and an H, or a ^3He and a neutron, *etc*. My guess is that the dominant nuclear reaction is $2D \rightarrow {}^4He + \gamma$, where γ is a gamma ray carrying the energy released. Other reactions can also produced some neutrons, which can then trigger other elements present to undergo fission. All these reactions amount to transmutations.

And what condition is it that the CF cell provides to make the linear isomers of water and heavy water? Basically, I believe it is a situation of chemical catalysis. The cathode in a CF cell is typically Palladium. That element comes from an area of the Periodic Table where famously catalytic metals are found. Some others are Silver, Platinum, and Gold. The CF anode is usually Platinum. Gold also sometimes appears, as a cathode. I have not seen Silver yet, but would not be surprised to see it. All these metals prefer not to be neutral, and upon encountering any other atom, will negotiate to give or take electrons. That is how they catalyze further reactions.

With Algebraic Chemistry, it is possible to calculate the energy costs and benefits of various electron rearrangements. So we can find out why a DHO molecule might get catalyzed into linear configuration in the CF cell.

The development of the relevant information about all the individual Hydrogen isotopes follows. For normal Hydrogen:

Write Formulae:

(Note: $\Delta IP_{1,1} \equiv 0$, and $\Delta IP_{1,0}$ does not exist)

$_1H \rightarrow {}_1H^+$: $IP_{1,1} \times 1/1 + \Delta IP_{1,1} \times 1/1 - \Delta IP_{1,0} \times 0/1$ eV's

$_1H \rightarrow {}_1H^-$:
$-IP_{1,1} \times \sqrt{1 \times 2}/1 - \Delta IP_{1,2} \times 2/1 + \Delta IP_{1,1} \times 1/1$ eV's

Insert Data (eV's):

$_1H \rightarrow {}_1H^+$: $14.250 \times 1/1 + 0 - 0$ eV's

$_1H \rightarrow {}_1H^-$:
$-14.250 \times 1.4142/1 - 35.625 \times 2/1 + 0 \times 1/1$ eV's

Evaluate Formulae:

$_1H \rightarrow {}_1H^+$: $14.250 + 0 - 0 = 14.250$ eV's

$_1H \rightarrow {}_1H^-$: $-20.1525 - 71.2500 + 0 = -91.4025$ eV's

For Deuterium:

Write Formulae:

(Note: $\Delta IP_{1,1} \equiv 0$, and $\Delta IP_{1,0}$ does not exist)

$_1D \rightarrow {}_1D^+$: $IP_{1,1} \times 1/2 + \Delta IP_{1,1} \times 1/2 - \Delta IP_{1,0} \times 0/2$ eV's

$_1D \rightarrow {}_1D^-$:
$-IP_{1,1} \times \sqrt{1 \times 2}/2 - \Delta IP_{1,2} \times 2/2 + \Delta IP_{1,1} \times 1/2$ eV's

Insert Data (eV's):

$_1D \rightarrow {}_1D^+$: $14.250 \times 1/2 + 0 - 0$ eV's

$_1D \rightarrow {}_1D^-$: $-14.250 \times 1.4142/2 - 35.625 \times 2/2 + 0 \times 1/2$ eV's

Evaluate Formulae:

$_1D \rightarrow {}_1D^+$: $7.125 + 0 - 0 = 7.125$ eV's

$_1D \rightarrow {}_1D^-$: $-10.07625 - 35.625 + 0 = -45.70125$ eV's

For Tritium:

Write Formulae:

(Note: $\Delta IP_{1,1} \equiv 0$, and $\Delta IP_{1,0}$ does not exist)

$_1T \rightarrow {}_1T^+$: $IP_{1,1} \times 1/3 + \Delta IP_{1,1} \times 1/3 - \Delta IP_{1,0} \times 0/3$ eV's

$_1T \rightarrow {}_1T^-$:
$-IP_{1,1} \times \sqrt{1 \times 2}/3 - \Delta IP_{1,2} \times 2/3 + \Delta IP_{1,1} \times 1/3$ eV's

Insert Data (eV's):

$_1T \rightarrow {}_1T^+$: $14.250 \times 1/3 + 0 - 0$ eV's

$_1T \rightarrow {}_1T^-$: $-14.250 \times 1.4142/3 - 35.625 \times 2/3 + 0 \times 1/3$ eV's

Evaluate Formulae:

$_1T \rightarrow {}_1T^+$: $4.750 + 0 - 0 = 7.125$ eV's

$_1T \rightarrow {}_1T^-$: $-6.71745 - 23.750 + 0 = -30.46745$ eV's

The development of the relevant information about Palladium goes as follows:

Write Formulae:

$_{46}Pd \rightarrow {}_{46}Pd^+$: $IP_{1,1} \times 46/M_{46}$
$\qquad + \Delta IP_{1,46} \times 46/M_{46} - \Delta IP_{1,45} \times 45/M_{46}$ eV's

$_{46}Pd^+ \rightarrow {}_{46}Pd^{++}$: $IP_{1,1} \times \sqrt{46 \times 45}/M_{46}$
$\qquad + \Delta IP_{1,45} \times 45/M_{46} - \Delta IP_{1,44} \times 44/M_{46}$ eV's

$_{46}Pd \rightarrow {}_{46}Pd^-$: $-IP_{1,1} \times \sqrt{46 \times 47}/M_{46}$
$\qquad - \Delta IP_{1,47} \times 47/M_{46} + \Delta IP_{1,46} \times 46/M_{46}$ eV's

$_{46}Pd^- \rightarrow {}_{46}Pd^{--}$: $-IP_{1,1} \times \sqrt{46 \times 48}/M_{46}$
$\qquad - \Delta IP_{1,48} \times 48/M_{46} + \Delta IP_{1,47} \times 47/M_{46}$ eV's

Insert Data:

$_{46}Pd \rightarrow {}_{46}Pd^+$: $14.250 \times 46/106.420$
$\qquad + 2.701 \times 46/106.420 - 1.980 \times 45/106.420$ eV's

$_{46}Pd^+ \rightarrow {}_{46}Pd^{++}$: $14.250 \times 45.4973/106.420$
$\qquad + 1.980 \times 45/106.420 - 1.289 \times 44/106.420$ eV's

$_{46}Pd \rightarrow {}_{46}Pd^-$: $-14.250 \times 46.4973/106.420$
$\qquad - 3.455 \times 47/106.420 + 2.701 \times 46/106.420$ eV's

$_{46}Pd^- \rightarrow {}_{46}Pd^{--}$: $-14.250 \times 46.9894/106.420$
$\qquad - 4.242 \times 48/106.420 + 3.455 \times 47/106.420$ eV's

Evaluate Formulae:

$_{46}Pd \rightarrow {}_{46}Pd^+$: $6.1596 + 1.1675 - 0.837 = 6.4899$ eV's

$_{46}Pd^+ \rightarrow {}_{46}Pd^{++}$: $6.0922 + 0.8372 - 0.5329 = 6.3964$ eV's

$_{46}Pd \rightarrow {}_{46}Pd^-$: $-6.2261 - 1.5259 + 1.1675 = -6.5845$ eV's

$_{46}Pd^- \rightarrow {}_{46}Pd^{--}$: $-6.2920 - 1.9133 + 1.5259 = -6.6794$ eV's

Summarize for Convenience:

$_{46}Pd \rightarrow {}_{46}Pd^{++}$: $6.4899 + 6.3964 = 12.8863$ eV's

$_{46}Pd \rightarrow {}_{46}Pd^{--}$: $-6.5845 - 6.6794 = -13.2639$ eV's

In [1], Gordon talks about 'co-deposition', meaning co-introduction of Palladium and Deuterium into the CF cell, both in solution form. The added Palladium is in the form of the salt $PdCl_2$, which presumably dissociates into the ions Pd^{++} and $2Cl^-$. The Deuterium is, I believe, in the form of DHO which, like normal water, does not dissociate very much, but stays as a molecule with ionic structure $(D^- + H^+ + O^{++})$. The available Pd^{++} ions can work on the normal DHO molecule to convert it to linear form, with ionic structure $(D^+ + H^+ + O^{--})$. There must be many pathways to this end result; indeed a 'riotous profusion' of possible pathways is typical of catalysis schemes. Here is just one reaction pathway, given for illustration of the principle involved:

$$(D^- + H^+ + O^{++}) + 10Pd^{++} + 20e^- \rightarrow (D^+ + H^+ + O^{--}) + 10Pd$$

From the data provided above, this reaction takes

$$45.70125 + 91.4025 - 17.5613 - 10 \times 12.8863$$
$$+7.125 + 14.250 - 27.3788 + 10 \times 0 =$$
$$45.70125 + 91.4025 - 17.5613 - 128.863$$
$$+7.125 + 14.250 - 27.3788 = -15.32435 \, eV's$$

Observe that the energy requirement for this reaction is negative, which means that this reaction will occur spontaneously.

7. Conclusion

For those of us in NPA who think physics went astray at the start of the 20th century, this paper serves to recommend Chemistry, and the allied technologies of energy generation, as fertile ground for applying alternative theories. The paper concentrates on two important technologies: the productions of Brown's Gas (BG) and the production of Cold Fusion (CF). The alternative theory applied is Algebraic Chemistry (AC). AC has been developed from a simplified model for atoms made possible by applying electrodynamics informed with a modified version of Special Relativity Theory (SRT).

About BG: we know that there exist potentially related techniques to change water into something fuel-like via electrolysis and catalysis [8], but we don't yet know much about the BG production process specifically. That fact may reflect a patenting issue. If so, then the present analysis using AC may be useful to move things along. I hope so, because the technology for producing Brown's gas appears potentially relevant for producing Cold Fusion (CF) as well.

About CF, we know first of all that the requirements for producing *any* kind of fusion include:

1) Removal of electrons from the immediate environs of nuclei to be fused.

2) Forcing of the naked nuclei into proximity sufficient for their attraction by nuclear forces to dominate their natural Coulomb repulsion.

We know that traditional Hot Fusion (HF) does these jobs in a brute-force way. To meet Requirement 1, the fuel material is heated into its plasma state. To meet Requirement 2, the plasma is confined and compressed with a huge magnetic field.

We see that CF must instead meet the two requirements with subtlety and guile.

For Requirement 1, AC indicates that chemical catalysis can do the job. The goal is to produce something analogous to BG. The catalysis converts normal DHO (analogous to normal water) into linear DHO (linear, like BG). The ionic structure of normal DHO keeps the D in association with two electrons, and so protected from intrusions to the nuclear level, but the ionic structure of linear DHO leaves the D exposed, unshielded by any electron.

For Requirement 2, there does exist some confinement in the form of Deuterium loading into the Palladium matrix of the cathode in the CF cell. But that is not enough confinement to cause neighbor-on-neighbor fusion inside the cathode. [9] Instead of fusion occurring interior to the cathode, fusion between the trapped cathode-loaded Deuterons and the exposed Deuterons in the electrolyte seems more likely. Basically, the Deuteron loading sets up the cathode like a dart board, and then the linear HDO molecules in the electrolyte, positively charged on the ends, are attracted to the cathode because it is negative, and they hit it like so many darts. When D's on those incident darts hit bull's eye D's on the target cathode, CF ensues. This CF would occur on the surface of the cathode. We have seen the pictures of cathode damage in [1]; especially images 18 – 22. These images do indeed look like surface damage.

The present vision of what goes on in a CF cell can suggest some possibly beneficial design choices for future exploration. For example, the cathode could be made a porous mesh instead of a smooth solid, or the electrolyte could be mechanically circulated through a heat exchanges instead of ever being allowed to boil. If produced, steam might be condensed and returned to the cell. If steam escaped, maybe light water could replace most of it. Maybe Helium produced in CF could be valuable enough to confine and harvest. *Etc*.

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