

Can Chemical Data Support a 'PIRT' ?

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Abstract

This paper addresses a long-standing problem about chemical elements that is **1**) most difficult to address with the methods of standard physical theory, but **2**) seems to yield significantly with a new approach based on a novel physical interpretation of relativity theory. The chemical-element problem is very rich with experimental data, and so is very tempting to address anew. Even if gained with a new and somewhat 'dissident' theory, progress on such a problem would be hard to reject solely on grounds of 'heresy'. The problem in question is the modeling of atomic ionization potentials on a synoptic scale, including all elements that can exist, and all orders of ionization that each element can allow. The new theory is tested for all elements and ionization orders for which data exist.

Introduction

Spectroscopy provides extensive data that both supports and challenges present-day quantum mechanics (QM). The support lies in the 'ratio relationships' among the dozens of spectral lines in the multiple spectral series of many chemical elements. The challenge lies in the overall scale of the spectral series, determined by the corresponding *IP*'s. The standard physical theory for calculating *IP*'s requires solution of Schrödinger's equation for arbitrarily complex systems involving a nucleus and many electrons. This kind of 'many-body problem' is difficult to solve, even with powerful modern computers. So standard QM estimates *IP*'s by several different computationally tractable approximation approaches. Computational results differ from each other, and from results of experimental measurements, by up to two electron volts (eV's). Since first *IP*'s are no more than twenty five eV's, the two-eV uncertainties are enormous, especially in comparison to the uncertainties for measured spectral lines, which are typically quoted to six significant figures. Thus conventional QM offers exquisite accuracy for calculating small perturbations from a baseline situation that is not itself at all well calculated.

The present paper offers a candidate new theory that can better address the baseline situation in spectroscopy. The basis for this new theory lies in the two PIRT papers that this author has presented previously. The first was "How Can Paradox Happen?" (year 2000; henceforth [1]). It introduced the concept that, contrary to traditional models that assume waves or photons, light propagation may actually be a more complex process involving two steps. The proposed description of light is presently refined to: "Light propagation consists of one (or more) sequences of two steps each: **1**) expansion from a source at speed $2c$ relative to the source, followed by **2**) collapse to a receiver at speed $2c$ relative to the receiver." The 2000 PIRT paper showed that the discrepancy between such a two-step process and a traditional one-step model can account for and resolve the many oddities and paradoxes discussed in the literature of relativity theory. The second paper was "Do Atoms Really Have States?" (year 2002; henceforth [2]). Using two-step light, it developed a model for atomic stability based on balance between two competing effects: **1**) the well-known energy loss due to radiation from accelerating charges, and **2**) a previously unrecognized energy gain from internal torquing within an atom, caused signal propagation delay, and quantified by the two-step light model.

The two-step-light model for atomic physics has the following attributes: **1**) it does not *a priori* assume Planck's constant, but instead derives it, **2**) it does not talk about different states of an individual atom, but rather associates different 'states' with different systems of *multiple* atoms, and **3**) it is useful in explaining some otherwise mysterious observations, and may be useful in suggesting other new observations to attempt. The present paper delivers further on the third claimed attribute. The model for ionization potentials that results can treat not only all known elements and all orders of ionization for which data exist, but also many more ionization potentials for which data have not yet been taken, and even ionization potentials for elements that have not yet been isolated or even discovered, either in the natural world or in the laboratory.

Although the new theory goes way beyond the presently-available data base, the *IP* problem is actually already very data-rich. Handbooks of chemistry have been publishing data on ionization potentials for decades, so there is a lot of

data available for comparison to any theory on offer. Wherever data do exist, the present paper offers comparison between theory and experiment.

From the point of view of spectroscopy, as a discipline, the new theory offered here points to many new measurements to make, as well as a few old ones to review and question. It could keep spectroscopists and chemists busy for years.

From the point of view of physical interpretations of relativity theory, as a discipline, the exercise of coordinating a large body of existing chemical data shows very concretely that the effort is very worthwhile. It could rightly command attention from establishment physicists.

The Elements

A coherent story about the chemical elements was first offered by Mendelyev, who introduced the concept of the Periodic Table (PT). The presently-traditional format for displaying the PT is illustrated by Figure 1a. Since Mendelyev's discovery, numerous other authors have offered different display formats for the PT. So there is a strong tradition here for looking at the same, known, information again and again, but arranged in a variety of different ways. This sort of exercise is extremely important for scientists to do, and *keep* doing, regularly. Experience has shown us over and over that looking at any information from a different angle can reveal aspects of it not consciously noted before, and so can trigger new and interesting questions to ask.

Therefore, I want to begin this discussion with a new display format for the information in the PT. This new display is illustrated by Figure 1b. Instead of the PT, which is linear, Fig. 1b shows an arch, which is curved. I call it the Periodic Arch (PA). Right away we see that, where the PT had mysterious footnotes and insertions of extra series of elements, the PA needs no such insertions. The PA is visually neat. This paper is basically about this neat (PA); especially, it is about the mathematical patterns that underlie the PA.

But first, observe that the PA display format immediately suggests an interesting new question. Consider the element Aluminum. It is classified traditionally as a 'low-melting' metal, and within the PA, it calls attention to itself because of that classification. Aluminum is not near any other elements classified as 'low melting'. As a 'low-melting metal', it looks quite out of place. Maybe it should have been classified as a 'light metal'. I believe Aluminum may have gotten the label 'low-melting metal' because, in the traditional PT, it was placed over Gallium on account of its chemical properties, especially valence. But in terms of its chemical properties, Aluminum might have fit just as well over Scandium, in which case its likely characterization would have been 'light metal'. But I won't pursue that interesting question further here; it is just an example of the kind of 'look-again' exercise that I now want to apply to the larger scope of received wisdom about spectroscopy.

There is definitely something more synoptic about the PA overall, more deeply important than anything about a particular element. Observe that the number of elements in each 'layer' of the PA follows an obvious algebraic pattern:

$$L = 2N^2 \text{ for } N = 1, 2, 2, 3, 3, 4, 4, \dots$$

This algebraic pattern can be considered the 'foundation' of the PA. Although actual element discovery is presently only up to atomic number $Z = 112$, I feel certain that the pattern identified will be followed by any heavier elements ever found in the future. And should we ever progress beyond $Z = 118$, we will be into the regime of $N = 5$ and $L = 2(5)^2 = 50$, and so on, according to the pattern. This pattern was also detectable in the traditional PT format, but because of all the confusing footnotes and insertions, it was less obvious than it is in the PA format.

The only defect to the 'PA' concept is that, as an 'arch', the PA lacks a 'keystone'. A keystone is an essential structural element for any arch. The keystone goes right in the center apex of an arch, and gives the whole thing structural integrity. But the PA has an even number of elements in every layer, so it does not *have* a keystone. It just has a big crack up the middle. If the PA is going to survive long term, we will have to give it a keystone of some sort. And while we cannot insert elements into the PA's crack, we can insert ideas into the PA's interpretation. That is the goal of the present paper.

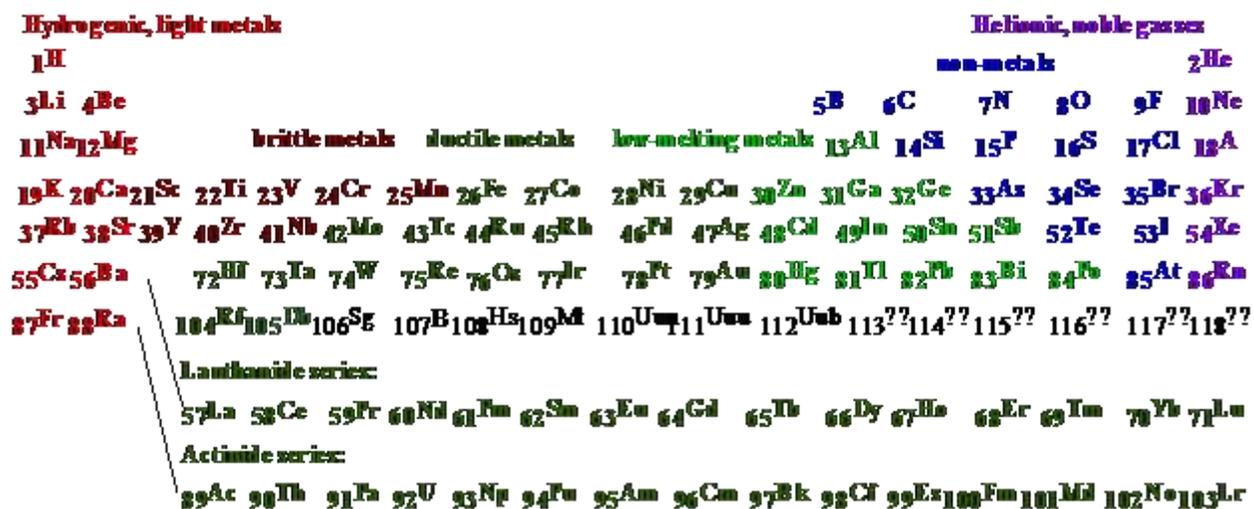


Figure 1a. Mankind's Periodic Table (PT).

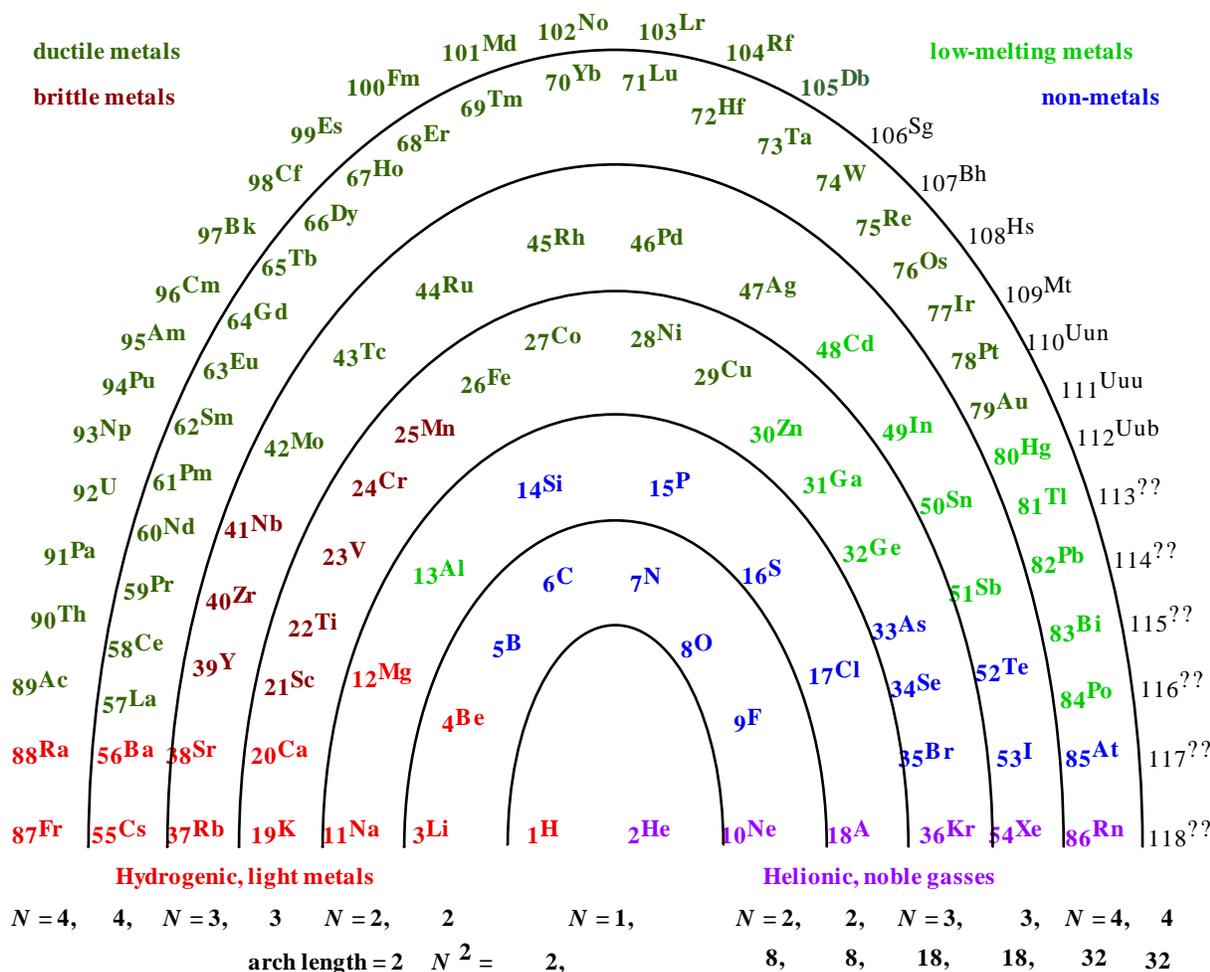


Figure 1b. Nature's Periodic Arch (PA).

Definitions

We should pause for a moment to think about what the phrase ‘ionization potential’ (IP) really means. The standard definitions found in textbooks characterize an IP as the energy required to completely remove an electron from its resting ‘state’ in an individual atom. This definition assumes the standard atomic model from QM, wherein the atom has a sequence of nested ‘shells’, each populated by a number of electrons in ‘states’ characterized by traditional quantum numbers. The quantum states are distinguished first by radial quantum number $n = 1, 2, 3, 4, \dots$ etc. Then for each quantum number n , there are states for angular momentum quantum number $l = 0, 1, \dots, n$. Then for each quantum number l , there are states for spin quantum number $s = \pm 1/2$. So for given n , there are $2n^2$ states. And then the number of all quantum states up through a given n follows the pattern $2n^2$ for $n = 1, 2, 3, 4, \dots$, etc.

But I have some doubts about that standard atomic model from QM. Those doubts are triggered by the observation about the PA that the number of elements per layer is $L = 2N^2$ for $N = 1, 2, 2, 3, 3, 4, 4, \dots$, *i.e.* there are repeats for the parameter N from the PA, whereas there are none for the parameter n from QM. So it is quite unclear whether the concept of ‘shell’ should be imagined to have something to do with n , or with N instead, or something else, or if the concept of ‘shell’ even makes sense. So I would prefer some other definition for an IP .

Another commonly used definition of is that an IP corresponds with the limit of a spectral series. This is a little better because it is operational in character: it focuses on something that one can actually measure; *i.e.* spectral lines. But there is still a problem to be faced. What is the meaning of an IP of order greater than 1? For example, should an IP of second order be thought of as the energy to remove two electrons from an atom? Or should it be one electron from an already positively charged ion? Or the limit of a spectral series from an atom that loses two electrons at once? Or the limit of a spectral series from a positively charged ion?

And what about atoms in ‘excited states’? Can one speak of IP ’s starting from excited states? And what *are* ‘excited states’, anyway? I raise these issues here and now just to alert the reader to their existence. I shall return to them only later.

IP Values – Present Status

The main techniques available for measuring IP ’s are **1)** extrapolation from observed spectral series, and **2)** analysis of products output from collisions between molecular beams and mono-energetic electron beams. For many decades, Chemistry handbooks have published IP values for most known elements, and for ionization orders (IO ’s) up to 6 or 7. There are sometimes disagreements among measurements done at different times and places. Sometimes data get withdrawn for a time, and then some time later on they get replaced with slightly different values. Some examples show in the following data for first IP ’s [from Lang’s Handbook of Chemistry (eV’s)]:

ELEMENT ↓ DATE →	1956	1961	2003
Phosphorus, $_{15}\text{P}$	11.0	10.9	10.4867
Lutetium, $_{71}\text{Lu}$	5.0	-	5.4259
Tungsten, $_{74}\text{W}$	7.98	8.1	7.8640
Osmium, $_{76}\text{Os}$	8.7	(8.7)	8.4382
Iridium, $_{77}\text{Ir}$	9.2	-	8.9670

Clearly, the task of measuring IP ’s has sometimes proved non-trivial. Furthermore, it would be nearly impossible to look at an individual measurement result and judge whether it might seem high or low. Figure 3, which is adapted from the relevant NBS web page, shows a great deal of complexity in the way first IP ’s vary as a function of atomic number Z . And what about calculation? Figure 3 is rather discouraging in that regard too. As noted before, the standard QM calculations are too complicated to carry out exactly, so various approximations are introduced to reduce the calculation load to something more tractable. Three different approximation schemes are quoted on Fig. 3, and they do not always agree very closely with each other. So this is the situation we hope to improve upon in the present paper. The objectives are: **1)** calculations that are simple to carry out; **2)** less emphasis on individual IP ’s in isolation, and more emphasis on the pattern that underlies them; *i.e.* THE BIG PICTURE; **3)** a basically smooth pattern except for certain well defined and well understood discontinuities; **4)** some candidate explanations for individ-

ual points that seem not to fit. Below, the objectives are pursued by using the two-step light model and its implications in regard to atomic stability.

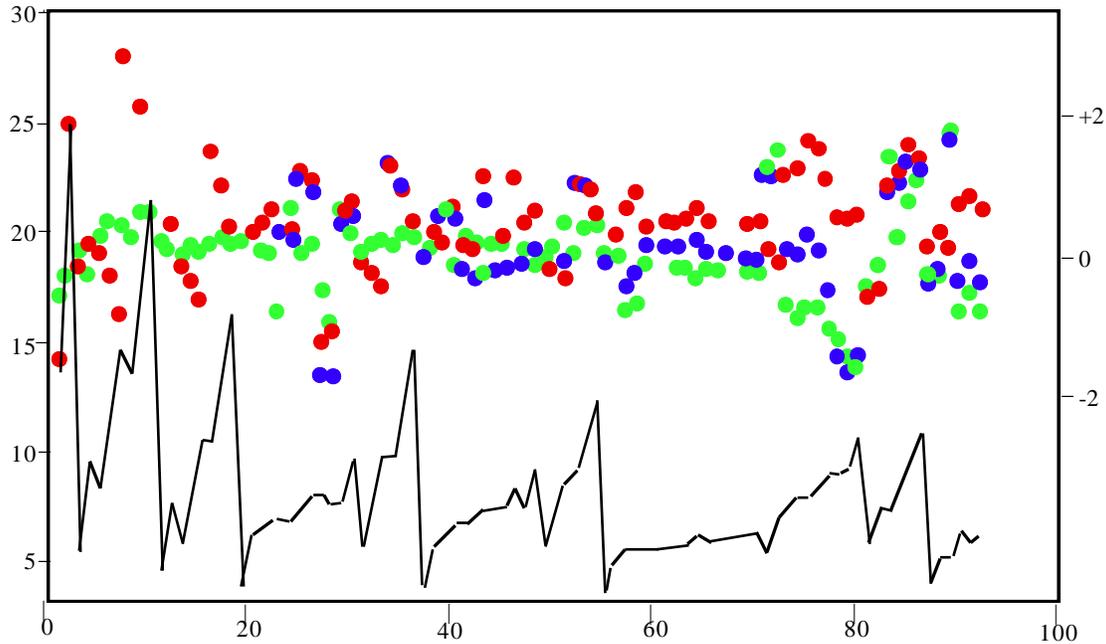


Figure 3. IP data (eV's) as a function of atomic number Z , with deviations of three standard approximations by which QM calculations are accomplished.

Review and Extension of the Hydrogen-Atom Analysis

For atomic balance, the rate of energy loss due to radiation must equal the rate of energy gain due to torquing. Ref. [2] shows how for Hydrogen that means

$$\frac{2^5 e^6}{3c^3 m_e^2 (r_e + r_p)^4} = \frac{e^4}{m_p c (r_e + r_p)^3}$$

where e is the charge on the electron, m_e is the mass of the electron, m_p is the mass of the proton, r_e is the radius of the electron orbit, and r_p is the radius of the proton orbit. This equation can be solved for $r_e + r_p$, yielding $r_e + r_p = 32m_p e^2 / 3c^2 m_e^2 = 5.5 \times 10^{-9}$ cm, which is close to the presently accepted value for r_e , which is 5.28×10^{-9} cm. That orbit radius implies the orbital energy

$$E_H = -\frac{1}{2} \times \frac{e^2}{r_e + r_p} \approx -14.25 \text{ eV}$$

which implies an $IP_{1,1}$ of +14.25 eV, which close to the presently accepted value of 13.5984 eV. So clearly, the model discussed in [2] does reasonably well on Hydrogen's so-called 'ground state'.

What about excited states? The title of Ref. [2] is the question "Do Atoms Really Have States?" My answer is "NO!" It is my belief that 'excitation' consists of the formation of multi-atom systems. For example, Hydrogen excited to $n = 2$ is not a single atom with its electron up in 'shell 2' instead of 'shell 1'; instead, it is just two Hydrogen atoms forming a system. Quantization comes not from the existence of different eigen-solutions of a differential equation postulated by Schrödinger; quantization comes from the count of the number of atoms involved in an atomic system.

Ref. [2] went on to suggest that an excited Hydrogen system would consist of charge *clusters* in place of single charges: a cluster of protons and a cluster of electrons, with the clusters orbiting each other just as single charges would. So basically the same analysis would apply, but with some scaling by functions of n . I must revisit that for readers who remember Ref. [2]. At that time, I was still overly influenced by standard QM, and so thought that linear dimensions would scale by n^2 . But by the time of writing Ref. 2b, I had changed my mind, concluding that linear dimensions scale as n , while charge squared scales as n^2 , and so total orbit energy scales as $n^2/n = n$; in other words, the formation of n independent Hydrogen atoms into an excited n -atom system does not change the total orbital energy at all! This means that, contrary to standard theory, the energy available for creating spectral lines must not be orbital at all; it can only be the energy involved in charge cluster formation. That is, light emission does not have to do with falling into a lower, negative-energy, orbital state; it has to do with releasing positive energy of cluster formation. Cluster formation energy is, apparently, proportional to orbital energy per electron, and the proportionality factor is, apparently, $1 - 1/n^2$. The meaning of $1/n^2$ is not the scaling for inverse orbit radius; it is something else. Ref 2b suggests that $1/n^2$ results from n/n^3 , n being the scaling for orbit energy, and n^3 being the scaling for cluster volume, so that $n/n^3 = 1/n^2$ is the scaling for cluster energy density.

Now what about an atom with a higher Z ? Presumably, such an atom would very much resemble an excited Hydrogen system with n equal to Z , except with a nucleus instead of a cluster of protons. There would still be the same sort of electron clusters. That concept suggest that for an arbitrary atom, the orbit-radius formula generalizes to

$$r_e + r_N = 32Me^2 / 3c^2m_e^2$$

where r_N is the radius of the nuclear orbit and M is the nuclear mass. Observe that this, and presumably all, linear dimensions of an atomic system scale with the nuclear mass M . The orbit-energy formula generalizes to

$$E = -\frac{1}{2} \times \frac{ZQ_-}{r_e + r_N} = -\frac{1}{2} \times Q_- Z \times \frac{3c^2m_e^2}{32Me^2}$$

where Z is the atomic number, or nuclear charge, and Q_- is the negative charge, or number of electrons, present. For a neutral atom $Q_- = Z$; for an ion, $Q_- \neq Z$. On a per-electron basis, orbit energy scales as Z/M . Compared to what one might expect from standard QM, this is quite a strong dependence on M . Referring to the classical ‘Rydberg factor’, one finds scaling according to $1/(1+m_e/M)$; *i.e.* system classical reduced mass divided by electron mass. Because m_e is so small, $1/(1+m_e/M)$ is always close to unity. But because different atoms have different proportions of neutrons along with protons, Z/M varies a lot more: from 1 for Hydrogen, to about 0.4 for the highest- Z elements found so far.

Now according to both standard theory and my own developing theory, IP ’s have something to do with orbit energies. So this Z/M scaling for orbit energies is quite important. It means that, in comparing IP ’s for different elements, we ought not compare the data in raw form. In order to compare ‘apples to apples’, raw IP data should be scaled by M/Z . This is the first big outfall from the two-step-light/atomic-stability approach. It clears the way to recognize patterns in the data that were previously obscure.

***IP* Values – New Status**

Figure 4 shows all the IP data points that were readily available to this author, including elements up to $Z = 112$ and IO ’s from 1 up to 7. Also shown on Fig. 4 are seven lines representing seven IO ’s calculated according to the mathematical model here developed for predicting IP ’s. A lot of the data points fall quite close to the model lines. Some do not. I shall return to those points later.

Observations and Characterizations

Let $IP_{IO,Z}$ denote the IP of order IO for the element with atomic number Z . For all IO ’s, the $IP_{IO,Z}$ follow a pattern keyed to the PA with element $Z = IO$ in the role of Hydrogen. That means **1**) the next IP after $IP_{IO,IO}$, namely $IP_{IO,IO+1}$ is higher, and it completes the first, $N = 1$, period, which has length 2. The next IP , namely

$IP_{10,10+2}$, is lower, and beings a new period, an $N = 2$ period, which has length 8. Then comes a second $N = 2$ period of length 8. And so it goes, on and on, just as in the PA. Any period has a first half (left side of the layer in the PA) and a second half (right side of the layer in the PA). The data scatter is always more extreme in the second half. One cannot know for sure how much of the data scatter represents real physical discontinuities and how much represents mere measurement difficulty, such as noise. But it is reasonable to ask if the data can be explained reasonably under the assumption that *real* discontinuities are limited to period breaks, and possibly mid-period breaks. The rise over any period starts sharp in the first half, levels out over the transition into the second half, and then turns sharp again by the end of the second half. Viewed in log space, every period seems to suggest anti-symmetry about the mid point of the period. On that basis, for any period, the rise from the beginning to the mid point is the square root of the rise to the endpoint.

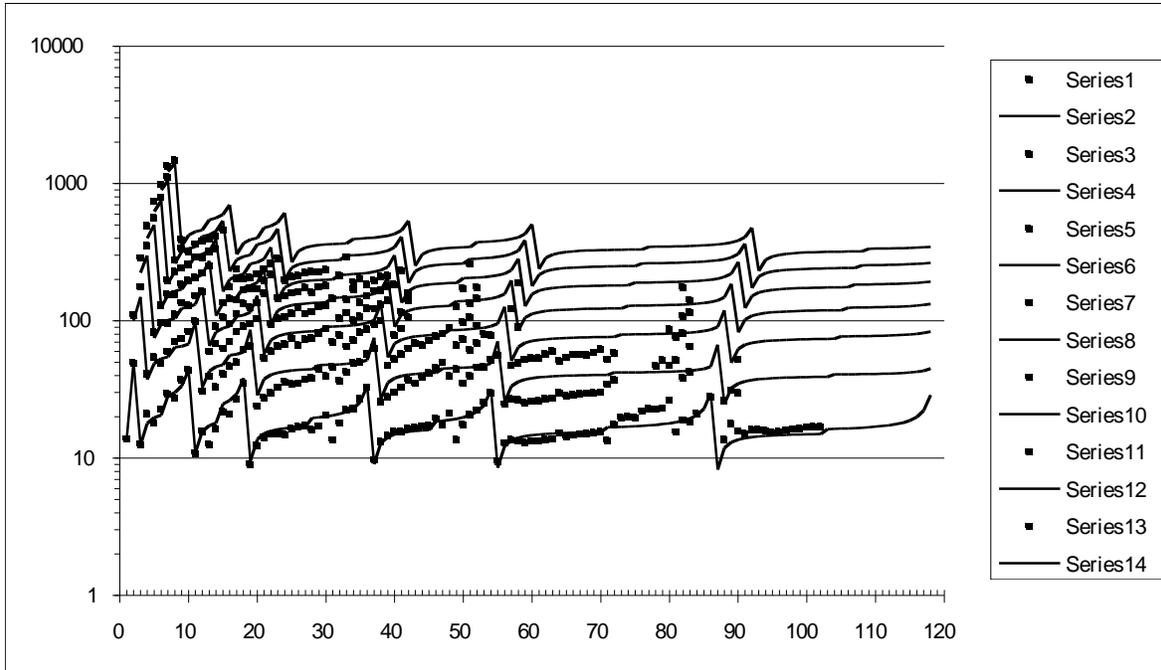


Figure 4. M/Z -scaled IP data (eV's) as a function of atomic number Z , as points, along with the model here developed, as lines.

The above observations are largely qualitative, but it is very easy to take the next step and make them quantitative. The first IP that occurs is that for Hydrogen, $IP_{1,1}$. Its M/Z -scaled value is computed from the orbit radius $r_e + r_p = 5.5 \times 10^{-9}$ calculated in Ref. 2b, which yields $IP_{1,1} = 14.25$ eV. The next IP that occurs is the first IP of Helium, $IP_{1,2}$. Its M/Z -scaled value is $IP_{1,2} = IP_{1,1} \times 7/2$, which in accord with the pattern developed below we choose to write as $IP_{1,2} = IP_{1,1} \times (7/4) \times 2$. The next IP that occurs is the first IP of Lithium, $IP_{1,3}$. Its M/Z -scaled value is $IP_{1,3} = IP_{1,2} / 4$, which in accord with the pattern developed below we choose to write as $IP_{1,3} = IP_{1,2} \times (1/4)$. [Also, it is useful to note that equivalently $IP_{1,3} = IP_{1,1} \times (7/8)$.] The rise in $IP_{1,Z}$ over this and every subsequent period is the same, $7/2$, which we choose to write as $(7/4) \times 2$, in accord with the pattern developed below. The falls in $IP_{1,Z}$ from one hydrogenic element to the next follow the pattern: Lithium to Sodium, $7/8$; Sodium to Potassium, $7/8$; Potassium to Rubidium, $17/18$; Rubidium to Cesium, $17/18$; Cesium to Francium, $31/32$. There is as yet no next hydrogenic element after Francium, but one could reasonably bet that if there were, the fall to it would be $31/32$!

Proceeding now to IO 's greater than 1, the first IP that occurs is that for the element with atomic number $Z = IO$. Its M/Z -scaled value is $IP_{IO,IO} = IP_{1,1} \times (7/4) \times (IO)^2$. (Note that only because of the factor of $7/4$ does this

formula not also hold for $IO = 1$.) The next IP that occurs is $IP_{IO,IO+1}$ and it has M/Z -scaled value $IP_{IO,IO+1} = IP_{IO,IO} \times (IO+1)/IO$. (This differs from the $IO = 1$ case, which also has a factor of $7/4$. The next IP that occurs is $IP_{IO,IO+2}$, and its M/Z -scaled value is $IP_{IO,IO+2} = IP_{IO,IO+1} \times (1/4)$. This is the same as for the $IO = 1$ case. The rise over the second and every subsequent period is $(7/4) \times (IO+1)/IO$. (This is the same as for the $IO = 1$ case, except that the $IO = 1$ case includes the first period as well.) The falls in $IP_{1,Z}$ from one hydrogenic element to the next follow the pattern: IP_{IO+2} to IP_{IO+10} , $7/8$; IP_{IO+10} to IP_{IO+18} , $7/8$; IP_{IO+18} to IP_{IO+36} , $17/18$; IP_{IO+36} to IP_{IO+54} , $17/18$; IP_{IO+54} to IP_{IO+86} , $31/32$. (This is the same for the $IO = 1$ case as well, with the $7/8$ also holding for the first drop in that case.)

Interpretations

All of the above observations and characterizations lend themselves to rational interpretation within the context of the two-step-light/atomic-stability model. To begin with, note that in the two-step-light model, the M/Z -scaled orbit energy **per electron** is $E \times M/ZQ_- = -3c^2 m_e^2 / 64e^2 = \text{constant}$, independent of what kind of atom it is. This constant characterizes the M/Z -scaled energy needed to send an electron out of the potential well of an atom, whether a Hydrogen atom, or any other kind of atom. In the two-step light model, this constant determines not only the M/Z -scaled orbit energy required for ionizations, but also the M/Z -scaled energy involved in rearranging the electron charge cluster. While any '1' in the present model represents one standard unit of M/Z -scaled orbit energy, and any '3/4' in the present model represents one unit of M/Z -scaled charge-cluster rearrangement energy. A $3/4$ arises from the cluster energy factor $1 - 1/n^2$ for $n=2$. The $3/4$ shows up in $7/4 = 1 + 3/4$, and in $1/4 = 1 - 3/4$. The plus sign represents a penalty for breaking a perfectly completed charge cluster, and the minus sign represents a payback for returning an uncomfortably overloaded charge cluster to a perfectly completed state. The characteristic falls from one period start to the next, the $7/8$, $7/8$; $17/18$, $17/18$; $31/32$, are $1 - 1/L$ where L is the length of the period in the PA, specified by $N = 2, 2, 3, 3, 4$. The shape of the rise over any period is something very like midpoint - (midpoint - start) \times declining factor, where the declining factor is $1, 1/2, 1/3, \dots$ followed by, midpoint + (end - midpoint) \times increasing factor, where the increasing factor is $\dots, 1/3, 1/2, 1$. The significance of the fractions is 'one nuclear charge out of however many there are to the nearest period break, defined by a perfectly completed charge cluster'.

And what exactly determines a perfectly completed cluster? Ref. 1 suggested that a plausible structure for the electron charge cluster correlates with the observed structure of the PT (now PA). Figure 5 recalls that structure.

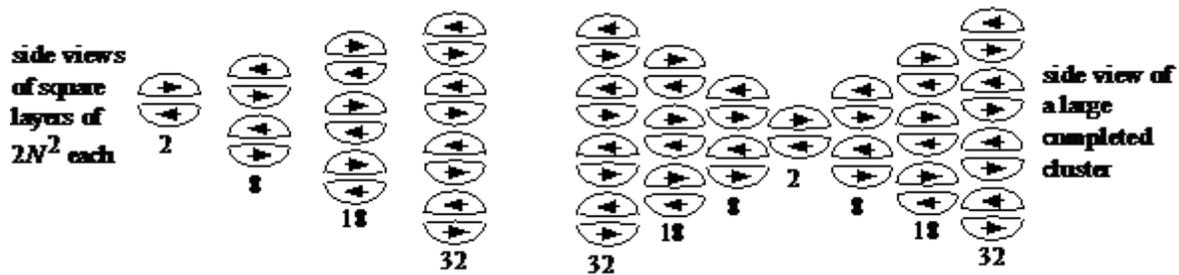


Figure 5. A proposed structure for charge clusters that: 1) is plausible, and 2) correlates with the structure of the PA.

The $(IO)^2$ factor deserves special comment. Note that this *same* factor governs the IP 's of order IO for *all* nuclear charge $Z \geq IO$. In textbook discussions of spectroscopy, the classical Rydberg factor involves the nuclear charge squared, Z^2 . The $(IO)^2$ factor that appears in the ionization data is the same as Z^2 only for the *first* element allowing an IP of order IO . But in general, the $(IO)^2$ factor is *not* the Z^2 factor that appears in the textbooks. Note that $(IO)^2$ is generally much smaller than Z^2 . There is no empirical evidence *whatever* for a Z^2 factor being involved in IP 's, or by extension, in spectroscopy.

The $(IO)^2$ factor has an obvious meaning: imagine removing IO electrons from an atomic system, which then has a net positive charge of IO , with M/Z -scaled orbit energy per electron still being held constant. What then is the meaning of the $(IO+1)/IO$ factor? This number is the same as the nuclear charge ratio $(Z+1)/Z$ for the first two elements allowing an IP of order IO . But since we have scaled out Z/M in the data, perhaps the interpretation should really be **electron** charge ratio $(Q_- + 1)/Q_-$ for the first two elements allowing an IP of order IO .

Also worthy of comment is a feature unique to first-order IP 's. Note that the rise from Hydrogen to Helium contains the factor of $7/4$. But for $IO > 1$, the **first** IP that occurs already contains the factor of $7/4$, so then the **rise** over the first period does **not** contain that factor of $7/4$. This pattern may be the result of the single Hydrogen atom being exceptional by virtue of having *no* charge clusters.

Finally, some data points invite special scrutiny. The fact is not visible from Fig. 4, but some data points actually fall on the model line for a different IO than the one they were assigned in the handbooks. Could these data points have been identified incorrectly? And some data points are just a factor of two higher than the next lower ionization order. (See elements 14 to 28 or 58 to 70.) Do these situations actually represent two simultaneous ionizations of lower order, rather than a single ionization of the assigned higher order? Some data points are low, out of line with neighboring data points. (See elements 13, 16, 49, & 71.) These data points *would* be in line with the element having twice the nuclear charge [*i.e.* 26, 32, 49, (&142)]. Do these situations represent ionizations starting from an already excited state; *i.e.*, ionizations from two atoms already together in an atomic system? And finally, a few data points are inexplicably high. (See first IP 's for elements 73-80). Does this mean that IP 's for some elements are particularly difficult to measure experimentally?

Conclusions

There now exists a simple model for predicting IP 's of arbitrary order for arbitrary elements - a problem not generally considered practical for computation with previously available techniques. This new model is based on a program of research about 'two-step-light', which suggested **1**) scaling out Z/M , **2**) looking for $(IO)^2$, not Z^2 , **3**) thinking in terms of 'charge clusters', **4**) looking for $3/4$'s, **5**) looking for $1/2N^2$, $N = 1,2,2,3,3,4,\dots$. The fit to IP data is pretty good. The occasional 'anomalous' data points *could* mean that: **1**) this model is actually worthless, or **2**) this model needs additional development, or **3**) certain measurements need revisiting, or **4**) something else - not clear what! But this excursion into an area of science outside of relativity theory *per se* could eventually stimulate main-stream researchers to re-evaluate relativity theory itself, and real technological advance could result if that ever happened. So readers are much encouraged to look for additional telling problems like this one!

Acknowledgment

This PIRT paper, like the two that preceded it, was developed from an earlier and more preliminary presentation given before conferences of the Natural Philosophy Alliance in the United States, at the University of Connecticut at Storrs, CT. The titles and dates for all the NPA presentations were: "Light is the Subject, Not the Object!" (1997), "Begging the Questions" (2000), and "Spectroscopy's Relativistic Keystone" (2003). The author is grateful for the support and feedback from the NPA audience. The Journal of New Energy has published some earlier NPA presentation papers, including "Begging the Questions" (JNE 5 (2) 56-63), and is now organizing a Proceedings volume for 2003 that may include "Spectroscopy's Relativistic Keystone".