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"A response to Labarca and Zambon on their claimed reconceptualization of the concept of element and its basis as a new representation of the periodic system. ", Eric Scerri
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Reflexiones

A RESPONSE TO LABARCA AND ZAMBON ON THEIR CLAIMED RECONCEPTUALIZATION OF THE CONCEPT OF ELEMENT AND ITS BASIS AS A NEW REPRESENTATION OF THE PERIODIC SYSTEM

Abstract

In 2013 Labarca and Zambon published an article in which they reviewed the philosophical research on the dual concept of a chemical element. They also claimed that the notion of an element as a basic substance could be characterized by focusing upon the lightest and heaviest isotopes of each element. By further focusing on just the lightest isotopes they presented a new version of the periodic system which they proceeded to compare with the conventional format as well as a form that I have revived. On making these comparisons they claimed that of the 22 triads that they examined, 15 triads involving the lightest isotopes were more accurate than the equivalent triads using the average atomic weights of the elements in question. The present article consists of an examination of these various claims.

Keywords: periodic table, Mendeleev, triads, philosophy of chemistry, chemical education

UNA RESPUESTA A LABARCA Y ZAMBON SOBRE SU PRETENDIDA RECONCEPTUALIZACIÓN DEL CONCEPTO DE ELEMENTO Y SU BASE COMO UNA NUEVA REPRESENTACIÓN DEL SISTEMA PERIÓDICO

Resumen

En el año 2013 Labarca y Zambon publicaron un artículo en el que revisaron la investigación filosófica sobre el concepto dual de un elemento químico. También afirmaron que la noción de un elemento como sustancia básica podría caracterizarse por centrarse en los isótopos más ligeros y pesados de cada elemento. Al centrarse más en sólo los isótopos más ligeros presentaron una nueva versión del sistema periódico que procedieron a comparar con el formato convencional, así como una forma que he revivido. Al hacer estas comparaciones, afirmaron que de las 22 tríadas que examinaron, 15 tríadas que incluían los isótopos más ligeros eran más precisas que las tríadas equivalentes usando los pesos atómicos medios de los elementos en cuestión. El presente artículo consiste en un examen de estas diversas reivindicaciones.

Palabras clave: tabla periódica, Mendeleev, tríadas, filosofía de la química, educación química

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A RESPONSE TO LABARCA AND ZAMBON ON THEIR CLAIMED RECONCEPTUALIZATION OF THE CONCEPT OF ELEMENT AND ITS BASIS AS A NEW REPRESENTATION OF THE PERIODIC SYSTEM

The following article presents a brief response to an article that was published in this journal by Labarca and Zambon in which they proposed a new form of periodic table and claimed that it was an improvement on a table that I previously proposed (Labarca, Zambon, 2013).

The article starts out well enough by expounding on the virtues of the philosophy of chemistry and by drawing attention to the dual sense of the concept of a chemical element that has received a good deal of attention in recent years (Earley, 2005; Hendry, 2005; Scerri, 2005; Scerri, 2012; Ghibaudi, Regis, Roletto, 2013; Mahootian, 2013)

Towards the end of the second page of their article Labarca and Zambon propose a reconceptualization of this distinction by considering that the more metaphysical sense of the concept of element, sometimes termed as element as 'basic substance', should be identified with the range of isotopes that an element can display. With no justification whatsoever the authors then focus exclusively on the lightest isotope of every element and calculate a property given by the expression L – Z, meaning the mass number of the lightest isotope minus the atomic number of the element concerned or the number of neutrons in each isotope. For example in the cases of hydrogen and carbon respectively, the lightest isotopes, according to current knowledge are ${}^{1}_{1}H$ and ${}^{8}_{6}C$. Appealing to the formula L – Z gives values of 0 and 2 respectively for these isotopes. The authors then present a table (figure 1) in which they tabulate values of L and L – Z for the lightest isotopes of the first twenty elements in the periodic table.

Z	Símbolo	Isótopo L	Función L - Z
1	H	1	0
2	He	2	0
3	Li	4	1
4	Be	5	1
5	B	7	2
6	C	8	2
7	N	10	3
8	O	12	4
9	F	14	5
10	Ne	16	6
11	Na	18	7
12	Mg	19	7
13	Al	21	8

14	Si	22	8
15	P	24	9
16	S	26	10
17	Cl	28	11
18	Ar	30	12
19	K	32	13
20	Ca	34	14

Figure 1. in Labarca and Zambon's article.

Finally, they claim that these values can be used to give a new representation for the system of the elements as shown in their figure 2. Along the left hand edge of their 'new system' the authors list ordinal numbers from 1 – 46. So far, so good.

However, it seems odd that the authors should wish to attach any chemical importance whatsoever to the quantity of L – Z given that this quantity represents the number of neutrons that are known to be chemically irrelevant. It might also be noted, in passing, that this table does not bear the slightest resemblance to the conventional periodic table. However, as far as the authors seem to believe this representation is somehow superior to those based on electronic configurations of atoms. They also claim, with no apparent justification, that the representation is more in spirit with Mendeleev's system because of its alleged connection with elements as basic substances.

These problems are then immediately compounded when the authors proceed to try to compare their new system with a version of the periodic table that was initially proposed by Janet but recently revived in the literature by myself (Scerri, 2013).

In order to make the necessary comparison between the two systems, those in their figures 2 and 5, the authors decide to focus on triads of elements and to calculate the percentage error between the calculated value of the intermediate member of each triad with the known experimental values. Unfortunately many of these sets of errors that are calculated and shown in figure 6 are incorrect.[1] In the case of the conventional system and the periodic system attributed to me, the Li-Na-K triad gives a calculated value of 23.020 which if compared with the observed atomic weight of 22.989. The calculated triad therefore shows an error of 0.136% and not 0% as shown by Labarca and Zambon. In the case of the triad of lightest isotopes in their own system, the calculated value is 18 as compared with an observed mass number of 18 and therefore an error of 0% as shown in figure 6.

	Triada	Masa atomica aceptada	(1) y (2) % Error	(3) % Error
1	Li-Na-K	Na: 23,0	0	0
2	Be-Mg-Ca	Mg 23,3	1,0	0,6
3	K-Rb-Cs	Rb: 85,5	0,58	0,47
4	Ca-Sr-Ba	Sr: 87,6	1,26	1,37
5	Al-Ga-In	Ga: 69,7	1,7	1,2
6	Si-Ge-Sn	Ge: 72,6	1,1	2,2
7	P-As-Sb	As: 74,9	2,0	4,3
8	S-Se-Te	Se: 79,0	1,1	1,0
9	Cl-Br-I	Br: 79,9	1,6	0,5

Figure 6. in Labarca and Zambon's article.

[1] The values shown in the column headed "massa atomica aceptada" are surprisingly inaccurate, since they are given to just one single decimal place. This is especially serious since most periodic tables display atomic weights to three or even four decimal places and since these values are being supposedly used to compare the errors involved in atomic weight triads of the elements in the competing periodic systems.

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10	Ar-Kr-Xe	Kr: 83,8	2,1	1,9
11	He-Ne-Ar	Ne: 20,2	8,7	1,5

We will now calculate errors for the second triad that the authors choose to focus upon, namely the Be-Mg-Ca triad, according to the conventional table and the table attributed to me (1) and according to the new proposed table of lightest isotopes. In the case of representations (1) the error in the calculated value is indeed approximately 1% as shown in figura 6.

However, in the case of the triad referring to lightest isotopes of Be-Mg-Ca, the error is found to be approximately 2.63% and not 0.6% as the authors claim in their figure 6. Next we consider the third triad as specified by the authors, namely K-Rb-Cs. Using accurate values of atomic weights the error is 1.2% and not 0.58% as shown by the authors. In the case of the same triad using the lightest isotopes of each element gives an error of 1.41%. We see little point in continuing this exercise and can only conclude that the authors of the article in question have made systematic errors in the way in which they have calculated all their triads with the possible exception of the very first one.

Another important concern is that the authors could equally well have chosen to work with the heaviest isotope of each element and would doubtless have arrived at a different set of errors for each of their triads. Nowhere in the article do Labarca and Zambon justify the ad hoc appeal to just the lightest isotopes as being representative of elements as basic substances.

Whereas the authors conclude that,

> En este trabajo hemos presentado un reconceptualización del término 'elemento' basado en el argumento de los 'isótopos límites'. La definición propuesta preserva su naturaleza dual y, en ese sentido, hemos caracterizado también la noción metafísica de 'sustancia básica'. Tal noción de 'elemento' da origen, entonces, a un sistema periódico basado en un nuevo criterio primario de ordenamiento.

This statement is problematic in several respects. Firslty the new system that was presented was based on the lightest isotope of each element and not on the range of isotopes as the authors are now claiming. Secondly, and perhaps more importantly, there is no argument to explain why this bizarre association should serve to characterize the elements as basic substances rather than as simple substances. In fact the authors are also guilty of contradicting something they write on the first page of their article in which they state,

> Pero el radioquímico austríaco Fritz Paneth sostuvo que la tabla periódica de los químicos podía retenerse. Considerando que las propiedades químicas de los isótopos del mismo elemento son indistinguibles, con excepción del hidrógeno, el descubrimiento de nuevos isótopos representaba nuevos elementos como sustancias simples, lo que justificaba dicha hipótesis.

This statement appears to be perfectly correct, in that the isotopes of each element should be regarded as various simple substances not as basic substances. Why then do the authors concentrate on isotopes as being representative of elements as basic substances? The only way out of this contradiction might be to make a case for the range of isotopes as somehow characterizing the possible range of existence of a particular element. At one point in their article the authors hint at this notion and even invoke the word "ontological" but they fail to follow through when they immediately revert back to considering only the lightest isotopes of each of the elements.

Returning to their conclusion the authors also write,

> No es nuestra intención afirmar que la nueva representación del sistema periódico aquí presentada sea superior a otras tablas periódicas.

This has to be regarded as something of an anti-climax given that figure 6, as presented by the authors, seemed to indicate the superiority of their system, at least as far as the accuracy of their triads are concerned. One cannot help asking why the authors therefore contradict their own findings, which clearly suggest that their system is indeed superior, given that 15 triads are deemed more accurate among the 22 calculated triads. Otherwise one has to wonder what the purpose for the comparison presented in figure 6 can possibly be.

I regret to say that I am very confused by the article by Labarca and Zambon, and am very eager to hear any response that they might have to the present critique.

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