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A COMMENT ON THE SRIVATHS – LABARCA PERIODIC TABLE

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The following article aims to draw attention to an important publication by Labarca & Srivaths (2016) on the placement of hydrogen and helium in the periodic table. First of all let me be clear in praising these authors for their detailed review of the variety of approaches that have been taken to this issue, ever since the discovery of the periodic system (Labarca & Srivaths, 2016).

Nevertheless, I believe that the original solution that they have proposed is mistaken in a very important respect that I will try to explain below. Labarca & Srivaths (2016) claim that there are three main criteria that have been used in order to obtain a secondary classification of the elements into a two-dimensional periodic system. This approach is a way of thinking about the periodic system that I promoted in my 2007 book on the subject (Scerri, 2007). The periodic system can be thought of as displaying both primary and secondary classification. Ordering the elements using atomic number, ever since the discoveries of Van den Broek and Moseley, unambiguously provides primary classification (Scerri, 2016a). Such a 'classification' if one may use the word in this context merely serves to place the elements into a one-dimensional list.[1)]

In order to recover the familiar 2-dimension grid one must also select a secondary criterion as a means of cutting the element line in several places. Cutting the element line then allows one to place several new shorter line sequences one above the other to display the places where chemical repetition occurs along the original element line.

Such a secondary criterion has traditionally been provided by chemical and physical similarities such valences. With the discovery of atomic and electronic structure there has been a turning towards microscopic criteria including electronic configurations of atoms to provide the secondary criterion. However as in the case of chemical and physical properties, electronic configurations do not provide a clear-cut and unambiguous criterion. This is why many other authors have been led to propose the use of yet other criteria such as electronegativity values or atomic number triads (Cronyn, 2003).

Whichever of these criteria might be used the debates remain open. In a somewhat desperate move, as I see it, Labarca and Srivaths now propose to avoid using one single criterion and write,

> [H]owever, if it is conceded that none of the three candidates has explanatory priority, that is, if they do not provide an unambiguous means of classifying elements into groups, it is then reasonable to ask why a single criterion should be privileged. This leads us to the following question: why not a new arrangement where the main secondary criteria are considered simultaneously? In other words, is it possible a new and positive secondary criterion for deciding on the placement for hydrogen and helium in the periodic system? (Labarca & Srivaths, 2016).

> [I]n the light of these arguments, as possible solution to this conundrum we propose a sort of "balance" among the main perspectives identified in the debate. This means to resist the compromise of both hydrogen and helium with any particular criteria (Labarca & Srivaths, 2016).

In Fig. 1 below I reproduce the periodic table that the authors have proposed on the basis of their 'balance' argument. As can be seen, hydrogen has been carefully placed so that it sits simultaneously among the elements in the alkali metal group and in the halogen group. Similarly, the element helium has been carefully placed in such a way as for it to appear simultaneously in the noble gas group as well as the alkaline earth group.

At first sight this might seem to be a reasonable solution to the long-standing debate. However, as I want to now suggest, this proposed solution is a blatant form of *ad hoc* maneuver. It is ad hoc for the simple reason that the solution has been especially designed to accommodate the facts and because it does not lead to any new predictions about any of the elements concerned. Let us recall that the literal meaning of the term "ad hoc" in the context of scientific theories, explanations or a system of classification in this case, to mean an explanation that is being brought to bear "to here". The only reason why Labarca and Srivaths have proposed their design is so as to accommodate the ambiguous nature of hydrogen and helium. This compromise does not solve the problem but rather surrenders to it fully.

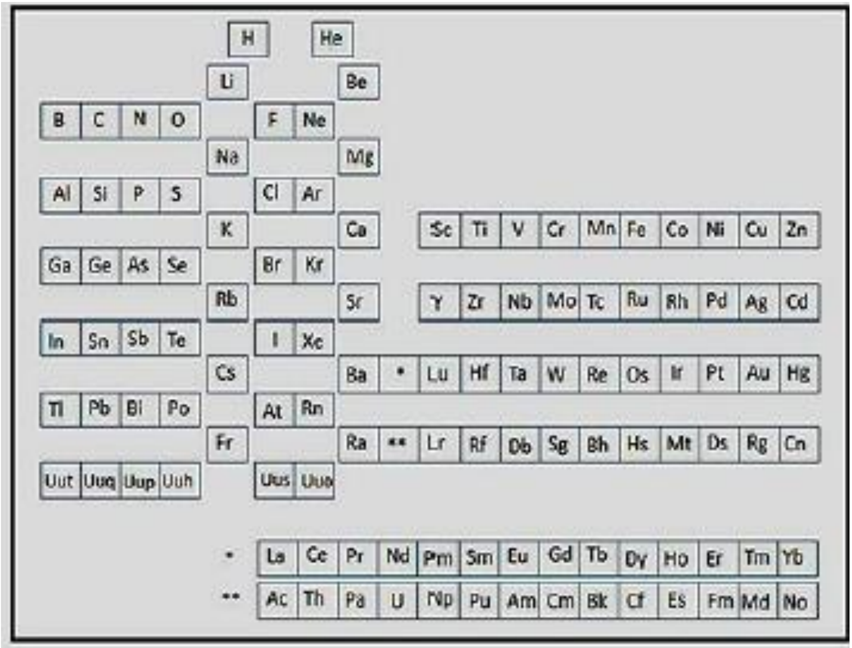

Figure 1. Reproduced from Fig. 8 of the Labarca & Srivaths (2016) article

It is far too easy to try to solve the problem by designing a periodic table that accommodates all the ambiguities at once. Labarca and Srivaths' solution does not offer a new criterion as they readily concede. It does not tell us how to classify any newly discovered elements or other ambiguous cases as perhaps the equally vexing group 3 issue (Scerri, 2012).

Nor are any of the reasons that the authors suggest to support their proposal any more convincing. For example, they state that one virtue of their approach is that it does not involve reducing the periodic table to quantum mechanics as though such an attempt is inherently suspect from the outset. I am tempted to suggest that in doing so the authors are committing an even bigger mistake than proposing their ad hoc and rather impotent periodic table.

Unfortunately, and for several reasons that I have analyzed in other publications, many philosophers of chemistry have fallen prey to the mistaken view that reductionism is inherently undesirable and that it must be opposed on principle (Scerri, 2016b; 2017). What they fail to understand is that reductionism is a direction rather than a goal. Although reduction is never complete we learn a great deal about the world by pursuing a reductionist approach, which remains at the heart of all of science. They also fail to understand that the success or otherwise of reductionism is a matter of degree rather than all or nothing affair.

To conclude, I agree with the authors who suggest that this topic can serve to deepen the study of chemistry and the philosophy of chemistry.

> [F]inally, independently of the acceptation of the arguments raised here, we do believe that this topic gives an excellent opportunity to chemistry teachers for developing arguments, a major theme in the field of science education since mid-90's (Erduran & Jiménez-Aleixandre, 2007). In this respect, philosophy of chemistry becomes an excellent pedagogical tool (Lombardi & Labarca, 2007) to foster argumentation processes in the classroom (Labarca & Srivaths, 2016).

As I see it Labarca and Srivaths' article can be used to point out the pitfalls of providing ad hoc scientific explanations and the dangers of rejecting reductionism in principle rather than in practice.

NOTES

1. Some authors dispute my use of the term "classification" to include ordering of the elements since they take classification literally to mean placing certain entities into classes.

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