A Review Paper on Periodic Table

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ABSTRACT: The current state of study into the conceptual basis of the periodic table is summarised in this article. We provide a brief history of the chemical elements table and periodic system, including the effect of contemporary physics because of the findings of Moseley, Bohr, and current quantum mechanics, among other things. The periodic table's significance in the dispute over chemistry's reduction is explored, as well as efforts to deduce the Madelung rule from fundamental principles. Other contemporary disputes include around the idea of an "element" and its dual role as a simple and elementary material, as well as whether elements and groupings of elements form natural types. The second of these concerns the possibility of additional arguments about the periodic table's placement of specific elements such as H, He, La, and Ac. While the overall shape of the periodic table has stood the test of time and is unlikely to change in the future, changes to the table have been made and are still being made. The atomic mass is one area where small alterations might occur. More precise techniques of determining the mass of atoms may be developed in the future. However, the magnitude of these changes would be negligible.

KEYWORDS: Atom, Bohr's Model, Electron, Pauli's Principle, Periodic table.

1. INTRODUCTION

The periodic table of elements is probably the most natural categorization scheme in all of science. Unlike biological categorization, which is constantly disputed, chemical element classification is considerably more clear-cut according to the periodic table, but some disagreements still exist [1]. The periodic table is a physical representation of two concepts that are more abstract, the periodic law and the periodic system, which are both more basic than the common periodic table. Nonetheless, in the following, the words periodic table and periodic system shall be used interchangeably [2]. Only chemistry, unlike other disciplines, has a single chart, the periodic table, which encapsulates the whole discipline both openly and implicitly, given that new parallels and correlations arise more all the time. The periodic rule, which underpins the periodic table, is one of chemistry's most important concepts, along with the concept of chemical bonding, with which it is inextricably linked. The periodic table, and its major elements, have received a lot of attention in the philosophy of chemistry, which is not unexpected [3].

The discovery of topological insulators, as well as the subsequent theoretical and experimental work, has resulted in significant progress in our knowledge of zero-temperature gapped phases. While the first novel systems found were topological phases of insulators and superconductors in one to 3-dimensions, they were later organised into some kind of "periodic table," which expanded the categorization to all dimensions and symmetry classes. Using links among K-theory and Bott periodicity on the one hand, and free fermionic topological phases with symmetries on the other, this unifying method discovered a surprising underlying periodicity [4]. In the presence of a boundary, the generalised topological insulators described by this classification system display robust, topologically protected edge modes, and are characterised by invariant integers encoded in the topology of their wave functions. The periodic table, in this form, contains the whole set of bulk-edge linkages between bulk Hamiltonians and their protected edge states. Alternatively, the periodic table may be seen as reflecting the relationship between the unitary time evolution of a constant Hamiltonian (evaluated after time T) and the associated edge eigenstates.

The periodic table of elements is probably the most natural categorization scheme in all of science. Unlike biological categorization, which is constantly disputed, chemical element classification is considerably more clear-cut according to the periodic table, but some conflicts still exist [5]. The periodic table may be seen as part of a larger framework of topological bulk-edge linkages between linear time growth operators and protected edge modes in this image. New forms of bulk-edge connections may emerge when the Hamiltonians involved are no longer restricted to be time-independent. In this paper, we develop an extended periodic table for free fermionic systems with time-dependent Hamiltonians in order to capture the structure of these dynamical bulk-edge linkages [6].

Despite the fact that we shall draw links to Coquet theory, our method describes time-dependent topological phases without requiring temporal periodicity. Instead, we focus on the instantaneous topological edge states that may exist in a system following a given time evolution by considering equivalence classes of unitary time-evolution operators in general. The development of a generalised periodic table of Coquet topological insulators, which may be found in Table II, will be our major result. We discover numerous previously unknown Coquet topological phases in the process, as well as a comprehensive and unifying description for all symmetry classes and dimension. This image, like that of (static) topological insulators, establishes a link between Bott periodicity in K-theory and the topological phases of driven free fermionic systems, defining both the system's weak and strong invariants [7].

1.1 Basic Group theory:

1.1.1 Some groups useful for the periodic table:

In physics and chemistry, the structure of a group is the most basic mathematical structure. A group is a collection of elements having an associative internal composition law, a neutral element, and an inverse for each member in the collection with respect to the neutral element. There are two types of groups:

- Discrete (with a finite number of elements)
- Continuous (with an infinite number of elements)

Both types of groups are used in physics and chemistry. The Periodic Table, on the other hand, is concerned with continuous groups, especially Lie groups. A Lie group is a continuous group for which the composition law has the property of analyticity. One and only one Lie algebra (i.e., a no associative algebra whose algebra rule is anti-symmetric and fulfils the Jacobi identity) belongs to a particular Lie group. In the sense that a given Lie algebra can correspond to many Lie groups, the contrary is not true.

Considering the implementation of orthogonal group in 3-dimensions, denoted SO_3, which is isomorphic to the point rotation group in three dimensions as an example of a Lie group. The Lie algebra1 of the Lie group SO_3, abbreviated as SO_3 or A_1, is nothing more than the algebra of angular momentum in quantum physics. Indeed, the Lie algebra SO_3 of the special unitary group in two dimensions SU is isomorphic to the Lie algebra SU_2. As a result, the Lie algebra A1 of the groups SO_3 and SU_2 is the same. Su_2 is isomorphic to SO_3[2] or SU_2 is homomorphic onto SO_3 with a kernel of type Z_2, or SO_3 is isomorphic to SU_2/Z_2- [3].

There are two types of Lie groups:

- Simple Lie groups without an invariant Lie subgroup
- Semi-simple Lie groups without an abelian (i.e., commutative) invariant Lie subgroup.

We have simple Lie algebras (with non-invariant Lie sub algebra) and semi-simple Lie algebras (with non-abelian invariant Lie sub algebra) because of this concept. A semi-simple (respectively simple) Lie group's Lie algebra is, of course, a semi-simple (respectively simple) Lie algebra. Any semi-simple Lie algebra is equal to the direct sum of simple Lie algebras.

Some early 20th physics discoveries had significant implications for the periodic table, albeit they did not fundamentally alter it. X-rays, radioactivity, atom splitting, elemental transmutation, isotopy, atomic number, and quantum mechanics and relativity are among the findings. Van den Broke and Moseley's discovery of atomic number offered a more natural ordering concept than the pioneers' use of atomic weight. In the case of tellurium and iodine, for example, the new ordering principle resolved a number of pair reversals that occur in the wrong order in chemical terms if one follows an order of rising atomic weight.

1.2 Bohr's Model:

Increasing advances in atomic structure led to increasingly successful interpretations of the periodic table in terms of electronic structure, albeit the periodic table often led to atomic structure discoveries rather than the other way around. Bohr's model of the atom, one of the first applications of quantum theory to atomic structure, merits special attention among these achievements. Bohr used a semi-empirical approach to the problem, relying on chemical activity and spectrum data to arrive at electronic configurations of atoms, which are then used to explain why particular elements are clustered together in the periodic table. Figure 1 shows the Bohr's model of atom [8].

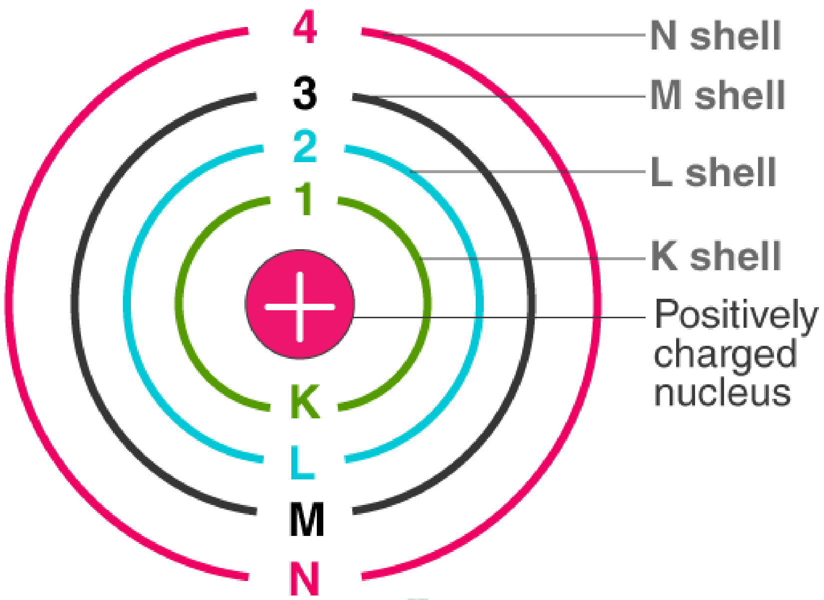

Figure 1: The above figure shows the Bohr's model of Atom [byjus].

1.3 Pauli's Principle:

Pauli's approach to explain the phenomenon of electron shells shutting once a certain number of electrons occupied them prompted him to develop the Exclusion Principle, which has far ramifications in all of science. Although Pauli's technique of introducing a fourth quantum number, in combination with prior work on the connection between three quantum numbers, offered a fully logical explanation for this occurrence, that isn't the case for the more chemically significant fact of period closure [9]. Figure 2 shows the Pauli's principle.

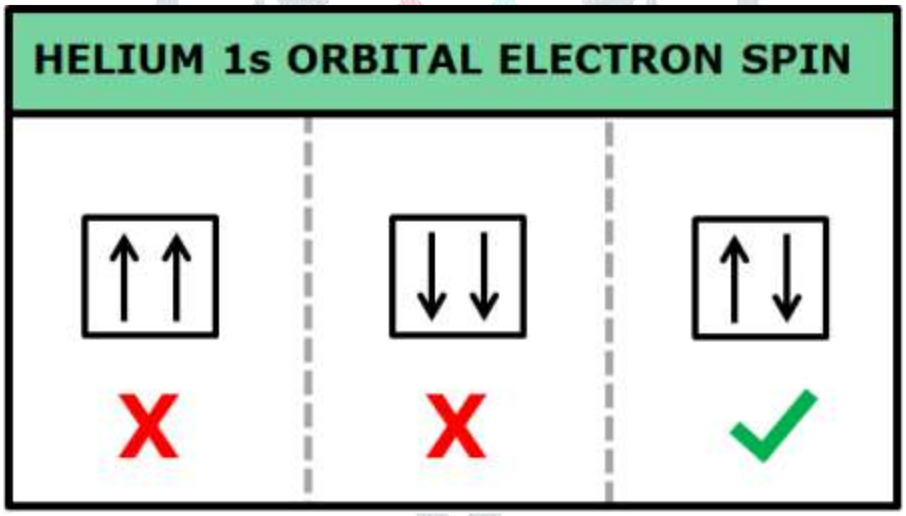

Figure 2: The above figure shows the Pauli's Exclusion Principle [study].

1.4 Forms of Periodic Table:

1.4.1 Short Form Periodic Table:

To represent the periodicity of the elements, the first pioneer periodic tables often included eight columns. When elements are placed in sequence of increasing atomic weight, the characteristics of the elements begin to repeat themselves after eight elements, until iron (atomic weight 55) is reached. To deal with the apparent break in periodicity, Mendeleev was compelled to remove sets of three elements like iron, cobalt, and nickel from each succeeding period and place them in an anomalous group he named the transition elements and labelled group VIII. Figure 3 shows the short form periodic table[10].

Series.	Group I. R_2O.	Group II. RO.	Group III. R_2O_3.	Group IV. RH_4. RO_2.	Group V. RH_3. R_2O_5.	Group VI. RH_2. RO_3.	Group VII. RH. R_2O_7.	Group VIII. RO_4.
1	H=1							
2	Li=7	Be=9.4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27.3	Si=28	P=31	S=32	Cl=35.5	
4	K=39	Ca=40	—=44	Ti=48	V=51	Cr=52	Mn=55	Fe=56, Ce=59 Ni=59, Cu=63
5	(Cu=63)	Zn=65	—=68	—=72	As=75	Se=78	Br=80	
6	Rb=85	Sr=87	? Y=88	Zr=90	Nb=94	Mo=96	—=100	Ru=194, Rh=104 Pd=106, Ag=108
7	(Ag=108)	Cd=112	In=113	Sn=118	Sb=122	Te=125	I=127	
8	Cs=133	Ba=137	? Di=138	? Ce=140	....	....	....	....
9	....	....	....	....	....	....	....	....
10	....	....	? Er=178	? La=180	Ta=182	W=184	....	Os=195, In=197 Pt=198, Au=199
11	(Au=199)	Hg=200	Tl=204	Pb=207	Bi=208	....	....	
12	....	....	....	Th=231	....	U=240	....	....

Figure 3: The above figure shows the short form periodic table.

1.4.2 Medium Long form Periodic Table:

The next significant alteration in the periodic table's appearance came when sets of 10 elements, rather than just three, were removed from the main body of the eight-column table, resulting in a block of thirty transition elements, to which ten more were subsequently added. The term "transition element" was also redefined to refer to an element whose atoms are occupying inner, rather than outer, electron shells. These elements are generally put between the s and p blocks, or the main body of the former short-form table, rather than on the right side, as Mendeleev had done with his transition elements. The purpose for this arrangement is to maintain the medium-long form periodic table's order of rising atomic weight and then atomic number. Figure 4 shows the Medium Long form Periodic Table.

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Lr	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg							

La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No

Figure 4: The above figure shows the Medium Long form Periodic Table.

1.4.3 Long form Periodic Table:

The general shape of the periodic table has changed even more recently, notably after new artificial elements were first created in the 1940s. The inner transition elements, traditionally known as rare earths, have been removed to form the f-block, which is put between the s- and d-blocks, once again to preserve the sequence of rising atomic number or commonly presented as a footnote. The current synthesizing of elements up to and includes element -118, with the exception of element 117, has sparked conjecture that the periodic table may be expanded again to include the g-block elements, which will technically begin at element -121. Figure 5 shows the long form of periodic table.

H																														He
Li	Be																								B	C	N	O	F	Ne
Na	Mg																								Al	Si	P	S	Cl	Ar
K	Ca														Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr														Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Th	Pa	U	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg							

Figure 5: The above figure shows the Long form Periodic Table.

2. DISCUSSION

The author has discussed about the periodic table, the periodic table is a physical representation of two concepts that are more abstract, the periodic law and the periodic system, which are both more basic than the common periodic table. Nonetheless, in the following, the words periodic table and periodic system shall be used interchangeably. The author has also discussed about the Bohr’s model, Bohr's model of the atom, one of the first applications of quantum theory to atomic structure, merits special attention among these achievements. Bohr used a semi-empirical approach to the problem, relying on chemical activity and spectrum data to arrive at electronic configurations of atoms, which are then used to explain why particular elements are clustered together in the periodic table. The author, Pauli’s approach to explain the phenomenon of electron shells shutting once a certain number of electrons occupied them prompted him to develop the Exclusion Principle, which has far ramifications in all of science, also discusses Pauli’s Principle. Although Pauli's technique of introducing a fourth quantum number, in combination with prior work on the connection between three quantum numbers, offered a fully logical explanation for this occurrence, that isn't the case for the more chemically significant fact of period closure.

3. CONCLUSION

The author has concluded about the periodic table's significance in the dispute over chemistry's reduction is explored, as well as efforts to deduce the Madelung rule from fundamental principles. Other contemporary disputes include around the idea of an "element" and its dual role as a simple and elementary material, as well as whether elements and groupings of elements form natural types. The second of these concerns the possibility of additional arguments about the periodic table's placement of specific elements such as H, He, La, and Ac. While the overall shape of the periodic table has stood the test of time and is unlikely to change in the future, changes to the table have been made and are still being made. The atomic mass is one area where small alterations might occur. The periodic table of elements is probably the most natural categorization scheme in all of science. Unlike biological categorization, which is constantly disputed, chemical element classification is considerably more clear-cut according to the periodic table, but some disagreements still exist. The author has also explained about the Bohr’s model, Pauli’s principle and the forms of periodic table.

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