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The Assembly and Classification of the Elements Using the Roberts-Janet Nuclear Periodic Table

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Abstract

A framework and surprisingly coherent analysis of the elements is presented using the Roberts-Janet table derived by inverting the Periodic Table coupled with the Quantum Mechanical Table established using the mathematics of the Standard Model and groups U (1) x S U (2) x S U (3). Having already identified in previous articles a one to one mapping between the two tables, this article seeks to consolidate such a framework to include nucleosynthesis by presenting the appearance of the highly stable numbers of neutrons and protons – magic numbers within the Nuclear Shell Model – as a consequence of the framework itself. The article also seeks to illustrate similarities between the electron structure of individual elements in condensed matter (Periodic Table) and the structure of neutrons and protons in plasma during fusion (Nucleosynthesis) and its possible extension to the Standard Model and beyond. Phase changes together with suitable boundary conditions lead to the hypothesis that all elements ultimately become metallic.

Keywords: Periodic table • Isotopes • Spectral energy • Quantum number

Historic and Current Framework

The Periodic Table crystallized in 1869 via Dmitri Mendeleev from the experimental and theoretical discoveries of new elements and the recognition of simple underlying trends during the 19th century. Arrhenius subsequently suggested a local ordering and self-assembly mechanism of positive and negative ions illustrated by the presence of hydrogen, carbonate, sulphate, hydroxide and ammonium compounds. Following the discovery of the inert gases by Ramsey the table was extended to include an extra column though the position of hydrogen remained and still remains a source of debate within chemists. Seaborg not only extended the table by discovering numerous transuranic elements and several isotopes but also developed the concept of the Actinides, similar to the set of Lanthanides, above them within the table. The issue of how to construct a sequential sequence of atomic numbers throughout the table, having been observed initially in theory by van den Broek and established experimentally by Moseley, remains to this day. Janet addressed the issue with his Left Step Periodic Table but the properties, particularly of hydrogen and helium, known at the time excluded any acceptance in general. Mass number though essential in quantitative calculations remains an enigma/anomaly as to its role in any underlying fundamental mechanism; despite the introduction of the concept of isotopes and a prediction of a particle – the neutron – by Soddy and its subsequent discovery by Chadwick in 1932. Mendeleev in the original construction of the table had to superimpose the significance of atomic number over and above that of mass number.

The Nuclear Shell Model was proposed by Dmitry Ivanenko in 1932 and developed independently by Maria Goeppert-Mayer, Eugene Paul Wigner and J Hans D Jensen in 1949. It envisages each neutron/proton to be moving in some potential and describes the energy levels in terms of quantum numbers n, l, j similar to the wavefunctions of individual electrons as classified in Condensed Matter since both neutrons and protons together with electrons are fermions. When the potential is approximated to the Saxon-Woods model a reasonable agreement with observed binding energies is obtained.

Configurations of 2, 8, 20, 28, 50, 82 and 126 protons and neutrons separately give rise to larger binding energies, spherical configurations and neutron absorption cross-sections up to two orders of magnitude less than other nuclei with similar masses. These were labelled magic numbers by Eugene Wigner. The first three numbers are created by the 1s state (n = 1, l = 0) which can contain up to 2 neutrons or protons followed by the 1p state which can contain up to 6 neutrons or protons giving 8 and the 1d and 2s being close enough to overlap with each other to form the next shell of 2 + 6 + 10 + 2 which is the number 20, the next magic number.

At this point spin-orbit coupling between the orbital angular momentum and spin angular momentum comes into play. In Condensed Matter the origin is magnetic and the effect small requiring a minor correction. In the case of nuclear binding, the effect is about 20 times larger and is a property of the nuclear potential itself with a term proportional to L.S (orbital angular momentum and spin angular momentum). A feature of this type of coupling is that states with higher j have lower energy.

The result is that the f (7/2) state containing 8 states overall arising from the next shell forms a separate shell itself giving 28 as the next magic number. Subsequent shells of 50, 82 and 126 appear to be structured similarly where the highest j value of the next n value of quantum states overlaps the previous n value of states, completing the shell and creating the stability of the magic numbers. This is the classical Nuclear Shell Model at work. In this model the question as to why two sets of magic numbers appear independently one for neutrons and one for protons and in what order remains unanswered. The assertion that magic numbers in themselves universally create a stable configuration has to be tempered by the transient existence of ^{10}He and ^{56}Ni and maybe other doubly magic nuclear configurations. Topology, quantum confinement and the fact that neutrons and protons are composite particles that can oscillate between fermionic and bosonic states may play a role in whatever space/time/geometric evolves to accommodate such variations.

The Standard Model developed in the 1970's as the result of discoveries of large numbers or a zoo of elementary particles. Quarks was a name coined by Gell-Mann having proposed the Eightfold Way; a method to organise hadrons along with Yuval Ne'eman in 1961. Subsequent theories by Weinberg, 't Hooft and others combined with experiments led to the discovery of three generations of quarks; to the prediction of Z, W, and

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Higgs bosons with their discoveries in 1983(Z, W) and 2012(Higgs) and to the merger of the electromagnetic and weak forces at high energies. Another parameter – colour – extended the range of particles via quantum chromodynamics following the appearance of a three-part structure for the proton in Rutherford-type experiments. Other groups of particles include leptons – electrons, muons and tau with their cousins; the electronic neutrino, muonic neutrino and tau neutrino. All particles have their own anti-particle within a mathematical framework of U (1) x S U (2) x S U (3) group symmetry.

The theory lays out; six quarks, six leptons, four force carriers for the four forces in Nature and the Higgs boson. Particles are now thought to be excitations of interacting fields within quantum field theory.

Questions

- Why do neutrinos have mass and can mix – oscillate from one type to another?
- What is Dark Matter? Does it exist? Does it require further particles or is it a property of gravity?
- Why is there so little anti-matter in the Universe?
- Why is the Universe accelerating – if at all?
- Having confirmed the existence of gravitational waves, what is a graviton's characteristics?
- What is the source of space-time?
- Does time play other roles in the quantization of space-time?
- Is time part of the space geometric?

The Periodic Table (Condensed Matter), The Nuclear Shell Model (Nucleosynthesis) and The Standard Model (Particle Physics and Cosmology) are compartmentalised yet linked through electrons; protons and neutrons; quarks, bosons and neutrinos. Can they be integrated in such a way that could merge them into one framework that might lead to quantum field theory and gravity being unified? Different research groups have now established several nuclei with pear-shaped structures alongside the more familiar spherical and oval configurations. As energies increase toward the Planck scale topologies and gauge groups may need to be developed to ten dimensions to allow quantum states to fold and unravel as a pathway between space-time and quantum field theory – So eloquently articulated in Beyond the Standard Model by Gordon Kane and replied to by Edouard Brezin in the journal 2576-4403 March 1 2019.

The Emergence of the Roberts-Janet Nuclear Periodic Table

In 2010 Roberts began to analyse the patterns within the Periodic Table itself. The sequence of numbers in the s, p, d, f states gave a classical arithmetic progression with first term 2 and common difference 4 resulting in a sum to n terms of $2n^2$ for each term in the series. The periodicity of the shell structure 2, 8, 18, 32 followed the pattern of $2n^2$ but how the repeating pattern of 8, 18, 32 arose could not be explained other than by the requirement of two such columns of $2n^2$ purely from a mathematical point of view. Suppose the whole table was inverted to accommodate spatial variation relative to the nucleus for gradually increasing atomic numbers. The two columns could be extended beyond zero and into negative values of n. Could such a series have any scientific interpretation? Initially he thought of plasma prior to fusion in which the electric field would be repulsive compared to the attractive mode of electrons occupying states surrounding the nucleus in condensed matter (Periodic Table).The counter-intuitive consequence of such a structure would be that as n became more negative the states became closer and closer together as the nucleus was approached. Scales of magnitude began to appear as 10^{-6} to 10^{-10} m for condensed matter and 10^{-18} to 10^{-20} m for plasma where the strong and weak forces began to couple with the electromagnetic force. The all-pervasive force of gravity mysteriously yet inevitably remained poised to act. One of the pairs of zeros generated by such sequences could be interpreted as a cut-off point for electrons in the condensed matter phase while the other would be an infinite separation of protons/nuclei in the plasma phase caused by the recycling of material from previous supernovae. Classifications of supernovae came and went – the patterns within the table were dominant. Any such table appeared not to require mass number in its structure. This was only an average value of all the isotopes of a particular element at any one time. It must surely change in the 40th, 50th or even higher order decimal place constantly as radioactive decay proceeded. The idea of different ratios of isotopes for each element being created unique to each supernova confirmed the intuitive leap to omit mass number from the table. The question of the source of radioactivity itself coupled with the range of time-scales for half-life for each radioactive nucleus remained an open one.

Such was the intensity of thought in the period 2011-2015 linking the idea of proton-proton interactions to produce neutrons or electron capture to produce neutrons – a change of an up quark to a down quark with a myriad of possible outcomes illustrated by Feynman diagrams that the role of nucleosynthesis was overlooked. The Standard Model and beyond became the final destination. Magic numbers were considered but their role at that time was not identified such was the thrust towards higher energies – second, third generation quarks and the newly discovered Higgs particle. Cosmology and its applications to particle physics entered the arena. By 2015 the mind had reached a confusion of infinities similar to the explosion of ideas in that initial moment of 2010.

The role of the second set of 2 in the two columns of $2n^2$ was still unresolved though the idea of extending group number to create a consecutive pattern of atomic number was steadily becoming apparent. Enter the work of Charles Janet and the Left Step Periodic Table of 1929. Here was someone-else who had addressed this issue and implied hydrogen and helium might be metallic and belong in groups 1 and 2. Such a concept appeared outrageous in 1929. Combining the inversion of the table with the columns Roberts named the table The Roberts-Janet Nuclear Periodic Table in 2016 when he published Those Infinities and The Periodic Table through York Publishing Services [1] in 2016 and proceeded to prepare an abstract for a journal in March 2017. Would it be rigorous enough to be accepted? (Table 1).

The Emergence of the Quantum Mechanical Table

In Roberts' mind there was no conflict between the Roberts-Janet table and the Periodic Table. The first was an underlying mechanism that began to explain how Periodic Tables of different abundances of isotopes and elements could be produced by the varying constituents and boundary conditions of temperature and pressure etc. within each supernova giving rise to unique Periodic Tables for each individual supernova. Following the publication of Proposed link between the Periodic Table and the Standard Model [2] in July 2017, a conference on Particle Physics and Cosmology at San Antonio occurred in November 2017. Here one of the speakers Claud Daviau stated that the $2n^2$ structure consisted of two components n (n+1) and n (n-1). These had been suggested by De Broglie and Dirac in the 1930's. This immediately gave Roberts the insight for the source of the two columns he was seeking. His persistence in reconciling the repeating patterns within the Periodic Table itself prevented him seeing a structure of periodicity n(n+1) for protons and compactness n(n-1) for neutrons until November 2019 – despite clear advice from conferences at Potsdam, Boston and elsewhere that n(n+1) was periodic and n(n-1) was compactness.

In Condensed Matter one column led the other but in Plasma it was reversed where the second column led the first. Since n(n+1) generates 2, 6, 12, 20 etc. for increasing n starting at n=1; n(n-1) generates 0, 2, 6, 12, 20 etc. for increasing n starting at n=1. Oscillations between these states could

Table 1. Roberts – Janet Nuclear Periodic Table.

			Limits to Quantum Energy States of Electrons				↑	↑
Period11	$221^{6h}242$	$243^{7g}260$	$261^{8f}274$	$275^{9d}284$	$285^{10p}290$	$291^{11s}292$	$2(6)^2$	
Period10		$171^{6g}188$	$189^{7f}202$	$203^{8d}212$	$213^{9p}218$	$219^{10s}220$		$2(5)^2$
Period 9		$121^{5g}138$	$139^{6f}152$	$153^{7d}162$	$163^{8p}168$	$169^{9s}170$	$2(5)^2$	
Period 8			$89^{5f}102$	$103^{6d}112$	$113^{7p}118$	$119^{8s}120$		$2(4)^2$
Period 7	Electron States Occupied by Atoms Outside Stars		$57^{4f}70$	$71^{5d}80$	$81^{6p}86$	$87^{7s}88$	$2(4)^2$	
Period 6				$39^{4d}48$	$49^{5p}54$	$55^{6s}56$		$2(3)^2$
Period 5				$21^{3d}30$	$31^{4p}36$	$37^{5s}38$	$2(3)^2$	
Period 4					$13^{3p}18$	$19^{4s}20$		$2(2)^2$
Period 3					$5^{2p}10$	$11^{3s}12$	$2(2)^2$	
Period 2						$3^{2s}4$		$2(1)^2$
← ∞								
	51 - 72	**33 - 50**	**19 - 32**	**09-18**	**03-08**	**01-02**	**GROUP**	
Period 1						$1^{1s}2$	$2(1)^2$	
			Zero Positive Electric Potential					$2(0)^2$
			Infinite Negative Electric Potential				$2(0)^2$	
	Reservoir Energy					2		$2(-1)^2$
	States occupied					2	$2(-1)^2$	
	By Protons in				6	2		$2(-2)^2$
	Plasma Prior to				6	2	$2(-2)^2$	
	Fusion			10	6	2		$2(-3)^2$
				10	6	2	$2(-3)^2$	
			14	10	6	2		$2(-4)^2$
			14	10	6	2	$2(-4)^2$	
		18	14	10	6	2		$2(-5)^2$
		18	14	10	6	2	$2(-5)^2$	
							∞	∞
							↓	↓
							∞	∞

achieve not only repeating 8, 18, 32 but also that of a repeating pattern of 2. This was illustrated in the Roberts-Janet Nuclear Periodic Table. There was in fact a one to one mapping between the two tables as the n(n-1) states became the lead column for n = -1 and increasingly negative values of n followed one integer behind by the n(n+1) states.

Since neither position nor energy was defined in the table, Heisenberg's Uncertainty Principle precluded precise solutions leaving the table's structure reliant on empirical values of energy for individual elements and energies for different layers within plasma during fusion. There was also no specific spatial structure – it could vary though the trend was for larger nuclei to have outer electrons configured further away from the nucleus. This could explain why the table – a mere two-dimensional representation – was beginning to imply 3 spatial, one time (a stable state being time independent) and energy, giving at least five dimensions if not more to describe such a framework. There was now a connection with the structure of the Condensed Matter phase of the table and the destination of the Standard Model resulting from group symmetries but by passing the Nuclear Shell Model (Nucleosynthesis).

To paraphrase Shakespeare

"*Vaulting intellect, which overleaps itself and falls on the other side*" (Table 2).

Enter fate/destiny/synchronicity whatever you want to call it. On March 1st 2018 NASA announced publicly that as a result of the Juno mission to Jupiter the central core of Jupiter consisted of metallic hydrogen. Here was experimental evidence as to conditions that could make hydrogen behave as a metal – reflect light, conduct electricity and create a magnetic field. This metallic property was implied in the position of hydrogen and helium in both the Roberts-Janet and Quantum Mechanical Tables. The decision was taken to publish Roberts' second article "Implications of the link between the Periodic Table and the Standard Model" [3] On March 31 2018 after peer review.

The focus now switched to the ordering of the energy states within the Periodic Table. During presentations at several conferences in 2018 the realization dawned that the Quantum Mechanical Table was creating a framework and the Roberts-Janet Table was indicating how in space-time, energy/geometric science conformed and adapted to such a structure. Reflection, following digestion of concepts such as Cooper pairings, BCS theory of superconductivity, nuclear magic numbers, local reversal of time/entropy, oscillations between fermionic states for odd numbers of electrons, protons, neutrons and bosonic states for even numbers of such particles together with radioactivity revealed a more detailed landscape within the tables as follows.

The total energy of electrons in condensed matter has to include principal quantum number, potential and kinetic energies, magnetic moment, lamb shift, angular momentum, spin orbitals and any internal interactions including entropy as the atomic number increases and the cloud of electrons becomes ever more complex.

An analogy is the murmuration of thousands of starlings prior to roosting. Research models indicate that provided the starlings monitor the speed and direction of their seven nearest neighbours no collisions occur similar to the electrons in the first three shells of the Periodic Table which is

Table 2. Quantum Mechanical Table.

				$2n^2$ = n(n+1) +n(n-1) TABLE				
						n(n+1)	**n(n-1)**	
22	18	14	10	6	2			
22	18	14	10	6	2	42	30	n = 6
	18	14	10	6	2			
	18	14	10	6	2	30	20	n = 5
		14	10	6	2			
		14	10	6	2	20	12	n = 4
			10	6	2			
			10	6	2	12	6	n = 3
				6	2			
				6	2	6	2	n = 2
					2			
					2	2	0	n = 1
					0			
					0	0	0	n = 0
					2			
					2	0	2	n = -1
				6	2			
				6	2	2	6	n = -2
			10	6	2			
			10	6	2	6	12	n = -3
		14	10	6	2			
		14	10	6	2	12	20	n = -4
	18	14	10	6	2			
	18	14	10	6	2	20	30	n = -5
22	18	14	10	6	2			
22	18	14	10	6	2	30	42	n = -6

why a stable set of eight was discovered by Mendeleev originally. Once you extend beyond group 8 in the Roberts-Janet table the situation becomes ever more complex – hence the need for electron density functional theory as applied to atoms and molecules to describe the properties of different materials. One indicator of how fields change for individual elements is the first ionization energy level which only deals with the outermost electron. The number of energy states in condensed matter is prescribed by the Quantum Mechanical table. As you increase the atomic number the corresponding electrons occupy the appropriate states, the energy associated with each of these states changes as the interaction/shielding of the electron cloud between the nucleus comes into play. So much so that having filled the 4s state the 3d state now overlaps so there is an interchange between them as the 3d is being filled. As completion of this state is approached the first ionization energy decreases (becomes more negative) and all the electrons in the last atomic number for that state belong in precisely that state. It is as if order, entropy increases locally shutting down that state so that when the atomic number increases to the next value a new prescribed state begins to be occupied. The result is the 4s state is filled before the 3d state but the 4s is ionised before the 3d state [4].

To help visualize such a picture it must be remembered that electrons are oscillations of a field with particle properties associated such as angular momentum, spin, kinetic energy. The total energy of each state can change depending on the local environment of the cloud of surrounding electrons whether in individual elements as in the Periodic Table or the ever increasingly complex structure of molecules. The electron is no longer a particle in a box stacked on fixed shelves. Such a model leads to a diversity of chemical pathways – all empirical – presented by inorganic, organic, viral mutation, biomedical disciplines, high temperature superconductivity where to navigate causality becomes increasingly difficult producing a myriad of outcomes from almost identical initial conditions.

Continuing with the energy states in condensed matter there is no overlap between the 4s and 3d with the p states because of their physical separation and the more negative values of their first ionization levels. A similar overlapping occurs between the 5s and 4d states. At the beginning of the f states with element 57 the number of states is prescribed as 14 in the Quantum Mechanical table. This time there is an overlap between the 4f and 5d states at the beginning of the set of 14 states. Increasing relativistic effects now begin to operate in the form of a spatial realignment known as the Lanthanide contraction. When this set is filled at element 70 all the electrons at that point are 4f and the first ionization energy decreases (becomes more negative) and the door is shut as it were ready for the next set of states to be filled as the atomic number increases again with the corresponding increase in electron states.

The way in which the outer electrons for the Lanthanides fill initially does not depend on the label attached by chemists to the state of 14 in the quantum mechanical table. The overlap is again empirical. As the state fills the more the electrons correspond to that state; until at the very last member they all fill with that state and order is established by the first ionization energy decreasing to close off the 14 states ready for the next to begin to be filled by element 71. Looking in more detail at the structure of the 14 states itself it should be noted at element 64 the ionization energy decreases significantly indicating a sub-set of 8 states followed by another sub-set of 6 states.

This is an indicator of a similar structure created by spin-orbit coupling in the plasma/fusion phase of the lower half of both the roberts-janet and quantum mechanical tables later in the article.

In the case of the Actinides there is an overlap of the 5f and 6d states but the values of the first ionization levels vary considerably more within the structure of the 14 states compared with the Lanthanides. At element 96 the first ionization level is just lower than 95 despite elements 90, 92, 93 and 94 being lower. This implies that the sub-set of 8 is hardly established. The periodic pattern and sub-set of 6 is firmly re-established from elements 97 to 102 where all the ionization energies show a consistent decrease. As atomic numbers increase beyond 118 will such a structure become drowned by increasing overlaps of states, relativistic effects such as contraction? Yet could periodicity be preserved at the very end of each state by for example element 138 consisting of 18 5g electrons? It should be noted that an examination of all completed quantum states shows a lowering of first ionization energy at the end of every prescribed state from elements 2 to 102 without exception [5].

The Aufbau Principle is at best a very specialised case for low atomic numbers as is the case for the concept of half-filled sub-shells. Hund's rule appears to be unaffected within this larger more general picture of energy states. It should be noted that the p states or 6 prescribed states in the quantum mechanical table consist of a sub-set of 2 and another of 4 while the d state or set of 10 prescribed states in the quantum mechanical table consist of a sub-set of 6 and another of 4. These are all even numbers similar to a subset of energy states within plasma during fusion shown in the lower halves of the Roberts-Janet and Quantum Mechanical tables discussed later in the article. It would appear to be no coincidence that all the magic numbers of the Nuclear Shell Model are themselves even numbers; as is the abundance of elements with even atomic numbers greater than elements of odd atomic numbers in the Universe by a factor of approximately ten (Table 3).

The table lists the structure of the quantum states within the Quantum Mechanical table, the separation into clusters of neutrons and protons and the production of the first seven magic numbers. For illustration purposes the next three magic numbers are shown below assuming the same pattern of energy states applies. Since neutrons are the lead the examples are given for n as applied to neutrons or the n(n-1) sequence. The first column of numbers indicates the total number of states for a given value of n. These are followed in the first set of brackets by the associated sub-set of states comprising the whole number of states. The final bracket for each n value indicates the resultant magic number. From n=-4 for neutrons and n=-5 for protons there is a second set of brackets containing first another bracket consisting of the least energetic states for that particular n value that via spin orbit coupling attach to the previous states creating the next magic number. The remaining numbers outside that bracket but still within the second bracket contribute to the next magic number completed by the next n value. Simple arithmetic should illustrate this result precisely [6].

n(n-1)

n=-8 -8(-9) 72 {30,22,14,6} ({16}14,12,10,8,6,4,2) {184}

n=-9 -9(-10) 90 {34,26,18,10,2} ({18}16,14,12,10,8,6,4,2) {258}

n=-10 -10(-11) 110 {38,30,22,14,6} ({20}18,16,14,12,10,8,6,4,2) {350}

Pairings of neutrons and protons appear to play a role similar to the Cooper pairings of electrons in superconductivity. The result of these even sub-set combinations creates local magic numbers within nuclei for both neutrons and protons yet to be assigned a physical role. This could involve local higher binding energy, longer half-life than neighbouring elements. As atomic number increases beyond 82 there could be increasing overlaps of states due to spin orbit coupling when again causality becomes ever more increasingly difficult to navigate as was the case with the first ionization energies in the top half of the Roberts- Janet table particularly for elements 89 and above.

Radioactivity appears to be a function of nucleon configuration and entropy. As the configuration of neutrons and protons is constantly changing, similar to the murmuration of starlings prior to roosting, this in itself does not trigger the discrete change in the number of neutrons or protons known as radioactivity. Only certain specific combinations within the nucleus will trigger such a change. The probability of such a configuration within the set of total combinations for that nucleus will determine the rate of decay and therefore the half-life. Depending on the type of isotope of whichever element is being considered the outcome will be the conventional pathways of alpha, beta gamma etc observed in decay chains. Stable nuclei produce many configurations none of which trigger any decay.

The implication of such decays is that the particular nucleus has become too ordered as a result of the boundary conditions imposed within the star producing it and by radioactive decay is losing entropy to head towards stability via one or several decay processes within the chain to achieve this with each new nucleus created in such a chain having its own configurations some of which trigger an ejection of neutrons/protons/ electrons or other particles with their own unique half-life – hence such a variation in half-life values. Three pathways have been identified in nucleosynthesis; r, s and p processes dependent on temperature, pressure, energy density and number of critical isotopes with magnetic and gravitational fields [7]. Increased ordering and a local increase in entropy appears at first sight to breach the laws of thermodynamics. As proposed by Maxwell and Boltzmann thermodynamics was statistical and macroscopic beyond the orders of magnitude for the confinement of neutrons/protons/ quarks and other elementary particles. Increasingly information entropy is seen as a component in quantum fluctuations at orders of magnitude of neutrons/protons – 10^{-18}m. Von Neumann suggested measuring one part of a quantum system would create sufficient quantum noise for all the probabilistic nature to be lost, whereas Luders argued that some properties of the particles could remain undecided while others became clear. This latter theory appears to be verified in a recent experiment in Sweden (Fabian Porkorny University of Stockholm). A transition of an electron from one state to another in a strontium ion took a millionth of a second. The change was an unfolding one as if the transition from complete uncertainty into a specific orbit is one of increasing probability rather than a sudden

Table 3. States for Periodicity and Compactness from the Quantum Mechanical Table.

Table of States for Periodicity and Compactness from the Quantum Mechanical Table				
Periodicity	**n(n+1) Protons**		**Compactness n(n-1) Neutrons**	
n=5	30 {18,10,2} (10,8,6,4,2)		20 {14,6} (8,6,4,2)	
n=4	20 {14,6} (8,6,4,2)		12 {10,2} (6,4,2)	
n=3	12 {10,2} (6,4,2)		6 {6} (4,2)	
n=2	6 {6} (4,2)		2 {2} (2)	
n=1	2 {2} (2)		0 {0} (0)	
				Phase change
n=0	0 {0} (0)		0 {0} (0)	
		Phase change		
n=-1	0 {0} (0)		2 {2} (2) {2}	
n=-2	2 {2} (2) {2}		6 {6} (4,2) {8}	
n=-3	6 {6} (4,2) {8}		12 {10,2} (6,4,2) {20}	
n=-4	12 {10,2} (6,4,2) {20}		20 {14,6} ({8}6,4,2) {28}	
n=-5	20 {14,6} ({8}6,4,2) {28}		30 {18,10,2} ({10}8,6,4,2) {50}	
n=-6	30 {18,10,2} ({10}8,6,4,2) {50}		42 {22,14,6} ({12}10,8,6,4,2) {82}	
n=-7	42 {22,14,6} ({12}10,8,6,4,2) {82}		56 {26,18,10,2} (14}12,10,8,6,4,2) {126}	
n=-8	56 {26,18,10,2} ({14}12,10,8,6,4,2) {126}[6]			

transition – some properties are left unaffected. Electron quantum jumps are a "gradual eruption of a volcano" rather than a switch similar to what Luders proposed rather than von Neumann. Yet when one considers this increased probability when viewed inside the nucleus regarding radioactivity it would appear that "the volcano has exploded producing separate particles" so not only is the energy considerably greater due to quantum confinement but the time scale will also be considerably shorter though nowhere near the Planck scale order of magnitude. The blowing off of the top of the volcano as it were would again be more akin to a switch.

In a study by Or Hen, Massachusetts Institute of Technology, of the structure of the core of a neutron star there appears to be a transition in the strong nuclear force. At large distances the strong force attracts neutrons to protons; at small distances the force becomes indiscriminate – interactions occur not just to attract a proton to a neutron but also repel or push apart pairs of neutrons. At the core of the neutron star a repulsive force between neutrons appears to prevent the core collapsing on itself. In the core neutrons and protons can be modelled independently without the need for more complex interactions between quarks and gluons, their composite parts, using the Argonne V18 model. Neutron stars could be viewed as a state of condensed matter. As the energy density increases does radioactivity become inhibited prior to or as the weak force merges with the electromagnetic? Neutron stars would then appear not to have reached the transition phase of cascading quarks to second and third generations within the experimental conditions at CERN. This would be the region at the base of both the Roberts-Janet and Quantum Mechanical Tables with the conditions at CERN heading further below the tables again – a quark gluon soup phase.

Has the energy density/quantum confinement in neutron stars reached a stage of stability where radioactivity has switched off completely only to be reactivated by a neutron star/neutron star/black hole collision? Here fragments of low atomic number nuclei could be engulfed by an almost infinite number of neutrons leading to a decay chain generating atomic numbers of an almost infinite value before order is re-established by further proton decay and a return to the ranges of atomic number observed in galaxies or the solar system. This extends the Roberts-Janet Table at the top and the Periodic Table in principle to an infinite value in the Universe; yet confined on the Earth by the configurations of existing combinations of isotopes to maybe the magic number of 126 protons and 184 neutrons.

Space to Think – Again

The doubly magic isotope Nickel, 28 neutrons 28 protons, appears at the watershed of binding energies between fusion and fission. It appears to play little if any role as it is part of a plateau in the peak of binding energies of the elements – not so much an island but a continent of stability.

To the chemists the Periodic Table conjures up the view of metals and non-metals whereas the astrophysicists/nucleosynthesis scientists envisage all elements except hydrogen and helium as being metals. The Roberts-Janet table coupled with the Quantum Mechanical table implies that all elements, given the appropriate conditions of temperature and pressure, have a phase where they become metallic. Confirmation by NASA in 2018 of the existence of metallic hydrogen in the core of Jupiter leads to the suggestion of a second probe to Saturn. The first probe established the existence of severe lightning strikes within Saturn possibly initiated by magnetism that appears to result in an internal heating mechanism of metallic production in the core in a phase prior to fusion as in the Sun. {Please note the position of helium in the Roberts-Janet table next to the zeros and immediately above the fusion states in the lower half of the table} A second probe could maybe detect metallic helium as Saturn appears to be the most likely candidate within the Solar System for such material. Quantum mechanics predicts that in other planetary systems given the appropriate temperature and pressure metallic helium does exist [8].

In the quest for fusion energy avoiding the extremely high temperatures of conventional fusion methods, the technique of targeting a boron nucleus with hydrogen nuclei controlled by extremely high energy lasers appears to be the most practical. Patents taken out in China, America and Japan by HB11 University of New South Wales Australia indicates a growing confidence in such a method. Just as China is planning to build a collider 3 to 4 times larger than CERN which is itself planning to become an anti-matter/Higgs boson factory there could be another future role for Darmstadt, Dubna, Oak Ridge and RIKEN – that of boron factories to meet the ever-growing demand for boron should the Australian technique prove successful.

Conclusion

Imagine the structure of the Roberts-Janet table being viewed from the zeros in both directions. It is as if one were at the top of Mount Everest on a perfectly calm sunny day. The peaks of mountains stretch in every direction – one way shows the atoms individually – the other the structure of the nucleus and their magic numbers. In recent studies of the benzene molecule, when the accompanying wavefunctions of the 42 electrons are analysed in 126 dimensions (n, l, j quantum numbers) the structure appears that some electrons with spin up form double bonds while those with spin down form single bonds (Timothy Schmidt, excellence in exciton science and UNSW Sydney Australia). The recently discovered d star hexaquark may be a candidate for Dark Matter (Journal of Physics G: Nuclear and Particle Physics). What lies between, below and beyond the peaks represents molecular chemistry, catalysis, biology, gene therapy, immunology, material science and high temperature superconductivity in one direction and the nuclear shell model, magic numbers, radioactivity, a quark gluon soup, particle physics and an ever increasingly granular space, time, cosmology and gravity in the other? This is the present vision inspired by the original vision of Charles Janet who could be regarded as the father of multi-disciplinary science and a serious candidate to be named after element 120, a limit he placed on the Periodic Table with the knowledge he had at the time.

Registration of both the Roberts-Janet and Quantum Mechanical Tables with the IUPAC must surely warrant serious consideration alongside the Periodic Table; as science seeks to acknowledge the role of quantum mechanics in an age of artificial intelligence, improving sensitivity and an increasingly interconnected interdisciplinary understanding of Nature.

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