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Letter from Indianapolis – American Chemical Society Meeting Spring 2023

John Roberts

Independent Researcher, Former Open University Tutor, UK

*Corresponding author

John Roberts, Independent Researcher, Former Open University Tutor, UK.

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With the theme of the conference being Crossroads in Chemistry the organizing committee, in their infinite wisdom, decided to place my article "Is there a role for the Periodic Table as Chemistry embraces Multidisciplinary Science and Quantum Field Theory?" in the last section of the History of Science Division on Wednesday 29th March. In one sense it was most appropriate; when at a crossroads one is looking back at the way you have travelled and looking forward to the way ahead with all its challenges using the experience and knowledge acquired on the way - a curious and open mind being an essential prerequisite. Many presentations described in forensic detail the work of individuals, relatively unknown, who have made crucial contributions to the development of science going back some three hundred years or more. Yet the above article seeks to make history by looking forward some one hundred and fifty years or more to a place where the periodic table and its cousins begin to describe nature as a complementary family of tables incorporating two fundamental cycles within the Universe. Will they ever be testable I hear you ask?

There were three days before the presentation so I explored the labyrinth of ideas, concepts and mechanisms being presented in the rooms of the conference. Broadly, there were three groups: mechanisms of catalysis, modelling of molecules using AI and History of Science.

In the first group over a period of a day and a half speakers grappled with the conventional ideas and models to explain current phenomena but were left still hypothesising and agreeing with each other that a solution could soon be found. One speaker in questions to other presenters in this group at one point contemplated the idea that the electron was a wave function but the enormity of this thought rendered him speechless as he retreated into silence preferring the status quo of the here and now within the group. Did Schrodinger ever experience such doubts as he became a biologist in later life? After a day's observation I was able to interject - no whisper – mechanisms of quantum tunnelling or superposition? To which the most revealing part of the answer was "Yes that's the fear." The obvious conclusion from this exchange being; tread carefully you might frighten the horses.

The second group produced some spectacular models of molecules rotating, spinning and vibrating beginning with the premise that

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an electron is like a cloud that can be in many superpositions of energy. This immediately triggered in my mind vibrational mixing, self-assembly and photosynthesis with which biology and nature are quite familiar. Maybe in the future with the aid of artificial intelligence the human brain can visualize and understand such processes. One immediate application is using artificial intelligence to prescribe appropriate strength of drugs to patients by matching symptoms identified in blood tests with available drugs. This would have to be overseen by doctors, regulatory authorities and clinical trials.

As to my own presentation, so as not to frighten the horses once more, there is an introduction to walk the reader through the concepts. Here it is in every excruciating detail.

"In 1869 Mendeleev published what we now call the periodic table. It has subsequently been added to and extended within as more elements have been discovered. It has become a Rosetta stone – a clear reference point for chemical and physical properties.

With recent developments in Particle Physics, Gauge Theory, Clifford Algebra and symmetries U (1) x SU (2) x SU (3) electrons are no longer perceived as particles stacked in shelves within a box but as oscillations within quantum fields that operate at both nano and macro scales- quarks to galaxies- independent of frames of reference.

I present to you today an evolution of the periodic table embracing multidisciplinary science and quantum field theory – the Roberts-Janet Nuclear Periodic Table and the Quantum Mechanical Table. The first is empirical the second theoretical which has been hiding in plain sight since 1934 courtesy of De Broglie's formula.

There is no conflict between the periodic table in its current form and these other two tables. They are simply underlying mechanisms that led to the periodic table in the first place via quantum tunnelling, superposition, entanglement and decoherence. The Universe is non-local.

I hope that, after due consideration, you may find such tables a complement to the fundamental understanding of Chemistry within science. The immediate consequence is the appearance of Citation: John Roberts (2023) Letter from Indianapolis – American Chemical Society Meeting Spring 2023. Journal of Chemistry & its Applications. SRC/JCIA-122. DOI: doi.org/10.47363/JCIA/2023(2)120

numerous periodic tables within the Universe as mass number is no longer a fundamental property – Mendeleev's dilemma in the construction of the original periodic table.

Such tables would be suitable for 1st, 2nd, year undergraduate and post doc students after the building blocks of mathematics, physics, chemistry, biology, physiology and neuroscience have been established in the student's mind."

Looking forward, the one-to-one mapping between the Quantum Mechanical Table and the Roberts-Janet Table implies that the Quantum Mechanical Table is proof of concept for the Roberts-Janet Table following attendance at conferences in Boston, New York, Miami, San Antonio, San Diego, Las Vegas, Los Angeles and other parts of the world. The challenges at San Diego and the insights at San Antonio have been particularly useful.

Day 4 morning of the meeting was in part devoted to Quantum Mechanics, an increasingly important development, in the current state of chemistry. This leads to a plea for quantum physicists to diversify into applications in chemistry, biology and biochemistry to apply quantum mechanisms in these fields even if this requires challenging the established approximations known at present. Could the American Chemical Society establish a Quantum field/ mechanics group to disseminate knowledge by raising awareness within the chemistry community and the global public of quantum mechanics and quantum field theory?

Let us now perform a thought experiment by placing the Roberts-Janet table so that it overlays the Quantum Mechanical Table what then? We pass through the rabbit hole into Lewis Carroll's 1865 Adventures of Alice in Wonderland. Beyond the rose garden leads to John Roberts's hidden garden in Anglesey in the 2021 Alice and Bob in Quantum land and finally for now John von Neuman's 1932 Foundations of Quantum Mechanics and Julian Swinger's quantum fields as referenced by John Clauser's Nobel Lecture 2022 on entanglement.

At present, the current most appropriate summary appears as a poem quoted at the Indianapolis meeting. Ode to Science

With eternal thanks to Rudyard Kipling Written by John Owen Roberts Dedicated to my father David Idwal Roberts Ynysybwl Morgannwg South Wales

If you can keep your head when all about you Are losing theirs and blaming it on you. If you can trust yourself when all men doubt you But make allowance for their doubting too. If you can wait but not be tired by waiting Yet don't look too good nor talk too wise.

If you can embrace the subtle ways That Nature constantly displays If you can explore distant galaxies in every detail And analyse their content as blind men read braille. If you can dream and invert the Periodic Table, If you can think and extend it as far as you are able. If you can put two and two together And place Hydrogen and Helium by each other.

If you can force fields and energy to serve you And locally reverse time and entropy aplenty Wilczek's asymptotic freedoms to enjoy. If you can picture how patterns within the table Allow neutrons and protons to intertwine and coalesce All manner of fusion, nucleosynthesis and elements possess To produce Wigner's magic numbers in excess.

If you can explain how radioactive decays Occur by such varied pathways In so many mysterious times and byways. If you can entangle every quantum state Then in an instant allow them to consolidate And all matter known to man create. If you can meet with gravity and quantum theory And treat those two imposters just the same. If you can apply mathematics stochastically yet with serendipity To show how Nature develops empirical yet orderly tranquility.

If you can bear to hear the truth you've spoken Twisted by knaves to trap men's minds and create indifference. If you can talk to chemists and keep your virtue Or walk with astrophysicists nor lose the common touch. If all scientists count with you but none too much. If you can follow quantum pathways Familiar to bacteria, plants; all manner of beings That photosynthesize and thrive.

If you can fill the unforgiving minute With sixty seconds worth of distance run Ladies and Gentlemen – yours is the Universe And all that's in it And – which is more – you'll be enlightened and inspired.

And yet and yet

Nature's mysteries still conspire like Heisenberg's Uncertainty To tunnel, superpose, entangle and decohere Within its very own quantum world so near To cloak its dynamic evolution Allowing only to reveal at any one instant What humans can observe by thought, action or experiment Maybe masquerading as fermionic bosonic phase transitions.

Two unfamiliar beasts – lepto-genesis and abiogenesis Emerge from the mists of Quantum Field's fuzziness. Will they produce future mellow fruitfulness? For what is a solitary Universe? Merely a glimpse of time Settled in the vast ocean of accompanying multiverses Connected by wormholes, black holes and higher dimensions? Spawned as matter is released once more in mergers and collisions Relentlessly recreating the paradox of beginning and end. Harken ye sceptical scientists old and new Behold a conjecture so bold That may well become a story to be told Uniting philosophers and researchers as one

Nature's vacuum, contrary to human thought, oscillates Between many quantum states, distinguishing singularities. Enter entropy coupled with its cousin least action Helping energy to assemble enigmatically in boundless phase transitions Converging physics, chemistry, biology and neuroscience With nucleosynthesis, particle physics and cosmology Within the fuzziness of quantum field theory. To be understood by a partnership of artificial intelligence and the human mind When they have learned, if ever they will, to talk, listen And interact as two minds in harmony. Citation: John Roberts (2023) Letter from Indianapolis – American Chemical Society Meeting Spring 2023. Journal of Chemistry & its Applications. SRC/JCIA-122. DOI: doi.org/10.47363/JCIA/2023(2)120

A tentative step, dear reader, Of all the electron interactions of atoms, molecules or elements throughout the Universe Can by artificial intelligence Be reduced to four fundamental equations Merging thousands of years of empirical work By alchemists, chemists and scientists alike Denoted by the letters n, l, m, s of quantum field theory Namely Principal Quantum Number, Angular Momentum, Magnetic Moment and Spin Orbital." And now to a five-minute footnote – a fleeting conversation with a Princeton professor on Tuesday 28 March in room 122 following his presentation on the History of Science in which he talked about magic numbers and heavy elements. He described how research centres Darmstadt, Dubna, Oak Ridge and Riken (in alphabetical apolitical order) persuade isotopes of different elements to merge, neutrons to decay to protons so that elements beyond 118 could be produced. I pointed out to him that this technique would probably put an upper limit of atomic number 126 on the periodic table. Did he want to see the next 150 years and beyond of the periodic table at tomorrow's presentation? This at least grabbed his attention. The lower reaches of the Quantum Mechanical Table theoretically produce in the n(n-1) column the magic numbers of neutrons within stars whilst the n(n+1) column generate the identical set of magic numbers for protons independently. With the aid of gravity, quantum mechanics conspires to extinguish radioactivity as white dwarfs with sufficient mass collapse to neutron stars, black holes and supermassive black holes as order increases and entropy decreases. By mergers or collisions of these objects, nuclei with low atomic numbers and very high mass number are released. These decay as radioactivity is reignited to nuclei of very large atomic number which decay by alpha, beta and gamma processes to heavy elements at the upper reaches of the Roberts-Janet Table before decaying further to elements familiar to the periodic table itself. He instantly intuitively understood this concept when I talked about sets of magic numbers 126, 184, 258, 350 and beyond. At the mention of De Broglie who originally suggested such a formula, he made a note of the Roberts-Janet Nuclear Periodic Table on his phone and was gone on a plane narrowly avoiding the tornadoes sweeping the United States both before and after the conference. How does entropy talk to decoherence and decoherence talk to entropy? What about chaos and self-assembly?

Roll on, roll on, ACS 2223 and ACS 2523, climate change, virus mutation and Nature permitting, when by then we may have telescopes throughout the Solar System and computing power to observe the Universe as the laboratory it truly is. We may then be able to distinguish signatures of these very heavy elements from the background noise.

Now that's Crossroads in Chemistry and then some!

$2n^2 = n(n+1) + n(n-1) \text{ TABLE}$												
						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				

Quantum Mechanical Table

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						or			
	LIM	ITS TO Q	UANTUN	I ENERG	Y STATES	OF ELECT	RONS	Î	Î
Period11		221 ^{6h} 242	243 ^{7g} 260	261 ^{8f} 274	275 ^{9d} 284	285 ¹⁰⁰ 290	291 ¹¹⁵ 292	2(6)²	
Period10			171 ^{6g} 188	189 ^{7f} 202	203 ^{8d} 212	213 ⁹⁹ 218	219 ¹⁰⁵ 220		2
Period 9			121 ^{5g} 138	139 ^{6f} 152	153 ^{7d} 162	163 ⁸⁰ 168	169 ⁹⁵ 170	2(5)²	
Period 8				89 ^{5f} 102	103 ^{6d} 112	113 ⁷⁰ 118	119 ⁸⁵ 120		2
Period 7	ELECTRON			57 ^{4f} 70	71 ^{5d} 80	81 ⁶⁹ 86	87 ⁷⁵ 88	2(4)²	
Period 6		STATES			39 ^{4d} 48	49 ⁵⁰ 54	55 ⁶⁵ 56		2
Period 5		OCCUPI	ED		21 ^{3d} 30	31 ^{4p} 36	37 ⁵⁵ 38	2(3)²	
Period 4	BY ATOMS					13 ^{3p} 18	19 ⁴⁵ 20		2
Period 3		OUTSID	E			5 ^{2p} 10	11 ³⁵ 12	2(2)²	
		STARS							
Period 2							3 ²⁵ 4		7
	∞ ←	51 - 72	33 - 50	19 - 32	9 - 18	3-8	1-2	GRO	UP
Period 1							1 ¹⁵ 2	2(1) ²	
		ZER	O POSITI	VE ELECT	RIC POTI	ENTIAL			2
	INFINITE NEGATIVE ELECTRIC POTENTIAL							2(0) ²	
	RESER	VOIR ENE	RGY				2		2
	STATES OCCUPIED						2	2(-1) ²	_
	STATES OCCOTIED					6	2	2(-2)2	2
	BYPRU	DIONSIN			10	6	2	2(-2)	2
	PLASMA PRIOR TO				10	6	2	2(-3) ²	
	FUSION								
				14	10	6	2		2
				14	10	6	2	2(-4) ²	
			18	14	10	6	2		2
			18	14	10	6	2	2(-5) ²	

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