Low Energy Nuclear Reaction Catalyst Identification Model

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Key Works

LENR catalysts, wave-particle equivalence, meson atomics,

Abstract

A new empirical method for identifying low energy nuclear reaction (LENR) catalysts is proposed based on an improved atomic model, developed by extending the "wave-particle duality" principle to "wave-particle equivalence", with particles modelled as waves trapped in "standing orbits". "Wave-particle equivalence" identifies low mass particles, such as electrons, as being much larger than heavier nucleons, and is consistent with the potential for smaller, below ground state "de-excited" electrons.

The model identifies a primary electron state, defined an electron with one wavelength per rotation. A new modification to the Rydberg electron model is proposed such that excited and de-excited state sizes are exponentially related. This modification allows the primary electron state to be resolved as consistent with "small hydrogen" previously identified as a potentially essential intermediary in LENR.

Introduction

Electro-chemical and biological low energy nuclear reactions (LENR's) were identified

in the early 1900's and have been extensively confirmed over the past 29 years since the

Pons and Fleischmann cold fusion announcement. Current LENR models, however, do

not yet provide a comprehensive theoretical model to identify why certain metals, such as

palladium and nickel, can catalyse these reactions. Inconsistencies between LENR

observations and current atomic theory highlight the need for theoretical improvements.

Atomic Theory Improvements

Recent progress in classical physics and atomics [1] have provided new perspectives on

electron resonance states, but classical models have has not yet been unified with LENR

experimental observations and theory.

New atomic model improvements are proposed based on the recognition of a

fundamental equivalence between the properties of waves and particles. An overview of

proposed atomic model improvements and the potential implications for LENR are

presented in this paper.

Wave-Particle Equivalence

"Wave-particle duality" theory, developed from double slit experiments, identifies an

interrelationship between waves and particles. Extension of this concept to "wave-

particle equivalence" is proposed, with particles identified as waves trapped in "standing

orbits", similar to a theory proposed by de Broglie in 1925, but with complex toroidal rotational and oscillating components. [2]

"Wave-particle equivalence" indicates that particle size will be inversely proportional to mass. This is a consistent with an electron size much larger than the nucleus. According to the Planck wave model, wavelength decreases as wave energy increases, so as mass is related to energy (Einstein's $E=Mc^2$), more massive particles (e.g. nucleons) are expected to be smaller and less massive particles (e.g. electrons) larger.

"Wave-particle equivalence" is consistent with quantised transition energies as quantisation is equivalent to a different integer (k) number of wavelengths per rotation.

A "primary state" is proposed for particles, defined as having one wavelength per rotation (k=1).

Primary Electrons

"Wave-particle equivalence" provides a new perspective on electrons. A primary electron is proposed with a radius (assuming an equatorial orbit) of:

Primary electron radius　　　　=　　511keV photon wavelength / 2π

　　　　　　　　　　　　　　=　　~386 fm

The calculated primary electron radius is consistent with the radius of "small hydrogen" (300-400fm), considered to be a potentially essential intermediary in low energy nuclear reactions, [3]

Molecular Electrons

The actual observed size of molecular electrons is much larger than the primary electron. According to "wave-particle equivalence", this is consistent with a large number wavelengths per rotation (k>>1).

The new model suggests that many electron states between the primary state and ground state are possible, each with a different integer (k) number of wavelengths per rotation. This is consistent with the wide range of observed atomic sizes and ionisation energies for different elements. Close to ground state, transition energies between adjacent states, i.e. k=j to k=j+/-1, are small (i.e. ~0.2eV).

Larger transfer energies, observed as the various spectral series for each element, are identified as transfers between "key resonances" where the number of wavelengths per rotation increases (or decreases) by a factor of 2, i.e. k=j to k=2j (or j/2).

For hydrogen, excited states are typically modelled by the Rydberg series. An extension to the Rydberg series to include states below ground state was previously proposed by Mills around 1990. [1] Direct extension of the Rydberg model suggests very high transition energies (100's of KeV's) would be required to form "small hydrogen". This is inconsistent with extensive LENR observations under relatively low energy conditions. To address this inconsistency, a modification to Rydberg model is proposed.

The Rydberg model currently defines electron state sizes as being proportional the Rydberg n value. This is "ground state centric", implying a fundamental importance for the ground state. "Wave-particle equivalence" suggests that the primary state, rather than

ground state, is the fundamental state, suggesting that "ground state centricity" should to be removed from the Rydberg model.

In the new model the existing Rydberg linear state size relationship is replaced with an exponential size relationship. Key resonance state sizes are now related to previous key resonance state sizes by a factor of 2, i.e.:

Excited state size $_{(n=j+1)}$ = state size $_{(n=j)}$ x 2,   *where j = 1, 2, 3, etc.*   *-- Equation 1*

Similarly for states below ground state:

De-excited state size $_{(n = 1/ [j+1])}$ = state size $_{(n=1/j)}$ x 1/2   *-- Equation 2*

where j = 1, 2, 3... etc.

Transition energies between key resonances of hydrogen can be calculated based on:

Transition energy $_{(n = j1 \text{ to } n = j2)}$ = [$(1/j_1)^2$ - $(1/j_2)^2$] x 13.6eV/c^2 *-- Equation 3*

where j_1 and j_2 are integers (1, 2, 3, etc.) or fractions (1/2, 1/3, 1/4, etc.)

Wave-particle equivalence also allows the "waveform" of the electron (e.g. the electrical electron) to be defined as equivalent to an infinite number of wavelengths per rotation (k=∞, n=∞).

The modified Rydberg n value for the primary electron is determined by comparing the radius of ground state Hydrogen (n=1), with the primary electron radius. The average of the Bohr radius (52,900fm) and hydrogen crystal radius (~46,000fm) is ~49,450fm which

is 128x the primary electron radius, (386fm). This indicates that the primary electron can be modelled by a Rydberg n value of 1/8, (as $2^{(8-1)} = 128$).

Formation energies for the primary electron can be calculated (from Equation 3) as:

Ground state (n=1) to primary state (n=1/8)   =   - 856.8eV

Wave state (n=∞) to primary state (n=1/8)   =   - 870.4eV

Sizes for and transition energies between other key electron resonance states can also be calculated based on the modified Rydberg model, as summarised in Table 1.

Low Energy Nuclear Reaction Catalysts

The new electron model has particular relevance for LENR's as it provides an empirical basis for catalyst selection by identifying transition energies required for the formation of dense hydrogen states, such as primary hydrogen (n=1/8).

Suitable catalysts for dense hydrogen formation are those that can accept the energy quanta released during a hydrogen electron transition to a de-excited state. Experimental augur electron energy values (i.e. energies that can excite inner electrons within atoms), such as those compiled by G. Williams, 2013, can be used to identify potential catalyst matches. [4, 5]

Table 1 – Key Resonance State Sizes and Transition Energies for Hydrogen

Rydberg n	Description	Radius with equatorial orbit , *fm*	Transition Energy from wave state, n= ∞, *eV*	Transition Energy from ground state, n=1 , *eV*	Wavelengths per rotation, k *no.*
∞	Wave state	∞	0	-13.6	∞
…					
6		1.6×10^6	0.38	-13.22	4096
5		7.9×10^5	0.54	-13.06	2048
4	Excited states	4.0×10^5	0.85	-12.75	1024
3		2.0×10^5	1.51	-12.09	512
2		9.9×10^4	3.4	-10.2	256
1	Ground state	4.9×10^4	13.6	0	128
1/2		2.5×10^4	54.4	40.8	64
1/3	De-excited states *(above primary)*	1.2×10^4	122.4	108.8	32
1/4		6.2×10^3	217.6	204	16
1/5		3.1×10^3	340.0	326.4	8
1/6		1.5×10^3	489.6	476.0	4
1/7		7.7×10^2	666.4	652.8	2
1/8	Primary state	3.9×10^2	870.4	856.8	1
1/9	Sub-primary states	1.9×10^2	1101.6	1088	1/2
1/10		1.0×10^2	1360.0	1346.4	1/4

This table lists proposed sizes and transition energies for unbound hydrogen states.

As an example, potentially suitable catalysts for the formation of the primary hydrogen (n=1/8) from a wave state electron (n=∞), are those that can accept an energy quanta of ~870.4eV. Potentially suitable candidates include:

- Neon, K 1s: 870.2eV

- Nickel, L_{ii} $2p_{1/2}$: 870.0eV

- Tellurium, M_{ii} $3p_{1/2}$: 870.8eV

- Iodine, M_{iii} $3p_{1/2}$: 875eV

In addition to the facilitation of LENR reactions, electron transitions to key below ground state resonances (n=1/2, 1/3, 1/4…) can directly release significant non-nuclear energy (hundreds of eV's), well above normal chemical reaction potential. These reactions can be described as super-chemical. Augur electron energy values can also be used to identify catalyst matches for these reactions.

Potential catalysts for key resonance transitions based on augur electron energy values are presented in Table 2.

Table 2 – Potential Catalysts for Below Ground State Hydrogen Transitions

From n=	To n= DE-EXCITED STATES ½	1/3	1/4	1/5	1/6	1/7	PRIMARY 1/8
∞	*Lithium*	**Copper**	Hafnium	**Palladium**	*Tungsten*	*Indium*	**Neon**
	Iron	*Thallium*	Krypton	Zirconium	Rhenium	Palladium	**Nickel**
	Scandium	*Iodine*	Radon	Calcium	Scandium	Osmium	**Tellurium**
	Iodine	Germanium	Xenon	Platinum	Vanadium	Manganese	*Iodine*
2	*Scandium*	Germanium	**Krypton**	Palladium	Tungsten	*Indium*	*Nickel*
	Iodine	Thallium	**Radon**	Platinum	Rhenium	Osmium	*Neon*
	Magnesium	Copper	Xenon	Zirconium	Scandium	Palladium	Iodine
	Iron	Iodine	Hafnium	Calcium	Tantalum	Manganese	Tin
1	Tellurium	Gold	*Arsenic*	*Argon*	Osmium	*Manganese*	*Lanthanum*
	Arsenic	Nickel	Lanthanum	*Rubidium*	Bismuth	Osmium	*Nickel*
	Chromium	Beryllium	Chlorine	Zirconium	Niobium	Gold	Neon
	Tantalum	Lanthanum	Hafnium	Gold	Titanium	Indium	Tellurium
1/2		**Nickel**	*Sulfur*	*Carbon*	*Lead*	Cadmium	*Antimony*
		Vanadium	Bismuth	Ruthenium	Zirconium	Silver	Indium
		Aluminium	Yttrium	Strontium	Bismuth	Manganese	Lanthanum
		Sodium	Tellurium	Krypton	Rhenium	Chromium	Barium
1/3			*Krypton*	Hafnium	Potassium	*Technetium*	Gold
			Thallium	Krypton	Mercury	Oxygen	Cadmium
			Silver	Molybdenum	Niobium	Palladium	Iron
			Bismuth	Selenium	Silver	Titanium	Cobalt
1/4				**Copper**	Chlorine	*Rhenium*	*Manganese*
				Thallium	Rhenium	Titanium	Osmium
				Iodine	Strontium	Bismuth	Gold
				Germanium	Lanthanum		Indium
1/5					**Silicon**	**Argon**	*Antimony*
					Arsenic	*Rubidium*	Oxygen
					Antimony	Zirconium	Vanadium
					Yttrium	Gold	Platinum
1/6						Zirconium	**Hafnium**
						Germanium	Potassium
						Tellurium	Niobium
						Iodine	Silver
1/7		**Legend:**	Resonance energy match				*Arsenic*
		BOLD	<= 0.1%				Lanthanum
		Italic	< 0.5%				Chlorine
			< 1.5%				Hafnium
			< 5.0%				

This table identifies potential super-chemical and LENR catalysts as elements with augur electron energies (from G. Williams, 2013), that match modified Rydberg hydrogen/electron transition energies. [4]

Extensions - Nuclear

"Wave-particle equivalence" is also expected to be applicable at the nuclear scale where it can be used to resolve layered meson based nucleon substructures that provide a potentially viable alternative to quark based subatomic models, refer to:

subtleatomics.com/new-atomic-model

The proposed new model is also consistent with the potential for sub-nuclear reactions based on interactions between sub-primary electron resonances and nuclear meson layer sub-entities.

Conclusions

"Wave-particle equivalence" may be an important tool for better understanding and engineering LENR processes and may facilitate significant positive practical technology opportunities in areas such as new chemicals, industrial processes, low carbon energy generation and nuclear waste remediation.

References
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