Quantum Nucleodynamics (QND): The theory underlying the lattice simulation of LENR transmutations

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In the first half of the 20th century, a quantitative explanation of atomic structure (quantum electro-dynamics, QED) was created based on the *known* Coulomb force and a wave-equation, where integral quantum numbers are used to define all possible *electron* states (Eq. 1):

$$\Psi_{n,l,m} = R_{n,l}(r)\, Y_{m,l}(\theta, \phi) \qquad \text{Eq. 1}$$

The energy states of electrons are given by unique combinations of $\boldsymbol{n}$=1, 2, …; $\boldsymbol{l}$=0, 1, …, $\boldsymbol{n}$-1; $\boldsymbol{m_l}$= -$\boldsymbol{l}$, …, -1, 0, 1, …, $\boldsymbol{l}$; and $\boldsymbol{m_s} = \pm 1/2$. The sequence and occupancy of allowed states can be stated as the Periodic Table and the energy of electron transitions can be calculated precisely in QED.

In the second half of the 20th century, a ***nuclear*** version of the wave-equation (Eq. 2) led directly to the nuclear independent-particle model (IPM), where all possible *nucleon* states were defined by:

$$\Psi_{n,j\,(l+s),m,i} = R_{n,j\,(l+s),i}(r)\, Y_{m,j\,(l+s),i}(\theta, \phi) \qquad \text{Eq. 2}$$

While many questions concerning the strong nuclear force remain unanswered, the quantal states of nucleons are given by: $\boldsymbol{n}$=0, 1, 2, 3, …; $\boldsymbol{l}$ = 0, 1, …, (2$\boldsymbol{n}$)/2; $\boldsymbol{j}$ =1/2, 3/2, …, (2$\boldsymbol{n}$+1)/2; $\boldsymbol{m}$ = -$\boldsymbol{j}$, …, -3/2, -1/2, 1/2, 3/2, …, $\boldsymbol{j}$; ***spin (s)*** = ±1/2; and ***isospin (i)*** =±1. The sequence and occupancy of allowed nucleon states in the IPM (Table 1) corresponds extremely well with empirical data.

Quantum Numbers	*n*	0	1			2						3										4					
	l	0	1		0	2			1		0	3				2			1		0	4					…
	j	1/2	3/2		1/2	5/2			3/2		1/2	7/2				5/2			3/2		1/2	9/2					…
	|*m*|	1/2	3/2	1/2	1/2	5/2	3/2	1/2	3/2	1/2	1/2	7/2	5/2	3/2	1/2	5/2	3/2	1/2	3/2	1/2	1/2	9/2	7/2	5/2	3/2	1/2	7/2
	s	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓	⇑⇓
Number of States		2	4		2	6			4		2	8				6			4		2	10					…
(Semi)magic Numbers		**2**	(6)		**8**	(14)			(18)		**20**	**28**				(34)			(38)		(40)	**50**					…
Total Nucleons	*i*	4	12		16	28			36		40	56				68			76		80	100					…

Table 1: The quantum states of the first 100 nucleons in both the IPM and the fcc lattice model.

Interestingly, Wigner [1] showed that the entire pattern of nucleon states (Table 1) corresponds to the symmetries of a face-centered-cubic (fcc) lattice of nucleons – theoretical work that was explicitly acknowledged in his 1963 Nobel Prize citation. We subsequently showed how the fcc lattice can be considered to be the structural basis for QND [2-5] *based on the fact that all nucleon states and their transitions can be defined in terms of lattice coordinates* (x, y, z). Specifically:

$\boldsymbol{n} = (|x| + |y| + |z| - 3) / 2$ $\boldsymbol{l} = (|x| + |y|) / 2$ $\boldsymbol{j} = (|x| + |y| - 1) / 2$ $\boldsymbol{m} = |x| * (-1)^{(x-1)/2} / 2$
$\textbf{spin} = (-1)^{(x-1)/2} / 2$ $\textbf{isospin} = (-1)^{(z-1)/2}$ $\textbf{parity} = \mathrm{sign}(x*y*z)$

which leads to *the exact same (sub)shell states and occupancies* as found in the IPM (Table 1).

We have used the identity between the IPM and the fcc lattice to explain LENR findings on transmutations [4-7]. In the present talk, we show how the nucleon lattice can be considered as the structural basis for QND – and represents a return to a realist, non-Copenhagen interpretation of quantum mechanics [8, 9] à la Einstein and Bohm, while producing the same computational results.

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