The “Renaissance” in Nuclear Physics: Low-energy nuclear reactions and transmutations

#Norman D. Cook [1] and Paolo Di Sia [2]
[1] Kansai University, Japan, cook@res.kutc.kansai-u.ac.jp
[2] Padova University, Padova, Italy

Nuclear structure theory has recently undergone an unexpected “renaissance” that can be attributed to two factors: (1) Since 1989, a steady stream of experimental findings has been reported indicating isotopic anomalies in “chemical” systems at energies well below the expected ~10 MeV nuclear level. (2) Since 2007, remarkable *ab initio* super-computer calculations of nuclear properties have been made under the assumption that nucleons have well-defined intranuclear positions ($\Delta x < \sim 2$ fm). Such theoretical work in so-called “Nuclear Lattice Effective Field Theory” (NLEFT) [1-4] runs contrary to the long-established dominance of the Copenhagen interpretation of quantum mechanics (where a low uncertainty in position is associated with high uncertainty in angular momentum). Non-Copenhagen theoretical assumptions that have previously been considered “unconventional”, at best, and “pre-modern” at worst [5] are now routinely made as a computational necessity in NLEFT. Moreover, the award by the European Physical Society of the Lise Meitner Award in Nuclear Physics to Ulf Meissner in 2016 for such theoretical work is clear indication that rigorous, numerical reproduction of experimental data trumps all considerations of philosophical “purity”.

Following the work of Dallacasa and Di Sia [6] and Di Sia [7] on the in-phase Biot-Savart magnetic attraction between rotating fermions, we have calculated (i) the nuclear binding energies of all stable/near-stable isotopes, and (ii) the magnetic moments of all stable odd-even, even-odd, and odd-odd isotopes whose magnetic moments have been measured experimentally. By specifying the positions of nucleons within a close-packed nucleon lattice, every nucleon is assigned a set of quantum numbers (*n, l, j, m, i, s*, and parity) based solely on its Cartesian coordinates [8-10]. This quantal description of nucleons in the lattice is isomorphic with the symmetries known from the independent-particle model (IPM, ~shell model) of conventional nuclear structure theory. A realistic nuclear force is typically modelled in NLEFT using 40-50 adjustable parameters, but the magnetic interaction between nucleons can be modelled with just 2 parameters, leading to vast improvements in nuclear binding energy and magnetic moment predictions, relative to the traditional shell model calculations.

Finally, we show that LENR transmutation data on Lithium, Nickel, and Palladium isotopes can be simulated using the nuclear lattice and the magnetic nuclear force. Because of the identity between the gaseous-phase IPM and the fcc lattice [8-10], lattice explanations of transmutation effects provide a direct link to conventional nuclear theory. We conclude that funding of LENR research should focus on the basic nuclear science of isotopic transmutation effects, regardless of their possible technological utility. Once the empirical data are unambiguous, *ab initio* computational simulations become possible.

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