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# HYPOTHESIS OF UNOBSERVABLE INTRINSIC RECTANGULAR NUCLEON "ORBITS" SUGGESTED BY A NEW NUCLEAR BINDING ENERGY DIAGRAM

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**Abstract:** Implications of a rearrangement concerning $^{16}O$ and subsequent nuclei up to $A=20$ for the accomodation of the $1d\frac{5}{2}$ subshell are presented. It is explained by a hypothesis of rectangular nucleon "orbits" composing an unobservable closest-packed "dynamic-lattice" structure of standing waves.

The short mean free path of nucleons in the nucleus has been a long-standing problem. Cook and Dallacasa[1] proposed a close-packed crystal model with nucleons **at rest.** The present work shows that rectangular "orbits" would allow **uninhibited motion.**

**Averages** $\overline{B^*}$ of nuclear binding energies $B^* = B - E_x$ for ground states ($B$) and excited states ($E_x$) **of mirror nuclei** with $T_z = \pm\frac{1}{2}$ were plotted as $-\overline{B^*} + (9.5\ \text{MeV}) \cdot A$ versus the mass number $A$. They were

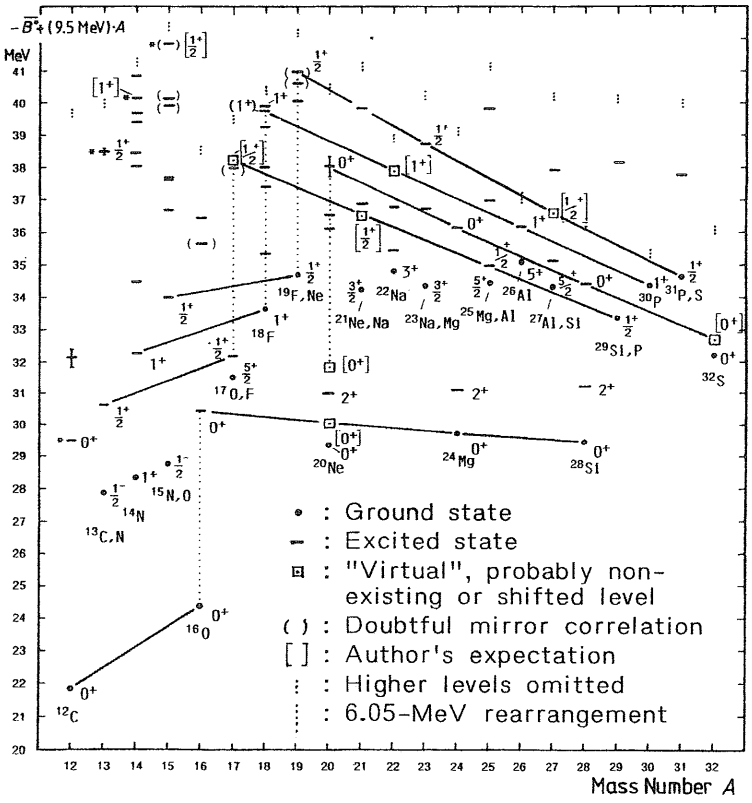


Fig. 1. Binding energy diagram with averages of mirror nuclei. Only the levels with $J^\pi = \frac{1}{2}^+$ for odd-$A$ nuclei, $0^+$ (in three cases $2^+$) for even-even nuclei, and $1^+$ for odd-odd nuclei are included. $J^\pi$ of levels is indicated on trends only and for levels with a star.
* (star): $^{12}C$ -7.65 MeV excitation perhaps reproduced at $A = 13$, 14, and 15. At $^{14}N$, $2^-, (1^+)$ is known and $1^+$ expected.

included in the corresponding diagram for self-conjugate nuclei [2]. About 40 trends of states with the same $J^{\pi}$ approximating straight lines with about 10 to 100 keV precision were found. **Fig. 1** shows examples and a **step** at doubly magic $^{16}O$ and thereafter **instead of a break** with increasing slope. This suggests a **rearrangement** before the $1d\frac{5}{2}$ subshell can be accomodated regularly. However, at $A = 17$, 20, 21, 22, 27, and 32 the states called "virtual" are missing or shifted. Corresponding steps were found at $^{4}He$ and $^{40}Ca$, but not at $^{28}Si$ and $^{56}Ni$, in accordance with the known distinction between the magic-number series ($N$ or $Z$ =) 2, 8, 20, (40), and (6), 14, 28, 50, etc.

Such rearrangement would be required if the nucleus had an **intrinsic standing-wave structure of rectangular nucleon "orbits"**, because $^{40}Ca$ does not contain $^{16}O$ with $l = 1$, the p-"orbit", at its center, as **fig. 2** shows.

In diagrams of Coulomb-energy differences $\Delta B^*$ of mirror nuclei, several linear trends and parallelities of connecting lines - precise to a few keV - were found as required by this hypothesis. The Coulomb energy of the repulsion between the odd proton and all others in the even-even core was calculated. The value $\Delta B(^{3}H,^{3}He)$ was used for the smallest distance in this standing-wave structure, representing a **face-centered, cubic closest-packed "dynamic lattice"**. No adjusted parameter was used. In several cases of little ambiguity, the agreement with the data was about 50 keV or 1 %.

**References:** 1) N. D. Cook and V. Dallacasa, Phys. Rev. **C 35**(1987)1883
2) F. Everling, Nucl. Phys. **A 115**(1968)563

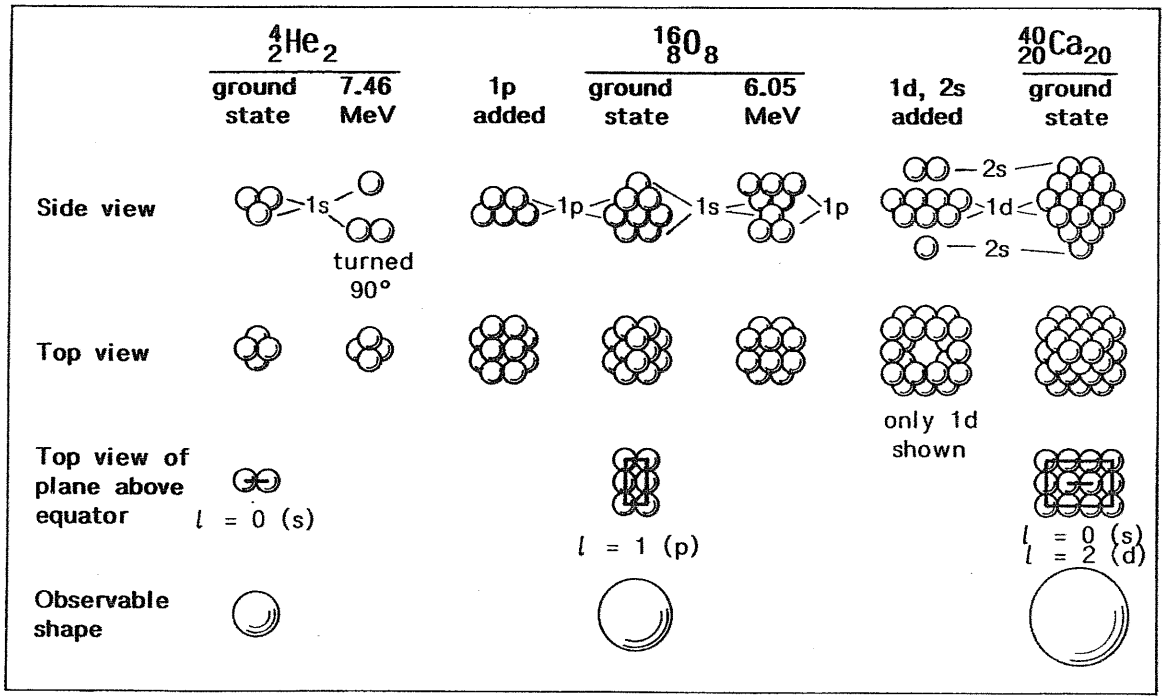


Fig. 2. Hypothetical standing-wave structures including rearranged states. The "virtual" state of $^{4}He$ obviously cannot exist. Rectangular "orbits" are shown together with orbital angular momentum quantum numbers $l$ and their symbols s, p, and d.