Symmetrical Models of Nuclear Bases

Dong Fu, Heng han
Research scholar, Department of Physics,
Changchun University of Science and Technology, china

Abstract

While experimenting with the more and more general neodymium attractive ball sets, the author established a method, by which models of nuclear bases can be formed. These macroscopic models visually signify numerous features of bases and atomic phenomena, which can be a valuable mean through the coaching of nuclear physics. Even though such macroscopic models are unable to depict the true quantum physical nature of nuclear procedures, they can be much extra valuable didactically than the before used disordered sets of balls, to signify the nuclear bases.

Keywords - *Nuclear Model, Magnetic Ball, Rotational Symmetry, 4-Fold Symmetry, Magic Number, Shell-Orbit Structure, Deformed State, Cluster Model, Collective Excitation.*

I. INTRODUCTION

While teaching atomic physics, a essential need can be knowledgeable rather often to explain somehow the simple possessions of atomic nuclei. Presently the representations of nuclear bases are regularly disordered sets of two differently colored ball-like items. However, this description is quite elementary, as none of the greatest significant possessions of nuclear bases are performing on these models. Apparently a three-dimensional model can help extra in the imagining of a bases, than a two-dimensional demonstration. The currently more and more general neodymium attractive ball groups can be a exact good tool for the three dimensional displaying of the bases. Primarily the author used disordered spherical sets of two differently colored attractive balls to illustrate the bases. But after flattering extra familiar with the prospects these attractive ball sets can deliver, the author realized that some symmetric forms are more practical, as they can signify certain possessions of the nuclear bases: the result of the Pauli principle, regularities, deformed conditions, attractive instants and level excitations. Thus, we are successful to see in the following units, that these attractive ball sets offer amazing potentials for the modeling of nuclear bases.

II. SYMMETRIC FORMS AND THE PAULI PRINCIPLE

The filling of similar sized spheres is a numerous hundred years old problematic in arithmetic. One of the primary and most significant declarations of this area is, that the stuffing thickness of systematic arrangements is regularly greatly greater, than that of the disordered methods. Disordered methods fill extreme 64% of the accessible space parting 36% unusable though methodical regular forms can reach up to 74% stuffing thickness. Due to the binding forces, the nucleons are also pursuing to reduce the planetary they occupy, when establishing the bases. Thus, even though there are other issues that essential be taken into thought, the highest stuffing thickness attitude propose that one necessity observe the role of the ordered, consistent arrangements, once making the bases. There are two types of methodical assemblies, into which similar sized domains can establish: frames and rotationally symmetric assemblies. Both kinds are categorized by the regularities of the sets.

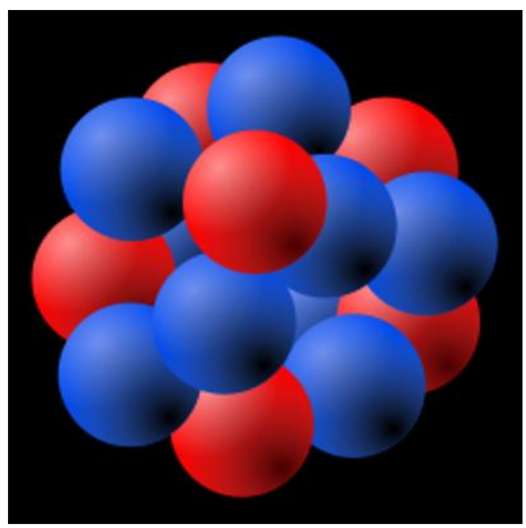

Fig 1 Atomic Nucleus

The well-known frames have translational symmetries in numerous instructions. The other kind of regularity is the rotational or circular symmetry: there are assemblies that can be replaced with a definite degree, and the alternated thing will be matching to the creative one.

The angle of alternation necessity be a certain portion of 360˚: if the degree in question is 360˚/n, we declare of n-fold regularity. For example the threefold symmetry of a assembly resources, that a turning leaves the thing unaffected, if the viewpoint of revolution is 360˚/3 = 120˚ or its multiples.

A simple feature of frame assemblies is that the amount of elements in the frame is not imperfect by some control. By the specific conversions of the network, in attitude one can growth the number of elements in the lattice to infinity, nevertheless it remains the same frame. In the event of the meetings with revolving regularity there are some limitations.

Fig 2 6-Fold Rotational Symmetry

III. ASSEMBLIES WITH 4-FOLD SYMMETRY AND THE ATOMIC MISSILE MODEL

The structures, that have 4-fold rotating regularity just as any other regular assembly can be shaped from minor regular units. In the case of lattices, these smaller units are the unit cells, which are recurring laterally the axes of regularity. Whereas in the instance of constructions with revolving regularity, these parts are rings, which make planes or rounded shells, that can be prepared further into composite matters. In the situation of 3 or 6-fold regularity, the balls are prepared into flat planes, without any curving, though in the case of four or fivefold regularities, strongly filled balls cannot form flat exteriors. In these belongings shell-like assemblies are shaped with a convex and a concave side, and thus, these three dimensional shells can obviously be prepared into three dimensional objects.

We might continue extra ahead, but the central opinion can be seen at this period already. In the first three cases there is a perfect competition with the element numbers of the greatest constant nuclear bases. The initial faultless can be associated with the 4He nucleus. The second model corresponds to the 16O nucleus, while the third one to the 40Ca nucleus. Nevertheless in the fourth case, the particle number of the fourth model does not meet with that of any outstandingly stable nucleus. Indeed, the first attempts of the shell model of atomic nuclei proposed an island of extreme stability to the particle number 80. But reality tells a different story: due to the increasing repulsion of positively charged protons, beyond 40Ca, the nuclei with identical proton and neutron numbers are no longer stable. On the other hand, the interaction of the angular momenta of particle the spin and orbital momentum further complicates the situation, so the next particularly stable nuclei have 50 protons or neutrons.

Fig 3 Rings Shells and Spheres with 4- fold symmetry

IV. OTHER MODELS WITH FOUR-FOLD SYMMETRY

The above thoughts are frequently grounded on the appearances of the 16O and 40Ca replicas. Once, though, we accomplished to find matches among the atomic shell perfect and the geometric models, we have the guidance to shape the regular model of any bases. All we essential to know for displaying is the shell construction of the bases in question: which conditions are engaged by the nucleons.

We concept the suitable rings, depicting the finished states and paths and formerly interrelate them for making the perfect, which illustrates numerous features of the bases in question.

The following typical after the 20Ne with four-fold revolving uniformity is the model of 24Mg that comprises 4 extra balls. The path structure of the 24Mg bases is exact simple. It encompasses four totally occupied orbits: there are 4 nucleons on the1s1/2 and the 1p1/2 orbits, and 8 nucleons on the 1p3/2 and 1d3/2 orbits. That is, the perfect of this bases contains of two 4 and two 8 ball rings. It is very modest to form this model. We essential to join the 4 and the 8 ball charms to method two semicircular shells and then, these two hemispheres can be fitted composed into a spherical model. The result is a surprisingly regular model. It has not only one but three rotational regularity axes, perpendicular to each other.

The geometric models of the $_{20}$Ne and $_{12}$C nuclei

V. GEOMETRIC MODELS OF DISTORTED BASES AND THE CLUSTER MODEL

Until now, it was a clear task to produce the geometric models. Founded on the shell- orbit building of the bases to be showed, one can generate the rings that resemble to the orbits of the bases and attached these rings finalizes the model. However, some special portents perform as we change away from the 24Mg model with its specific regularity and an internal cavity. When aggregate the amount of balls to 28, the circular regularity disruptions and the internal cavity is occupied in numerous dissimilar ways. Thus, the following model with four fold regularity, the 28Si model can exist in numerous dissimilar procedures, which is certainly very comparable to the true nature of the 28Si nucleus.

The bottom energy state, the ground state is not a spherical form, but a faintly compressed shape, so called oblate form. The additional, enthusiastic conditions may procedure powerfully compressed oblate forms, or extended prior shapes. Classically, the advanced is the excitation dynamism of the state, the larger is the distortion.

Fig 4 Two Identical Models of 24Mg

VI. MAGNETIC INSTANT IN THE SYMMETRICAL REPLICAS

We have realized so far, that regular mockups made of attractive spheres may help to exemplify numerous phenomena of the nuclear world for students. These models are not just disorderly packages of balls to represent the nucleons of an nuclear bases. Regular procedures can illustrate the Pauli attitude, the shell-orbit assembly of a bases, the mechanism of combined excitations and deformation, and done these, the attendance of gathering procedure. These instances are more than sufficient to prove that such geometric models can be valuable in exemplifying the simple structures of a center while teaching atomic physics. Nevertheless, there are even more opportunities.

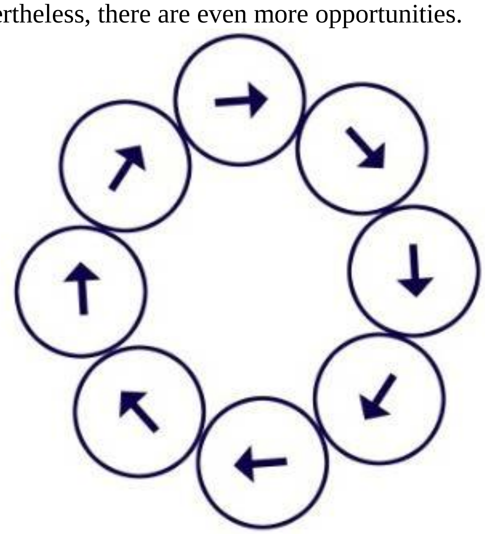

Fig 5 Direction of Magnetic Moments in a Ring of Magnetic Balls.

When imagining the attractive instants of the mockups, we do not essential to trust only on our imagination. Though we cannot see the attractive field of the bases, we can see that of the model. A very simple, age-old technique stretches us nice outcomes: the attractive field is complete noticeable by placing a sheet of paper on the model and sprinkling fine iron concentrate on it. The replicas have fairly composite attractive picture, which again gives food for some opinions.

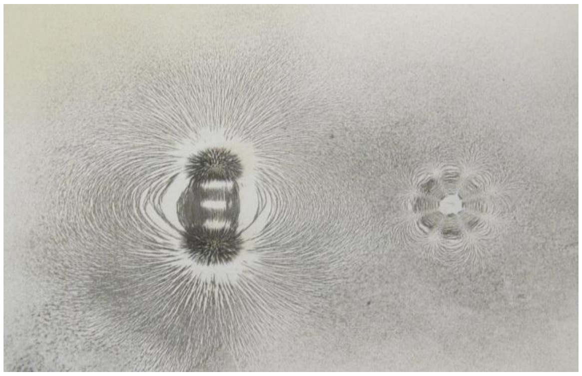

Fig 6 Magnetic Field of the Open Line and Closed Ring of Four Magnetic Balls

Fig 7 Magnetic field of the Models Made of 16 and 15 Balls.

First of all, these magnetic images reveal, how important is the effect of closing the field lines. The model of 4He, a closed ring of four balls has a very weak field outside the model, compared to a linear arrangement of four balls. And even though we are seeing only the magnetic field of some macroscopic balls, one can imagine the similar effect of closure of field lines in the case of the strong nuclear force.

And examining the attractive possessions of the additional composite models, it develops clear, that the models made of closed rings must very faint attractive field external the perfect. However, it is sufficient for one ball to be missing from the model; a burst of attractive field looks on the picture. Such pictures certainly, nicely exemplifying, how the durable force burst out of those bases, which failures only one or two nucleons to have a locked shell. In the case of these bases the preoccupation cross unit is much developed than in the event of bases with totally occupied shells. And certainly, these models, that failure only one ball to fill a ring, drags a solitary attractive ball from a much greater expanse, than additional replicas with shut rings.

VII.CONCLUSION

At first, it may appear to be a strange impression to model a compound, multi-particle important motorized scheme by the help of macroscopic matters; we have seen that occasionally there are around comparisons. The above opinions have exposed that showing the nuclear bases with sets of attractive balls is not as strange idea as it may sound. Even still this displaying procedure has its restrictions, these models might prove that the macroscopic imagining of atomic features is not a totally desperate task. These models may give a perceptible image as to how the piles of nucleons can position to such composite assemblies as the nuclear bases. Due to the longitudinal restrictions of this object, numerous stimulating topics had to be deserted. For example, 3-fold regularity may relate for the showing of those bases, in which there are two periods more neutrons than protons or more protons than neutrons. In these belongings there are only three nucleons in each formal, so the models have to have 3-fold proportion. Again, stimulating assemblies seem, when the protons and neutrons are displayed with differently shaded balls: as the spin-pairs of nucleons must be opposite to individually other in the models, chains of protons and neutrons perform within the model. Also, showing of very light bases and heavy bases are two captivating tasks. Thus, there are extensive viewpoints in the symmetrical showing of nuclear bases.

REFERENCE

[1] Conway, J.H. and Sloane, N.J.A. (1993) Sphere Packings, Lattices and Groups. New-York, Springer-Verlag (The Maximum Packing Density Was Hypothesized by Johannes Kepler in 1611 and C.F. Gauss Proved the Lemma for Lattices. While the Perfect Proof for Every Type of Packing Is Still Missing).

[2] Coxeter, H.M.S. (1989) Introduction to Geometry. Wiley.

[3] Sharrad, F., Hamoudi, A. and Radhi, R. (2015) Charge Density Distributions and Form Factors of Some Light Nuclei. Scholar's Press.

[4] Darai, J., Cseh, J. and Jenkins, D.G. (2012) Shape Isomers and Clusterisation in the 28Si Nucleus. Physical Review C, 86, Article ID: 064309. https://doi.org/10.1103/PhysRevC.86.064309

[5] Abe, T., Seki, R., & Kocharian, A.N., Physical Review C70, 014315, 2004.

[6] Aichelin, J., & Stocker, H., Physics Letters B163, 59, 1985.

[7] Anagnostatos, G.S., International Journal of Theoretical Physics 24, 579, 1985. Angeli, I., Heavy Ion Physics 8, 23, 1998.

[8] Antonov, A.N., Hodgson, P.E., & Petrov, I.Zh., Nucleon Momentum and Density Distributions in Nuclei, Clarendon Press, Oxford, 1988.

[9] Antonov, A.N., Hodgson, P.E., & Petrov, I.Zh., Nucleon Correlations in Nuclei, Springer Verlag, Berlin, 1993.

[10] Barreau, G., et al., Nuclear Physics A432, 411, 1985. Bauer, W., Physical Review C38, 1297, 1988.