New hypothesis shows geometry of atomic nucleus

A summary of recent work by Dr. Robert J. Moon, adapted from an article by Laurence Hecht in the April 1987 German-language magazine Fusion.

The following summary of a groundbreaking new view of the atomic nucleus developed by University of Chicago physicist Dr. Robert J. Moon is adapted from a longer article by Laurence Hecht. Hecht collaborated with Moon to develop the implications of his geometrical model of the atomic nucleus for the periodic table and the arrangement of extranuclear electrons. Dr. Moon, an experimental physicist of vast experience, and a veteran of the World War II Manhattan Project, began his work at the University of Chicago in the 1930s under Prof. William Harkins.

While an elaborately refined set of rules exists to explain many phenomena observed at the atomic level, there remains no satisfactory model of the atomic nucleus, the central core of the atom around which a precise number of negatively charged electrons can be considered to orbit. Any attempt to produce a coherent theory of orbiting electrons, without knowledge of the structure around which these orbits are constructed, would seem to be doomed to failure. Nonetheless, a highly elaborated algebraic theory of the atom, designed to account for a mass of data gathered from spectral analysis and other operations, does exist in the form of the quantum mechanical model. Most of this theory presumes no more about the atomic nucleus than that it contains a certain number of positively charged particles agglomerated in a central mass.

It would seem past time to arrive at a more developed theory of the atomic nucleus, and Dr. Robert J. Moon has proposed a geometrical model of the nucleus to do just that.

The existing dogma of nuclear physics requires us to believe that protons, being all of positive charge, will repel each other up to a certain very close distance corresponding to the approximate size of the nucleus, at which point they repel again. So, the holding together of the protons in the nucleus is accounted for.

Since we disdain such arbitrary notions of "forces," and prefer to view the cause of such phenomena as resulting from a certain characteristic of physical space-time, a different view is demanded. Considerations of "least action" suggested to Dr. Moon a symmetric arrangement of the charges on a sphere, while the number of such charges and the existence of orbitals beyond the nucleus suggested a nested arrangement of such spheres, containing intrinsically the Golden Section ratios (see box).

The model

We are led immediately to the Platonic solids. The surfaces of the Platonic solids and related regular solids represent unique divisions of the surface of a sphere according to a least-action principle. All of the Platonic solids can be formed by the intersections of great circles on a sphere, the great circle being the least-action path on the surface of the sphere, and the sphere the minimal three-dimensional volume created by elementary rotational action.

The best way to see this is to consider the intersections of the great circles in a Torrianian, or Copernico-Pythagorean planetarium (cf. Johannes Kepler, Mysterium Cosmographicum, Dedicatory Letter, Abaris Press). In the device constructed by Giovanni Torriani to demonstrate Kepler’s nested-solids model for the solar system, the vertices of the regular solids are formed by the intersections of great circles. Three great circles intersect to form an octahedron. Six great circles intersect triply in eight places to form the vertices of a cube and doubly in six places over the faces of the cube. Fifteen great circles intersect five-at-a-time in 12 locations, three-at-a-time in 20 locations, and two-at-a-time in 30 locations.
An algebraic construction of the Golden Section

The Golden Section, or Golden Mean, divides a line into two segments, such that the ratio of these segments is proportion to the ratio of the whole length to the larger of the segments.

\[
\frac{AC}{CB} = \frac{AB}{AC}
\]

This being the case, when the length AB is extended by the segment AC, the ratio of the original to the new length, A'B/AB, will also be proportion to the Golden Section ratio.

\[
\frac{AC}{CB} = \frac{AB}{AC} = \phi
\]

(\(\phi\) is the traditional symbol for the Golden Mean)

The Golden Section ratio is \((1 + \sqrt{5})/2\), which is approximated by the number 1.61802. A simple construction of the ratio \((1 + \sqrt{5})/2\) can be determined from the Pythagorean Theorem. Construct a square on an extended line. Draw a diagonal through one half of the square, and mark this length on the line. The extended line will be in the Golden Section ratio to the length of the side of the original square.

A geometrical construction of the Golden Section

The Golden Section can be constructed directly from a circle, as follows: Take any circle, and determine the length of its diameter by folding it in half. Now produce a tangent from any point on the circumference of the circle, which is extended so that it has the same length as the diameter. Connect the endpoint of the tangent to the center of the circle, and continue this new line until it reaches the opposite half of the circumference. This line will be cut in the Golden Section proportion (\(\phi\)) by the diameter.

\[
\frac{PQ^2}{QB \times QA} = QA = AB + QB
\]

\[
AB^2 = (AB + QB)QB \text{ and } \frac{AB}{QB} = \frac{(AB + QB)}{AB} = \phi
\]

The relationship \(PQ^2 = QB \times QA\) can easily be shown by noting that PQB and PQA are similar triangles.
axial symmetry of the latter. The octahedron may still be
placed within the icosahedron in a manner that is beautiful.
The ratio of five-to-four provided Dr. Moon a clue. Six ver­
tices of the octahedron may be placed near to six vertices of
the icosahedron, such that the distance from the nearby vertex
of the icosahedron to the edge opposite it is divided in the
Divine Proportion, as the Golden Section was called in the
Renaissance (Figure 3).

The axis of the cube-octahedron pair is thus skew to the
axis of the icosahedron-dodecahedron dual—a fact of great
importance later.

Examining the edges of the figures so nested, considering
that of the smallest inner figure, the cube, to be unity, we
find:

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Building the nucleus

With the structure of the microcosm so determined, we
are now prepared to demonstrate the unique arrangements of
singularities that may exist within it. There are 92 such ar­
rangements known as the naturally occurring elements (see
Fig. 6) and some more that we can manufacture but not
maintain for very long. Each element has a unique number Z
of positively charged protons in its nucleus.

As a first approximation for the nucleus, Dr. Moon pro­
poses that protons be placed at the vertices, beginning with
the cube and moving outward. We thus get:

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Filling the outermost figure, the dodecahedron, we reach
palladium Z = 46. To go further, a twin structure joins at one
of the faces of the dodecahedron (Figure 4) and begins to fill
up its vertex positions with protons beginning on the outer-
FIGURE 3
Nesting of octahedron in icosahedron

most figure. (47-Silver is the first.) Six positions are unavailable to it—the five vertex positions on the binding face of the second figure and the one at the face center where a vertex of the inscribed icosahedron pokes through.

Thus, on the second figure, 15 out of 20 of the dodecahedral vertices are available, and 11 out of 12 of the icosahedral vertices. We now fill 11 of the 20 available dodecahedral vertices, thus creating 47-Silver and continuing through 57-Lanthanum. Here, one face of the dodecahedron remains open to allow filling of the inner figures. The cube and octahedron fill next, producing the 14 elements of the lanthanide, or rare earth series (58-Ce to 71-Lu). Placing the proton charges on the inner solids causes a corresponding inward pulling of the electron orbitals. Thus, the otherwise unaccounted-for filling of the previously unfilled 4-f orbitals, and the mystery of the period of 14 for the rare earths, are explained.

The figure is complete at 86-Radon, the last of the noble gases. To allow the last six protons to find their places, the twin dodecahedra must open up, using one of the edges of the binding face as a “hinge.”

87-Francium, the most unstable of the first 101 elements of the periodic system, tries to find its place on the thus-opened figure, but unsuccessfully so. Less than one ounce of this ephemeral substance can be found at any one time in the totality of the Earth’s crust. 88-Radium, 89-Actinium, and 90-Thorium find their places on the remaining vertices. Two more transformations are then necessary before we reach the last of the 92 naturally occurring elements.

To allow for 91-Protactinium, the hinge is broken, and the figure held together at only one point (Figure 5).

The construction of 92-Uranium requires that the last proton be placed at the point of joining, and the one solid slightly displaced to penetrate the other in order to avoid two protons occupying the same position. This obviously unstable structure is ready to break apart at a slight provocation. And so we have the fission of the uranium atom, as hypothesized by one of those who first made it happen.

Dr. Moon was led to the elaboration of this theory on the basis of a review of the work of Klaus von Klitzing which he published in the October 1985 issue of the International Journal of Fusion Energy. Klitzing won the Nobel Prize in 1985, for the discovery of the quantum Hall effect.

Klitzing investigated the surfaces of semiconductors under extreme conditions—low temperatures and high magnetic fields. The Hall effect is a kind of resistance created by the Lorentz force which appears as a new, transverse electric-
cal potential. It is generated when an electrical current flows in a conductor which lies in a plane perpendicular to the magnetic field.

According to a classical explanation, the Lorentz force will deflect the charged particles sideways. The particles will collect on the edge parallel to the electron velocity. This charge separation leads to the buildup of an electrical field (the Hall field). This can be considered to create a compensating force to the Lorentz force, which ultimately annuls it, allowing an undeflected current to flow. When Klitzing investigated the surfaces of semiconductors under extreme conditions, he found a surprising result: The Hall resistance does not occur continuously, but as a step function, which depends only upon the constant value $\frac{2h}{e^2\mu_0C}$, and a value $n$, which depends upon the strength of the magnetic field, and the charge strength.

The value of this natural resistance turns out to be determined by the ratio of Planck's constant to the square of the electron charge—which also is a ratio which determines the fine structure constant ($\alpha = \text{fine structure constant}$):$^1$

$$\frac{1}{\alpha} = \frac{2h}{e^2\mu_0C}$$

Moon was interested in the geometry which underlay the fine structure constant and the Hall resistance. He developed a two-dimensional model for this geometry, and then considered a three-dimensional model which involved the five Platonic solids. This model was like the one described, with electrons, rather than protons, arranged at the vertices of the figure. However, it brings together three, not two, completed dodecahedra. If we allow for one position to be lost by the joining, then there are 137 electrons.

This figure is of significance because it is the integer most closely related to the fine structure constant ($1/137.036$). The fine structure constant is of crucial importance for the entire concept of quantum physics. Its value, among other things, is the ratio of the velocity of an electron at the lowest level in a hydrogen atom, to the velocity of light.