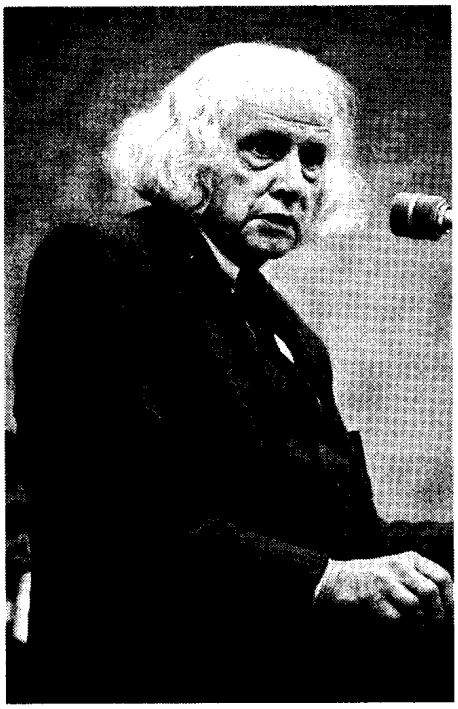


Dr. Robert Moon, speaking in 1987 at Human Rights Commission hearings on the LaRouche case.

Advances in Developing The Moon Nuclear Model

by Laurence Hecht

In the atomic nuclear structure hypothesized by Dr. Robert J. Moon[1] in 1986, protons are considered to be located at the vertices of a nested structure of four of the five Platonic solids (Figure 1).

Eight protons, corresponding to the Oxygen nucleus, occupy the vertices of a cube which is the first nuclear "shell." Six more protons, corresponding to Silicon, lie on the vertices of an octahedron which contains, and is dual to, the cube. The octahedron-cube is contained within an icosahedron, whose 12 additional vertices, now totalling 26 protons, correspond to Iron. The icosahedron-octahedron-cube nesting is finally contained within, and dual to, a dodecahedron. The 20 additional vertices, now totalling 46 protons, correspond to Palladium, the halfway point in the periodic table (Figure 2).

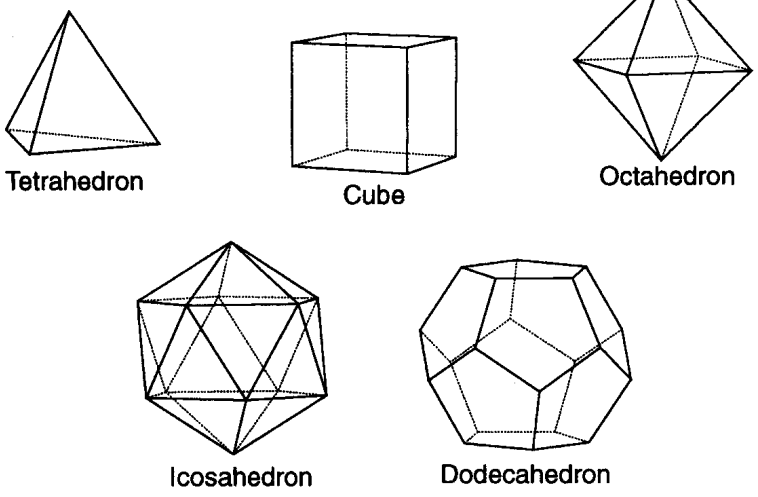


Figure 1
THE FIVE PLATONIC SOLIDS

The five regular, or Platonic, solids are best conceptualized as the regular tilings of the surface of a sphere. They thus define a crucial boundary of what can be constructed in visual space. In nested arrangements, the solids and their implicit variations may represent a multiply connected manifold, which serves as a metaphor for the relationship of the individual to the whole universe in physical space. Construction of the solids, and exploration of their variations, has thus always been the foundation for creative work in science.

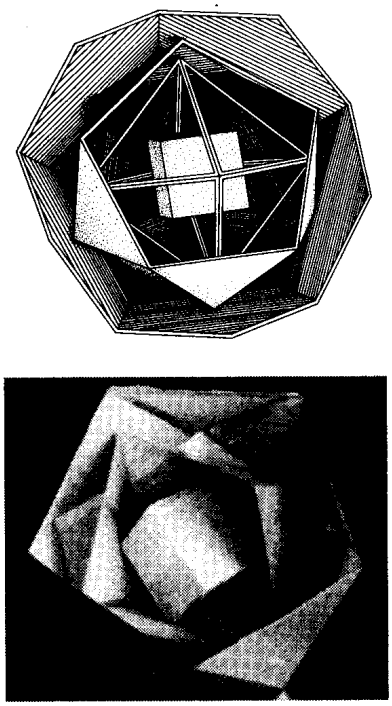


Figure 2
A WORKING MODEL OF THE NUCLEUS

In the Moon model of the nucleus, a nesting of four of the five Platonic solids similar to that conceived by Johannes Kepler to describe the Solar System, is employed. Also shown is a photograph of a working model of the nucleus, made for Moon by retired machinist George Hamann in 1986. The scale model was constructed out of used aluminum offset printing plates.

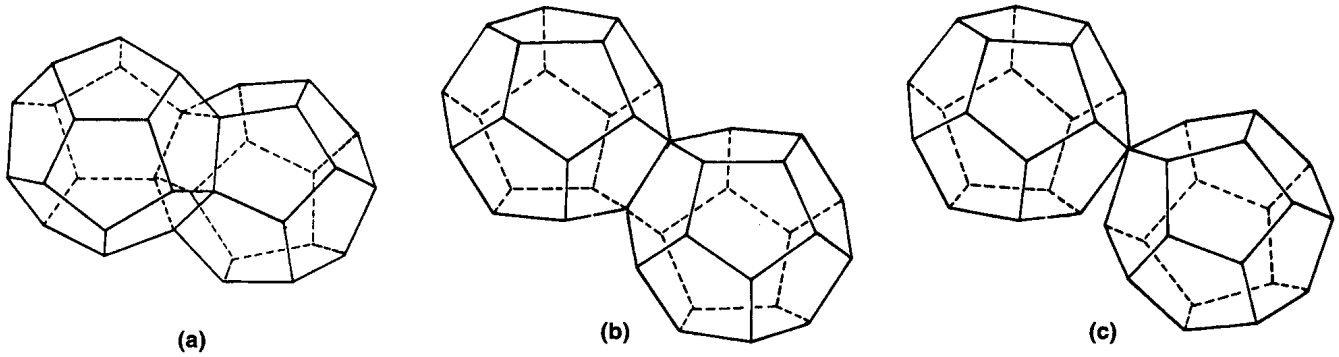


Figure 3
THE COMPLETED URANIUM NUCLEUS

(a) To go beyond palladium (atomic number 46), which is represented by the completed dodecahedron, an identifcal dodecahedron joins the first one at a face. When the second dodecahedron is completed, it is seen that six positions on the common dodecahedral face are already occupied. This represents the nucleus of radon (atomic number 86).

(b) To go beyond radon, the twin dodecahedra open up, using a common edge as if it were a hinge.

(c) To create 91-protactanium, the hinge is broken at one end. To create 92-uranium, the position where two protons join must be slightly displaced, creating the instability which permits fission.

Beyond Palladium, a second dodecahedral shell begins to form as a twin to the first. After 10 of its 20 vertices are filled at Lanthanum (atomic number 56), a cube and octahedron nesting fill inside it, accounting for the 14 elements of the anomalous Lanthanide series.

Next, the icosahedron forms around the cube-octahedron structure, completing its 12 vertices at Lead (atomic number 82), which is the stable, endpoint in the radioactive decay series. Finally the dodecahedron fills up, and the twinned structure "hinges" open, creating the instability which leads to the fissioning of uranium (Figure 3).

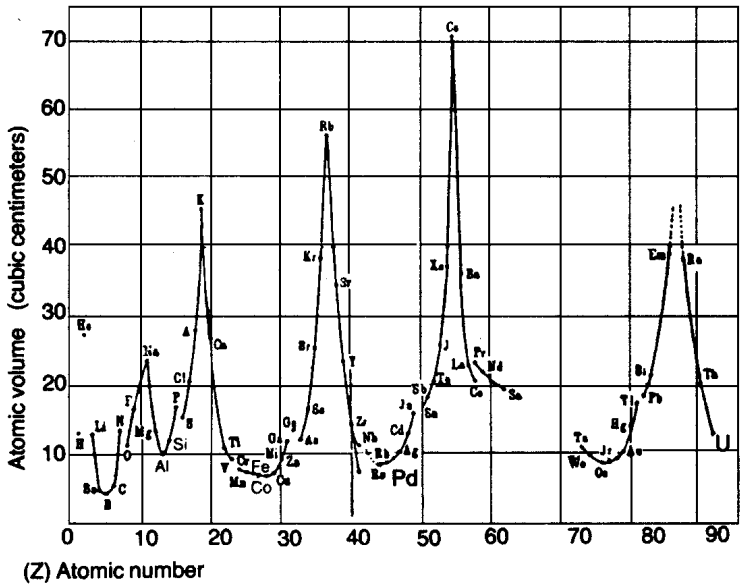


Figure 4
PERIODIC PROPERTIES OF THE ELEMENTS

The periodicity of the atomic volumes of the elements (the ratio of their atomic weight to density) guided Lothar Meyer in the 19th-century in developing the periodic table. The maxima in the graph at atomic numbers 3, 11, 19, 55, and 87 identify the Group 1A elements that begin each period. However, minima occur in the same graph at or near the atomic numbers 8, 14, 26, and 46, which mark the completed proton shells in the Moon nucleus.

Source: Arnold Sommerfeld, *Atomic Structure and Spectral Lines*, p. 144.

The completed "shells" of the Moon model, correspond to the elements whose stability is attested by their abundance in the Earth's crust: Oxygen, Silicon, and Iron. These elements also occur at *minima* in the graphs of atomic volume (Figure 4), and of other physical properties (viz. compressibility, coefficient of expansion, and reciprocal melting point) as established by Lothar Meyer in the 1870s to 1880s. Palladium, which is an anomaly in the modern electron-configuration conception of the periodic table— because it has a closed electron shell, but occurs in the middle of a period— is not anomalous in the Moon model. Further, as I discovered since my 1988 article on the subject, all four closed-shell elements in the Moon model occur at maxima on the graph of paramagnetism (versus atomic number), as reported by William Draper Harkins.[2]

The Moon model is thus consistent with much of the same experimental data which underlies the periodic table of the elements, and explains additional features not explained by the modern, electron-configuration

Continued on page 8

Who Was Robert J. Moon?

Robert James Moon (1911-1989): Arriving at the University of Chicago at the age of 16 in 1928, Moon expressed his intention to solve the problem of controlled thermonuclear fusion. Arthur Compton, then chair of the Physics Department, told him his department was not working on that problem, and sent him to the chairman of the Department of Physical Chemistry, William Draper Harkins.

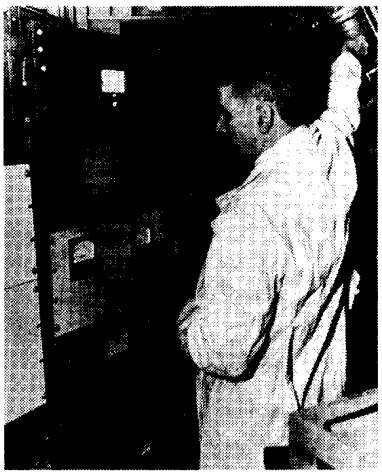
Moon earned a Ph.D. degree in Physical Chemistry under Harkins, and then a doctorate in Physics. He taught in both departments at the University of Chicago, starting in the 1930s. During World War II, he played a key role in the Manhattan Project; he later conducted biophysical research in connection with Argonne National Laboratory.

In the 1930s, Moon built the second cyclotron in the world, with many improvements over the first device constructed by E.O. Lawrence. During the Manhattan Project, he solved the problem of the carbon moderator, making the first atomic pile possible. After the war, he constructed the first scanning X-ray microscope, and pioneered in optical biophysics studies on the action potential in nerves.

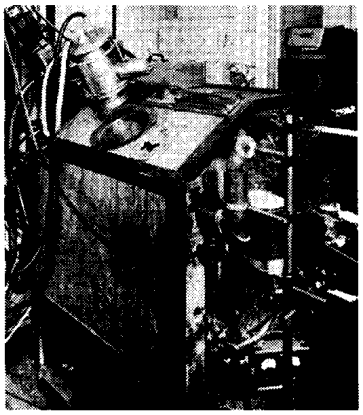
His study of the electrodynamic theories of André-Marie Ampère and Wilhelm Weber, led him to reconsider the usual interpretation of the Rutherford scattering data, which ignores the variation in force between charged particles as a result of relative velocities and accelerations. Calculations based on the Weber electrodynamics forced Moon to re-conceptualize most of what is, still today, taken for granted in atomic and nuclear physics.

From 1974 onward, he was a key collaborator of Lyndon H. LaRouche, Jr. A founding member of the Fusion Energy Foundation, from 1984-1986 he edited its *International Journal of Fusion Energy.* He was a member of the advisory board of *21st Century Science & Technology,* until his death in 1989.

As an outgrowth of seminars conducted with LaRouche and other scientific collaborators in the 1984-1986 period, Moon came up with his proposal for a geometric ordering of the atomic nucleus, inspired by Johannes Kepler's conception of the solar system, as described in his work *Mysterium Cosmographicum.*

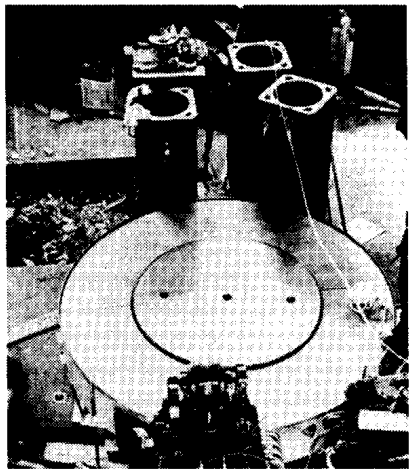


Dr. Moon (about 1952) at the control panel of the world's first scanning X-ray microscope, which he built at the University of Chicago. He used the device in the early 1950s, in conjuction with a gated microspetrophotometer operating in the ultraviolet band, for studies of the action potential in unmyelinated axons. Also shown is the storage system and viewing kinescope. Below: The scanning X-ray assembly. Outer box contains one-half-inch thick shield of lead. Vaccum pumps are exterior to box on right. Calcium fluoride single crystal housing and photo multiplier tube are at upper left.



Philip Ulanowsky/EIRNS

Dr. Moon teaching a class on the principles of electrodynamics (1986) at a summer camp in Virginia run by the Schiller Institute. Students were instructed in the use of basic machine tools, and encouraged to reproduce original experiments of André-Marie Ampère.



The world's second cyclotron, designed and built by Dr. Moon at the University of Chicago (about 1936), had many improvements over the first one, built by E.O. Lawrence in California. Here, the core of the cyclotron being assembled.

PROPOSED NEUTRON DISTRIBUTION CHART

Element	N=	Alpha particle	Edges of Tetrahedron	Cube	Octahedron	Icosahedron	
2-He-4	2	2	Complete period				
3-Li-7	4	2	2				
4-Be-9	5	2	3				
5-B-10	5	2	3				
6-C-12	6	2	4				
7-N-14	7	2	5				
8-O-16	8	2	6	Complete proton shell			
9-F-19	10	4	6				
10-Ne-20	10	4	6	Complete period			
11-Na-23	12	4	6	2			
12-Mg-24	12	4	6	2			
13-Al-27	14	4	6	4			
14-Si-28	14	4	6	4	Complete proton shell		
15-P-31	16	4	6	6			
16-S-32	16	4	6	6			
17-Cl-35	18	4	6	8			
18-Ar-40	22	4	6	12	Complete period		
19-K-39	20	4	6	10	0		
20-Ca-40	20	4	6	10	0		
21-Sc-45	24	4	6	12	2		
22-Ti-48	26	4	6	12	4		
23-V-51	28	4	6	12	6		
24-Cr-52	28	4	6	12	6		
25-Mn-55	30	4	6	12	8		
26-Fe-56	30	—	6	12	12	Complete proton shell	
27-Co-59	32	—	6	12	12	2	
28-Ni-59	31	—	6	12	12	1	
29-Cu-64	35	—	6	12	12	5	
30-Zn-65	35	—	6	12	12	5	
31-Ga-70	40	—	6	12	12	10	
32-Ge-73	41	—	6	12	12	11	
33-As-75	42	—	6	12	12	12	
34-Se-79	45	—	6	12	12	15	
35-Br-80	45	—	6	12	12	15	
36-Kr-84	48	—	6	12	—	30	Complete period
37-Rb-85	48	—	6	12	12	18	
38-Sr-88	50	—	6	12	12	20	
39-Y-89	50	—	6	12	12	20	
40-Zr-92	52	—	6	12	12	22	
41-Nb-93	52	—	6	12	12	22	
42-Mo-96	54	—	6	12	12	24	
43-Tc-98	55	—	6	12	12	25	
44-Ru-101	57	—	6	12	12	27	
45-Rh-103	58	—	6	12	12	28	
46-Pd-106	60	—	6	12	12	30	Complete proton shell

Continued from page 6

presentation of the periodic table. However, it seems to be inconsistent with the evidence from spectroscopy (upon which the electron-configuration conception rests) which suggests the periods of 2, 8, 18, and 32; it is also not consistent with the older "law of octaves," which was developed to explain the phenomena of chemical bonding, and was subsumed in Mendeleyev's conception.

An Ordering of Neutrons

From the period of my first exposure to Moon's nuclear model, I was of the opinion that the two apparently contradictory orderings (electron and proton) must be governed by some higher principle, which was in some way contained in the Moon conception. Moon encouraged such speculations, pointing out that the theory of electron orbits (the "extra-nuclear electrons," as he insisted on calling them), had always suffered

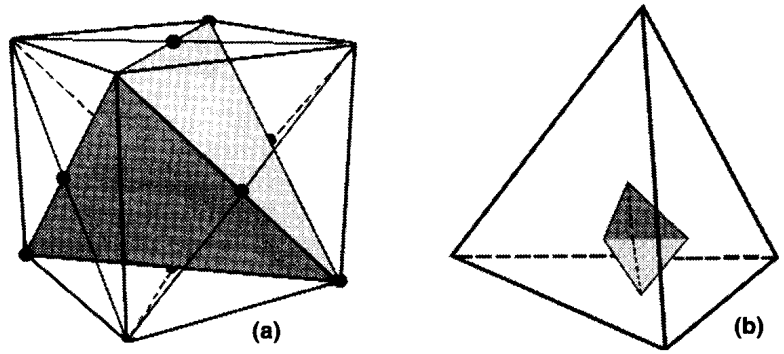


Figure 5
TETRAHEDRON INSCRIBED IN A CUBE
Every cube implies a tetrahedron. Four diagonally opposite vertices of the cube form the vertices of the tetrahedron (a). The alpha particle is conceived as a smaller tetrahedron (b), whose vertices fit at the centers of the faces of the larger tetrahedron pictured in (a).

from an aseptic separation of the electron from the nucleus.

During his lifetime, I worked out an ordering principle, using the unfilled faces and edge midpoints of his nested configuration, to determine the otherwise undetermined distribution of the neutrons in the nuclei.[3] I assumed the addition of the fifth Platonic solid (tetrahedron) as the structure of an Alpha particle at the center of the nucleus (Figure 5), and distributed the neutrons at the unoccupied edge-midpoints of the set of solids. The neutron "shells" closed at the electron-shell singularities (2-helium-4, 10-neon-20, 18-argon-40, 36-krypton-84), specified in the modern periodic table (see table).

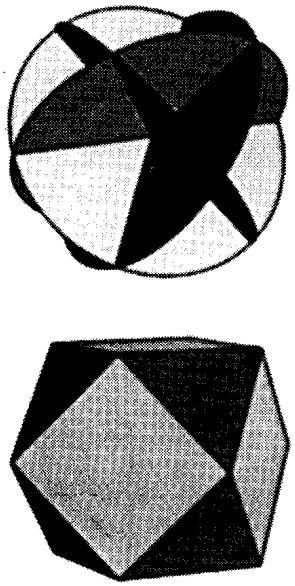


Figure 6
THE FOUR 'CURRENT RING' CONFIGURATION
Consider the four hoops pictured as four current-carrying loops. Their magnetic poles would point to the centers of the eight triangles formed by the intersection of the hoops. These correspond to the eight vertices of a cube.

This suggested, for the first time, a relationship between the ordering of the nucleus and that of the electron shells. However, I could not see the cause for a relationship between the supposedly neutral neutrons, and the extranuclear electrons. The difficulty suggests some error of assumption, which must be contained in the oversimplification provided by the Rutherford-Bohr model.

Recently, I began to re-examine this problem. I was now aided by the intensive study of the Ampère-Gauss-Weber electrodynamics I had since carried out. The following are speculations I have examined in pursuit of this still unfinished task.

1.1 PROTONS CONSIDERED AS AMPERE MAGNETIC MOLECULES

In 1821, André-Marie Ampère adopted the hypothesis, suggested by his friend and colleague Augustin Fresnel, that there existed within matter, tiny circular loops of electrical current, which, like the macroscopic ones he had studied, acted like magnets. If the current loop were thought of as the "equator" of an imaginary sphere, the north and south poles of the sphere would be the north and south poles of the magnet which the current loop produced. Ampère supposed that magnetization of a piece of iron consisted of alignment of these "magnetic molecules" in parallel columns, so as to magnify their effect.

I wondered what would result if we considered the Moon nucleus as constructed of magnetic molecules of positive charge, each one representing a proton. I supposed that each proton consisted of a tiny ring of electrical current. If one arranges four hoops into the configuration which produces the 12 vertices of a cuboctahedron at the intersection points of the hoops (Figure 6), it is seen that the poles of the four hoops (taken as "equators") point to the 8 spherical triangles produced by the configuration. The centers of these 8 triangles correspond to the 8 vertices of a cube. The "magnets" thus lie along the four axes which connect the 4 pairs of diagonally opposite vertices of a cube.

The cube is thus magnetically "polarized." Can the magnetic poles find a stable position in this configuration? By proper choice of polarities, it will be seen that they can. We will first examine this stability, and then turn to the question of what we mean by the magnetic poles. In the original Moon model, the protons are represented as singularities at the vertices of the various solids. In the variation under investigation here, the protons are rings of current, while the vertices of the solids are now magnetic poles produced by them. Let us turn, first, to the possibility of stable arrangements.

Consider a perspective cube drawn on a sheet of paper. On the top face, assign north poles to two diagonally opposite vertices (that is, along the diagonals of a face), and south poles to the other pair (Figure 7). The vertices which lie diagonally opposite these (that is, along the long diagonals which pass through the cube) must have the opposite magnetic polarity. Consider any vertex bearing a south polarity. It will be seen that its three nearest neigh-

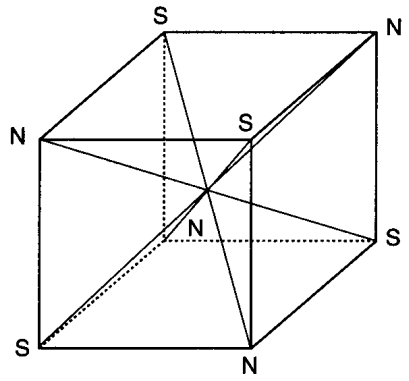


Figure 7
FORMATION OF DIPOLES
Dipoles formed by long diagonals on a cube create stability at each vertex.

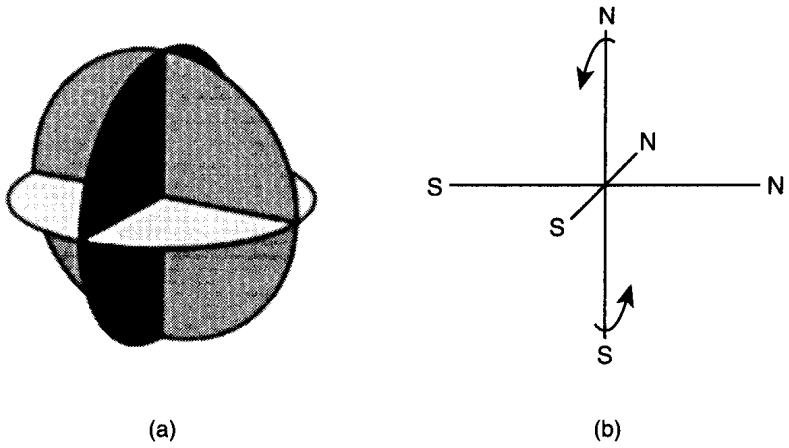


Figure 8
INSTABILITY OF OCTAHEDRAL MAGNETIC DIPOLES
Three circular loops (a) in which the poles point to the six vertices of the octahedron. The magnetic dipoles in this configuration (b) must be unstable; for example, the north pole at top experiences rotational moment.

bors (distant by the length of an edge) all carry a north polarity, while its three more distant neighbors (distant by the length of a face diagonal) carry the south polarity.

Now, consider the diagonally opposite vertex (that is, the one along the long diagonal that passes through the cube). It is a north pole, while its nearest neighbors are south, and its more distant neighbors are north. The attractions and repulsions in opposing directions being equal and mutually opposite, it is seen that the magnetic dipole we have examined will have no moment of rotation. The same holds for the other three magnetic dipoles which connect the remaining vertices of the cube.

Thus, a set of four insulated, circular loops of copper wire, constrained so as to remain around a common center, and electrified, would find a steady state in the mooted configuration, or even be induced to take up such a configuration. I have thought of building such a model using slotted hoops as forms for the circular wire loops.

Stability of Octahedron

Now turn to the octahedron. The configuration is simpler. It can be constructed from three rings, placed in three mutually orthogonal directions (Figure 8a). In this case, the six vertices produced by the intersections, correspond to the six poles produced by the three magnetic molecules. The "magnets" may thus be represented by a drawing of three mutually orthogonal axes (Figure 8b). It is readily seen that no arrangement, in which north and south poles are opposite each other, will produce a stable configuration; rather a rotational moment will always be imparted to the magnets.

Such would be the end of any attempt at a linear modelling, one derived merely from properties of the solids taken one at a time. However, the nesting of the solids in Moon's nucleus, produces a multiple connectivity that now makes the octahedron possible. To see it, we must now superimpose upon the drawing of the perspective cube, the six poles of the octahedron, one standing above the center of each face of the cube (Figure 9). It is now seen that, in relationship to the nearest underlying face of the cube, the pole of the octahedron, whether north or south, is balanced, being mutually attracted in two opposite directions, and mutually repelled in another pair of opposite directions perpendicular to the first.

Thus, when we consider the poles of the octahedron, by themselves, they are unstable. However, when the octahedron is circumscribing the cube, we see that any given octahedral pole is considerably closer to the corners of the underlying cube than to the nearest adjacent pole of the octahedron. Since the force of a single magnetic pole upon another, falls off as the square of the distance, it will be seen that the effect of the nearer cubic poles is three times as great as that of the adjacent octahedral ones.

(If the length of the edge of the cube is taken as 1, the edge of the circumscribing octahedron is $3/\sqrt{2}$. The distance of the octahedral pole to the nearest cubic one is 2/3 the altitude of the face triangle of the octahedron, or $\sqrt{6}/2$.

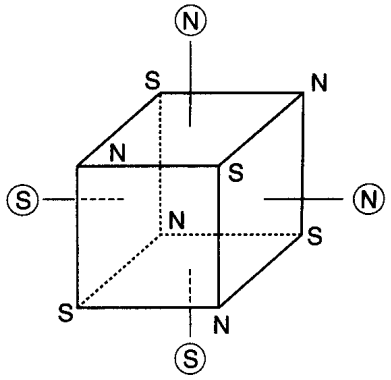


Figure 9
OCTAHEDRAL VERTICES INSIDE A CUBE
The octahedral vertices (circled) standing above the face centers of a cube, are stable with respect to the magnetic polarity of cube vertices

Hence, the ratio of the squares of the distance from the nearest cubic vertex to the nearest octahedral vertex stands as 1:3).

Thus, three Ampère magnetic molecules in octahedral formation would possess a considerable stability, when circumscribing the arrangement of four magnetic molecules in the configuration that produces poles at the eight vertices of a cube. They would not possess such stability when not in the nested ordering. This also would suggest why the cube must precede the octahedron in the Moon configuration.

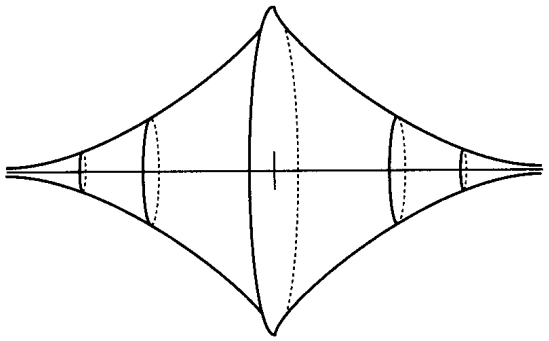
Progression to 5-Fold Symmetries

Let us next consider the circumscribing icosahedron and dodecahedron as a group. To move from the octahedron to icosahedron, the nested model must pass through a singularity, the same one examined in Johannes Kepler's famous "Six-Cornered Snowflake," that is the transition from the six-fold to five-fold symmetry. In Moon's configuration, the six vertices of the octahedron are placed along the altitude lines of 6 of the 20 triangular faces of the icosahedron, at a distance defined by the golden section.

In my recent consideration of protons as Ampère current loops, I chose to make a variation on this. My arrangement is built around the long-range relationship between the inner cube and the outer dodecahedron. The cube in my configuration, is oriented so as to align itself with one of the five possible cubes whose 12 edges can be inscribed within the 12 faces of the dodecahedron. In that case, the cube's vertices align with 8 of the 20 dodecahedral vertices, and the latter are designated a polarity such that the relationship to the nearest underlying cubic vertex is attractive.

This arrangement of the cube determines that the octahedron, unlike in Moon's arrangement, is fitted such that its 6 vertices sit at the midpoints of 6 of the 30 edges of the icosahedron. It will then be seen that the polarities can be assigned, such that each of the 6 octahedral vertices are held in place by 4 nearby vertices of opposing polarity, two of these are the nearest adjacent vertices of the icosahedron, and two are the nearest adjacent vertices of the dodecahedron, which lie on an axis perpendicular to the just-mentioned icosahedral pair. (A three-dimensional model makes this very clear).

Figure 10
MAGNETIC STRENGTH AROUND A WEBER 'MOLECULAR AGGREGATE'



The circles represent the magnetic strength around Weber's "molecular aggregate" of two protons, and form a double, exponential, pseudophere-like solid of rotation.

In such a fashion, the completed structure of four nested solids achieves a stability, based on the multiple connectivity of magnetic pole relationships ranging from inner cube to outer dodecahedron, which each of the figures by themselves (the cube excepted), would not possess. The criterion of stability rests entirely upon two features: the hypothesis of the magnetic molecule first asserted by Ampère, and the geometric properties inherent in the structure. It will be seen however, that despite this pretty stability, more problems arise in considering such a structure as a model for the nucleus.

1.1a The Problem of Doubling

On the assumption that each of the above described rings corresponds to a single charged particle, the entire construction so far results in only half the necessary charges. As the relative abundancies and many other properties indicate, nature favors the even-numbered elements. The fact that the nuclear dipole and quadrupole moments measure zero for all even-numbered elements, has suggested that there is a pairing of charges in the nucleus.

It is easy to imagine each of the current rings we have constructed as pairing, with one rotating in the opposite sense to the other, thus eliminating the magnetic polarity of every other element. However, such a solution would eliminate the original basis for the construction, which was to provide a reason, in the laws of electrodynamics, for the nested arrangement of the Moon model.

One might overcome this drawback simply by supposing that each ring is capable of carrying two charges rotating in the same direction, thus doubling its magnetic strength. However, in such a case the even-numbered elements would no longer be magnetically neutral. I have not given up this possibility, because the cause of the measured nuclear dipole magnetic moment may not correspond with the magnetism that results from this putative variation on the Moon model. However, in the course of contemplating the problem, another variation occurred to me, which I will now describe.

1.2 PROTONS CONSIDERED AS OSCILLATING WEBER PAIRS

Wilhelm Weber's "Sixth Memoir of 1871"[4] is, in part, a response to an ideologically based criticism by Hermann Helmholtz, charging that Weber's Fundamental Law of Electrical Force violates the principle of conservation of energy. Weber's reply was so thorough and devastating that James Clerk Maxwell was forced to withdraw his earlier support for Helmholtz on this matter. But the piece is far more than a refutation of Helmholtz's insistent carping. It is one of the few truly revolutionary documents of theoretical physics. In the course of development of the "Memoir," Weber derives from his Fundamental Law of Electrical Force a *critical length,* below which the repulsion of like particles is reversed. The so-called "Coulomb barrier" is overcome, and the particles, rather than repelling each other, experience an attraction.

In exploring the possibilities of motion of electrical particles as a consequence of this law, Weber recognizes two cases in which *molecular states of aggregation* of particle pairs may lawfully occur. In one such state, two particles of unlike charge may rotate around one another. Supposing, as he does, that one of the charged particles is considerably heavier than the other, the representation corresponds to the view of the hydrogen atom, not generally accepted until half a century later (and based on far less firm foundation). Weber describes this state of aggregation of two dissimilarly charged particles as representing an *Ampèrian molecular current.*

This conception forms the basis for his attempt to construct the periodic table on the basis of the laws of electrodynamics as hinted at in the "Sixth Memoir," (Section 16. Applicability to Chemical Atomic Groups), and later developed in his last memoir *Determinations of Electrodynamic Measure: particularly in respect to the Connection of the Fundamental Laws of Electricity with the Law of Gravitation.*[5]

There also exists a second molecular state of aggregation, according to Weber. In this case, two *like* particles will form an oscillating pair, containing themselves within the bounds of the critical minimal length. According to Weber's derivation, the two particles, starting from a distance of separation just below the critical length, accelerate towards each other on a straight line, pass one another at a maximal velocity, then decelerate to zero velocity as they reach the boundary point of the critical minimal length, at which point the process repeats itself. (It seems necessary that the two material particles literally pass through one another, a difficulty which is overcome by use of Louis deBroglie's conception of particle-wave.)

1.3 APPLICATION TO THE MOON MODEL

I have imagined this latter derivation of Weber's to be the state of aggregation of proton pairs, whose straight-line trajectories are aligned along the diagonal axes of the nested Platonic solids of the Moon nuclear model. Thus, the oscillating pairs orient in the same direction as the magnetic dipoles of the previously examined hypothesis. In this case, the orientation of the pairs would not appear to be guided by the least-action configurations of magnetic poles which we constructed in the first case. One would rather have to assume that the arrangement expresses an underlying spatial geometry, or results from some other cause not yet adduced.

We may also briefly consider the trajectory of an extra-nuclear electron guided by a Weber pair of oscillating protons. A moving charge produces a magnetic effect in the shape of a circle in a plane perpendicular to the direction of its motion. The strength of the magnetic effect is proportional to the velocity of the charge. Let us picture the magnetic effect by allowing the radius of a surrounding circle to designate its strength at that point in the charge's trajectory.

In the Weber molecular aggregate, the two charges are accelerating towards the centerpoint where they meet. Thus, an axial cross-section of the surrounding circles would show an exponential curve increasing from both ends towards the center (Figure 10). It would look much like an axial slice of a pseudosphere. An extranuclear electron moving in this field would tend to circle the axis of the proton pair, and at the same time be carried along the axis by the motion of the proton, the resultant being a spiral path. One would expect that an electron pair would follow opposing spiral trajectories around this pseudosphere-like object, guided by the frequency of oscillation of the paired protons.

The motion of the electron, itself a charged particle, along this trajectory would now produce a magnetic dipole aligned with the axis of the proton pair. That weaker dipole, created as an effect of the motion of the extra-nuclear electron, would have precisely the same alignment as that produced under the first conception (of the Ampère magnetic molecule) and might thus be thought of as providing the structure to the nucleus.

Yet, the continued stability of the nucleus under condition of being stripped of the extra-nuclear charge (ionization) casts doubt on such a construction. It were possible, however, to imagine the just-described trajectories as being those of the nuclear electrons. While these are now usually conceived as bound with a positive charge into a small sphere (the neutron), it were possible to explore other, more probable configurations. The strict, but as yet unexplained, determination of the isotope variations by addition of neutrons, suggests that the neutron must be a *necessary* part of the nuclear structure, not an arbitrary addition. Such explorations remain to be carried out.

Notes

1. Laurence Hecht, "The Geometric Basis for the Periodicity of the Elements," *21st Century,* May-June 1988, p. 18.
   Interview with Dr. Robert J. Moon (in two parts), *Executive Intelligence Review,* Oct. 30, 1987, p.31 and Nov. 6, 1987, p. 18.
2. William D. Harkins and R.E. Hall, "The Periodic System and the Properties of the Elements," *J. Amer. Chem. Soc.*, Vol. 38, No. 2 (Feb. 1916), p. 169.
3. Hecht, *op. cit.*, pp. 25ff.
4. In English as, "Electrodynamic Measurements—Sixth Memoir, relating specially to the Principle of Conservation of Energy," *Philosophical Magazine,* S.4. Vol. 43 No. 283, Jan. 1872.
5. Unpublished English translation by George Gregory in *21st Century* archive.