Why the Orbits Are Discrete: Quantization as Winding, and the Harmonic Towers of the Weak Fiber

Martin Scholl — Independent Researcher

It Is All One — Notes. July 2026 (readable edition)

Abstract. Why does an electron in an atom occupy only certain orbits, with nothing permitted in between? This note's answer is one sentence: because the state lives in a wound space, and a rotation in a wound space must come home. Single-valuedness — the requirement that a state, carried once around, return to itself — is the whole of quantization; everything discrete in quantum mechanics is a winding number. The note walks that theorem through its three appearances (the rolled-up circle, the atomic orbit, the quaternion sphere), shows that the very existence of electrons proves the wound space is the double cover (measured in the laboratory since 1975), computes the exact vibration catalogue of the weak fiber — every note it could sound, each a predicted mass — and reports honestly what the measured spectrum says back: the naive tower is excluded, which is itself information, and one strange near-miss (the fiber's lowest note sits 3.7 percent from the Higgs boson) is recorded as a curiosity that will either mean something or die in public. Every symbol is introduced before use.

1. The Answer Is a Theorem: Closure Quantizes

In open, endless space, every frequency is allowed — a wave can have any wavelength it likes. On a *closed* path, only the motions that bite their own tail survive: a wave running around a circle must, after one full circuit, rejoin itself crest-to-crest, or it cancels itself out. That single requirement — called single-valuedness — is the entire origin of the discreteness of quantum mechanics. It already runs the subject under three names:

On a rolled-up circle of radius R: a wave fits only if a whole number n of its wavelengths closes the loop, forcing the allowed momenta to the discrete ladder $p = n \cdot \hbar / R$ (ħ as always the quantum of action). In the trade this ladder is called a Kaluza–Klein tower.

Around an atomic orbit: the electron's internal phase — the W-circle of this series, its imaginary-time clock — must close: a whole number of wavelengths around the circumference, $n \cdot \lambda = 2\pi \cdot r$. That is Bohr's original 1913 quantization rule, here recognized for what it is: a winding condition. An orbit is allowed exactly when the state quaternion returns to itself after one circuit. Count the windings — n = 1, 2, 3, … — and the entire hydrogen spectrum follows: $E = -13.606/n^2$ electron-volts, every line of it. The discrete orbits of chemistry are the closed paths of the phase.

On the quaternion sphere S^3 — the weak fiber itself: the allowed motions are the harmonics of the sphere, and that is where the catalogue of particle spins comes from (next section).

One sentence answers the title: **everything discrete in quantum mechanics is a winding number.** Our three-dimensional world, as the projection of the quaternion space, shows us only the rotations that close — and shows their frequencies as energies, $E = \hbar\omega$, level by level.

2. The Catalogue: Spins Are the Harmonics of the Wound Sphere

A drum's possible tones are set by its shape. The quaternion sphere's possible tones are known exactly (the Peter–Weyl theorem): they are labeled by spin $j = 0, ½, 1, 3/2, \ldots$ — every value nature uses, integer *and half-integer*. And the half-integers exist only because the fiber is the full sphere S^3 — the double cover, where a turn of 720° and not 360° brings you home — rather than its halved quotient. **If nature had wound the halved sphere, no fermions could exist: no electrons, no atoms, no chemistry, no us.** Every fermion in existence is therefore an observational proof of which space is wound.

And the double cover is not an interpretation — it has been measured directly. In 1975, neutron interferometry experiments (Rauch; Werner) rotated a neutron through 360° and watched its wavefunction change *sign*, returning to itself only after 720°. The 4π periodicity of the spinor — the receipt that our world is the shadow of a quaternionic one — has been in the laboratory record for fifty years.

3. The Calculation: the Harmonic Towers of the Weak Fiber

If the weak fiber is a geometric sphere of radius $R_f = \hbar/(m_W \cdot c)$ — the 2.5 attometres of the Metrics note — then its full tone catalogue is computable exactly, and each tone is a predicted particle mass. Two towers emerge (Figure 1): the *scalar* tower (ordinary vibrations), at $m_W \cdot c^2$ times $\sqrt{n(n+2)}$: 139.2, 227.3, 311.3, 393.8 … GeV; and the *Dirac* tower (spinor vibrations), at $m_W \cdot c^2$ times $(3/2 + k)$: 120.6, 200.9, 281.3, 361.7 … GeV.

Two honest readings, in order of discipline.

The exclusion reading. Colliders have long since swept these energies, and no new weak-coupled particles sit at 139, 227 or 311 GeV. The naive free tower is therefore *excluded* — which is itself information, the same lesson as the Metrics note's two-fiber tension: the weak winding is not a bare geometric sphere; its higher tones are lifted, projected out, or hidden. The fiber is stiffer and more one-handed than bare geometry.

The curiosity reading, flagged at this series' standard for curiosities. The lowest spinor tone of the fiber is $(3/2) \cdot m_W \cdot c^2 = 120.6$ GeV. The measured Higgs boson sits at 125.25 GeV — a 3.7 percent match with no adjustable anything: the measured ratio $m_H/m_W = 1.5583$, against the pure number 3/2. If the Higgs were the ground tone of the wound quaternion sphere, the particle that gives the fiber its stiffness would itself be the fiber's lowest note — the stiffness problem and the Higgs problem collapsing into one geometric statement. Against it, sternly: the Higgs is a scalar, not a spinor — the identification would require the tone's spin to be carried by the fiber rather than by spacetime (not impossible for fiber harmonics, but undemonstrated); the match uses one particular convention for m_W; and Eddington's ghost patrols every corridor where pure numbers meet measured masses. Recorded as the curiosity it is: a number that either means something or will die in public.

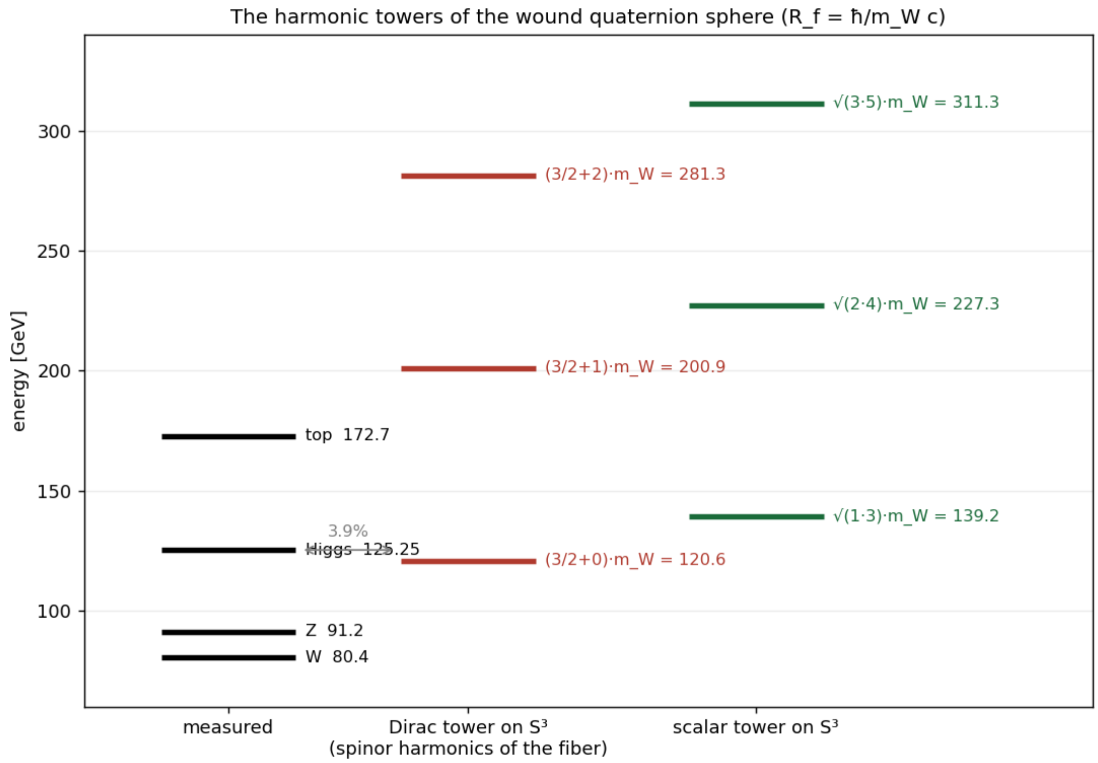

Figure 1. The harmonic towers of the wound quaternion sphere against the measured spectrum. The lowest Dirac tone sits just below the Higgs; the scalar tower is experimentally excluded as free states — the fiber is not bare geometry.

4. The Projection Dictionary

What observation sees is the three-dimensional shadow of quaternion rotation, and the dictionary is compact. The state turns at *half* the frequency of its shadow (the double cover in motion); what instruments measure — the sandwich $q \cdot v \cdot \bar{q}$ of Paper 1 — turns at the full frequency. Measured energies are the closed frequencies, $E = \hbar\omega$. Spin-½ objects are the ones whose shadow repeats before they do — the 720° citizens of Section 2. And a "discrete orbit" — atomic, nuclear, or fiber-borne — is nothing but a rotation whose quaternion comes home.

5. Open Problems

(i) What lifts the scalar tower — the stiffening mechanism, which is the Higgs/hierarchy question in fiber language; a one-handed (chiral) winding is the natural suspect and would simultaneously explain why the weak force touches only left-handed particles.

(ii) The 3/2 curiosity: derive it or bury it — a genuine fiber-tone account of the 125 GeV particle must explain the spin bookkeeping and survive the mass-convention distinction. (iii) The Z boson: $m_Z/m_W = 1.134$ is *not* a ratio of sphere harmonics; the mixing angle between the weak sphere and the electromagnetic circle remains outside the bare geometry — presumably the relative winding of the two fibers, uncomputed. (iv) Selection rules as winding arithmetic: transitions as changes of winding number, with the State Octonion paper's per-axis ledger as the bookkeeping — the natural next calculation of this thread.

References

H. Peter and H. Weyl, Math. Ann. 97, 737 (1927); N. Bohr (1913); T. Kaluza (1921), O. Klein (1926); H. Rauch et al., Phys. Lett. A 54, 425 (1975) and S. A. Werner et al., Phys. Rev. Lett. 35, 1053 (1975) — the 4π experiments; spectra of Laplace and Dirac operators on spheres (standard results, e.g. C. Bär 1996); Particle Data Group values of m_W, m_Z, m_H; and the papers and notes of this series (the State Quaternion, corrected; Matter Meets Space; the Metrics of the Living Spaces; the State Octonion). *(Citations from memory; the literature-verification pass applies.)*