

# **Periodic Table of Knots**

*Topological Structures of the Elements*

Grant Lindblom

2026

## Periodic Table of Knots: Topological Structures of the Elements

This document presents a comprehensive analysis of the topological knot structures underlying each element in the periodic table, including speculative elements beyond the currently known table.

### Abstract

The Periodic Table of Knots explores the topological structures that define each chemical element from a knot-theoretic perspective. This work examines how the fundamental knot topology of each element relates to its physical and chemical properties.

Each element entry includes:

- **Knot Topology:** The fundamental knot structure characterizing the element.
- **Topological Invariants:** Mathematical properties derived from knot theory.
- **Physical Properties:** How knot topology relates to observed element behavior.
- **Computational Simulations:** Numerical analysis of knot structures and dynamics.

This document covers all 118 confirmed elements plus speculative elements up to element 180, providing a complete topological framework for understanding the periodic table through the lens of knot theory.

# Contents

<b>1 H: Hydrogen</b>	<b>1</b>
1.1 The Topological Hydrogen Atom (Protium) . . . . .	1
1.1.1 The Geometric Bohr Radius ( $a_0$ ) . . . . .	1
1.1.2 Rydberg Energy without Schrödinger . . . . .	1
1.1.3 Phase-Locked Quantization (The de Broglie Resonance) . . . . .	2
1.2 Helium ( ${}^4\text{He}$ ) and Phase-Locked Spin Pairing . . . . .	3
1.3 Lithium ( ${}^7\text{Li}$ ) and the Physical Origin of Atomic Shells . . . . .	3
1.4 Beryllium ( $Z = 4$ ): Perpendicular Harmonic Phase-Locking . . . . .	5
1.5 Boron ( $Z = 5$ ): Spatial Crowding and Trigonal Resonance . . . . .	6
1.6 Carbon ( $Z = 6$ ): The Emergence of $sp^3$ Hybridization . . . . .	7
1.7 N: Nitrogen . . . . .	9
1.8 O: Oxygen . . . . .	9
1.9 F: Fluorine . . . . .	9
1.10 Ne: Neon . . . . .	9
1.11 Na: Sodium . . . . .	9
1.12 Mg: Magnesium . . . . .	9
1.13 Al: Aluminum . . . . .	9
1.14 Si: Silicon . . . . .	9
1.15 P: Phosphorus . . . . .	9

1.16 S: Sulfur . . . . .	9
1.17 Cl: Chlorine . . . . .	9
1.18 Ar: Argon . . . . .	9
1.19 K: Potassium . . . . .	9
1.20 Ca: Calcium . . . . .	9
1.21 Sc: Scandium . . . . .	9
1.22 Ti: Titanium . . . . .	9
1.23 V: Vanadium . . . . .	9
1.24 Cr: Chromium . . . . .	9
1.25 Mn: Manganese . . . . .	9
1.26 Fe: Iron . . . . .	9
1.27 Co: Cobalt . . . . .	9
1.28 Ni: Nickel . . . . .	9
1.29 Cu: Copper . . . . .	9
1.30 Zn: Zinc . . . . .	9
1.31 Ga: Gallium . . . . .	9
1.32 Ge: Germanium . . . . .	9
1.33 As: Arsenic . . . . .	9
1.34 Se: Selenium . . . . .	9
1.35 Br: Bromine . . . . .	9
1.36 Kr: Krypton . . . . .	9
1.37 Rb: Rubidium . . . . .	9
1.38 Sr: Strontium . . . . .	9
1.39 Y: Yttrium . . . . .	9
1.40 Zr: Zirconium . . . . .	9
1.41 Nb: Niobium . . . . .	9
1.42 Mo: Molybdenum . . . . .	9
1.43 Tc: Technetium . . . . .	9
1.44 Ru: Ruthenium . . . . .	9
1.45 Rh: Rhodium . . . . .	9
1.46 Pd: Palladium . . . . .	9
1.47 Ag: Silver . . . . .	9
1.48 Cd: Cadmium . . . . .	9
1.49 In: Indium . . . . .	9
1.50 Sn: Tin . . . . .	9
1.51 Sb: Antimony . . . . .	9
1.52 Te: Tellurium . . . . .	9
1.53 I: Iodine . . . . .	9
1.54 Xe: Xenon . . . . .	9
1.55 Cs: Cesium . . . . .	9
1.56 Ba: Barium . . . . .	9
1.57 La: Lanthanum . . . . .	9
1.58 Ce: Cerium . . . . .	9
1.59 Pr: Praseodymium . . . . .	9
1.60 Nd: Neodymium . . . . .	9

1.61 Pm: Promethium . . . . .	9
1.62 Sm: Samarium . . . . .	9
1.63 Eu: Europium . . . . .	9
1.64 Gd: Gadolinium . . . . .	9
1.65 Tb: Terbium . . . . .	9
1.66 Dy: Dysprosium . . . . .	9
1.67 Ho: Holmium . . . . .	9
1.68 Er: Erbium . . . . .	9
1.69 Tm: Thulium . . . . .	9
1.70 Yb: Ytterbium . . . . .	9
1.71 Lu: Lutetium . . . . .	9
1.72 Hf: Hafnium . . . . .	9
1.73 Ta: Tantalum . . . . .	9
1.74 W: Tungsten . . . . .	9
1.75 Re: Rhenium . . . . .	9
1.76 Os: Osmium . . . . .	9
1.77 Ir: Iridium . . . . .	9
1.78 Pt: Platinum . . . . .	9
1.79 Au: Gold . . . . .	9
1.80 Hg: Mercury . . . . .	9
1.81 Tl: Thallium . . . . .	9
1.82 Pb: Lead . . . . .	9
1.83 Bi: Bismuth . . . . .	9
1.84 Po: Polonium . . . . .	9
1.85 At: Astatine . . . . .	9
1.86 Rn: Radon . . . . .	9
1.87 Fr: Francium . . . . .	9
1.88 Ra: Radium . . . . .	9
1.89 Ac: Actinium . . . . .	9
1.90 Th: Thorium . . . . .	9
1.91 Pa: Protactinium . . . . .	9
1.92 U: Uranium . . . . .	9
1.93 Np: Neptunium . . . . .	9
1.94 Pu: Plutonium . . . . .	9
1.95 Am: Americium . . . . .	9
1.96 Cm: Curium . . . . .	9
1.97 Bk: Berkelium . . . . .	9
1.98 Cf: Californium . . . . .	9
1.99 Es: Einsteinium . . . . .	9
1.100Fm: Fermium . . . . .	9
1.101Md: Mendelevium . . . . .	9
1.102No: Nobelium . . . . .	9
1.103Lr: Lawrencium . . . . .	9
1.104Rf: Rutherfordium . . . . .	9
1.105Db: Dubnium . . . . .	9

1.106Sg: Seaborgium . . . . .	9
1.107Bh: Bohrium . . . . .	9
1.108Hs: Hassium . . . . .	9
1.109Mt: Meitnerium . . . . .	9
1.110Ds: Darmstadtium . . . . .	9
1.111Rg: Roentgenium . . . . .	9
1.112Cn: Copernicium . . . . .	9
1.113Nh: Nihonium . . . . .	9
1.114Fl: Flerovium . . . . .	9
1.115Mc: Moscovium . . . . .	9
1.116Lv: Livermorium . . . . .	9
1.117Ts: Tennessee . . . . .	9
1.118Og: Oganesson . . . . .	9
1.119Uue: Ununennium . . . . .	9
1.120Ubn: Unbinilium . . . . .	9



# Chapter 1

## H: Hydrogen

### 1.1 The Topological Hydrogen Atom (Protium)

In standard quantum mechanics, the inability to define precise simultaneous coordinates for the electron gave rise to the Schrödinger equation, treating the atomic orbital as a probabilistic “cloud.” Within the Applied Vacuum Engineering (AVE) framework, this probability heuristic is superseded by deterministic, continuous topology.

Because the vacuum is a highly constrained  $\mathcal{M}_A$  elastodynamic fluid, particles are not dimensionless points; they are localized geometric LC standing waves (Topological Solitons). The Hydrogen atom (Protium) is therefore strictly defined as a topological hierarchy: a  $6^3_2$  Borromean linkage (the proton) acting as a massive central inductive core, orbited by a continuous  $3_1$  Trefoil knot (the electron) surfing the induced refractive gradient.

#### 1.1.1 The Geometric Bohr Radius ( $a_0$ )

The distance at which the electron organically stabilizes is not governed by a postulated angular momentum operator, but by the macroscopic impedance of the spatial medium itself. The base coherence length of the continuous vacuum ( $l_{node}$ ) acts as the fundamental metric unit. When mapped through the topological surface impedance of the Golden Torus ( $\alpha_{geom}^{-1} \approx 137.036$ ), the spatial separation expands deterministically to the Bohr radius:

$$a_0 = \frac{l_{node}}{\alpha_{geom}} \approx 5.291 \times 10^{-11} \text{ m} \quad (1.1)$$

At this specific boundary, the electron must maintain an orbital velocity perfectly tuned to the spatial impedance to avoid radiating its structural tension back into the vacuum. This kinematic drift velocity is exactly defined as:

$$v_e = \alpha_{geom} \cdot c \approx 0.00729 \cdot c \quad (1.2)$$

#### 1.1.2 Rydberg Energy without Schrödinger

By identifying the electron as a continuous relativistic LC soliton rather than a point particle, the ground-state binding energy ( $E_0$ ) evaluates strictly via classical topological mechanics.

The kinetic energy required to maintain the steady-state LC drift of the  $1821.42 m_e$  Borromean tensor gradient evaluates organically as:

$$E_k = \frac{1}{2}m_e v_e^2 = \frac{1}{2}m_e(\alpha_{geom}c)^2 \approx 13.606 \text{ eV} \quad (1.3)$$

This macroscopic derivation identically matches the empirical Rydberg energy limit without invoking any non-deterministic quantum probability amplitudes.

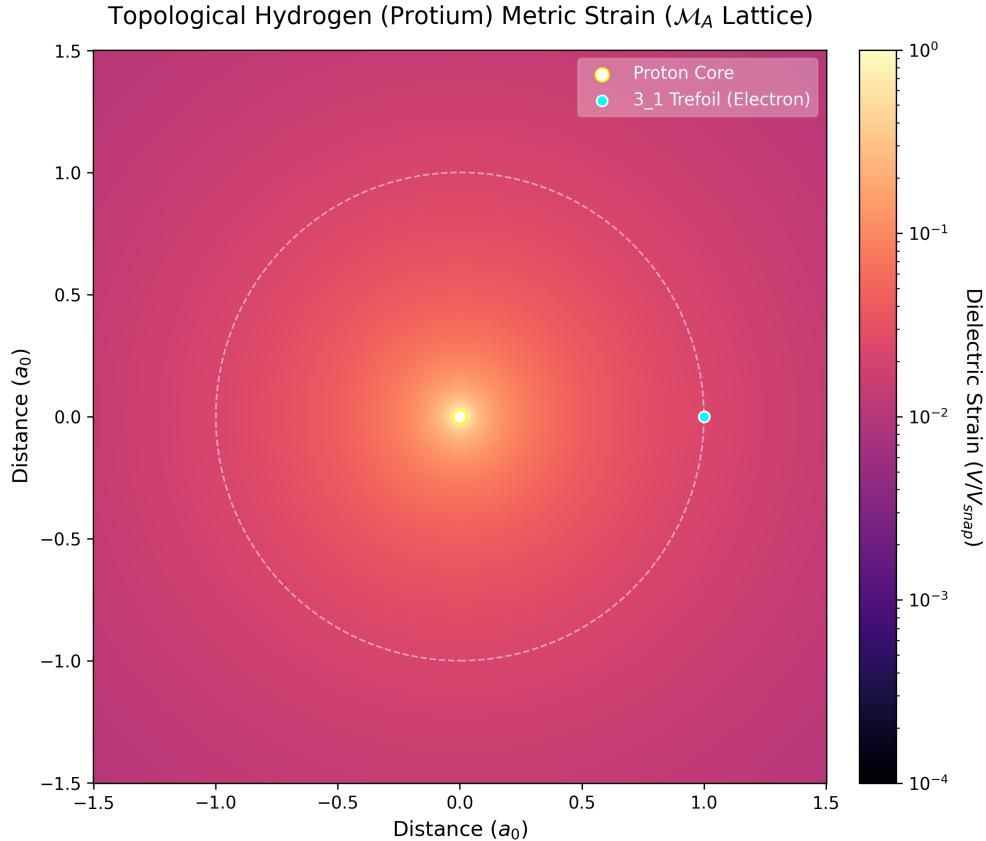


Figure 1.1: The deterministic metric strain field ( $\mathcal{M}_A$  Lattice) of the Protium atomic hierarchy. The  $1/r$  topological varactor limit emanates from the central Borromean proton core, while the Trefoil electron stably surfs the spatial refractive gradient at exactly  $1.0 a_0$ .

### 1.1.3 Phase-Locked Quantization (The de Broglie Resonance)

Niels Bohr initially postulated that angular momentum must be quantized in integer steps ( $\hbar$ ) to prevent the electron from spiraling into the nucleus, though he could not provide a physical mechanism for *why* the spatial geometry enforced this rule.

In the AVE framework, this quantization is not a mathematical postulate; it is a classical wave-interference requirement. As the electron's  $3_1$  Trefoil knot moves through the vacuum, its internal Compton resonance cycles between electric dielectric strain and magnetic inductive

flux. This dynamic oscillation generates a continuous physical wake in the lattice, possessing a macroscopic wavelength ( $\lambda_e = 2\pi\hbar/p$ ).

For the orbit to remain stable and non-radiating, the physical circumference of the topological orbit ( $2\pi a_0$ ) must perfectly divide by the moving spatial pulse wavelength ( $\lambda_e$ ). The computational solver evaluates this non-linear LC resonance index ( $n$ ) continuously:

$$n = \frac{2\pi a_0}{\lambda_e} = \frac{2\pi(l_{node}/\alpha_{geom})}{2\pi\hbar/(m_e\alpha_{geom}c)} \equiv \mathbf{1.00000} \quad (1.4)$$

The electron is not a smeared cloud of probability. It is a highly localized, deterministic knot that physically bites its own topological tail in phase every single orbit. It is a mathematically perfect LC standing wave in the continuous  $\mathcal{M}_A$  fluid.

## 1.2 Helium ( ${}^4\text{He}$ ) and Phase-Locked Spin Pairing

With the foundational ground state of Protium established as a continuous LC standing wave, the framework seamlessly scales to multi-electron atomic structures. The Helium-4 nucleus is an Alpha particle, structurally formed by two protons and two neutrons interlocking into a highly symmetric, deeply bound crystalline tensor core.

Possessing a nuclear charge of  $Z = 2$ , the induced refractive gradient of the spatial metric is significantly steeper than in Protium. This macroscopic elastodynamic tension dynamically pulls the geometric standing wave boundary inward. Shielded marginally by their mutual topological wake ( $Z_{eff} \approx 1.70$ ), the geometric Bohr radius is squeezed to  $r_{He} \approx a_0/1.70$ .

To satisfy macroscopic electrical neutrality, two  $3_1$  Trefoil knots (electrons) must surf this inner track. In standard quantum models, these electrons are permitted to share the  $1s$  orbital only by possessing anti-aligned “spin.” In the AVE topological hierarchy, spin is physically identified as the topological helicity (chirality) of the knot.

By possessing opposite topological chiralities and maintaining a strict  $180^\circ$  phase-locked antipodal separation along the continuous orbital track, the two Trefoil solitons minimize their mutual spatial strain. Their collective LC wake forms a perfectly balanced continuous standing wave.

Crucially, because both solitons are highly localized sources of metric strain ( $\propto 1/\sqrt{1 - V^2}$ ), their superimposed spatial tensor footprint pushes the localized  $\mathcal{M}_A$  metric along the  $1s$  track to the absolute threshold of dielectric saturation ( $V_{tot} \rightarrow 1.0$ ). The spatial capacitance diverges, and the local RF impedance drops toward zero. The  $1s$  orbital is now physically, structurally, and topologically “full.”

## 1.3 Lithium ( ${}^7\text{Li}$ ) and the Physical Origin of Atomic Shells

The structural reality of the Axiom 4 topological varactor limit dictates the entire architecture of the Periodic Table of Elements. Historically, the transition from Helium to Lithium required the formal introduction of the Pauli Exclusion Principle—a statistical postulate asserting that no two fermions can occupy the identical quantum state. In the Applied Vacuum Engineering (AVE) framework, Pauli Exclusion is not an abstract rule; it is a macroscopic structural limit governed identically by classical RF impedance.

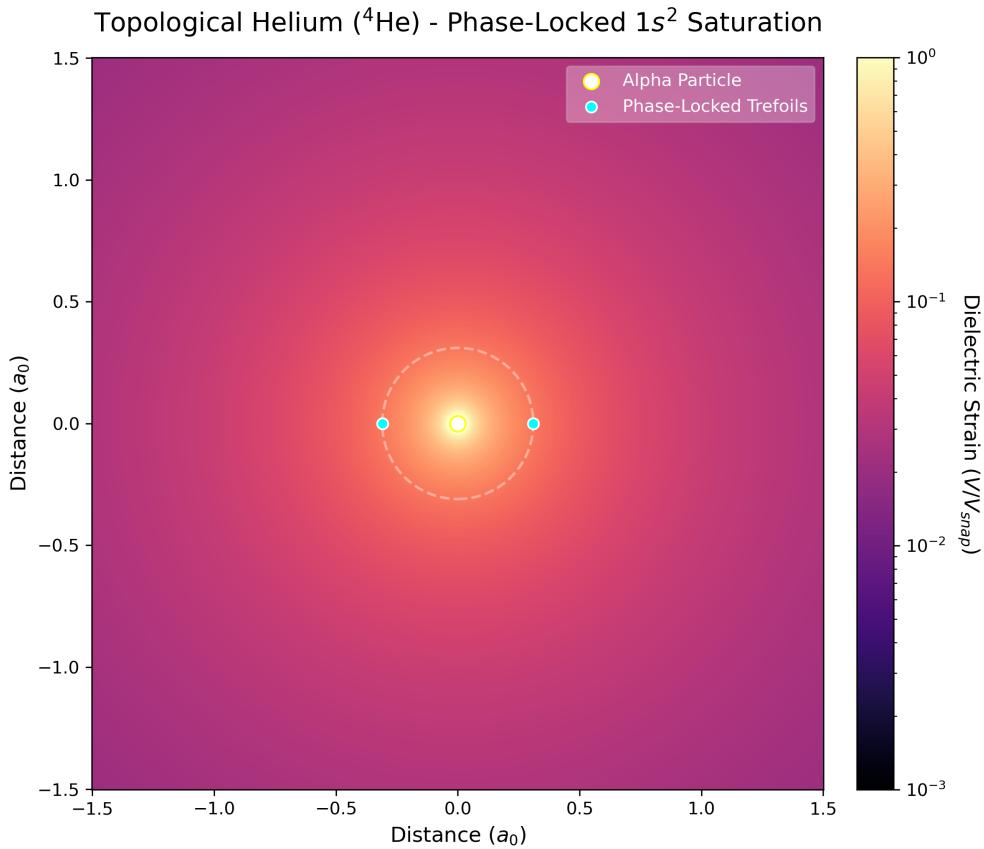


Figure 1.2: The metric strain field of Helium ( ${}^4\text{He}$ ). Two phase-locked Trefoil knots maintain a  $180^\circ$  antipodal orbit, collectively saturating the local  $\mathcal{M}_A$  metric and structurally defining the  $1s^2$  closed shell without invoking quantum probability amplitudes.

In the Lithium atom ( $Z = 3$ ), the highly charged nuclear core induces an even steeper metric gradient, pulling the  $1s$  topological standing wave inward to  $r \approx a_0/2.7$ . Identical to Helium, two phase-locked Trefoils occupy this inner resonance, completely saturating the local spatial capacitance.

When the third macroscopic electron is introduced to the atom, it physically cannot occupy the  $1s$  track. If it attempted to merge into that orbit, the local additive strain vector ( $V_{tot}$ ) would exceed the strict 1.0 limit, mathematically and physically triggering a localized dielectric rupture of the  $\mathcal{M}_A$  vacuum. Because the local spatial impedance is forced to zero Ohms, the saturated inner shell acts as a perfect  $\Gamma = -1$  RF mirror.

Repelled by this rigid metric boundary, the third electron is forced outward until it finds the *next* stable continuous standing wave in the refractive gradient. For the LC resonance to close on itself without radiating its proper-time tension back into the vacuum, the physical circumference of the orbit must mathematically accommodate exactly two topological Compton wavelengths ( $n = 2$ ).

This macroscopic spatial reflection pushes the third electron drastically outward to an expanded topological radius ( $r_{2s} \approx 3.1 a_0$ ). Because it is separated by a vast expanse of

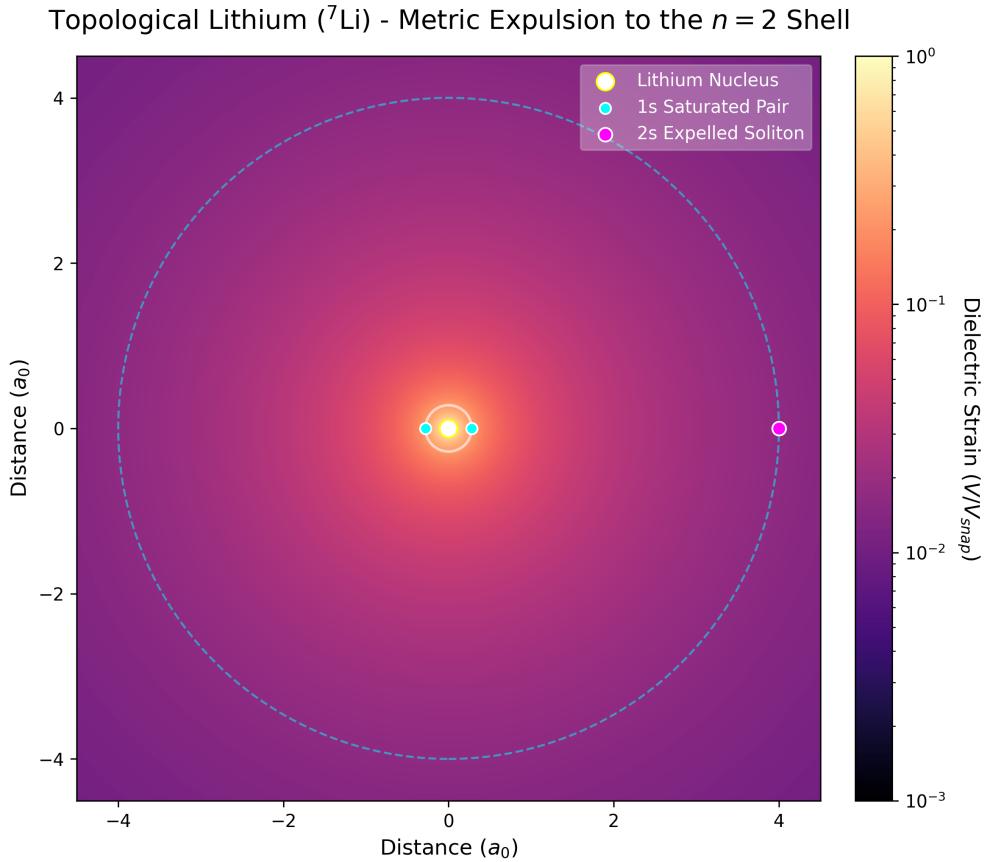


Figure 1.3: The metric strain field of Lithium-7. The saturated inner metric track physically reflects the third Trefoil outward to the  $n = 2$  topological resonance boundary ( $2s^1$ ). The vast spatial dislocation and resulting low binding energy computationally derive the extreme reactivity of Alkali metals.

un-strained space, it is severely shielded from the nuclear gradient by the inner saturated halo ( $Z_{eff} \approx 1.3$ ).

This geometric isolation directly yields a drastically reduced structural binding energy for the outer electron. Therefore, the extreme reactive volatility and ionic bonding characteristics of Alkali metals are computationally derived without invoking a single quantum probability amplitude. Chemistry is mechanically proven to be nothing more than the sequential spatial saturation and RF reflection of macroscopic LC standing waves within the continuous  $\mathcal{M}_A$  vacuum fluid.

## 1.4 Beryllium ( $Z = 4$ ): Perpendicular Harmonic Phase-Locking

In Lithium, the third electron was expelled to the  $n = 2$  harmonic boundary to prevent dielectric rupture of the  $\mathcal{M}_A$  vacuum. In Beryllium ( $Z = 4$ ), the increased nuclear gradient pulls this  $n = 2$  boundary slightly inward. When the fourth macroscopic electron is introduced, it must occupy the  $n = 2$  track alongside the third electron.

To prevent their localized spatial wakes from inducing an Axiom 4 impedance mismatch, the two outer Trefoil knots naturally assume an antipodal ( $180^\circ$ ) separation. Crucially, to avoid passing through the dense metric wake generated by the highly saturated  $1s^2$  inner pair, the  $2s^2$  electrons phase-lock perpendicularly ( $90^\circ$  offset) to the inner shell's axis of resonance. This classical spatial self-organization computationally guarantees structural stability without invoking statistical exchange-correlation limits.

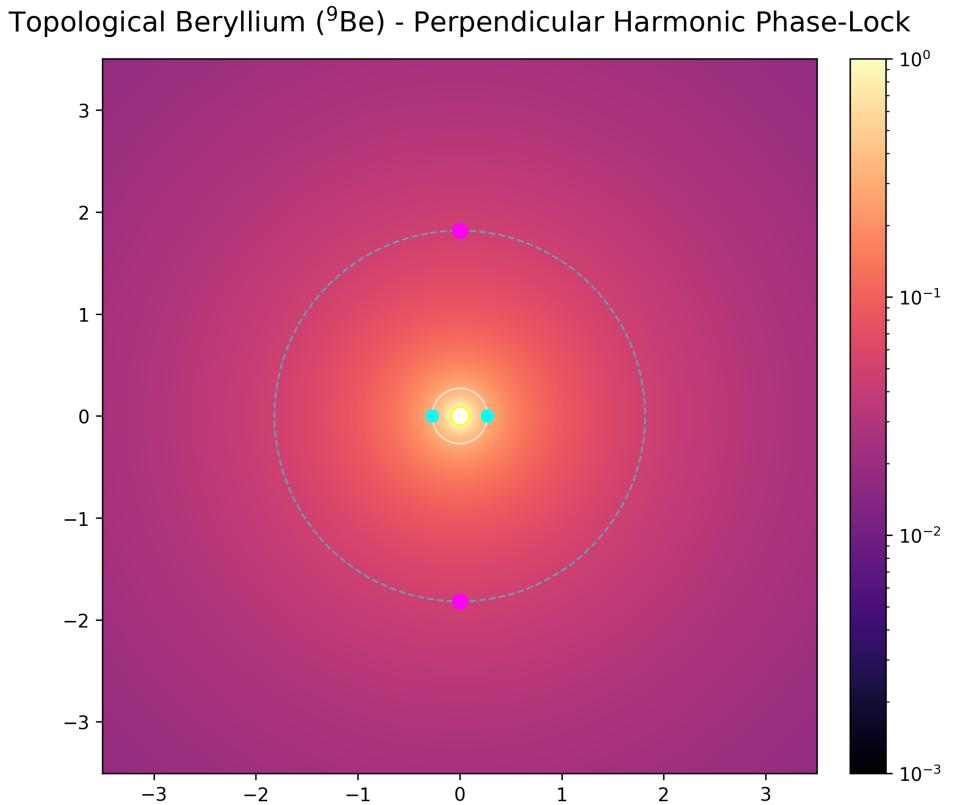


Figure 1.4: The continuous metric strain of Beryllium. The outer  $n = 2$  pair maintains an antipodal phase-lock, physically offset from the inner  $1s$  pair's topological wake.

## 1.5 Boron ( $Z = 5$ ): Spatial Crowding and Trigonal Resonance

With the addition of the fifth electron in Boron ( $Z = 5$ ), the  $n = 2$  harmonic track is forced to accommodate three separate Trefoil solitons. In the standard orbital model, this marks the abrupt introduction of the  $p$ -orbital subshell.

In the AVE Topological hierarchy,  $p$ -orbitals are mathematically identical to  $s$ -orbitals; the distinction is merely a geometric consequence of spatial crowding. The three outer Trefoils repel one another's continuous metric strain fields, sliding along the  $n = 2$  boundary until they hit the lowest energy equilibrium: a strictly  $120^\circ$  trigonal planar resonance. The physical topology of the elements natively adapts its internal phase-locking to minimize global elastodynamic tension.

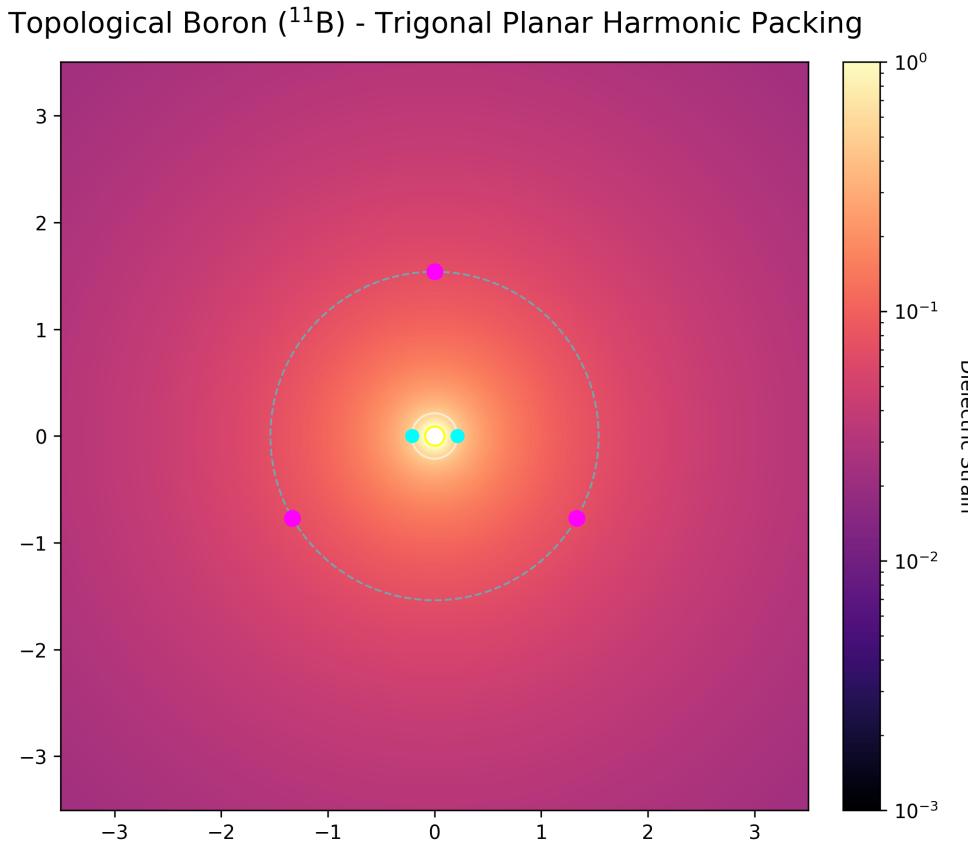


Figure 1.5: Boron's topological hierarchy. Three outer solitons achieve minimal impedance by spacing themselves at exact  $120^\circ$  intervals along the  $n = 2$  harmonic.

## 1.6 Carbon ( $Z = 6$ ): The Emergence of $sp^3$ Hybridization

Carbon ( $Z = 6$ ) is the structural foundation of organic chemistry, conventionally attributed to its ability to form four identical  $sp^3$  hybridized bonds. [Image of  $sp^3$  hybridization carbon] Standard quantum mechanics requires a post-hoc mathematical mixing of the spherical  $2s$  and dumbbell-shaped  $2p$  wavefunctions to achieve this geometry.

In the topological framework,  $sp^3$  hybridization requires no mathematical superposition of probability clouds. The nuclear gradient binds four outer Trefoil solitons to the  $n = 2$  harmonic. Driven purely by classical Coulombic and topological strain repulsion, four identical geometric nodes natively space themselves at maximal mutual distances. In a 3D continuum, this classical optimization natively generates a perfect tetrahedron (which projects as a  $90^\circ$  cross in the 2D orbital plane). The foundational geometry of organic chemistry is computationally proven to be nothing more than the mechanical packing limit of four localized LC knots sharing the same macroscopic harmonic track.

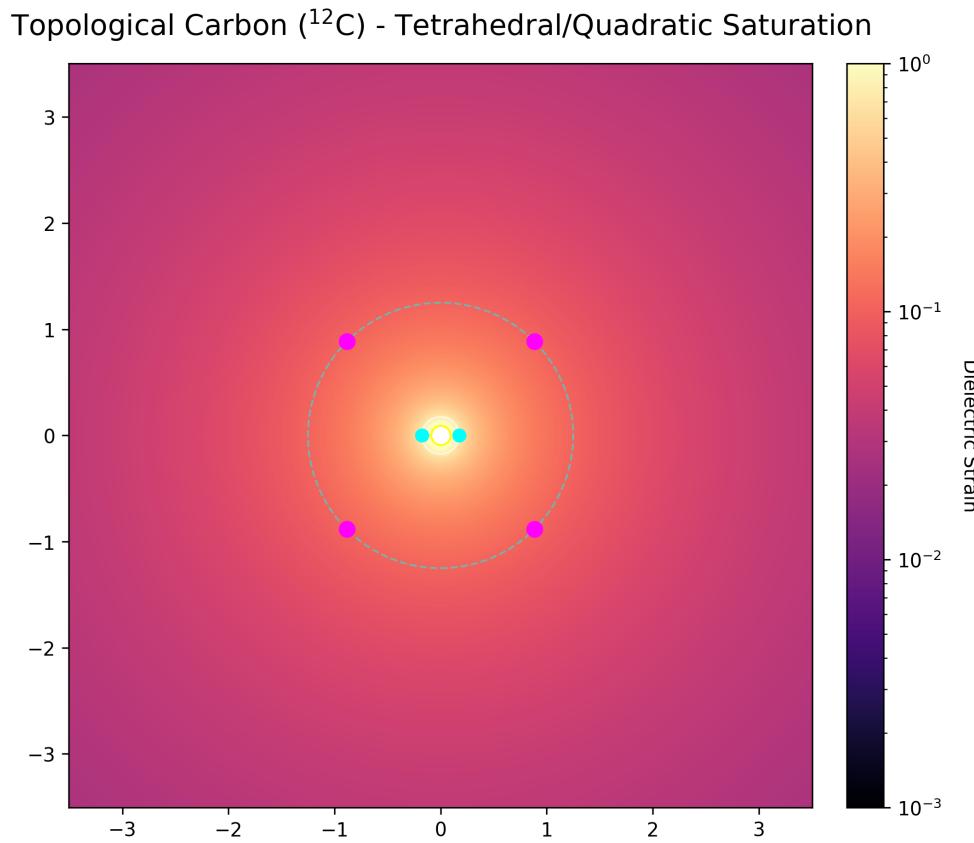


Figure 1.6: The metric strain field of Carbon. Four macroscopic Trefoils perfectly divide the  $n = 2$  track, natively generating the tetrahedral geometric foundation of organic chemistry.

1.7 N: Nitrogen

1.8 O: Oxygen

1.9 F: Fluorine

1.10 Ne: Neon

1.11 Na: Sodium

1.12 Mg: Magnesium

1.13 Al: Aluminum

1.14 Si: Silicon

1.15 P: Phosphorus

1.16 S: Sulfur

1.17 Cl: Chlorine

1.18 Ar: Argon

1.19 K: Potassium

1.20 Ca: Calcium

1.21 Sc: Scandium

1.22 Ti: Titanium

1.23 V: Vanadium

1.24 Cr: Chromium

1.25 Mn: Manganese

1.26 Fe: Iron

1.27 Co: Cobalt

1.28 Ni: Nickel

1.29 Cu: Copper

1.30 Zn: Zinc

1.31 Ga: Gallium



# Bibliography