

What the Lectures Leave Out

One Rule, Three States, and an Open Problem Set from the Vacuum.Net Theory

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1. Why this text exists

A physics curriculum teaches the vacuum as a background. It is a stage with fixed constants on which fields and particles act. A mathematics curriculum teaches modular arithmetic, random walks and coupled oscillators as separate chapters. They come with separate exams.

The Vacuum.Net theory starts elsewhere. It treats the vacuum as the only thing there is. Everything else is a pattern in it that closes on itself. It uses one rule and three states. The mathematics students already know returns there as one picture, not three chapters.

This text gives that picture in a few pages. It then lists the open problems. They are real problems, not exercises. Nobody has solved them.

2. The picture: a fishnet under tension

Think of a fishnet under tension. A single strand crosses itself. Where it crosses there is a knot point. Between knot points lie the meshes.

At each crossing the strand goes over, goes under, or does not cross. Write these states as +1, -1 and 0. One such state is a trit. The register is balanced ternary.

Five starting rules carry the theory:

- **N1.** There is one strand.
- **N2.** Only what closes persists.
- **N3.** A closed configuration carries memory.
- **N4.** The response of the medium is a state function. Constants are not fixed numbers. They depend on the state of the net.
- **N5.** Each step deeper multiplies the states by three.

N4 is the point no lecture makes. In the standard frame, c , h and the coupling constants are given. In the net, they are readings of a state. A constant that looks fixed is a state that does not change on the scale where it is measured.

3. The closure rule is a rule you already know

Take three crossings in a row. This is a window. A window closes when its trits sum to a multiple of three.

Count the windows. There are $3 \times 3 \times 3 = 27$. Exactly 9 close. **Computed.**

The 9 come in two kinds:

- 3 uniform windows: (+1, +1, +1), (0, 0, 0), (-1, -1, -1);
- 6 mixed windows: the six orders of (-1, 0, +1).

In $\mathbb{Z}_3$, three elements sum to zero exactly when they are all equal or all different. **Proved;** checked here over all 27 cases.

Mathematics students in Delft know this rule from the card game SET. A SET is three cards that are, on every attribute, all equal or all different. In $\mathbb{Z}_3^n$ this is three vectors with sum zero: an affine line. The cap-set problem asks how many cards can lie on the table with no SET among them. Its best upper bound uses the polynomial method over $\mathbb{F}_3^n$.

So the closure rule of the net is the SET rule in one attribute. The two kinds behave differently in the net:

- A **uniform** closure holds and does not turn. It is the form of a crystal.
- A **mixed** closure keeps turning while it stays closed. It is the form of living matter.

Where a uniform stretch meets a mixed stretch, the window on the seam stays open. It carries tension.

What lectures leave out: that a combinatorial rule about cards can be read as a selection rule for what persists in a physical medium.

4. One act gives all three states

Give a single act the value +1 and repeat it in $\mathbb{Z}_3$:

- once: +1;
- twice: $1 + 1 = 2 \equiv -1$;
- three times: $1 + 1 + 1 \equiv 0$.

$\mathbb{Z}_3$ is cyclic and generated by one element. **Proved.** One act produces all three trit values. The mirror is not a second thing. It is the same act taken twice.

There are two roads to 0. An act meets its mirror: $+1 + (-1) = 0$. Or the same act goes round three times: $(+1, +1, +1)$. These are the two kinds of closure from section 3.

5. Why a one-dimensional strand stays bound

Let the movement from a point be random. Each step is +1, 0 or -1 with equal chance.

The chance of exact return after n steps behaves as $\sqrt{3} / (2\sqrt{\pi n})$. Each step has variance 2/3. The sum of these chances over all n diverges. So the walk returns to its start with certainty, and does so infinitely often.

Proved: Pólya, 1921.

In three dimensions the return probability is about 0.3405. **Source:** Watson, 1939.

In the net this has a direct reading. A movement along one line needs no force to stay bound to its point. That is N1, one strand, without an extra carrier. **Reading.**

Exact returns after 0, 1, 2, 3, ... steps are counted by the central trinomial coefficients 1, 1, 3, 7, 19, 51, 141, ... After three steps, 7 of the 27 strings return exactly. Counted modulo 3, 9 of 27 return. The two extra strings, $(+1, +1, +1)$ and $(-1, -1, -1)$, do not come back along the line. They go once round a ring of three. **Computed.**

What lectures leave out: that the difference between 7 and 9 separates two kinds of binding, coming back and going round.

6. Closure is phase locking

A closed winding returns on itself in phase. In oscillator language, this is phase locking.

Huygens saw it in 1665 with two pendulum clocks on one beam. The Kuramoto model gives the modern form. N oscillators with natural frequencies ω_i and coupling K lock once K passes a critical value K_c . The order parameter r measures how many have locked.

In the net, locking is not one phenomenon among others. It is the persistence rule itself. What does not lock does not stay. Its tension passes to the meshes beside it. **Reading.**

7. The units come from hydrogen

The net fixes its units from the reduced-mass Rydberg constant $R_H = 10,967,758.340 \text{ m}^{-1}$.

- Length: $S_0 = 1/(2R_H) = 4.5588 \times 10^{-8} \text{ m} = 45.588 \text{ nm}$.
- Time: $T_0 = S_0/c = 1.5207 \times 10^{-16} \text{ s}$.
- Energy: $E_0 = hc/S_0 = 27.197 \text{ eV}$, the Hartree energy of hydrogen.

All **computed.** Length, time and energy are together one photon of wavelength S_0 .

Each step deeper multiplies by three. The depth ladder is $3^n \cdot S_0$:

- **n = 2:** $9 \cdot S_0 = 410.29 \text{ nm}$. This is the vacuum wavelength of the Balmer H δ line. It is an identity, not a fit: $1/(R_H(1/4 - 1/36)) = 9/(2R_H)$.
- **n = 5:** $243 \cdot S_0 = 11.08 \text{ }\mu\text{m}$. By Wien's law this is the thermal peak at about 262 K.
- **n = 31:** $3^{31} \cdot S_0 = 2.816 \times 10^7 \text{ m}$. The lowest ideal mode of the Earth-ionosphere cavity has wavelength $2\pi R/\sqrt{2} = 2.831 \times 10^7 \text{ m}$, for $R = 6,371 \text{ km}$. The two differ by 0.52 %.

What lectures leave out: a single unit, read at different depths of three, that lands on an atomic line, on thermal radiation and on the planetary cavity.

8. An older account of the same structure

In 1993 a tomb at Guodian, Hubei, yielded bamboo slips from about 300 BCE. Beside the oldest known Laozi material lies a short text, the *Taiyi sheng shui*: "The Great One gave birth to water."

It describes arising by return. Water returns and assists the One, and heaven is completed. Heaven returns, and earth is completed. Then each pair supports itself, and the next layer arises, up to the year. The One is called the warp of all things, hidden in water. **Source.**

From this, three rules can replace the five starting rules:

- **R1.** One movement leaves a place through a crossing. The place is light. The movement is bound to it.
- **R2.** Return gives birth. What arises returns to its source, and from that return the next thing arises.
- **R3.** Mutual support builds the ladder. Two things that have arisen support each other, and the next layer arises.

Reading. No physics course places a 2,300-year-old cosmology next to Pólya's theorem. Here they describe one structure.

9. Open problems

These are not exercises. They are open.

1. **Order.** The register records sums. The pairs $(+1, -1)$ and $(-1, +1)$ have the same sum but differ. The first closes towards each other; the second opens. A quantity that records order is needed. What is the right algebraic object?
 2. **Dimension.** A one-dimensional random movement is bound with certainty. In three dimensions the return chance is 0.3405. If space consists of one-dimensional bound movements, where do three dimensions come from?
 3. **Nine and nine.** From water to the year, the *Taiyi sheng shui* names nine products. The register has nine closing windows. Is there a structure-preserving map between them, or is the match an accident? This must be computed, not read in.
 4. **Caps in the net.** A cap set in $\mathbb{F}_3^n$ is a set with no closed line. In the net, a cap is a configuration in which no window closes, so all of it carries tension. What is the largest tension-carrying configuration at depth n , and does the cap-set bound limit it?
 5. **Locking on a ternary lattice.** Kuramoto locking is known on complete graphs and on many networks. What is K_c when the oscillators sit on the balanced-ternary lattice of the net, with closure in $\mathbb{Z}_3$ as the coupling rule?
 6. **Constants as states.** If c is a state function (N4), the step from address to address per update varies locally. Which measurement would show that variation first, and at which depth?
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10. What the reader can do with this

Each problem fits a bachelor or master project. Problems 1, 3 and 4 are combinatorics and algebra. Problems 2 and 5 are probability and dynamical systems. Problem 6 sits between theory and measurement.

The full theory, its derivations and its status lists are public at constable.blog. That includes the Foundational Paper, edition 8.1, and *The Way Before the Net* (20 October 2026).

Annotated references

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