

Aquahydrates: Water as Structure

Vadim Kovalev, 2026

VOLUME ③ · SCIENTIFIC EDITION OF THE CENTRE FOR DIRECTED SELF-ORGANIZATION

English edition of the volume, made from the Russian original. The work defines a class of crystalline hydrates in which water occupies regular lattice positions rather than cavities or surfaces, and asks what such a structure can and cannot do as a carrier of a prescribed state. Twenty-two chapters in five parts; three results follow from constants and reference data alone and are reproducible with a calculator in two minutes.

The full text of the work, exactly as the site opens it without signing in.
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AQUAHYDRATES

Water as Structure · Volume ③

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AQUAHYDRATES

WATER AS STRUCTURE

A protocol for obtaining data, written before the experiment rather than instead of it

Volume ③ of the series · Scientific edition of the Centre for Directed Self-Organization

ABSTRACT

Claims about a medium "retaining a state" are made frequently and almost always without a number. This volume supplies the numbers, and it supplies them before any measurement of its own: it contains none.

The work defines a class of crystalline hydrates in which water occupies regular lattice positions rather than cavities or surfaces, and asks what such a structure can and cannot do as a carrier of a prescribed state. Three results follow from constants and reference data alone, and each is reproducible with a calculator in two minutes.

First, the band of activation barriers useful for storage is narrow: everything from seconds to millennia lies between 0.8 and 1.4 eV, a span of 0.6 eV, and one hydrogen bond of difference multiplies the lifetime by $2.2 \cdot 10^3$. Second, the carriers of order in aqueous media form a ladder of at least nine physically distinct rungs whose lifetimes differ by more than twenty-seven orders of magnitude; the question "does water re-

member" is therefore ill-posed, and the answerable question is "which carrier, and for how long". Third, the interval in which a carrier may exist in a homogeneous solution is bounded from below by the lifetime of the hydrogen-bond network itself, and within it exactly one stable occupant remains — an ion together with its first coordination shell. The position of the work is consequently presence, not memory, and this is a result of computation rather than of caution.

The volume declares, in advance, the thresholds at which its central claim is to be counted as supported and the outcome at which it is to be withdrawn.

Keywords: crystalline hydrates · activation barrier · Arrhenius relation · order parameter · mesophases · topological protection · Landauer limit · ultraweak photon emission · Bragg condition · pre-declared thresholds · reproducibility

FOUR DECLARATIONS — PLACED BEFORE THE TEXT, NOT AFTER IT

- ① — No measurements of our own appear in this volume. All in-house measured values were withdrawn from circulation by the quarantine act of 10.08.2026, and the volume is built so as not to depend on them.
- ② — Every number is derived from constants or reference data and is accompanied by a statement of what it does not mean (Appendix C, twelve numbers).
- ③ — All thresholds are declared before the experiment, together with the outcome that refutes the claim (§ 20.5, § 20.6, § 21.4).
- ④ — The word "proven" is not used as a status of any statement; in empirical disciplines it names a step the scale does not have (§ 22.2).

STRUCTURE

Part — Chapters — Content

- I · The class — 1–5 — four defining criteria; the class exists independently of any single substance
- II · Coordinates — 6–9 — the quantities in which statements about order may be made at all; five conditions for a record
- III · The price of a record — 10–14 — barrier and lifetime; the price of a bit; the capacity ceiling; the ladder of lifetimes; memory versus presence
- IV · Field and light — 15–18 — mesophases of biopolymers; topological memory; light as a witness; nonlinear dynamics and its limit
- V · Verification — 19–22 — the computed corridor; energy instead of waiting; what betrays fabricated data; the verification circuit and the loudness scale

THE TWELVE NUMBERS — REFERENCE TABLE FOR ALL CHAPTERS

№ — Value — Derived from — 🔴 What it does not mean

- 1 — 45.6 % water by mass — molar masses — nothing about the properties of that water
- 2 — ≈ 92 °C — reference data — not the stability of a record
- 3 — $5.56 \cdot 10^{20}$ unit cells cm^{-3} — $(12.16\ Å)^{-3}$ — not the number of stored states
- 4 — 0.018 eV — price of a bit at 300 K — $kT \ln 2$ — not the energy of any process of ours

- 5 — ≈ 70 EB cm^{-3} — no. 3 ÷ 8 — an upper bound, not a measured capacity
- 6 — 1.60 J — no. 3 × price of a bit — not the consumption of any device
- 7 — barrier → lifetime table — Arrhenius relation — not a property of our sample
- 8 — $6.02 \cdot 10^{23}$ — the dilution bound — Avogadro's number — not an argument in our favour
- 9 — $2.7 \cdot 10^{22}$ water molecules cm^{-3} ≈ 0.8 of liquid water — 48 per cell × no. 3 — not "structured water"
- 10 — V_{eff} = 24.5 $Å^3$ per water molecule — (449.3 − 154.8)/12 — not a mark of distinction: the median of the published range is 24 $Å^3$
- 11 — 65 % water by volume — [composition withheld until the patent applications are filed]
- 12 — $10^4 \ldots 10^6$ kT — price of a topological defect — $(\mu\, b^2/4\pi)\, \ln(R/r_c)$ over one micron — an order-of-magnitude estimate; 🔴 never to be substituted into the Arrhenius exponent

Constants used throughout: $k = 8.617 \cdot 10^{-5}$ eV K^{-1} · kT(300 K) = 0.02585 eV · kT(310 K) = 0.02671 eV · $\tau_0 \approx 10^{-13}$ s (an estimate, § 10.7).

THRESHOLDS DECLARED IN ADVANCE

What — Threshold

- Distinguishability of states — ≥ 3 standard deviations of repeated measurements
- Prior correspondence — table published before the series; any edit annuls the series
- Blind read-out — identification above chance at a pre-set series size

- Barrier mechanism ① — accepted at ≥ 0.8 eV; refuted below 0.8 eV; 0.8…1.4 eV is the band of practical storage
- Topological mechanism ② — accepted at ≥ 10^3 kT; refuted below 10^2 kT; 10^2…10^3 kT is the declared undecided band
- Flux mechanism ③ — a named source and loss of the state when it is switched off
- Collective mechanism ④ — lifetime depends on ensemble size
- Temperature series — ≥ 4 points, window ≥ 50 K, mass control at every point
- Optical series — ≥ 3σ of the dark count, paired samples, blind coding, size fixed in advance
- Acceptance of a data set — left tail of χ^2: $p \le 0.01$ withholds the set; 0.01…0.05 flags and repeats it
- Terminal digits — uniformity by χ^2, 9 d.f., $p \le 0.01$ withholds the set

CHAPTERS 1–5

CHAPTER 1. THE CLASS AND ITS FOUR CRITERIA

The volume speaks not about one substance but about a class, and the class is defined before any single representative is named. Four criteria, each checkable against reference data:

Criterion — How it is checked

- ① — water constitutes a substantial fraction of the mass — of the order of half — molar masses
- ② — water molecules occupy regular lattice positions, not cavities and not surfaces — X-ray diffraction, reference structural data
- ③ — removal of water destroys the structure rather than depleting it: what results is a different substance, not "the same one without

water" — thermal analysis, change of the diffraction pattern

- ④ — the substance melts in its own crystallisation water rather than dehydrating stepwise — reference melting data

🔑 The point of defining a class rather than a substance is stated at once: it makes the volume independent of the choice of a particular representative, and it makes the claims checkable by anyone who has a reference book. A property of a class cannot be a merit of a specimen.

CHAPTER 2. THE ARITHMETIC OF WATER

2.1. WHY A CHAPTER OF NUMBERS STANDS SECOND AND NOT IN AN APPENDIX

Every subsequent statement of the volume rests on four numbers. Placed in an appendix, they would be read as decoration; placed here, they are the foundation, and each of them can be recomputed by the reader in a minute.

2.2. FIRST NUMBER: HOW MUCH WATER IS IN THE SUBSTANCE

For the reference representative [composition withheld until the patent applications are filed] — twelve water molecules per formula unit — the mass fraction of water is 45.6 %. Almost half the mass of the crystal is water, and it is not moisture: it is a structural component.

🔴 What this does not mean: nothing whatever about the properties of that water. The number says how much, not what kind.

2.3. SECOND NUMBER: ORDERED SITES PER CUBIC CENTIMETRE

The cubic cell parameter is $a \approx 12.16$ Å, hence $V_{cell} \approx 1.80 \cdot 10^{-21}$ cm³ and

$N \approx 5.6 \cdot 10^{20}$ cells cm^{-3}.

2.4. A CONSISTENCY CHECK WORTH DOING ALOUD

With 48 water molecules per unit cell, the density of water molecules in the crystal is ≈ $2.7 \cdot 10^{22}$ cm^{-3} — that is, about 0.8 of the molecular density of liquid water.

🔑 The check matters more than the number: two independent routes — through mass fraction and through lattice geometry — must give consistent answers, and they do. 🔴 And the honest limit: the resulting figure is not a sign of "structured water". It says that water in this lattice is packed about as densely as in the liquid, and nothing more.

2.5. THIRD NUMBER: THE VOLUME PER WATER MOLECULE

Comparing the cell volumes of the hydrate and of its anhydrous parent gives the effective volume per water molecule, V_eff = (449.3 - 154.8)/12 = 24.5 Å³, and the volume fraction of water in the crystal — 65 %.

🥇 This number was expected by us to be distinctive and is not: 24.5 Å³ falls in the middle of the published range (median ≈ 24 Å³). It is retained in the volume precisely because it did not work in our favour. By volume the crystal is two-thirds water; that is "much water", not "special water".

2.6. FOURTH NUMBER: MELTING IN ITS OWN WATER

The reference representative melts at ≈ 92 °C — in its own crystallisation water. This is criterion ④ of the class, and it also sets a hard experimental boundary: the temperature series of Part V must stay safely below it, and loss of water begins earlier still (§ 7.2a).

2.7. WHAT THE CHAPTER ESTABLISHED, AND WHERE THAT RESULT ENDS

Four numbers establish that water here is a construction element rather than an impurity. Storage, prescription and read-out are claims of an-

other class, and these four numbers do not reach them.

CHAPTER 2A. THE GROUP: WHERE THE BOUNDARY RUNS

2A.1. WATER AS A CONSTRUCTION, NOT AS AN IMPURITY

Crystalline hydrates are numerous, and they are not alike. The class of this volume is the one in which water satisfies all four criteria of ch. 1 at once. The boundary is drawn by comparison, not by assertion:

Substance — Water, % by mass — Melts in its own water — Verdict

- Gypsum $CaSO_4 \cdot 2H_2O$ — 20.9 — no — borderline: ② yes, ① no, ④ no
- Copper sulfate $CuSO_4 \cdot 5H_2O$ — 36.1 — no — dehydrates stepwise — borderline: close on ①, fails ④
- Reference representative [composition withheld until the patent applications are filed] — 45.6 — yes, ≈ 92 °C — in the class
- Isostructural relatives (ammonium, rubidium, chromium analogues) — 41.5…47.7 — yes — in the class
- Washing soda $Na_2CO_3 \cdot 10H_2O$ — 63.0 — yes, ≈ 34 °C — in the class

2A.2. WE SOLVED OUR OWN EXERCISE, AND THE CLASS TURNED OUT TO BE WIDER THAN IT SOUNDS

The reader is invited to admit or reject candidates by the four criteria. We ran the exercise ourselves, and the result is inconvenient and instructive: washing soda contains more water than our reference representative — 63.0 % against 45.6 % — and satisfies all four criteria as well.

🥇 The conclusion is stated in the body rather than in a footnote: the criteria of the class do not single out our substance inside the class. They establish that the class exists and that our representative belongs to it. Why this member rather than another is a question of ch. 4, and it

is answered functionally — by solubility, dehydration temperatures, stability of the hydrated state, availability of pure material — not by the criteria of belonging.

2A.3. WHAT THE GROUP GIVES THE CARRIER PROBLEM, AND WHAT IT DOES NOT

Gives: an established example of water as a lattice-building element; a reference frame in which "much water" has a number; a family of isostructural analogues that later becomes a control series (ch. 4).

Does not give: any statement about retention, about a prescribed state, or about the distinction between our representative and its relatives.

CHAPTER 3. SYMMETRY AND ITS PRICE

3.1. SYMMETRY DOES NOT ADORN A SUBSTANCE; IT FORBIDS THINGS TO IT

The crystal of this class is cubic, space group Pa$\bar{3}$, the characteristic habit an octahedron. Popular accounts take the first half of that: regular form, a Platonic solid, beauty. The physical content is in the second half.

🔑 A symmetry group is first of all a list of prohibitions. If the structure is centrosymmetric — if it has a centre of inversion — then a whole class of phenomena in it is identically forbidden: not "weak", not "not yet detected", but impossible by symmetry.

3.2. WHAT IS FORBIDDEN IN A CENTROSYMMETRIC CRYSTAL

The point group is m$\bar{3}$; it contains a centre of inversion and no polar axis. Line by line:

Phenomenon — What it requires — Status in m$\bar{3}$ — Consequence for the work

- Piezoelectric effect — absence of a centre of inversion — forbidden — ⛔ "piezoresonant" explanations of the carrier fall away
- Pyroelectricity, ferroelectricity — a polar axis — forbidden — ⛔ there is no spontaneous polarisation to serve as memory
- Second-harmonic generation and other even nonlinear-optical effects — absence of a centre of inversion — forbidden — ⛔ "nonlinear optics of the crystal" as a mechanism falls away
- Optical activity — absence of a centre of inversion — forbidden — ⛔ there is nothing to rotate the plane of polarisation
- Birefringence — optical anisotropy — absent in the ideal crystal: the cubic system is optically isotropic — ⛔ polarisation microscopy of a perfect specimen shows nothing — 🔑 and § 3.4 is the more interesting for it

🔴 The first row directly refutes an explanation that appeared in early project material. It is removed by symmetry — an argument that cannot be evaded by better specimens or better instruments. The position goes to "What did not pass verification", and it goes there by our own computation, not on an opponent's remark.

3.3. ONE EFFECT IN THIS ROW THAT SYMMETRY DOES NOT FORBID

A list of prohibitions would be incomplete, and therefore dishonest, without the exception it contains.

The flexoelectric response — polarisation in response to a gradient of strain — is allowed in all crystal classes, including centrosymmetric ones. The reason is checkable by reasoning rather than by reference: piezoelectricity links polarisation to uniform strain, and a centre of inversion forbids that link; a strain gradient is not itself symmetric under inversion, so the prohibition does not extend to it.

🔴 And immediately the boundary, so that this does not become a loophole. The flexoelectric response in ordinary dielectrics is small, and we have no measurements of it in our subject. We do not advance it as a mechanism. It is named here for one reason: a list of prohibitions from which an inconvenient exception has been struck out is not rigour but forgery. If someone presents us with an electrical response in a centrosymmetric crystal, we are obliged to know in advance that it need not be an error.

💎 This is what genuine work with symmetry looks like: it names both the prohibitions and the one door the prohibition left open, and does not pretend the door is absent.

3.4. WHAT SYMMETRY LEAVES

Vibrational spectroscopy — in a centrosymmetric crystal the rule of mutual exclusion holds: modes active in Raman scattering are inactive in infrared absorption and vice versa, so the two methods give complementary pictures and their agreement is itself a check. Dielectric response of the aqueous subsystem — not subject to the even-order prohibition. Diffraction — the principal way of seeing order. Thermal analysis — the route to the barrier.

3.5. WHERE SYMMETRY IS BROKEN — AND WHY THAT IS THE MOST INTERESTING PLACE

A perfect lattice forbids much. But a real crystal is perfect only on average: defects, growth sector boundaries, inclusions and local distortions break the symmetry locally without changing it globally. Precisely where symmetry is broken, a state acquires somewhere to live.

🟢 An established fact worth quoting here. Crystals of this class have long shown anomalous birefringence: a crystal optically isotropic by symmetry displays, in polarised light, a pattern repeating its growth sec-

tors. The phenomenon has been known since the nineteenth century and is associated with different faces incorporating impurities differently during growth — that is, the conditions of growth remain in the body of the crystal and are read optically.

🔴 Precision matters more than effect here: the fact is established and reproducible; a single accepted explanation does not exist. Several mechanisms are discussed — ordered incorporation of impurities by sector, internal stresses, local lowering of symmetry. The work takes the fact only and does not choose a mechanism on the specialists' behalf.

🔴 And at once the discriminator of ch. 9: this is a chronicle, not a record — it carries information about growth conditions and has no alphabet, no addressing and no read-out of any prescribed message. It is cited not as evidence of a record but as evidence that a carrier of this class is physically able to retain the history of its own formation — and as the nearest specimen of what must later be told apart from a record.

💎 The formula of the chapter: symmetry takes effects away from us and gives trust back. An author who names for himself what is impossible in his substance buys the right to what is possible in it.

CHAPTER 4. SERIES AND SUBSTITUTIONS: ONE PATTERN IN DIFFERENT BODIES

4.1. A FAMILY, NOT A SUBSTANCE

The reference representative is a member of a broad isomorphous family of general formula $M^{+}M^{3+}(SO_4)_2{\cdot}12H_2O$, where the monovalent site is taken by potassium, ammonium, rubidium, caesium, thallium or sodium, and the trivalent site by aluminium, chromium, iron, gallium, indium and others. The family divides into three structural types, differing in the orientation of the sulfate groups and the environment of the

monovalent cation; membership of a type is set primarily by the size of that cation.

🔑 The point for which this chapter stands in Part I: the lattice pattern belongs to the class, not to the atom. Change the ion occupying the site and the geometry survives. Order proves to be a quantity separable from composition — the first place in the volume where that separation is seen directly rather than postulated.

4.2. MIXED CRYSTALS: CONTINUITY INSTEAD OF A MIXTURE

Members of the series form continuous solid solutions: cations replace one another in the same positions in any proportion rather than forming a mechanical mixture of two phases. The classical demonstration is the growth of a seed of one member in a solution of another, continuing without a break in the lattice and changing only the colour of the layers.

4.3. WHY THIS IS INCONVENIENT FOR US — SAID BY US FIRST

🔴 If the criteria of the class and its geometry belong to the whole family, then they single out no substance within it. The question "why this member of the series" is not solved by this chapter — it is sharpened by it: the opponent acquires a ready list of isostructural analogues to each of which everything said in chs. 1–3 applies.

The work answers not with a justification but with an order of reasoning: the choice within the series must be argued functionally, and where it is not yet closed by numbers, that is said plainly.

4.4. WHAT THE SERIES GIVES IN RETURN: A BUILT-IN CONTROL SERIES

The inconvenience turns into an instrument, and this is probably the chief practical consequence of Part I.

The usual affliction of studies of this kind is the absence of a proper control: the specimen is compared with water, with an empty cell, with "nothing". Such a comparison almost always yields a difference, and the difference means nothing.

Control pair — What changes — Variables — What it discriminates

- ① two members of one structural type — the ion in the site — 1 — composition ↔ geometry
- ② protonated ↔ deuterated specimen of one substance — the hydrogen isotope only — 1 — whether the effect belongs to hydrogen bonds
- ③ hydrate ↔ its dehydrated form ⚠️ — the aqueous subsystem and with it the framework geometry — 2 — whether water in the lattice is needed at all; does not separate water from geometry
- ④ specimens of one substance with different growth histories — conditions of crystallisation — 1 — a trace of growth ↔ a prescribed state

💎 The value lies in the number of variables in each row being declared in advance — one for pairs ①, ② and ④, two for pair ③, stated before the experiment rather than after the result. This converts "our specimen differs from water" into "the effect follows geometry rather than composition", or the converse — that is, into a statement that can be refuted.

4.4A. AN ERROR OF OURS STOOD HERE, AND IT IS WORTH THE ANALYSIS

In the first revision, row ② read: "one and the same member of the series in different structural types — the environment geometry changes, the chemistry stays". On a full check the row failed.

Why. The structural type in this family is set by the size of the monovalent cation (§ 4.1). Hence one cannot move from type to type without

changing the ion: changing the type obliges one to change the composition. Row ② promised one variable and contained two — it was not a control pair but an ordinary comparison of two different substances.

🔑 And this is exactly the risk we named ourselves in the method passport: "show that more than one parameter changes inside the pair". We named it — and did not check our own table against our own criterion. The error was found by us during the read-through.

What replaced it, and why the replacement is stronger. Isotopic substitution of hydrogen by deuterium gives what no chemical substitution can: composition, structure and geometry stay the same, and only the mass of the nucleus in the hydrogen bond changes. Deuterated crystals of this class are not a thought experiment: they have been prepared and studied, and deuteration is known to strengthen hydrogen bonds and to shift the internal vibration frequencies of the sulfate ion.

💎 What this pair settles in a single experiment. If the state the work speaks of lives in the hydrogen-bond subsystem, deuteration must shift the barrier and the lifetime. If it lives in the ionic framework and its geometry, it need do nothing. Two mutually exclusive predictions on one substance, without a single new instrument.

CHAPTER 5. THE LIMITING CASE: THE CLATHRATE

5.1. WHY THE CLASS NEEDS A LIMITING CASE

Part I has moved by increasing the role of water: impurity → structural component → almost half the mass. The logical limit of that sequence is a state in which water constitutes the framework entirely and everything else sits inside it as a guest. Such a state exists, is well studied and is industrially significant. The class ends there — and there it is best seen what memory of a carrier is.

5.2. WHAT IS ESTABLISHED ABOUT CLATHRATE HYDRATES

Water molecules form closed polyhedral cages joined by hydrogen bonds; the simplest and best known is the pentagonal dodecahedron. The cages assemble into several framework types, and the type is set by the size of the guest molecule, not by its chemistry. This is not a hypothesis: clathrate hydrates block gas pipelines and form seabed deposits of natural gas. 📐 One volume of hydrate releases of the order of 160 volumes of gas on decomposition (the reference figure for methane hydrate of structure sI at normal conditions is 164 volumes at full cage occupancy; rounded down in the text, against us, by the rule of the volume).

🔑 What matters here is the fact itself: water builds regular polyhedra by itself, and does so not in metaphor but in a structure confirmed by diffraction. The project needs this proposition in exactly one capacity — as an established example that geometry can be a property of the aqueous subsystem.

5.3. THE EMPTY FRAMEWORK: WHERE THE BOUNDARY OF MEMORY RUNS

The key question of the whole direction — does water retain the shape after the guest departs — has, in the clathrate case, a measured answer.

The empty framework exists: it is obtained by removing the guest from a filled hydrate, and it constitutes a separate crystalline form of ice (ice XVI), the least dense of the experimentally obtained crystalline forms of water, 📐 about 0.81 g cm^{-3}. It holds only at cryogenic temperatures, 📐 of the order of minus one hundred and thirty degrees Celsius.

📌 The qualifier "crystalline" is not pedantry: water also has amorphous low-density forms, and without that word the statement would be broader than the data beneath it. "Experimentally" is added for the same reason: still lighter framework structures of water have been predicted by computation.

📌 How it was actually obtained says more about the price of the question than the figure does: neon — a guest small enough to leave without breaking the fragile framework — was pumped out of the hydrate continuously over several days at 142 K. The empty framework was not "found"; it was extracted from the substance molecule by molecule.

🔴 And the kind of stability must be named exactly, because it works against us. The empty framework is not stable but metastable: thermodynamically such a form is expected to be stable only at negative pressures, and at ordinary pressure it persists kinetically — only because at that temperature it lacks the mobility to rearrange into ordinary ice. The statement "water remembers the shape of the guest at −130 °C" is true; the statement "at −130 °C such a state of water is stable" is not.

The question "does water remember the shape of the guest" has been moved from the realm of belief to the realm of the thermometer. The answer: yes, it does — at −130 C. Under ordinary conditions the shape vanishes together with the guest.

5.4. PRESENCE AND MEMORY ON ONE SCALE

State — What it is — Price of retention

- Cage with guest — pure presence: the structure is held by what is inside it — costs nothing
- Empty framework — pure memory: the structure holds without what set it — requires cryogenic temperatures — and even there is metastable

🔴 Here the work must apply its criterion to itself. In this limiting case the transition from presence to memory costs a great deal — more than a hundred degrees below zero. That is not an argument in our favour, and it is given in full: if the aqueous subsystem has any way at all of holding a prescribed geometry without what set it, then at room tem-

perature that way must rest not on the hydrogen-bond network but on the barrier of the lattice — which is the subject of Part III.

5.5. HOW OUR CLASS DIFFERS FROM A CLATHRATE

Clathrate hydrate — Aquahydrate (the class of this volume)

- Role of water — the entire framework — an element of the lattice alongside the ions
- What holds the structure — the guest inside the cage — ionic and hydrogen bonds of the lattice
- Stability of the empty form — cryogenic only, and metastable at that — no empty form exists: water is an element of the lattice, and its departure rebuilds the framework into a different substance
- Temperature of existence — low, or high pressure — ordinary conditions

5.5A. A SECOND ERROR OF OURS IN THE SAME PART — AND IT CONCERNS CONTROL PAIR ③

In the first revision the last-but-one row read: "stability of the empty form — the question does not arise: water cannot be removed without destroying the substance". The row was withdrawn.

The question does arise, and we raised it ourselves. Control pair ③ of ch. 4 — "hydrate ↔ its dehydrated form" — is precisely the experiment of removing water. So the dehydrated form exists and is studied; saying in ch. 5 that the question does not arise would contradict our own verification programme one chapter later.

What actually happens on dehydration. Water here is not a guest in a ready cage but an element of the lattice: its departure does not leave the framework empty, it forces the framework to rebuild. The hydrate is cubic; anhydrous representatives of the same family crystallise in a differ-

ent system with entirely different cell parameters. This is not "the same house without its tenant" but a different house.

🔴 Hence an honest limitation on pair ③, which must stand beside the pair itself. Pair ③ is not a strict one-variable pair: the framework geometry changes inescapably together with the aqueous subsystem. It answers "is water needed in the lattice at all" and does not separate water from geometry — pair ② serves that purpose, where the structure is preserved entirely and only the mass of the nucleus in the hydrogen bond changes.

💎 The difference between pair ②, withdrawn earlier, and pair ③, qualified here, matters methodologically: the first was defective — it promised one variable and could not deliver it; the second is sound but with a declared limitation. The method does not require every pair to change exactly one parameter; it requires the number of variables in a pair to be named before the experiment, not after the result.

🔑 The conclusion for which this chapter stands last in Part I: our class occupies an intermediate position between an ordinary crystalline hydrate and a clathrate — the aqueous subsystem is almost as developed as in the clathrate, yet it is held not by a guest but by the lattice. That combination is what makes discussion of storage at room temperature meaningful — and it is also what obliges us to name the barrier.

CONCLUSION OF PART I

Chapter — What is established — Kind of evidence

- 1 — the class is defined by four checkable criteria — definition + reference data
- 2 — 45.6 % water · $5.6 \cdot 10^{20}$ cells cm^{-3} · $2.7 \cdot 10^{22}$ water molecules cm^{-3} (≈ 0.8 of liquid water) · 65 % by volume · ≈ 92 °C —

computation from constants, checked against reference works

- 2a — the criteria do not single out our representative inside the class: washing soda holds more water and satisfies all four — our own solution of our own exercise
- 3 — centrosymmetry forbids piezo-, pyro- and ferroelectric effects and even-order nonlinear optics; the flexoelectric response is the one exception; anomalous birefringence keeps the history of growth as a chronicle — reference crystallography
- 4 — the pattern belongs to the class, not to the atom; the series supplies a built-in control set — reference crystal chemistry + our methodological conclusion
- 5 — the limiting case: water as framework; memory without a guest costs cryogenic temperatures and is metastable even there; our class has no empty form at all — reference crystal chemistry

🔴 What Part I does not contain and will not: a single measurement of ours · a single claim of an effect · a single "proven" · a single word about any use of the substance.

💎 What Part I did for the volume. It answers "why this substance" by a property of the class rather than a merit of the specimen — and immediately admits that a property of the class does not single out a member within it. From that admission grow both the requirement of ch. 4 (a functional justification of the choice) and the control series of Part V. The work set itself the question it is obliged to answer with numbers — and that is the best thing Part I could do for its own defence.

CHAPTERS 6–9

CHAPTER 6. FOUR COORDINATES OF ORDER

6.1. A FIELD POISONED BY WORDS WITHOUT QUANTITIES

The area in which this volume works is saturated with terms that carry no magnitude: "structured", "vibration", "energy-informational". Such a word cannot be wrong, because there is nothing in it to be wrong about. The remedy is not to ban the words but to replace each of them with quantities that have units and a measuring procedure.

Order in a medium is described by three quantities, and by these three alone.

① Magnitude of order — how strongly the directions or positions are correlated. Formally the order parameter: zero for complete disorder, one for complete order. ② Scale — over what distance the order still holds. Formally the correlation length. ③ Lifetime — how long the state persists. Formally the relaxation time.

Coordinate — Answers — Unit — Measured by

- Magnitude of order — "how strongly" — dimensionless, 0…1 — diffraction, anisotropy of response
- Scale — "how far" — m — scattering, width of the reflection
- Lifetime — "how long" — s — relaxation methods, spectroscopy

The third coordinate is measured in one way and predicted in different ways. The number itself — seconds on an instrument — does not depend on the mechanism of retention. But to predict it, and to relate it to temperature, the mechanism must be known: in the barrier model the lifetime follows from the Arrhenius relation (ch. 10); in the topological model, from the work of forming a critical nucleus and the lifetime of the phase (ch. 16); in the flux-driven model, from the duration of the flux; in the collective model, from ensemble size (§ 10.8). A measured lifetime therefore does not testify to the mechanism, and the converse is asserted nowhere in the volume.

The word "critical" is essential: the full price of a configuration (10^4…10^6 kT for a defect one micron long) is not substituted into the exponent. Destruction proceeds through a nucleus of finite size and through boundaries — by the cheapest channel, not by the one computed.

💎 Three numbers, and the word "structured" ceases to be a matter of belief. To say "structured" is to say: the order parameter is such, the correlation length is such, the lifetime is such. Anything else is not a disagreement but an absence of assertion.

6.2. THE FOURTH COORDINATE: CONTROLLABILITY

Three coordinates describe a state. They are not enough, and a snowflake shows this best.

A snowflake is ordered in all three coordinates. And it stores — literally: its shape is set by the temperature and supersaturation along its path of fall, and the conditions in the upper air are read from the morphology of the crystal. The physicist who charted these forms called snow crystals letters sent from the sky — and that is not poetry but a working property: the letter really is read.

What a snowflake lacks is the fourth coordinate. Nobody set its conditions and nobody checked that it responds reproducibly to a prescribed input. It stores a history; it does not answer a question.

An error of ours stood here, and it is worth showing. The first revision read: "a snowflake is ordered in all three — and stores nothing". That is wrong twice. Factually, a snowflake stores its growth conditions, and this is established rather than contentious. Logically, the statement contradicted our own table half a page later, where a trace is defined as "order present, control absent" — that is, precisely a snowflake. We took the best example of a trace in the world and called it an example of storing nothing.

After the correction the example works better than before: it shows not the absence of storage but the absence of control — the very distinction for which the fourth coordinate is introduced.

The difference between order and a record lies not in the degree of order but in whether we can prescribe it.

④ Controllability — whether the state responds reproducibly to a prescribed action. Formally a transfer characteristic: the ratio of the change in the observable to the normalised magnitude of the action. It is a metrological quantity, measured by setting up an experiment with a prescribed input, not by observation.

🔑 The fourth coordinate is logically independent of the first three: a high degree of order may be entirely uncontrollable, and a weak one controllable. This is a testable claim, and the way to refute it is named directly: show that controllability can be computed from the first three coordinates.

6.3. WHAT FOLLOWS IMMEDIATELY

Notion — Definition through the coordinates

- Trace — order present (①–③), no control (④ = 0)
- Marking — control present (④ > 0), no read-out of a prescribed message
- Record — all of it together, subject to the conditions of ch. 9

Three words that the whole field uses as synonyms of "memory" turn out to be three distinct positions on one axis. The discriminator is developed in ch. 9.

6.4. A REQUIREMENT IDENTICAL FOR EVERYONE

Name the four quantities. A statement for which they are not named is not discussed — not as false, but as unformulated.

🔴 The requirement applies to us first and in full. For our subject today: magnitude of order — not measured; scale — not measured; lifetime — not measured; controllability — not measured. After the quarantine act the project has no values of its own on any coordinate, and Part V is built as a programme for obtaining them rather than a report on it.

📌 This does not contradict the count "one of five" (the condition of discrimination is marked there as satisfied). It is satisfied by a fact from the literature — different growth conditions produce distinguishable optical patterns across growth sectors (ch. 3) — not by a coordinate measured by us. The zero here and the tick there refer to different things, and both are true.

CHAPTER 7. THE FIFTH QUANTITY: THE BARRIER — AND AN HONEST CAVEAT ABOUT IT

7.1. WHY A FIFTH QUANTITY WAS NEEDED

Four coordinates describe the state here and now. They do not answer the question that matters most for a carrier: why the state holds at all, and what determines how long it will hold.

The answer of condensed matter physics is simple: the state is held by an energy barrier separating it from other states. Denoted B in the working core, measured in eV or $J \cdot mol^{-1}$, and related to lifetime by the Arrhenius relation $\tau = \tau_0 \exp(B/kT)$.

7.2. HOW THE BARRIER IS MEASURED

Not by waiting. By a temperature series of at least four points: relaxation times are measured at several temperatures, the logarithm is plotted against inverse temperature, and the barrier comes from the slope.

💎 The practical consequence for which the fifth quantity was introduced: a state with a lifetime of a year is measured in hours. This overturns the whole verification programme (ch. 20) and replaces monitoring with measurement.

7.2A. WHY "FOUR POINTS" IS AN INSUFFICIENT REQUIREMENT

The accuracy of the barrier is set not by the number of points but by the span in inverse temperature:

$\sigma(E_a) \approx (k\,\sigma(\ln \tau)\sqrt{2})/(\Delta(1/T))$

🧱 At a realistic 20 % noise in the measured time ($\sigma(\ln \tau) = 0.2$):

Temperature window — $\Delta(1/T)$, K^{-1} — Uncertainty in the barrier

- 0…60 °C — $6.6 \cdot 10^{-4}$ — ± 0.04 eV
- 17…37 °C — $2.2 \cdot 10^{-4}$ — ± 0.11 eV

The step of the reference table of ch. 10 is 0.2 eV. In a wide window the barrier is resolved five times finer than that step; in a narrow one the uncertainty exceeds half the step, and 1.0 eV can no longer be told from 1.2 eV — two states differing in lifetime by a factor of two thousand merge into a single measurement.

The requirement replacing the earlier one: not "at least four points", but at least four points within a window of at least 50 degrees, with the achieved uncertainty of the slope stated.

🔴 And a boundary set by the substance itself. The window cannot be widened upwards at will: in our class, melting in the crystallisation water sets in at ≈ 92 °C, and loss of water begins appreciably earlier. In heating a specimen for the sake of span, the experimenter at some point measures something other than what was placed in the instrument. The upper limit of the series must be declared before the experiment, together with mass control.

💎 A merit of the method worth naming: the slope gives the barrier independently of the pre-exponential factor. The value $\tau_0 \approx 10^{-13}$ s is an estimate, and any conclusion from a single measurement at a single temperature inherits it. A series is free of it: τ_0 sets the intercept, not the slope.

7.3. A CAVEAT THE WORK MAKES ABOUT ITSELF

The barrier is not a fifth coordinate of the same kind as the first four, and this must be said before an opponent says it.

At fixed temperature the lifetime is uniquely determined by the barrier and the pre-exponential factor. B is therefore not independent of the third coordinate — it generates it, describing how it depends on temperature.

That statement holds within the barrier model of retention and only there. If the state is held topologically, by a flux or collectively (§ 10.8), the lifetime is set by the price of forming a defect, the duration of the flux or the size of the ensemble, and the link $B \to \tau$ ceases to exist. Consequence for the programme: a temperature series measures the barrier where the mechanism is the barrier one, and does not itself establish the mechanism.

Fourth coordinate (controllability) — Fifth quantity (barrier)

- Relation to the first three — logically independent — declared as testable — dependent: it generates the third
- What it introduces — the distinction "order ≠ record" — the distinction "observation ≠ computation"
- Status in the work — a coordinate — a parameter, not a coordinate

🔴 Equally obligatory: the parameter B was introduced into the core later than the others and has not been identified experimentally — the

project has not a single measured temperature series on its own subject. Everything the volume says about the barrier is computation from constants and reference relations (Part III), and not one line more.

📌 The work keeps B despite both caveats for one reason: it alone turns the question of durability into a computable one. But it carries exactly the status named here.

7.4. THE CORE OF PARAMETERS, RUN THROUGH THE WORK'S OWN CRITERION

R rhythm · E energy · I information · G geometry · B barrier.

The previous revision stated that each of these carried "a physical bearer, a unit, a procedure and a range (the rule of ch. 8)". The claim was made and the check existed nowhere: the table of § 8.2 sifted eight borrowed words and not one of the four core parameters, the barrier apart. The work declared itself to have passed its own gate without passing it. Corrected on the spot, with the count given openly.

Bearer — Unit — Procedure — Verdict

- R rhythm — periodicity of the action — Hz — set by the generator, checked by spectrum — ✅ admitted — 🔴 as a parameter of the input, not a property of the specimen
- E energy — energy introduced into the system — J · J/m³ · W/m² — power measurement, calorimetry — ✅ admitted — same caveat about the input
- I information — distinguishable states of the carrier — bit — entropy count over the distribution of states — 🟡 conditionally: unit and procedure exist, but the procedure is unexecutable until an alphabet is defined (ch. 9, condition ① ⛔)
- G geometry — — — — — — — ⛔ not a quantity but a group of quantities

- B barrier — energy of the transition — eV — temperature series (§ 7.2a) — ✅ admitted with the status of § 7.3

What is done with G. By the rule of § 8.1 the name of a group does not enter relations. In its place stand measurable representatives: lattice parameter (m) · interfacial angles (deg) · correlation length (m) · topological charge (dimensionless integer, § 10.8). Each passes the criterion; the word "geometry" remains a notion and works as a heading, not as a quantity.

What is done with I. It remains in the core as a goal, not as a working quantity: bits are counted against an alphabet, there is no alphabet, and until one appears any number of bits would be assigned rather than measured. 📌 Hence the direct link to the capacity ceiling (ch. 12): 70 EB cm^{-3} is called an upper bound precisely because the real number of states is unknown.

💎 The count against our own core: two parameters pass cleanly, one with a status, one conditionally, one does not pass. It is an inconvenient line, and it stands in the body of the text — by the same rule that puts the count "one of five" in the body.

🔴 The former symbolic formula that reduced the description to a single expression has been removed from the work, not replaced by another formula. The reason, stated in the dissertation revision: it had neither units, nor a procedure, nor dimensional consistency — nothing followed from it and nothing could refute it. 💎 It was the most striking place in the work and the only one about which it was impossible to say whether it was true or false.

CHAPTER 8. THE ADMISSION CRITERION FOR A QUANTITY

8.1. THE RULE IN FOUR LINES

A quantity enters the work as a working one only if all four conditions hold at once:

1. a physical bearer is named — that through which the quantity is expressed; 2. a unit is given; 3. a measuring procedure is described — an instrument or an algorithm over data; 4. a range of applicability is named, together with what ceases to be true outside it.

A quantity failing even one condition is not expelled from the book — it moves to the section of notions and interpretations and takes part in no relation.

💎 The sense of the rule is exactly one: while a quantity is not measured, any outcome is compatible with it — so one cannot be wrong with it, and therefore cannot be right either.

8.2. THE RULE APPLIED TO OUR OWN VOCABULARY

This is the most inconvenient table in the volume, and it stands in the body rather than in a footnote.

Word — Bearer — Unit — Procedure — Range of applicability — Verdict

- Degree of coherence — agreement of phases — dimensionless, 0…1 — interferometry — stationary signal; meaning is lost under strong multiple scattering — ✅ admitted
- Coherence time — the same — s — autocorrelation of the signal — bounded above by the measurement time — ✅ admitted
- Coherence length — the same — m — scattering, width of the reflection — 10^{-9}…10^{-3} m; undefined below instrument resolution — ✅ admitted
- Resonant frequency — maximum of response — Hz — frequency sweep with response recording — linear response; the peak shifts

under strong excitation — ✅ admitted — as a measured peak, not as a metaphor

- Q-factor — sharpness of the peak — dimensionless — width at half height — Q > 1; at Q ≤ 1 the response is aperiodic and there is no resonance — ✅ admitted
- Barrier — energy of the transition — eV — temperature series ≥ 4 points in a window ≥ 50 degrees — 0.3…4 eV, one relaxation channel; under multiple channels the value is effective — ✅ admitted (status of § 7.3)
- R rhythm — periodicity of the action — Hz — generator + spectral control — generator bandwidth; linear response of the specimen — ✅ admitted as an input parameter
- E energy — energy introduced — J, W/m² — power measurement, calorimetry — up to the threshold at which the specimen itself changes (heating, water loss) — ✅ admitted as an input parameter
- I information — distinguishable states — bit — entropy count — undefined: there is no alphabet — 🟡 conditional, enters no relation
- G geometry — — — — — — — — — ⛔ a group of quantities → lattice parameter, angles, correlation length, topological charge
- Order — order parameter — dimensionless, 0…1 — diffraction, anisotropy — within the existence of the phase; outside it there is nothing to measure — ✅ admitted
- "Structured" — — — none — none — — — ⛔ not a quantity → replaced by the three coordinates of ch. 6
- "Vibration" — — — none — none — — — ⛔ not a quantity → admitted only as frequency (Hz) and amplitude
- "Energy-informational" — — — none — none — — — ⛔ not a quantity → remains a notion, enters no relation

- "Information matrix" — — — none — none — — — ⛔ the name of an object, not a quantity — § 8.3

8.2A. THIS TABLE USED TO CHECK THREE CONDITIONS OUT OF FOUR

The rule of § 8.1 requires four: bearer · unit · procedure · range of applicability. The table enforcing that rule had columns for bearer, unit, procedure and verdict. The fourth condition was absent from every row — including the four rows of our own core, entered the same day: they were written in without anyone noticing that the column did not exist.

🔴 Without softening: of the four conditions the one omitted was the hardest. Bearer, unit and procedure are lexicographic work. A range requires saying where the quantity stops working — that is, constraining oneself. A gate that checks three easy conditions and is silent about the hard one looks like a gate and is not one.

💎 What filling the fourth column produced beyond formal closure: two rows split into five. "Coherence" stood as one row with units "s, m", although its bearer is the degree of phase agreement, which is dimensionless — three different quantities lived in one row. "Resonance" stood with "Hz, Q-factor dimensionless" — two quantities in one.

🔴 The price of the finding, named at once: the range column immediately brought two constraints that were not in the volume — $Q > 1$ (below it the word "resonance" is undefined at all) and the barrier as an effective quantity under multi-channel relaxation. Both constrain us. Both appeared within minutes of there being a place in the table where they had to be written.

8.3. SEPARATELY — ABOUT OUR OWN NAME

The working name of the subject contains the expression "information matrices". The rule is applied to it without exception:

"Information matrix" is the name of a class of objects, not a measured quantity. It says what is being spoken of, and enters no relation of the work. Everything asserted quantitatively about the subject is asserted through the coordinates of ch. 6 and the parameters of ch. 7.

🔑 This is not a demotion of the name but a separation of two roles. A name must be recognisable; a quantity must be measurable. Trouble begins where the name is substituted into formulas — and the work does that nowhere.

8.4. WHAT THE RULE SAVES

⛔ A quantity without a procedure makes a work irrefutable — that is, removes it from science while preserving a scientific appearance. Most work in this area dies exactly so: not from an error in a computation, but because there is nothing for the computation to be checked against.

✅ A quantity with a procedure allows one to be wrong. The work accepts that as the price and considers it low.

CHAPTER 9. WHAT A RECORD IS: TRACE, CHRONICLE, MARKING, RECORD

9.1. FOUR THINGS UNDER ONE WORD

The field calls "memory" several distinct phenomena. They differ by two independent features, and by these alone: whether the state was prescribed deliberately, and whether it is read by a rule declared in advance. Two features give four cells, not three:

not read by a rule — read by a rule

- not prescribed — Trace — a change remains, nobody can read it: a scar, a scratch, a clouded layer in glass — Chronicle — nobody prescribed it, but reading has been learned: tree rings, annual layers

of sediment, ice cores, a snowflake (ch. 6), the pattern of growth sectors in a crystal

- prescribed — Marking — the state is set deliberately, no prescribed message is read from it: a blank with a grid applied, a specimen grown to a set regime — Record — prescribed and read by a third party under a declared rule: a barcode, a magnetic domain, a DNA sequence

An error stood here, and it mirrors the one in ch. 6. In the first revision the discriminator had three cells and tree rings stood in the column "Record". By our own definition a record requires the state to be prescribed — and nobody prescribed tree rings. We put into the highest category an example that fails its condition.

In ch. 6 the converse: a snowflake — the perfect readable trace — was called an example of storing nothing. The same slip from two sides: the feature "is read" was being confused with the feature "was prescribed".

Separating the features produced a cell the discriminator did not have, and it is not empty — a whole class of real science lives in it: dendrochronology, palaeoclimatology, ice cores. Nature writes chronicles constantly and prescribes them never. Science has learned to read them, and that does not make them records.

🔑 Hence the exact formula of the discriminator: readability and prescription are independent. What is readable need not be prescribed (a chronicle); what is prescribed need not be readable (a marking). A record is the only cell in which both hold.

9.2. FIVE CONDITIONS FOR A RECORD

To have the right to say "something is recorded here", five things are needed, not one and not three:

1. A set of distinguishable states — it is named in advance which states count as different. 2. A correspondence fixed in advance — what each state means is decided before the experiment, not fitted afterwards. 3. Repeatability — the same input gives the same result: in different specimens, on different days, in different hands. 4. Discrimination — different inputs give different marks. 5. Read-out by a third party — someone who does not know the answer can read it from blinded labels.

🔑 The second condition looks like a formality and is the hardest: most claims of a record in matter break on it. While an author who knows the answer recognises his own sample, there is no test — there is recognition.

📌 How the five conditions map onto the two axes of § 9.1, and why there are exactly five: conditions ③ and ④ secure the prescription axis — that the input controls the state reproducibly; conditions ①, ② and ⑤ secure the readability axis — that there is an alphabet, that it was fixed beforehand, and that someone other than the author can apply it.

9.3. WHERE THE VOLUME STANDS AGAINST THESE FIVE

🔴 One of five is satisfied, and a second in part. Discrimination (④) is satisfied by a fact from the literature: different growth conditions give distinguishable optical patterns across growth sectors. Repeatability (③) is satisfied partially and by others' data, not by ours. Conditions ①, ② and ⑤ — alphabet, prior correspondence, blind read-out — are not satisfied, and Part V names for each of them a way of closing and a threshold declared in advance (§ 20.4).

📌 Until those three lines are closed, the volume calls what has been achieved a marking, not a record. The word changes together with the data, and not otherwise.

CHAPTERS 10–14

CHAPTER 10. BARRIER AND LIFETIME: THE NARROW BAND

10.1. THE QUESTION THAT IS USUALLY NOT ASKED

The statement "a substance retains its state for some time" appears constantly in the literature on memory in media, and almost always without a number. In condensed matter physics, however, it has a precise meaning and a precise price.

A state separated from equilibrium by an energy barrier survives the longer, the higher that barrier stands above the thermal noise. The dependence has been known since the beginning of the twentieth century and is written in the Arrhenius form

$\tau = \tau_0 \exp(E_a/kT)$

where τ is the lifetime of the state, E_a the barrier height, k Boltzmann's constant, T the absolute temperature, and τ_0 the attempt time, taken for solid-state systems as the lattice vibration period, $\tau_0 \approx 10^{-13}$ s.

At room temperature (T = 300 K) the thermal scale is kT = 0.0259 eV.

Everything that follows in this chapter is a consequence of that single formula. It contains no experimental result, and none is required: all of it is reproducible with a calculator in two minutes.

10.2. THE REFERENCE SCALE

Barrier E_a, eV — E_a/kT — Lifetime τ (300 K)

- 0.026 (the thermal scale itself) — 1 — ~10^{-13} s — the state is not held
- 0.2 (one hydrogen bond) — 7.7 — ≈ $2 \cdot 10^{-10}$ s
- 0.5 — 19.3 — ≈ $2 \cdot 10^{-5}$ s
- 0.8 — 30.9 — ≈ 3 s

- 1.0 — 38.6 — ≈ 2 hours
- 1.2 — 46.4 — $1.45 \cdot 10^7$ s — about six months
- 1.4 — 54.1 — ≈ 10^3 years
- 2.0 — 77.4 — ≈ $1.3 \cdot 10^{13}$ years
- 4.0 (a covalent bond) — 155 — 🔴 ≈ 10^{46} years — a number with no physical meaning, see § 10.2a

10.2A. TWO CAVEATS WITHOUT WHICH THE TABLE IS READ WRONGLY

① The last row is not "geological time" — it is nonsense, and must be called so. At 4.0 eV the formula returns ≈ 10^{46} years: the age of the Universe is shorter than this by thirty-six orders of magnitude. Such a value is not a prediction. It means only that in this region the formula ceases to describe anything: other decay channels will act long before, the specimen itself will be destroyed, the conditions will change. Hence a rule that holds throughout the volume: a number exceeding the lifetime of the object is not published as a lifetime — what is published is the statement "above the limit of measurability".

② The whole table is computed at 300 K — a room, not a body. Ten degrees look like a detail and are not one:

Barrier — τ at 300 K — τ at 310 K — Shorter by

- 1.0 eV — ≈ 2 hours — ≈ 35 minutes — 3.5×
- 1.2 eV — ≈ six months — ≈ 37 days — 4.5×
- 1.4 eV — ≈ 10^3 years — ≈ 180 years — 5.7×

The exact factor is $\exp[E_a(1/kT_{300} - 1/kT_{310})]$, the exponent being 1.247 E_a. 🔴 For the subject of this work the operating temperature is not room temperature. Wherever a lifetime is quoted for a living medium it must therefore be recomputed at 310 K rather than taken from this ta-

ble. The recomputation always works against us: at body temperature every state lives several times shorter than in the laboratory.

10.3. FIRST CONSEQUENCE: THE BAND IS NARROW

Everything of practical use for storage — from seconds to millennia — lies between 0.8 and 1.4 eV:

$\Delta E_a \approx 0.6$ eV.

Six tenths of an electronvolt separate a state that vanishes as one watches from a state that outlives civilisations. Outside this band there is no choice: below 0.8 eV the state is unfit for storage, above 2 eV the lifetime exceeds any relevant period and the distinction between "long" and "forever" stops being physical.

A statement corrected in our own text, and the correction is a point in favour of the method of ch. 7. It formerly read "below 0.5 eV the state cannot be observed by available methods". That is false: 0.5 eV corresponds to $\approx 2 \cdot 10^{-5}$ s, twenty microseconds, whereas relaxation techniques work confidently from picoseconds — dielectric spectroscopy, NMR relaxation, time-resolved optics cover that range and far below. Precisely because the fast region is well observable, the barrier can be measured in hours instead of a year: a temperature series drives the state into the short-time region where the instrument sees it, and the barrier is extracted from the slope. Unfitness for storage and unobservability are different things, and we of all people must not confuse them.

A direct requirement upon language follows. The phrase "the state is retained for some time" carries no assertion: almost the entire range of possible barriers yields either "unobservably fast" or "longer than the experiment". The intermediate regime exists, but it requires the barrier to be set within tenths of an electronvolt — and it cannot be discussed without naming the number.

10.4. SECOND CONSEQUENCE: THE PRICE OF A STEP IS NEGLIGIBLE

Within the band the sensitivity is extreme. A step of 0.2 eV — of the order of a single hydrogen bond (the reference spread for hydrogen bonds in water is 0.1…0.4 eV, 0.2 eV typical) — multiplies the lifetime by

$\exp(0.2/0.0259) \approx 2.2 \cdot 10^3$.

Two thousand times for one hydrogen bond. A step of 0.4 eV gives a factor $\approx 5 \cdot 10^6$: from two hours to a thousand years.

💎 This explains what in the field looks like a dispute about opinions. Two observers working with systems that differ by one hydrogen bond see incompatible pictures: one reports "nothing is retained", the other "it is retained stably". Both are right. They stand on opposite sides of the narrow band, and the difference between their systems is smaller than the precision with which they describe those systems.

10.5. THIRD CONSEQUENCE: WHAT CANNOT BE A CARRIER

The relation of § 10.1 works as a prohibition as well. Substituting the hydrogen bond energy,

$E_a \approx 0.2$ eV Rightarrow $\tau \approx 2 \cdot 10^{-10}$ s.

📌 This is an upper estimate and must be read as one. The value $\tau_0 = 10^{-13}$ s is taken for solid-state systems (§ 10.1); direct measurements of hydrogen-bond network rearrangement in the liquid give times two orders of magnitude shorter — units of picoseconds. The discrepancy strengthens the conclusion below rather than weakening it: the real carrier lives shorter still.

Consequently the hydrogen-bond network is excluded as a carrier of a long-lived record — not on grounds of plausibility but quantitatively. Any model in which the state is stored in the configuration of hydrogen

bonds at room temperature must account for a discrepancy of seventeen orders of magnitude between the required time and the one obtained.

This prohibition strikes the hypotheses most convenient to the present work. The aqueous subsystem of aquahydrates is exactly a hydrogen-bond network, and the temptation to explain storage through it is maximal. The computation closes that route. It is placed first in the chapter rather than in a footnote, because a work that excludes its own convenient explanation is testable in a way that a work preserving it is not.

What remains possible (and is treated in chs. 11–16): barriers associated with reorientation of structural groups, defect pinning, phase boundaries and the topology of orientational order — carriers for which 1.0… 1.4 eV is a normal rather than an exceptional value.

10.6. A CORRECTION TO OUR OWN RESULT

This chapter corrects an arithmetic error in an earlier formulation of our own result, and gives it in full.

As it stood: "a change of the barrier by 0.2 eV changes the lifetime from two hours to fifteen hundred years"; elsewhere, "by seven orders of magnitude".

What is wrong. Both statements refer to a step of 0.4 eV, not 0.2. By our own reference table on the same page, two hours correspond to 1.0 eV and millennia to 1.4 eV. A step of 0.2 eV gives a factor of $2.2 \cdot 10^3$ — three orders and a little, not seven.

Why the error arose. The table was computed correctly and the verbal conclusion beneath it took the extreme rows, skipping the intermediate one. This is a typical defect: the formula computes, the human generalises.

Why it was found. The statement was built so as to be checkable in two minutes with a calculator. 🥇 The property we advance as a merit of the work operated against our own formulation — which is the best confirmation that the property is real. A number that cannot be checked is neither wrong nor right; it is merely asserted.

What changed in substance. Nothing. The band is narrow — that is the content of the result; its narrowness now carries an exact number (0.6 eV) and its sensitivity an exact factor ($2 \cdot 10^3$ per 0.2 eV).

10.7. LIMITS OF THIS CHAPTER

Everything said refers to one barrier and one relaxation channel. A real system has many, and the observed lifetime is set by the fastest, not the slowest. Therefore:

- the computation gives a necessary condition of stability, not a sufficient one;
- multi-barrier and cooperative processes obey the same formula only to within an order

of magnitude, with an effective barrier;

- the value $\tau_0 \approx 10^{-13}$ s is an estimate, and changing it by an order shifts the

computed lifetime by an order without affecting conclusions about the width of the band, since it shifts the whole scale together.

🔴 And the principal limitation: we have not measured the barrier height in our substance. The chapter sets a requirement; it does not report a result.

10.8. A FORK: WHAT ELSE CAN HOLD A STATE

10.8.1. AN ASSUMPTION THAT HAD NOT BEEN NAMED AS ONE

All the foregoing rests on a single premise: the state is held by the height of an energy barrier. The premise follows from nothing in chs. 1–9. It entered together with the formula of § 10.1 and operated as a law, while being a choice of model.

Retention is of at least four kinds, and barrier height is only the first.

Mechanism — What holds the state — What the substance must provide

- ① — Barrier — height of the barrier above thermal noise — a barrier of 0.8…1.4 eV (§ 10.2)
- ② — Topological — impossibility of a continuous path to another state — an ordered phase with an order parameter
- ③ — Flux-driven — a continuous supply of energy from outside — a named source of the flux
- ④ — Collective — redundancy: a single element is unstable, the ensemble is not — an estimate of ensemble size and failure statistics

10.8.2. WHY THE SECOND MECHANISM MATTERS PARTICULARLY

Topological protection does not require a high barrier per elementary act. It charges not one particle but the whole extent of the defect at once.

The energy of a linear lattice defect per unit length is

$E/L \approx (\mu b^2)/4\pi \ln R/r_c$

 An order-of-magnitude substitution ($\mu \approx 10$ GPa, $b \approx 1$ nm, $\ln(R/r_c) \approx 7$) gives $E/L \approx 5.5 \cdot 10^{-9}$ J m^{-1}, so that for a defect one micron long $E \approx 3.4 \cdot 10^4$ eV $\approx 10^6$ kT — against 30…54 kT for the working barrier band.

The difference lies not in the height but in how the price is assembled. The barrier mechanism requires a single elementary act to be expensive;

the topological one does not require that at all — it makes the disappearance of the whole configuration expensive, because the entire length must be paid for at once.

🔴 The conclusion is robust against ignorance of the exact figure: even at μ = 1 GPa and b = 0.5 nm the result remains of order 10^4 kT, two to three orders above any row of the barrier table. ❓ The elastic constants of this crystal have been measured in the literature by ultrasonic and Brillouin methods; we do not have their numerical values, and until they are substituted the figure is published only as an order-of-magnitude estimate.

📐 The same mechanism in soft matter gives figures many orders lower — the elastic constants of mesophases are of the order of piconewtons — and it is nevertheless sufficient: bistable liquid crystal cells hold their state with no power at all. That is working technology, not a hypothesis (ch. 16).

10.8.3. WHAT THIS CHANGES FOR OUR SUBJECT

1. The barrier line is not withdrawn — it remains the first and best developed. 2. It ceases to be the only one. Chapter 16 describes topological memory as established physics; until this fork was introduced, Part III did not know of it. 3. The refutation condition becomes addressed. "A barrier below 0.8 eV buries the hypothesis" is false as a general statement: it buries the barrier model, not the subject. Each mechanism receives its own threshold — otherwise the refutation of one model would be read as the refutation of the whole work, and that is a substitution.

10.8.4. THRESHOLDS DECLARED BEFORE THE EXPERIMENT

Mechanism — Counts as support — What refutes it

- ① barrier — measured activation energy ≥ 0.8 eV (0.8…1.4 eV being the band of practical storage) — a value below 0.8 eV

- ② topological — reproducibly distinguishable states of the order parameter, persisting without an external field, with a computed transition price ≥ 10^3 kT — absence of an ordered phase, or a transition price below 10^2 kT
- ③ flux-driven — a named source and loss of the state when it is switched off — the state does not depend on the flux
- ④ collective — lifetime depends on ensemble size — independence of size

🔴 The thresholds are declared before any measurement, all four at once, and are not subject to rewriting in the light of results.

🔴 The silent gap between the two thresholds of mechanism ② is named. Acceptance at ≥ 10^3 kT and refutation below 10^2 kT do not meet. The band between them is the undecided band: neither counted nor refuted. Falling into it requires one of two actions and no third — repeating the computation with measured elastic constants, or declaring the mechanism indistinguishable at the precision achieved. Reading it as partial support is prohibited. 📌 The rule extends to every threshold of the volume: a threshold must either meet its refutation or carry a named zone of indeterminacy. Mechanism ① was corrected accordingly (the gap there lay above 1.4 eV); ③ and ④ meet by construction.

10.8.5. THE LIMIT OF THE FORK — SO THAT IT DOES NOT BECOME A LOOPHOLE

Extending the list of mechanisms relaxes none of the five conditions for a record (ch. 9). A topologically protected state remains a marking, not a record: it has neither an alphabet nor a procedure of addressed read-out. The mechanism answers the question "what holds it", and no mechanism answers the question "what does it mean".

🔴 A second honest boundary: topological protection forbids a state to disappear but does not forbid it to move. The barrier to defect motion is incomparably lower than the price of its creation, so the configuration may drift while remaining topologically the same. For a carrier whose meaning is assigned to a place, this is a separate threat, and it enters the verification programme on equal terms with the rest.

CHAPTER 11. WHAT ONE BIT COSTS

11.1. TWO QUANTITIES THAT TURNED OUT TO BE ONE

In the physics of information there is a limit established by Landauer: the irreversible erasure of one bit in a medium at temperature T requires at least

$E_{min} = kT \ln 2$.

At T = 300 K this gives $E_{min} = 0.0259 \times 0.693 = 0.0179 \approx 0.018$ eV, that is $\approx 2.9 \cdot 10^{-21}$ J.

In condensed matter physics there independently exists another quantity — the thermal scale kT, which determines what state the medium will destroy spontaneously. Anything held by a barrier of order kT lives for a time of the order of the lattice vibration period (ch. 10).

🔑 The observation that constitutes the content of this chapter: these are the same quantity in two roles. The factor ln 2 ≈ 0.693 is all that separates them.

Role — Value at 300 K — What it fixes

- Price of information — kT ln 2 = 0.018 eV — the minimum cost of irreversibly erasing a bit
- Stability threshold — kT = 0.026 eV — the level below which the medium erases the state itself

Both propositions have been known for decades. Placing them side by side as one quantity in two roles has not, to our knowledge, been done — and that is a statement about our work, refutable by producing an earlier publication containing the same juxtaposition.

The status of this claim is provisional, and it is named so from bitter experience of the same day. Our claim about the water number sounded exactly as confident — "nobody has compared water in the crystal with liquid water by volume" — and a literature check withdrew it: the comparison was already in print. The line above therefore stands only until a specialist review of the information-physics literature, and "we were first" is asserted neither here nor on the public pages.

11.1A. AT WHAT TEMPERATURE THE PRICE OF A BIT WAS COMPUTED

All figures in this section are obtained at 300 K. For a medium at body temperature:

300 K — 310 K

- Thermal scale kT — 0.0259 eV — 0.0267 eV
- Price of a bit kT ln 2 — 0.0179 eV — 0.0185 eV

The difference is small and works against us twice: in a warm medium a bit costs more, while the barrier holding the state stands lower relative to the noise. Wherever a living medium is concerned, the second column is used.

11.2. WHAT FOLLOWS

① Thermal noise ceases to be merely a nuisance. In one role it is what spoils the record; in the other it is what the record is paid for. A medium in which nothing is erased spontaneously is at the same time a medium

in which erasure is expensive; cheap writing and long memory are thermodynamically opposed requirements, not independent wishes.

② A requirement upon any model of a record. It is stated in one line and addressed to all, including the present work:

Name a barrier substantially exceeding kT — or do not speak of a record.

"Substantially" has the numerical sense of ch. 10.  For one year at 300 K this means $E_a \approx 1.21$ eV, roughly 47 times the thermal scale.

This value was corrected during the read-through: it formerly read "1.2 eV for a year". By the reference table of ch. 10, 1.2 eV yields $1.45 \cdot 10^7$ s, about six months; a year requires 1.21 eV. The difference is one hundredth of an electronvolt, and it changes the answer twofold. That is not pedantry about rounding but an illustration of the narrow-band theorem itself: in the region where the carrier operates, the second decimal place is already physics.

③ Limits of applicability. The Landauer limit concerns irreversible erasure and sets a lower bound. It does not assert that a record exists in the system, and does not forbid reversible operations at lower cost. The refutation is stated: exhibit a writing regime in which the cost of a bit is unrelated to the temperature scale of the medium.

11.3. LIMITS OF THIS CHAPTER

The computation speaks of cost and stability, not of the presence of a carrier, an alphabet or a read-out procedure. That a bit is cheap does not imply that one has been written; that the medium does not erase it does not imply that there is anything to erase.

CHAPTER 12. THE CAPACITY CEILING — AND ITS COLLAPSE

12.1. HOW MANY ORDERED SITES THERE ARE IN A CUBIC CENTIMETRE

For the cubic lattice of the class considered, the cell parameter is a ≈ 12.16 Å (reference structural data). The cell volume is V_cell = a^3 ≈ $1.80 \cdot 10^{-21}$ cm^3, whence

$N = 1/(1.80 \cdot 10^{-21}) \approx 5.6 \cdot 10^{20}$ cells cm^{-3}.

If each cell carried one bit,

$C = (5.6 \cdot 10^{20})/8 = 7 \cdot 10^{19}$ bytes = 70 exabytes per cm^3.

The everyday anchor for that volume is a lump of sugar.

The assumption "one bit per cell" is named explicitly and is justified by nothing beyond convenience of estimation. It overstates the result: a genuinely distinguishable state generally requires a collective of cells. The number is therefore used only as an upper bound.

12.2. THE PRICE OF COMPLETE ERASURE

Multiplying the number of sites by the price of a bit from ch. 11:

$E_{total} = 5.6 \cdot 10^{20} \times 2.9 \cdot 10^{-21}$ J ≈ 1.6 J.

In order of magnitude this is the energy of raising a glass of water (250 g) by 65 centimetres: from the table to eye level.

Two corrections carried over from the Russian read-through, both against us. The everyday anchor formerly read "by some ten centimetres"; the direct computation h = E/mg gives 0.65 m, so the anchor understated the height six-fold and made the energy look more negligible than it is. And the value itself stood in our register of results as "about 1.5 joules", whereas direct multiplication gives 1.62 J — a small discrepancy that arose from rounding in the convenient direction. Hence a rule adopted in the volume: rounding always goes against us —

figures favouring our position are rounded down, figures constraining us are rounded up.

💎 The meaning of this number is the opposite of what is expected. A colossal information capacity costs a ludicrously small amount of energy — whence a prohibition: observed effects in such a system may not be explained by energy transfer. There is negligibly little energy there. If an effect exists, its carrier is organisation, not energy.

12.3. THE COLLAPSE: WHAT IS THERE TO READ WITH

All the above concerns capacity. Between capacity and information lies what we do not have:

1. an alphabet — which distinguishable states of a cell or of a collective encode symbols; 2. addressing — how to reach a chosen site rather than the specimen as a whole; 3. a read-out procedure — non-destructive, reproducible, with an error estimate; 4. a writing procedure — setting the state of a chosen site rather than of the whole volume.

None of the four is solved in the present work. We possess no means either of writing cell by cell or of reading cell by cell.

Capacity is a property of the carrier. Information is a property of whoever can read. A disk with no connector stores zero bits.

12.4. WHY THIS NUMBER MAY BE PUBLISHED AT ALL

An upper estimate is invulnerable precisely because it asserts nothing about the problem being solved. It states one thing: nature does not forbid the task — 📐 the site density exceeds, by four to five orders of magnitude, what has been achieved in semiconductor recording (a deliberately conservative comparison). And it states a second thing at once: we have neither an alphabet nor a read-out.

🥇 We publish the ceiling together with the admission that there is nothing to read it with, and that is the only construction in which such a number is not a claim of superiority. The number without its second half would work against us before the first attentive reader.

12.5. LIMITS OF THIS CHAPTER

The upper bound follows from lattice geometry and is independent of what happens inside the substance. It does not account for the collective state required for distinguishability, the interaction of neighbouring sites, degradation on read-out, or noise. Each of these four corrections reduces the result and none increases it — which is why 70 exabytes remains a ceiling under any refinement.

CHAPTER 13. THE LADDER OF LIFETIMES: TWENTY-FIVE ORDERS OF MAGNITUDE

13.1. Why the dispute about the memory of water is insoluble in the form in which it is conducted

The question "does water possess memory" has been discussed for more than three decades and has no answer — not because data are scarce, but because the carrier is left unspecified. In aqueous and water–mineral media several physically distinct subsystems coexist, each with its own lifetime, and these lifetimes differ by tens of orders of magnitude.

"There is no memory" is true of one subsystem. "There is memory" is true of another. Both sides tell the truth about their own rung and say nothing about the rest.

13.2. THE LADDER

Each rung is a studied carrier with published times. Bottom upwards.

— Carrier — Characteristic time — Status

- 1 — Hydrogen-bond network of bulk water — ~10^{-12} s — 🟢 measured
- 2 — Water in the first coordination shell of an ion — picoseconds to seconds, depending on the ion — 🟢 measured
- 3 — Dissolved gases and microbubbles — minutes to days — 🟢
- 4 — Water at a phase boundary — far longer than in the bulk; the value is debated — 🟡 frontier
- 5 — Impurities and ionic composition — practically unlimited — 🟢
- 6 — Clathrate frameworks — hours to geological epochs, while the guest is present — 🟢
- 7 — Liquid-crystalline phases — as long as the phase holds: hours, days, the lifetime of a cell — 🟢
- 8 — Solid lattice defects — years — 🟢
- 9 — Mineral zoning — 10^{8} years — 🟢

Span of the scale. From 10^{-12} s to 10^{8} years = $3.15 \cdot 10^{15}$ s:

$(3.15 \cdot 10^{15})/(10^{-12}) \approx 3 \cdot 10^{27}$,

that is, more than twenty-seven orders of magnitude. The register of results claims "not fewer than twenty-five" — deliberately more cautious than the computation, and we do not raise it: a claim robust to any refinement of the boundaries is worth more than a claim exact under one set of assumptions.

13.3. WHAT THE LADDER YIELDS

① The question is reformulated. Instead of "does water remember" — "which carrier, and for how long". In that form the question has a definite answer for every rung, and the answer is testable.

② Rung 1 closes the most discussed hypothesis. The structure of water itself lives picoseconds; a long-lived record in the hydrogen-bond network is excluded — and we state this ourselves, without waiting for the objection.

The computation of § 10.5 gives an upper estimate for the same quantity, $2 \cdot 10^{-10}$ s, because τ₀ there is taken for solid-state systems, while direct measurement in the liquid gives two orders less. Both figures are negligible against any period of storage, and the prohibition of rung 1 rests on either of them. The word "agrees" formerly stood here and was removed: two hundred picoseconds and units of picoseconds are not agreement, and the discrepancy works for the prohibition, not against it.

③ Rungs 5–9 show where it is sensible to look. The dullest carrier — ionic composition — is at the same time the most reliable: what has entered the medium stays there until it is removed.

🔑 The ladder is useful above all because it excludes. The list is not declared closed: carriers not included in it are possible. What is asserted is different — whoever claims a carrier is obliged to name it.

13.4. LIMITS OF THIS CHAPTER

The times of the rungs are taken from the literature for model systems and differ between substances, ions and conditions. The scale gives orders of magnitude, not values for our specimen: we have no relaxation-time measurements of our own on any rung.

CHAPTER 14. MEMORY AND PRESENCE

14.1. A DISTINCTION THAT REMOVES HALF OF THE DISPUTES

The word "memory" in this field covers two phenomena that behave in opposite ways.

Memory — a trace remaining after the cause has gone. Presence — an order existing together with the cause.

The distinction is not terminological. It is experimental: the two regimes yield opposite predictions in independent measurements.

Test — If it is memory — If it is presence

- Remove the introduced substance (ion exchange, sorption, filtration) — the effect persists — the effect disappears with the substance
- Dilute below the detection limit of the substance — the effect persists — the effect vanishes and does not return
- Wait a time far exceeding the lifetime of the subsystem — the effect persists — the effect decays on its own timescale

🔑 None of the three tests requires new apparatus or new physics. They are ordinary procedures, and they separate the two regimes unambiguously.

14.2. THE COMPUTED CORRIDOR: WHERE A CARRIER MAY RESIDE AT ALL

From below — the lifetime of the structure of water itself: ~ 10^{-12} s. Below that boundary a carrier cannot exist: that which is proposed to do the storing does not itself exist.

From above — the residence time of the introduced particles in the medium: practically unlimited until they are removed (rung 5 of the ladder).

In a homogeneous solution — where there is no second phase — exactly one stable occupant is found in this interval: an ion together with its first coordination shell. The residence time of a water molecule in the first shell of certain small multivalent cations reaches seconds; these are

classical data of coordination chemistry, differing between ions by many orders of magnitude.

$(1\ \text{s})/(10^{-12}\ \text{s}) = 10^{12}$.

Twelve orders of magnitude is the distance from the lower boundary of the corridor to the lifetime of that occupant — not the width of the corridor, which is unbounded above. The gap is the same as between one second and thirty-one thousand years.

The condition of homogeneity is essential and was added deliberately. Rungs 3, 4, 6 and 7 of the ladder live longer than a second in the same interval; there is no contradiction with any of them, because each requires a second phase — gaseous, interfacial, clathrate, mesomorphic. Uniqueness of the occupant holds for a homogeneous solution and for that alone. Without this condition § 14.2 would silently deny chapter 16.

14.3. OUR POSITION — AND WHY IT IS COMPUTED RATHER THAN CHOSEN

We claim presence, not memory.

What matters is the manner in which this is claimed. The modest position here is not the result of caution and not a concession to critics: there is simply no other place for a carrier in the corridor. From below it is excluded by the lifetime of the structure of water; from above, by the fact that what lives longest is the introduced particles themselves, not a trace of them. This is a rare case in which restraint of formulation is the result of a computation.

A direct consequence for the language of the whole volume: the constructions "the water remembered", "the structure persisted after removal", "information remained in the solution" are not used — not as forbidden phrases, but as contradicting our own corridor.

14.4. WHAT THEN REMAINS OF THE SOLID CARRIER

The question that must be asked here rather than in the conclusion: if in solution the carrier ceases to be a carrier, what is it for?

The solid phase is a way of manufacturing and preserving a prescribed state until the moment of use. The order set during growth is held by barriers of 1.2…1.4 eV at 300 K — from six months to millennia by the reference table of § 10.2. At the moment of dissolution the long-range order disappears; this is an established fact confirmed by direct methods: the characteristic diffraction pattern vanishes. What remains is what § 14.2 lists: ions, their near environment, and the altered parameters of the medium.

The temperature is named deliberately. The figures above hold at 300 K, which is legitimate for storage — storage takes place at room temperature. In a living medium (310 K) the same barriers give times 3.5 to 5.7 times shorter: 1.2 eV yields about 37 days instead of six months, 1.4 eV about 180 years instead of a thousand. Barriers of 1.0 eV formerly appeared in this sentence as holding a state "for years"; by our own table 1.0 eV is two hours, and years begin at about 1.25 eV.

● What the work does not assert: that the dissolved state carries structural information of the original crystal. Such a statement would contradict §§ 14.1–14.2 and is not supported by measurement.

14.5. A TESTABLE PREDICTION INSTEAD OF A DEFENCE

The distinction of § 14.1 turns the principal blow against the work into a programme:

1. Prepare the system and record the observable. 2. Remove the introduced substance by a procedure that changes no other condition. 3. Prediction, declared in advance: the observable returns to the control

level. If it persists, the regime "presence" is refuted — and it is our position that is refuted, not the opponent's.

📌 The acceptance threshold declared before the experiment, and the required series size, are given in chs. 19–22. 🔴 We have no measurements of our own by this procedure; the chapter formulates the experiment, not its result.

14.6. LIMITS OF PART III

Part III as a whole establishes requirements and prohibitions, not facts about our substance. The barrier necessary for a year of storage is named; the carrier impossible by lifetime is excluded; the corridor in which a carrier is possible is bounded from both sides; the regime in which we state our result is named and equipped with a procedure for its refutation. No quantity in Part III was obtained by measurement of ours, and none requires trust in us: all are verifiable with a calculator and a reference book.

CHAPTERS 15–18

CHAPTER 15. THE LIQUID-CRYSTALLINE STATE OF BIOPOLYMERS

15.1. A THIRD STATE OF MATTER THAT IS USUALLY SKIPPED

Between a crystal, where molecules are ordered both in position and in direction, and a liquid, where neither is ordered, there exists a class of states with one kind of order and not the other: directions are correlated, positions are not. These are mesophases, or liquid crystals.

What matters for the present work is that orientational order:

- is order in the strict sense — it is described by an order parameter, has a correlation

length and a lifetime (the coordinates of chs. 6–7);

- does not require a rigid lattice — it exists in a mobile medium;
- is set from outside — by a boundary and an external field, not by composition.

15.2. WHAT IS ESTABLISHED ABOUT BIOPOLYMERS

① Concentrated DNA forms mesophases. At high concentrations DNA solutions pass into a cholesteric and then a columnar hexagonal phase. This is established by direct methods — polarising microscopy, scattering — and has been studied in detail by the school of Livolant and Leforestier. It is not a model: the phase diagram has been constructed and the textures described.

② In a number of unicellular organisms the chromosomes are in a liquid-crystalline state. The best-studied example is the dinoflagellates, whose chromatin is organised cholesterically.

③ Cell membranes are liquid-crystalline media. The lipid bilayer possesses orientational order without positional order, has its own phase transitions and changes state with temperature and composition. This is textbook biophysics.

🔑 The conclusion of the chapter matters more than the list: the liquid-crystalline state is not an exotic notion imported to explain our subject, but the normal state of biological matter. A carrier operating through orientational order therefore enters a medium that is built the same way — and this is a statement about the medium, not about our specimen.

15.3. WHAT DOES NOT FOLLOW FROM THIS

🔴 From the fact that both the carrier and the medium possess orientational order, transfer of order between them does not follow. Coincidence of the type of order is a condition of possibility, not a mech-

anism. Statements of the form "the structure of the carrier passes into the structure of the tissue" are not advanced in this work: such a transfer would require separate measurements, which do not exist.

The term "biofield" is not used. The organism's own electromagnetic fields are measurable and several orders of magnitude weaker than the geomagnetic field; the existence of a field and the ability to transmit structure by it are different statements, and the second is not supported by data.

15.4. LIMITS OF THIS CHAPTER

All three propositions of § 15.2 refer to model systems and preparations — concentrated solutions, isolated chromatin, artificial bilayers. Transfer to a living cell in its normal state requires caution: concentrations, temperatures and the presence of proteins alter the picture. The work takes from this chapter only what it needs: orientational order in biological matter is an established fact, not a supposition.

CHAPTER 16. TOPOLOGICAL MEMORY: A STATE THAT LIVES IN GEOMETRY

16.1. THE CORE OF PART IV

If a carrier is required that holds a state for a long time and without expenditure of energy, there is a solution demanding neither new physics nor concessions: store the state not in the molecules but in the configuration of a field of directions.

In a mesophase the mean direction of the molecules at a point is described by the director field n(r). Configurations of this field differ not only in shape but in topological class: there exist states that cannot be carried into one another by continuous deformation. To each such state an integer is assigned — the topological charge.

16.2. WHY SUCH A STATE IS STABLE

Stability here is of a different nature from that of ch. 10. There the barrier was set by a bond energy; here a transition between states requires a break in the continuity of the field — the formation of a defect that costs a finite energy. The state is not "held by force"; it has no continuous path to another state.

A direct consequence observed in technology: bistable liquid-crystal cells hold their state with no power at all. Devices of this kind — zenithally bistable cells among them — retain one of two configurational states until a switching signal is applied. This is not a hypothesis and not a result of ours; it is working display technology.

The phrase "indefinitely long" formerly stood here and has been removed. It contradicted two places in our own work: the rule of § 10.2a ("a number exceeding the lifetime of the object is not published as a lifetime") and § 16.7 below, where the lifetime of the carrier is bounded by the lifetime of the phase. A cell holds its state within the service life of the device, and its merit is not eternity but something else: no energy is spent on maintaining the state. That is precisely what the work needs; the absolute added nothing and made a testable statement untestable.

🔑 Hence the proposition on which the whole line rests:

Directional order fixed by topology is a carrier for which long storage without expenditure of energy is the norm rather than the exception.

16.3. THE TORUS AS A PHYSICAL OBJECT, NOT AN IMAGE

In liquid crystals, localised configurations of the director field with a closed toroidal structure of lines are observed — torons and hopfions. They have been produced, photographed, and their stability and mobility are under study.

💎 This is the one place in the two-book cycle where the torus ceases to be an analogy: in the first book a closed contour was the form of a process (a smoke ring, a vortex); here it is a stable configuration in matter, distinguishable by topological charge. The formula of the cycle — "the laws are the same, the carrier is different" — is fulfilled here literally.

🔴 At the same time: the existence of torons in laboratory liquid-crystal systems is not a statement about the presence of such configurations in our substance or in living tissue. It establishes a class of admissible states, not the fact of their presence.

16.4. HOW THIS RELATES TO THE COORDINATES OF ORDER

Coordinate (Part II) — What it is for topological memory

- Magnitude of order — the order parameter of the mesophase, S
- Scale — the size of the localised configuration
- Lifetime — bounded not by a bond barrier but by the cost of forming a defect
- Controllability — switching by an external field — yes; addressed read-out — no

🔴 The fourth row is the boundary of the chapter: control is demonstrated, read-out is not solved. By the discriminator trace — chronicle — marking — record this yields a marking, not a record: the state can be prescribed and it holds, but there is no alphabet and no procedure of addressed reading (ch. 12).

16.5. WHY THIS IS STRONGER THAN AN EXPLANATION THROUGH EXOTICA

The temptation to explain long storage by special properties of water, by field interactions, or by a level of reality "where different laws apply", is

strong in this area. This chapter shows that it is superfluous:

- orientational order — 🟢 established physics;
- topological protection of a state — 🟢 established physics;
- storage without power — 🟢 working technology;
- the presence of such states in our substance — 🔵 a hypothesis requiring measurement.

Three of the four require nobody's trust. One remains a hypothesis — and it is named as one.

16.6. CONNECTION WITH PART III: THIS MECHANISM IS NOW ON EQUAL FOOTING WITH THE BARRIER

Until the fork of § 10.8 was introduced, the volume computed the lifetime of a state in one way only — through barrier height — although the present chapter described a second mechanism and assigned it to firmly established physics. The two lines were not joined, and that produced a bias: the whole of Part III rested on a premise that Part IV did not share.

Three consequences follow for this chapter:

① The price of a state is computed differently. In the barrier model a single elementary act must be expensive (the band 0.8…1.4 eV = 30…54 kT); here what is expensive is the disappearance of the whole configuration — 🧱 of order 10^4…10^6 kT for a defect one micron long, because the entire length must be paid for at once.

And immediately a prohibition on the step the reader will take unaided. The number "10^6 kT" stands next to the formula $\tau = \tau_0 \exp(E_a/kT)$ and invites substitution into its exponent. It must not be substituted there, and the work is obliged to say so before an opponent does. $\exp(10^6)$ is a magnitude beside which the 10^{46} years of § 10.2a look modest; it is ex-

actly the case for which the rule of the volume exists — a number exceeding the lifetime of the object is not published as a lifetime.

Why the substitution is illegitimate in substance, not merely in decorum. The relation of § 10.1 describes a single-act hop over a single barrier. A topological state perishes otherwise: through the nucleation of a defect of finite size — the price grows with the size of the nucleus, and the system need not pay for the whole length at once; through boundaries, surfaces and inclusions, where the price is far lower than in the bulk; and through the disappearance of the phase itself (§ 16.7). The channel realised is always the cheapest, not the one computed.

The price $10^4 \ldots 10^6$ kT is therefore published as a measure of the protectedness of a configuration and never as a duration of storage. The lifetime of a topological carrier is predicted not by Arrhenius but by the lifetime of the phase and the work of forming a critical nucleus — quantities we do not have.

② The refutation condition is addressed. "A barrier below 0.8 eV" buries the barrier model, not the subject. The topological line has its own threshold: reproducibly distinguishable states of the order parameter, persisting without an external field, with a computed transition price $\geq 10^3$ kT; it is buried by the absence of an ordered phase in the specimen, or by a transition price below 10^2 kT.

Between the two thresholds lies the band $10^2 \ldots 10^3$ kT, and until it was named the volume said nothing about it. A silent gap in declared thresholds is not a detail: it is exactly the opening through which a result is later read in one's own favour ("it fell short of acceptance, but then it did not refute either"). Thresholds are declared in advance precisely so that this cannot happen. The band is named directly: neither counted nor refuted. Falling into it obliges one of two actions and no third — repeat the series with measured elastic constants, or declare the mechanism indis-

tinguishable at the precision achieved. Reading it as partial support is prohibited.

③ The weak point is named in its own place. Topological protection forbids a state to disappear and does not forbid it to move: the barrier to defect motion is far below the price of its creation. For a carrier whose meaning is assigned to a place this is a separate threat — and it is entered into the verification programme rather than left to the reader.

16.6A. WHAT THE FIVE CONDITIONS FOR A RECORD STILL REQUIRE

Extending the list of mechanisms leaves all five conditions for a record standing. A topologically protected state is a marking: it has neither an alphabet nor a procedure of addressed read-out. The mechanism answers the question "what holds it"; the question "what does it mean" is answered by an alphabet and a read-out procedure, and those are what the conditions still ask for.

16.7. LIMITS OF THIS CHAPTER

Topological protection acts within the existence of the phase. Destruction of the mesophase — by heating, dilution or change of composition — destroys both the configuration and its topological class: there is nothing left to protect. The lifetime of such a carrier therefore equals the lifetime of the phase (rung 7 of the ladder, ch. 13), not infinity, and in solution it obeys the same corridor of presence as described in ch. 14.

📌 The counterpart condition stands in ch. 14: uniqueness of the occupant of the corridor is declared there for a homogeneous solution in which there is no second phase. A mesophase is a second phase, and this chapter does not contradict the corridor.

CHAPTER 17. LIGHT AS A WITNESS

17.1. WHAT EXACTLY IS MEASURABLE

Biological objects emit ultraweak optical radiation — of the order of units and tens of photons per second per square centimetre, in the visible and near ranges. The phenomenon has been measured with photomultipliers in dark chambers since the 1950s and is described in the modern literature as ultraweak photon emission.

The established mechanism of the main part of this radiation is chemiluminescence: recombination of the products of oxidative reactions, primarily involving reactive oxygen species. The intensity varies with the metabolic state of the object, with damage, with stress.

🔑 The formulation the work adopts: light here is a witness of processes, not a carrier of a message. The radiation reports the state of the medium in which it arose, exactly as the glow of embers reports combustion, encoding nothing in the process.

17.2. THE HISTORICAL LINE — WITH HONEST STATUSES

Work — What is established — Status

- Gurwitsch, 1920s: "mitogenetic radiation" — an ultraviolet signal influencing cell division — the fact of ultraweak radiation was later confirmed instrumentally; the biological function of the signal has not been independently reproduced — 🟡 historically important, not accepted as a mechanism
- Popp and followers: measurements of photon emission, the hypothesis of coherence of the radiation — the measurements — 🟢; the interpretation as a coherent informational field — not generally accepted — 🟢 fact / 🟡 interpretation

🔴 The work builds no conclusions on an interpretation that is not generally accepted. It uses the fact of measurability and the dependence of

intensity on state — which suffices for light to serve as an instrument of control.

17.3. DIFFRACTION INSTEAD OF HOLOGRAPHY

An explanation through holography is widespread in this literature: the medium is said to record a volumetric image of an object.

🔴 The work does not use that explanation, and the reason is technical rather than a matter of taste. Holographic recording requires a reference wave — a second coherent beam of known phase interfering with the object beam. In biological and water–mineral systems there is no reference wave, and therefore no hologram in the physical sense of the word.

✅ The exact replacement, giving the same thing without the vulnerability: an ordered medium is a three-dimensional diffraction grating, and the interaction of radiation with it is described by the Bragg condition

$$2d \sin \theta = n\lambda.$$

From this follows everything that was required: selectivity in wavelength and direction, sensitivity to the period of the structure, the possibility of reading structure from the scattering pattern.

First boundary — periodicity. The Bragg condition works where there is long-range order or a regular structural pitch: in a crystal, in a cholesteric phase with its selective reflection, in columnar phases. In a homogeneous solution there is no periodicity and no Bragg reflections; what remains is diffuse scattering, from which short-range order is extracted rather than a picture of structure. Otherwise there would be a head-on collision with § 14.4, where dissolution makes the characteristic diffraction pattern vanish. Both places are true so long as it is said what they refer to: diffraction read-out is an instrument for the solid phase and for mesophases, not for a solution — which is why it stands in

the work as a way of characterising the carrier before use, not of detecting it afterwards.

Second boundary, and a harder one: the wavelength must match the period. From the condition itself, with $\sin\theta \le 1$ and $n = 1$, follows $\lambda \le 2d$. For atomic order ($d \approx 0.5$ nm) this gives $\lambda \le 1$ nm — the X-ray range. Visible light (400…700 nm) exceeds the limit by a factor of hundreds and produces no Bragg reflections on a crystal lattice at all: not "weakly", but with no solution to the equation.

Hence a division without which the section is read wrongly: atomic order is read with X-rays — this is ordinary diffraction analysis; the visible range works where the period of the structure is itself of the order of hundreds of nanometres, in cholesteric and columnar mesophases whose selective reflection produces observable iridescence (ch. 15). The same law at a different scale.

And the consequence that must be said aloud, because it is precisely where this line is caught: in both cases the probe is external — an X-ray tube or a laser, with known wavelength, direction and coherence. The specimen's own ultraweak emission is unfit for reading structure: it is incoherent, undirected, and lies outside the Bragg condition for atomic order. The statement "the medium reads itself by its own glow" is advanced by this work in no form whatever — and its absence is now secured by computation rather than by silence.

17.4. WHAT THE WORK TAKES FROM THE LINE OF LIGHT, AND WHAT IT DOES NOT

Takes: 1. Ultraweak emission as a measurable indicator of the state of a medium — an instrument of control in the verification programme (Part V, § 20.7.2: dark count, pairing, blind coding, a 3σ threshold and an interpretive gate). 2. Diffractive interaction of radiation with an ordered

structure as a way of reading structure (not a message), within the applicability of the Bragg condition (§ 20.7.1).

Does not take: 1. "Radiation transfers structural information between objects" — not supported by data. 2. "A coherent biophoton field governs the organism" — an interpretation not generally accepted; not used as support. 3. Any statement about effects of light on health.

17.5. THREE FACTUAL CORRECTIONS TO THE SOURCE MATERIAL

They are made here because an opponent strikes at any one of them first, and the blow is scored against the whole text at once.

① Jacques Benveniste was not a Nobel laureate. A French immunologist, head of an INSERM unit; the publication on basophil degranulation appeared in Nature in 1988. He held no Nobel Prize. If a Nobel laureate who worked with electromagnetic signals of diluted DNA sequences is required, that is Luc Montagnier (the 2008 prize, for HIV; the electromagnetic-signal work dates from 2009–2011).

And immediately a caveat, without which this correction does more harm than the error it corrects. Replacing "the wrong laureate" with "the right laureate" leaves intact the argument from title itself, and that argument falls at a single stroke — the more painfully because we would have offered it ourselves. Montagnier's 2009–2011 work on electromagnetic signals has not been independently reproduced and stands, by the criterion of ch. 21, where the DNA phantom stands; the prize was awarded for other research and has no bearing on it. How this must be read: the correction repairs a factual error of name and title — and nothing more. Neither Benveniste nor Montagnier nor their prizes are supports of the present work; a title does not appear in the list of things by which anything is confirmed in this volume — there stand a series, a threshold and reproduction (ch. 21). Rule of the volume: when correct-

ing someone else's argument from authority, do not offer a better authority in its place.

② Gerald Pollack, not "Elie Pollack". University of Washington, Seattle; the exclusion-zone concept and the book The Fourth Phase of Water. Under a wrong name the work cannot be found.

③ The "DNA phantom", recorded over weeks, is a single observation by one group. What is at issue is a resonant interaction of laser radiation with a DNA preparation: laser correlation spectroscopy, early 1990s, a single laboratory. It has not been independently reproduced; the most discussed explanation is an artefact of the apparatus — residual contamination of the cuvette, dust, drift.

Why the set-up is named here, not a surname. A result can be checked; a person cannot. A result has a wavelength, a cuvette, a registration time and a number of repeats — and on each of these points it can be repeated, disputed or explained as an artefact. A surname has none of these features: in a dispute it can work only as an argument from name — the very device this chapter declined to use in point ①. The rule here is the same for both sides: what is disputed is not a person but the result of a specific set-up. The address of the primary source in the literature is kept in the service apparatus of the Russian edition and in the corpus literature catalogue, section C; the surname is not carried into the printed text of the chapters.

🔴 Decision on the phantom: it does not enter the supports of the work. It is placed in the section "What did not pass verification" — beside Kelvin's vortex atoms: a beautiful form, ideally suited to a book about closed contours and traces in a medium, and one that failed the volume's own criterion (ch. 21 — signs of unreliable data; a proof is a series, not an observation).

📌 This is not a denial of the idea. It is calling the status by its name: a single observation, not an established fact. Should the result be independently reproduced, it will move from one section to the other — and the work states in advance the condition under which that happens.

CHAPTER 18. NONLINEAR DYNAMICS AND ITS LIMIT

18.1. WHAT GENUINELY EXISTS

The nonlinear dynamics of DNA is a real area of theoretical physics. Models are known that describe localised excitations in the double helix: base-pair opening as a nonlinear wave, soliton solutions of the corresponding equations (the Peyrard–Bishop model and its developments, the work of Yakushevich and others). The models are used to describe thermal denaturation and the mobility of segments of the chain.

This is conscientious physics with publications and computations. The work does not dispute it.

18.2. WHERE THE MODEL ENDS AND THE SURPLUS BEGINS

From the existence of soliton solutions it does not follow that a soliton carries a genetic message. Between the two statements lies a gulf that this literature often crosses in silence:

Statement — Status

- Localised nonlinear excitations are possible in the double helix — a model exists, applied to denaturation 🟡
- Such excitations carry information about the sequence — not supported 🔵
- Such transfer occurs between organisms through a medium — not supported by data ⛔

🔑 The work stops at the first line and declares the second an open question, not a mechanism. The reason is not caution: a mechanism asserted without data brings down with it, at the first check, those parts of the work that are supported by data.

18.3. WHY "DIFFERENT LAWS" IS A WEAK POSITION

A strategic recommendation is current in this area: move the discussion to a level where different laws apply, and thereby remove the subject from the objections of chemistry.

🔴 The work does not accept that recommendation — because it is weaker, not because it is more cautious. A claim to laws of one's own reads unambiguously: it did not work out in known physics, so new physics was appointed. It removes the subject not from objections but from the possibility of proving anything.

The position of the work:

The laws are the same. The carrier is different.

Everything required — a carrier storing a state in geometry rather than in molecules — is supplied by orientational order, topological protection, lattice defects and activation barriers, that is, by ordinary condensed matter physics (chs. 10, 16).

18.4. CONCLUSION OF PART IV

Position — Status — Role in the work

- Mesophases of biopolymers — 🟢 established — the medium is built as the carrier is
- Topological memory, bistability — 🟢 established — a mechanism of storage without expenditure of energy on maintenance — within the existence of the phase

- Ultraweak emission — 🟢 fact of measurability — an instrument of state control — a witness, not a carrier
- Diffraction on structure (Bragg condition) — 🟢 — a way of reading structure with an external probe: X-rays for atomic order, visible light for mesophases ($\lambda \leq 2d$)
- Interpretation of emission as an informational field — 🟡 not generally accepted — not a support
- Soliton transfer of a message — 🔵 — an open question
- The DNA phantom — ⚠️ a single observation — "What did not pass verification"

💎 The principal result of the part is not in the list: the line the author holds to be a priority was brought into the work in full, without the loss of a single one of its motifs — field, light, structure, memory — while the supports were taken exclusively from what is established. The motif is preserved, the vulnerability removed. That is what it means to speak loudly: not to lower the voice, but to choose those statements that cannot be overturned.

18.5. LIMITS OF THE PART

Not one position of Part IV has been measured by us. Everything established refers to other systems — laboratory mesophases, liquid-crystal devices, biological preparations. The statement that the described mechanisms operate in our substance is made in no chapter of the work and is the subject of the programme (Part V).

CHAPTERS 19–22

CHAPTER 19. THE COMPUTED CORRIDOR: WHAT MAY BE ASSERTED BEFORE MEASUREMENT

19.1. WORK WITHOUT A LABORATORY IS NOT AN EXCUSE BUT A GENRE

The project has no measured values of its own: after the quarantine of 10.08.2026 there are none, and Part I says so directly. What follows is not a demotion of the work but a choice of genre: the volume is not a report on data but a protocol for obtaining them, in which every quantity stands with its value field empty and its acceptance threshold declared in advance.

💎 A work that cannot present data but can present a project for obtaining them stands not behind an empirical study but ahead of one.

🔴 And the price of that position immediately: the genre disposes of the demand "show the raw data", but in exchange it obliges us to do what an ordinary paper does not — to declare the outcome that will bury us (§ 20.5).

19.2. THE CORRIDOR: WHERE A CARRIER MAY LIVE AT ALL

Before searching, it is useful to compute where searching is pointless.

Boundary of the corridor — Value — Source

- Below — $\approx 10^{-12}$ s — lifetime of the hydrogen-bond network of water itself — spectroscopic data
- Above — residence time of the introduced particles — practically unlimited until they are removed — rung 5 of the ladder, ch. 13
- Lifetime of the single stable occupant — seconds — retention of water in the first shell of a multivalent ion — reference data on ligand exchange
- Distance from the lower boundary to that occupant — $\approx$ 12 orders of magnitude — arithmetic

🔑 In a homogeneous solution, where there is no second phase, the stable occupant of this interval is exactly one — an ion with its near shell. Hence the position of the volume, obtained by computation rather than by caution: what is named as the carrier in the liquid phase is the presence of a substance, not the memory of a medium. There is no other place in the corridor.

19.3. WHAT COMPUTATION FROM CONSTANTS GIVES, AND WHAT IT DOES NOT

Gives 🟢 — Does not give 🔴

- the order of magnitude and upper bounds — the third decimal place
- prohibitions: where an effect is impossible by energy or by symmetry — confirmation that an effect exists
- the expected range of a measurable quantity before the experiment — the value of that quantity
- grounds for declaring an acceptance threshold in advance — the right to call the threshold a result

📌 A rule of the volume: a number computed from constants has the right to constrain and no right to confirm. All twelve numbers of the work are used in the constraining role only.

19.4. THREE PREDICTIONS MADE BEFORE ANY MEASUREMENT

They can be tested and refuted, and they are recorded here for exactly that purpose.

① The barrier. If the state the project speaks of does live for months at room temperature, its barrier must lie in the band 1.1…1.3 eV, the point "months" falling at ≈ 1.20 eV ($1.45 \cdot 10^7$ s). The edges of the band are stated honestly wide: 1.1 eV yields only three or four days, 1.3 eV already

decades. A measured barrier outside the band refutes the claim of long-term retention; it does not refine it.

The temperature of the prediction is named. The band above is computed at 300 K. For a living medium:

Condition — Band for "months" — Point ≈ 5.5 months

- Storage, 300 K — 1.1…1.3 eV — 1.20 eV
- Living medium, 310 K — 1.14…1.34 eV — 1.24 eV

The shift is +0.04 eV, and it is small only until one recalls the price of the second decimal place — the same hundredth that turns six months into a year. Consequence for the programme: the barrier is measured in the laboratory and applied to a medium at another temperature, therefore the report of a series must state the temperature at which the band was declared, otherwise acceptance and refutation are compared against different scales.

② The temperature response. The logarithm of the relaxation time must be linear in inverse temperature over the working interval. A systematic departure from the straight line means that there is more than one process, and then the single number "lifetime" loses its meaning — which is also a result.

③ Capacity. The upper bound on the number of distinguishable states is set by the number of cells — $5.6 \cdot 10^{20}$ per cubic centimetre. Any claim of a capacity above this bound is arithmetically wrong, including our own, should one ever appear.

CHAPTER 20. MEASURE THE ENERGY INSTEAD OF WAITING OUT THE TIME

20.1. THE MISTAKE THAT RUINS PROGRAMMES OF THIS KIND

The natural plan for testing durability is to observe: lay down specimens and measure them after a month, six months, a year. The plan looks honest and is a dead end: it costs a year, yields one point, and does not distinguish "the state survives" from "the instrument drifts".

20.2. THE REPLACEMENT: FOUR POINTS INSTEAD OF A YEAR

Lifetime depends on the barrier exponentially (ch. 7). It is therefore sufficient to measure the relaxation time at four or more temperatures, plot the logarithm of the time against inverse temperature, and take the slope.

A year of waiting is replaced by the slope of a line.

What the series does — What comes out of it

- 4+ temperatures, each with its relaxation time — the barrier in eV
- barrier + the Arrhenius relation — the lifetime at any temperature, including one nobody will wait out
- scatter of the points about the line — an estimate of the reliability of the barrier itself
- systematic departure from the line — 🔑 a result in its own right: there is more than one process

💎 The last row matters most. In an ordinary setting a departure is a nuisance; here it is a finding — a multi-barrier process is a substantive statement about the carrier.

20.2A. FOUR POINTS ARE NOT ENOUGH — THE FULL REQUIREMENT ON THE SERIES

The accuracy of the barrier is set by the span in inverse temperature, not by the number of points. 🧱 At a 20 % noise level in the measured time, a window of 0…60 °C yields ± 0.04 eV, whereas a window of 17…37 °C yields ± 0.11 eV. The step of the reference table is 0.2 eV — so in a

narrow window 1.0 and 1.2 eV merge into one measurement, though their lifetimes differ by a factor of two thousand.

Requirement on the series — Value

- Number of points — ≥ 4
- Span of the window — ≥ 50 degrees
- Upper limit — declared before the experiment; for our class, safely below 92 °C (melting in its own water), loss of water beginning earlier
- Specimen mass control — mandatory at every point
- Reporting — the achieved uncertainty of the slope is stated

🔴 The sense of the last two rows: in heating a specimen for the sake of span, the experimenter at some point begins to measure something other than what was placed in the instrument. Mass control is the only cheap way to notice this.

💎 And a merit of the method, stated plainly: the slope yields the barrier independently of the pre-exponential factor. The value $\tau_0 \approx 10^{-13}$ s is an estimate, and any conclusion drawn from a single measurement at a single temperature inherits it. A series is free of it.

20.3. THE CONTROL SERIES: WHAT TO COMPARE AGAINST

The programme does not compare our specimen with water. Such a comparison always yields a difference and means nothing. Controls are taken from the isomorphous series — four pairs, each changing exactly one parameter:

Pair — What changes — Variables — What it discriminates

- ① two members of the series of the same structural type — the ion — 1 — composition ↔ geometry

- ② protonated ↔ deuterated specimen of one substance — the hydrogen isotope only — 1 — whether the effect belongs to hydrogen bonds
- ③ hydrate ↔ dehydrated form ⚠ — the aqueous subsystem and the framework geometry — 2 — whether water in the lattice is needed at all; does not separate water from geometry
- ④ one composition, different growth history — conditions of crystallisation — 1 — a trace of growth ↔ a prescribed state

Pair ③ is marked ⚠ and is not withdrawn: it answers the question "is water needed" while changing two quantities — on dehydration the lattice rebuilds into a different substance. Hence the operative formulation of the method: not "one variable per pair", but a declared number of variables, declared before the experiment.

🔴 Requirement on every pair: the threshold of difference is declared before the measurement, together with a computation of the sensitivity of the method. A difference smaller than the declared threshold counts as no difference, not as "a hint of an effect".

20.4. HOW THE THREE UNFULFILLED CONDITIONS FOR A RECORD ARE CLOSED

The debt from ch. 9: discrimination and, in part, repeatability are satisfied; the alphabet, prior correspondence and blind read-out are not.

Condition — How it is closed — Acceptance threshold, declared in advance

- ① Alphabet — name a finite set of distinguishable states of the carrier and the quantity that distinguishes them — states count as distinguishable if separated by ≥ 3 standard deviations of repeated measurements

- ② Prior correspondence — a table "preparation condition → expected state", published before the series, with its date fixed by hash — the table is not edited after the data arrive; an edit annuls the series
- ③ Blind read-out — specimens anonymised by a third party; the reader does not know the key — identification above chance at a declared significance level and a pre-set series size

📌 Until these three lines are closed, the volume calls what has been achieved a marking, not a record — and will go on calling it so however much time passes. The word changes with the data, not with fatigue.

20.5. THE OUTCOME THAT WILL BURY US — DECLARED IN ADVANCE

If, at a confirmed sensitivity of the method, none of the four control pairs yields a difference above the declared threshold, and the measured barrier proves to be below 0.8 eV, then the claim of a prescribed and retained order in this carrier is not supported, and this is published in the same volume as any other result.

The second half of this condition is addressed, not universal. "A barrier below 0.8 eV" buries the barrier model of retention, not the subject. After the fork of § 10.8 the work has four candidate mechanisms, each with its own threshold (§ 20.6). The formulation above stands in full and applies provided the mechanism is the barrier one; if the barrier proves low, the work is obliged either to present another mechanism by its thresholds or to withdraw the claim. A third option — "then the mechanism must be some other, unknown one" — is not provided for: such an answer removes the possibility of refutation and is therefore prohibited.

💎 A genuine test is recognised by one feature: it is capable of harming the one who set it.

20.6. FOUR MECHANISMS OF RETENTION — HOW TO TELL THEM APART BY EXPERIMENT

Mechanism — What counts as support — What buries it

- ① barrier — measured activation energy ≥ 0.8 eV (series of § 20.2a); the band 0.8…1.4 eV is the region of practical storage, above 1.4 eV the mechanism is supported but the state is hard to switch — a value below 0.8 eV
- ② topological — reproducibly distinguishable states of the order parameter, persisting without an external field; computed transition price ≥ 10^3 kT from measured elastic constants — absence of an ordered phase, or a transition price below 10^2 kT
- ③ flux-driven — a named source of the flux and loss of the state when it is switched off — the state does not depend on the flux
- ④ collective — lifetime depends on ensemble size — independence of size

🔴 The thresholds are declared before the measurements, all four at once, and are not subject to rewriting in the light of results. This is the only defence against fitting: a mechanism whose threshold is set after the data is always supported.

The undecided band of mechanism ②. The thresholds of acceptance (≥ 10^3 kT) and refutation (< 10^2 kT) do not meet. The band between them is named directly: neither counted nor refuted. Falling into it requires one of two things — repeating the computation with measured elastic constants, or declaring the mechanism indistinguishable at the precision achieved. Reading it as partial support is prohibited: a silent gap between thresholds is the most convenient entrance for fitting, because

formally no declared rule is broken. The rule is extended to the whole volume: a threshold must either meet its refutation or carry a named zone of indeterminacy. Mechanism ① was corrected accordingly (its gap lay above 1.4 eV); ③ and ④ meet by construction.

20.6A. A SEPARATE TEST FOR DRIFT — IT FOLLOWS FROM THE WEAK POINT OF CH. 16

Topological protection forbids a state to disappear but not to move: the barrier to defect motion is incomparably lower than the price of its creation. For a carrier whose meaning is assigned to a place, this is a separate threat, and it is tested separately: what is required is the preservation of the arrangement, not merely of the set of states.

20.7. THE OPTICAL CIRCUIT: TWO INSTRUMENTS FROM CHAPTER 17

20.7.1. INSTRUMENT ① — DIFFRACTION READ-OUT OF STRUCTURE

What it does: characterises the order in the carrier before use — the period of the structure and, through the width of the reflection, the correlation length (coordinate ② of Part II).

Where it applies: the solid phase and mesophases with a regular pitch (the Bragg condition, § 17.3). 🔴 Where it does not: a homogeneous solution — there is no periodicity and no Bragg reflections; what remains is diffuse scattering and short-range order. Demanding a diffraction pattern from a solution and declaring its absence a result is an error announced here in advance.

What to probe with is assigned by wavelength, not by habit. 🟥 From the Bragg condition follows $\lambda \leq 2d$, hence:

What is characterised — Period d — Probe

- atomic order, the hydrate sublattice — 0.1…1 nm — X-rays (visible light fails the condition by a factor of hundreds)
- a mesophase with regular pitch — hundreds of nm — visible range, selective reflection

🔴 In both cases the probe is external and coherent. The specimen's own ultraweak emission (instrument ② below) is unfit for reading structure and is not used in that role: the two instruments of this section solve different problems and are not to be conflated. A protocol in which structure is "read" by the specimen's own glow is not accepted for execution.

20.7.2. INSTRUMENT ② — ULTRAWEAK EMISSION AS AN INDICATOR OF STATE

What it does: registers changes in the intensity of the specimen's own optical emission and that of the medium — a quantity depending on metabolic and oxidative state (§ 17.1).

Condition of the series, declared in advance — Requirement

- Dark count — measured before and after every sample; drift above the declared level annuls the sample
- Pairing — specimen and control in one chamber, on one day, on one instrument
- Blinding — samples coded by a third party, decoded after processing
- Acceptance threshold — difference in intensity ≥ 3 standard deviations of the dark count, at a pre-set number of repeats
- Size — the number of repeats is fixed before the series and is not increased after the first look at the data

🔴 The interpretive gate matters more here than the instrumental one. Even a fully accepted difference in intensity means only that processes

in sample and control run differently. It does not mean transfer of information by light, the existence of a coherent field, or the transmission of structure between objects — the three statements § 17.4 explicitly declines, and the result of an optical series does not create them. 🔑 Light in this work is a witness, not a carrier; the protocol must end with the same word the chapter begins with.

CHAPTER 21. WHAT BETRAYS FABRICATED DATA — AND WHY WE KNOW THIS PRECISELY

21.1. THE TEST THAT IS USUALLY ABSENT

Papers customarily test whether a difference is significant. They almost never test the converse: whether the agreement is too good.

Scatter substantially smaller than expected requires explanation just as much as scatter substantially larger.

The reason is simple: a real measurement is noisy. Instruments drift, temperature wanders, hands differ. A series whose scatter is suspiciously small usually indicates not high precision but that the data never met reality.

21.2. WHERE THIS METHOD CAME FROM IN THIS VOLUME

It was extracted from the project's own error. In an early revision of the second work, constructed data were identified precisely by the implausibly small scatter of control values. The result was a quarantine act: all in-house measured values of the project were withdrawn from circulation, and the volume is built so as not to depend on them.

💎 Anomalously small scatter is not a sign of precision. It is a sign that the data never met reality. We know this not from the literature.

📌 That is why the line "measurements of our own — none" stands throughout the volume: it is not modesty and not a pose, but the conse-

quence of a decision that was carried out.

21.3. THE SET OF TESTS, APPLIED TO ANY DATA, INCLUDING OURS

Test — What it looks for

- Scatter against expectation — implausibly good agreement (§ 21.1)
- Distribution of the last significant digits — traces of manual "tidying" of numbers
- Repeated blocks of values — copied fragments of a series
- Coincidence of outliers with dates and batches — substituted conditions instead of an effect
- Agreement with the author's expectation across all subgroups — absence of blinding

🔴 Rule of order: the set is applied first to one's own data and before publication. An error found by the author is part of the work; an error found for the author is a characteristic of the author.

21.4. A NUMBER INSTEAD OF AN EYE

This chapter demands numbers of every other chapter and, until this section was added, had none of its own. "Anomalously small scatter", "suspiciously even digits" are formulations of exactly the kind the volume condemns elsewhere: a statement without a quantity. The ruler by which the other chapters are measured must be graduated first.

① Implausibly good agreement — criterion and threshold. For a series of n values with a previously declared expected variance, the statistic χ^2 is computed and its left tail examined:

$\chi^2 = \Sigma_{i=1}^{n}((x_i - \bar{x})^2)/\sigma^2_{exp}$, p_left = $P(\chi^2_{n-1} \le \chi^2_obs)$.

p_left — Reading

- > 0.05 — agreement is normal
- 0.01 … 0.05 — 🟡 suspiciously good — the series is flagged and repeated
- ≤ 0.01 — 🔴 agreement better than physically possible; the series is withheld until the cause is explained

🔑 The test is neither new nor ours: the left tail of χ^2 has been used to examine "too smooth" data since the classical re-examinations of historical series in genetics. The work takes a standard procedure and declares its threshold in advance, as it does for every other threshold in the volume.

② Last significant digits. The terminal digits of a series must be distributed uniformly (10 % each). The test is χ^2 for uniformity with 9 degrees of freedom; the threshold is the same, $p \le 0.01$ withholds the series. 🔴 The typical trace of manual tidying is an excess of zeros and fives, and it is visible arithmetically, without any assumption about intent.

③ Requirement on the order of operations. The expected variance σ^2_{exp} is declared before the series is obtained, from the instrument specification and repeated measurements of a standard. A variance assigned after looking at the data turns the whole test into decoration: any result can be fitted to it.

📌 Both thresholds apply to our own future series first and are entered into §§ 20.2a, 20.3 and 20.7.2 as a mandatory acceptance procedure for a data set, not as a recommendation.

CHAPTER 22. THE VERIFICATION CIRCUIT AND THE LOUDNESS SCALE

22.1. THREE LEVELS THROUGH WHICH EVERY STATEMENT PASSES

Level — Question — What answers it

- V · Rules — by what rules is the statement testable at all — status marking, pre-declared refutation, the queue of competing explanations, the withdrawal protocol
- VI · Quantities — in what quantities must it be expressed — the coordinates of ch. 6, the parameters of ch. 7, the admission criterion of ch. 8
- VII · Instruments — by what means are those quantities obtained — the methods of ch. 20, control pairs, sensitivity

🔴 A statement that fails even one level is not part of the work. Not "weak", not "contentious" — simply not part of it.

22.2. THE LOUDNESS SCALE: FIVE STEPS, NONE TO BE SKIPPED

Step — What must stand behind it

- we assume — internal consistency and computation from constants
- we observed — a recorded observation with a described procedure
- we showed — a series with controls and a threshold declared in advance
- it is established — independent reproduction by other hands
- 🔴 it is proven — not used in empirical disciplines

Where this volume stands is stated plainly: the first step for its own claim about a prescribed order in the carrier; the facts of the class on which it leans — composition, symmetry, the clathrate limit — stand on the fourth, having been reproduced many times by others and taken from reference works.

Those facts formerly stood on the second step, on the grounds that they "were not observed by us". That confused the status of a statement with

our participation, whereas the scale measures the former. A reference fact reproduced by independent groups is established by the definition of step four, whoever reproduced it; the step "we observed" denotes a single recorded observation with a described procedure — and on that step stands, for example, the DNA phantom (§ 17.5). The correction is at once more honest and stronger: the volume leans on the fourth step of others' knowledge and claims the first for its own.

💎 Between "we assume" and "we have proven" lies not courage. There lie years of work, and we state how many of them remain.

22.3. THE ASYMMETRY IN THE PRICE OF AN ERROR

A claim accrues to its author. The bill for an error is sent to three addresses, none of which is the author:

1. those who believed — they acted on what was said; 2. those working nearby — after a loud failure the whole field stops being funded; 3. the subject itself — it ceases to be investigated for years.

🔑 Hence the rule of loudness in this volume, and it is not a moral one: speak at full voice only of what you can present — and present it loudly. Restraint in claims stops being a trait of character and becomes a calculation of price.

22.4. THE PROTOCOL FOR WITHDRAWING ONE'S OWN STATEMENT

A work describes in advance how it will renounce its words — otherwise the renunciation never happens.

Step — What is done

- 1 — a result falling under § 20.5 is recorded and dated before any discussion

- 2 — the statement is moved one step down the scale of § 22.2 on the same day; 🔴 for a statement already on the first step there is no step below — it is withdrawn and transferred to "What did not pass verification" with its date (the zero step of the protocol: without it the protocol failed exactly where the volume itself stands)
- 3 — it is published as a separate text, not as a footnote in a new revision
- 4 — every place where the statement stood is marked but not deleted — the history remains visible

💎 Honesty here is not a trait of character. It is a construction in which the author has no technical possibility of quietly rewriting the past.

CONCLUSION OF PART V AND OF THE VOLUME

Part — What it gives — Measurements of ours

- I · The class — the class exists and is defined by four criteria; five numbers from reference works — 0
- II · Coordinates — the language in which statements about order can be made at all — 0
- III · The price of a record — barrier, price of a bit, capacity ceiling, ladder of lifetimes, memory ≠ presence — 0
- IV · Field and light — the author's line sorted by status marking; the frontier named as frontier — 0
- V · Verification — corridor, programme of measurements, control pairs, thresholds, circuit and scale — 0

🔴 The zero in the right-hand column is not a weakness of the volume but its construction. Everything asserted in it is verifiable by the reader with no trust in us whatever: constants, reference works, a calculator.

Everything requiring trust has been moved into the programme and equipped with a threshold declared before the experiment.

💎 The lock of the volume. We do not ask anyone to believe in the carrier. We hand over the corridor in which it must lie, the threshold below which it does not exist, and the outcome after which we shall say so ourselves.

SECTION «WHAT THIS STANDS ON»

Everything the volume asserts rests on four layers. The layers are not equal in strength, and they are marked rather than blended: the reader must see where the ground changes.

LAYER 1 · PHYSICAL CONSTANTS AND ARITHMETIC — CANNOT BE OVERTURNED

What — Where it works

- Molar masses, Avogadro's number — 45.6 % water · $2.7 \cdot 10^{22}$ molecules/cm³
- Boltzmann's constant, kT at 300 K and at 310 K — price of a bit 0.018 eV · stability threshold 0.026 eV · 🔴 recalculation of all lifetimes to body temperature (§ 10.2-bis)
- The Arrhenius relation — the whole scale "barrier → lifetime" (Appendix B)
- Cube geometry and the lattice parameter — $5.6 \cdot 10^{20}$ cells/cm³ · ceiling of 70 EB
- Two structures: the hydrate and its anhydrous parent ([composition withheld until the patent applications are filed]) — V_{eff} = 24.5 Å³ · water fraction by volume 65 % (Appendix C)

🔑 This layer is checked with a calculator without us. It is also the reason the volume has the right to speak loudly while holding zero measurements of its own.

LAYER 2 · REFERENCE CRYSTALLOGRAPHY AND CRYSTAL CHEMISTRY

Cell parameter 12.16 Å and space group $Pa\bar{3}$ · density ≈ 1.76 g/cm³ · incongruent melting ≈ 92 °C · isomorphous series and three structural types · clathrate frameworks, type set by guest size, the empty framework (ice XVI, metastable) up to ≈ −130 °C · anomalous birefringence by growth sectors · the anhydrous parent — the mineral [composition withheld until the patent applications are filed], P321, V = 154.76 Å³, Z = 1, density 2.80 g/cm³.

🔴 These are other people's results and they are named as such. Our contribution is not the results but their assembly into a framework of carriers: the class, the boundaries of the class, the corridor, and the discriminator between memory and presence.

LAYER 3 · ESTABLISHED IN ADJACENT FIELDS — TAKEN WITH RESTRAINT

Mesophases of concentrated DNA · cholesteric packing of chromatin in several unicellular organisms · the liquid-crystalline state of membranes · topological memory and bistable cells holding a state without power · ultraweak emission from biological objects as a measurable fact · the Bragg condition as a means of reading out structure.

🔴 Not one conclusion about transfer of order between a carrier and a medium is drawn from this layer. Coincidence in the type of order is a condition of possibility, not a mechanism.

LAYER 4 · OUR OWN PROPOSITIONS — AND THERE ARE EXACTLY AS MANY AS ARE NAMED

Proposition — Status

- Definition of the class "aquahydrates" by four checkable criteria — 🔵 ours, verifiable against reference works
- The narrow-band barrier theorem (0.6 eV for the entire scale) — 🔵 our assembly of known quantities
- Four order coordinates + the admission criterion for a quantity — 🔵 ours
- The discriminator "trace — marking — record", five conditions — 🔵 ours
- Memory ≠ presence; the computed corridor with a single occupant — 🔵 ours
- The isomorphous series as a built-in control series — ✅ entered by the author into the registry as D-19, 12.08; 🔴 wording refined: not "one variable within a pair" but the number of variables declared before the experiment
- The fork of four retention mechanisms (barrier · topological · flow · collective) with thresholds set in advance — 🔵 ours, § 10.8
- The discriminator as a 2×2 lattice (prescribed × read out), the fourth cell being the chronicle — 🔵 ours, ch. 9
- The water number W and the computation of water fraction by volume (65 %) for our substance — 🔵 candidate D-18: no classification by volumetric water fraction was found; no priority is claimed
- The claim of a prescribed and retained order within a carrier — 🔵 hypothesis, rung "we suppose"

Values measured by us: zero. There is no layer "our data" in this list, and that is not an omission of the apparatus but the state of the work after the quarantine of 10.08.2026.

SECTION «WHAT DID NOT PASS»

🔴 This section is obligatory and stands in the body of the volume, not in the notes. It holds what would have been convenient for us and what we rejected ourselves.

Position — Why rejected — By whom

- A piezoelectric account of the carrier — the structure is centrosymmetric — the effect is forbidden identically, not merely weak — by us, ch. 3
- The DNA phantom — a single observation by one group, never independently reproduced — by us, part IV
- "Water memory" in its strong form — the hydrogen-bond network lives $\approx 10^{-12}$ s; 0.2 eV $\rightarrow 2 \cdot 10^{-10}$ s — by computation, ch. 10
- The project's own measured values — identified by an anomalously small spread, withdrawn by the quarantine act — by us, 10.08
- An annulled permit document — not used as evidence of purity; only the test protocol is in force (Appendix D) — by the author, 25.07
- "Other laws" as a strategy — weaker, not more cautious: it removes the subject not from objections but from the possibility of demonstrating anything — by us, ch. 18
- Soliton transfer of a message — the existence of soliton solutions does not entail transfer of information — by us, ch. 18
- Vortex atoms as a working model — a historical form, beautiful and refuted — by the history of science

- "1.2 eV → one year" — our own arithmetical error, found 12.08 while assembling Appendix B: correctly ≈ half a year — by us, the same day
- The control pair "one member of the series in different structural types" — physically impossible: the type is set by cation size, so two quantities change rather than one — by us, on reading ch. 4
- "The stability of the empty form does not arise as a question" — it contradicted our own control pair ③; our class has no empty form at all — the lattice rebuilds into a different substance — by us, on reading ch. 5
- "Ice XVI is stable at −130 °C" — it is metastable: thermodynamic stability is expected only at negative pressures — by us, against the primary source
- "No one has compared water in a crystal with liquid water" — the comparison stands in the literature as an upper bound on V_eff; the claim is withdrawn — by us, in the literature check for D-18
- Density of the anhydrous salt 1.725 g/cm³ — a third-party aggregator's misprint (that is the density of the hydrate); the true value is 2.80. It would have yielded "water twice as dense as the liquid" — by us, tracing the origin of the number
- "Below 0.5 eV the state is not observable by available methods" — it is observable: 0.5 eV = 20 μs, and relaxation methods work from picoseconds — by us, on reading ch. 10
- "4.0 eV → geological times" — 10^{46} years is a number without physical meaning; in that region the formula describes nothing — by us, on recomputation
- The core R·E·I·G·B as "having passed the admission criterion" — the criterion was never applied to it: G is not a quantity, and I is not executable without an alphabet — by us, on reading ch. 7

- "A temperature series of ≥ 4 points" as a sufficient requirement — powerless without a span in inverse temperature: within a 20-degree window, 1.0 and 1.2 eV are indistinguishable — by us, from an error estimate

💎 Nineteen entries, sixteen of them rejected by us, ten of them in a single day of continuous reading. The list of what failed to hold is the most reliable part of the work: it cannot be embellished, and every item is checkable.

🔑 And the thing visible only at this volume of material: almost every withdrawn position was to our advantage. The work rejects not other people's objections but its own conveniences, and it does so before anyone presents them.

APPENDIX A · PASSPORT OF THE GROUP

Criteria of the class (ch. 1): ① water constitutes a comparable share of the mass · ② it occupies regular lattice positions · ③ its removal destroys the structure · ④ the substance melts in its own water of crystallization.

Substance — Water in the structure — Role of the water — In the class

- Quartz, corundum — none — — — ⛔
- Zeolites — in framework cavities — guest; leaves and returns reversibly — ⛔
- Gypsum $CaSO_4 \cdot 2H_2O$ — 2 molecules — structural, but the share is small — 🟡 borderline
- Copper sulfate pentahydrate $CuSO_4 \cdot 5H_2O$ — 5 molecules — structural, partly coordinated by the ion — 🟡 borderline

- [composition withheld until the patent applications are filed] — 12 molecules, 45.6 % by mass — builds the lattice, melts in its own water — ✅ reference representative
- Isomorphous analogues of the series $M^{+}M^{3+}(SO_4)_2{\cdot}12H_2O$ — 12 molecules, isostructural — the same — ✅
- Clathrate hydrates — the framework entire — water is the whole construction, the guest sits inside — ✅ limiting case
- [composition withheld until the patent applications are filed] (the anhydrous parent) — none — — — ⛔ and this matters: removing the water does not leave an empty framework but yields a different substance — trigonal in place of cubic

🔴 The criteria of the class do not single out any individual substance within it — stated in ch. 4 and repeated here so that the table cannot be read as proof that one row is exceptional.

APPENDIX B · BARRIER → LIFETIME AT 300 K

Formula: $\tau = \tau_0 \cdot \exp(B / kT)$, with $\tau_0 \approx 10^{-13}$ s and $kT = 0.0259$ eV.

Barrier B, eV — B/kT — Lifetime τ — What such a barrier is

- 0.026 — 1 — ~10^{-13} s — the thermal scale itself — no state is retained
- 0.2 — 7.7 — $2{\cdot}10^{-10}$ s — one hydrogen bond
- 0.5 — 19.3 — $2{\cdot}10^{-5}$ s — weak coordination
- 0.8 — 30.9 — ≈ 3 s — lower edge of the practical band
- 1.0 — 38.7 — ≈ 2 hours
- 1.2 — 46.4 — ≈ $1.5{\cdot}10^{7}$ s — about half a year — 🔑 the working point of the volume's hypothesis
- 1.4 — 54.1 — ≈ 10^{3} years — upper edge of the practical band

- 2.0 — 77.4 — ≈ 10^{13} years — practically forever
- 4.0 — 155 — 🔴 ≈ 10^{46} years — above the threshold of measurability, not a lifetime — a covalent bond

The 4.0 eV row was corrected on 12.08 during the continuous reading of ch. 10. It had read "geological times" — an understatement by more than thirty orders of magnitude, and it concealed the essential point: in that region the formula ceases to describe anything. Rule of the volume: a number exceeding the age of the subject is not published as a lifetime.

THE TABLE IS COMPUTED AT 300 K. FOR A LIVING MEDIUM — RECALCULATION TO 310 K

Barrier — τ at 300 K — τ at 310 K

- 1.0 eV — ≈ 2 hours — ≈ 35 minutes
- 1.4 eV — ≈ 10^{3} years — ≈ 180 years

Ten degrees shorten the lifetime by a factor of 3…6 across the working band. Wherever a time is quoted for a living medium, the second column is used. The recalculation always works against us.

How to read the table. ① The entire practically meaningful scale lies between 0.8 and 1.4 eV — a span of 0.6 eV. ② A step of 0.2 eV (one hydrogen bond) multiplies the lifetime by ≈ $2.2 \cdot 10^{3}$. ③ The hydrogen bond is excluded quantitatively as a carrier of a long-lived state.

Two rows of this table were corrected on 12.08.2026 as it was being assembled — 1.2 eV (it read "one year", correctly "about half a year", and the error was in our favour) and 2.0 eV (it read 10^{10}, correctly ≈ 10^{13} years). The corrections were carried into seven files of the corpus. The ratio of neighbouring rungs did not change: the narrowness of the band — that is, the substance of the finding — is untouched.

APPENDIX C · HOW IT WAS COMPUTED — TWELVE NUMBERS

Full records are held in the working archive of calculations, each with five fields, including the obligatory "what this number does NOT mean". What follows is the summary.

The heading was corrected in the night part of the session: it read "nine numbers" against twelve rows of the table. Three numbers (items 10–12) were entered on 12.08 and the count was not carried with them — although the line immediately below already read "five records out of twelve". Hence an open debt: full records exist in the content pack for nine numbers; for items 10–12 they do not yet exist, and the pack contains a record ("how many samples are needed") that is absent from this summary. The two sets are not fully reconciled, and the debt is entered in the registry of promises rather than left in a note.

№ — Number — From what — 🔴 What it does not mean

- 1 — 45.6 % — molar masses — nothing about the properties of this water
- 2 — ≈ 92 °C — reference data — not the stability of a record
- 3 — $5.6 \cdot 10^{20}$ cells/cm³ — (12.16 Å)³ — not the number of states recorded
- 4 — 0.018 eV — the price of a bit — $kT \cdot \ln 2$ — not the energy of any process of ours
- 5 — 70 EB/cm³ — item 3 ÷ 8 — an upper bound, not a measured capacity
- 6 — 1.6 J — item 3 × the price of a bit — not the consumption of any device
- 7 — the table "barrier → time" — Arrhenius — not a property of our sample

- 8 — $6.02 \cdot 10^{23}$ — the boundary — Avogadro's number — not an argument about dilutions in our favour
- 9 — $2.7 \cdot 10^{22}$ water molecules/cm^3 ≈ 0.8 of liquid water — 48 molecules per cell × item 3 — not "structured water" and not a property
- 10 — V_eff = 24.5 $Å^3$ per water molecule — (449.3 − 154.8) / 12, from two structures: the hydrate and [composition withheld until the patent applications are filed] — 🔴 not a mark of distinction: the middle of the literature distribution (median 24 $Å^3$)
- 11 — 65 % — water fraction by volume — [composition withheld until the patent applications are filed]
- 12 — 10^4…10^6 kT — the price of a topological defect — $(\mu b^2/4\pi) \cdot \ln(R/r_c)$ over a micron — an order-of-magnitude estimate: ❓ the elastic constants of our crystal are not available to us

🔑 Five records out of twelve work against conclusions convenient to us (items 5, 8, 9, 10, 11). This is deliberate and is stated within the section itself.

APPENDIX D · DOCUMENTARY CONTROL OF COMPOSITIONAL PURITY

The basis is test protocol No. 180Л/3-31.05/24 of an accredited testing laboratory. 🔴 It is used strictly within the scope of the protocol and it alone: the annulled permit document of the former category is not mentioned anywhere in the volume.

Indicator — Limit, mg/kg — Result — How we read it

- Lead — not more than 5.0 — less than 0.01 — 500 times below the limit

- Arsenic — not more than 3.0 — less than 0.25 — several times below the permissible value
- Mercury — not more than 1.0 — less than 0.008 — more than 100 times below the limit

🔴 The limits of the document, named by us: 1. The scope of the protocol is three impurities. The principal substance [composition withheld until the patent applications are filed] was not included in the tests; the protocol is not a test of the principal substance. 2. "Less than X" is the limit of quantification of the method, not a measured value. The correct reading: the content lies below the threshold at which the method yields a number. 3. The protocol speaks of compositional purity and of nothing else: not of properties, not of action, not of application.

📌 The full citation rule for the protocol is set out in the work's documentary-basis passport. Departure from it in either direction — extending the conclusions or suppressing the document — counts as distortion.

APPENDIX E · WHAT IS NOT CLOSED IN THE VOLUME — REGISTRY OF OPEN DEBTS

The appendix exists because the volume requires others to state the boundaries of their claims, and therefore must keep the list of its own unclosed places inside the text, not in working files.

№ — Debt — What exactly is required — What may not be asserted until it is closed — Status

- D-1 — The barrier of our substance has not been measured — a temperature series of ≥ 4 points across a window of ≥ 50 degrees, with control of sample mass (§ 7.2-bis) — not one number about the retention time of our carrier — ⏳ requires an instrument

- D-2 — Elastic constants of the crystal — numerical values of C_{11}, C_{12}, C_{44}; the work exists (Brillouin spectroscopy, ultrasonic resonance), the values lie outside open access — the price of a topological defect is published only as an order-of-magnitude estimate — ⏳ requires an instrument or access
- D-3 — Priority on the water number W — a specialist review of the classification literature; two searches on 12.08 found no thresholds by volumetric water fraction — "we are the first" is not asserted; the status of D-18 remains candidate — ⏳ requires a review
- D-3-bis — Priority on placing the two roles of kT side by side (price of a bit ↔ stability threshold, D-02) — a review in the physics of information: were these two roles set side by side earlier — "to the best of our knowledge, they were not" is held as a candidate claim; "we are the first" is written nowhere — ⏳ requires a review
- D-4 — Thresholds of mechanisms ②–④ are declared but untried — a first experimental setup for each (§ 10.8.4) — that the retention mechanism in our substance is established — it has been not chosen — ⏳ requires an instrument
- D-5 — Not one measured order coordinate — the programme of part V in full — any quantitative claim about the state of our sample — ⏳ requires an instrument
- D-6 — Continuous reading of the volume — chapters 1–22 — that the volume has been read through in full — ✅ closed: the volume has been read in full, all 22 chapters; 31 defects corrected, 16 refinements entered
- D-7 — English edition — translation to the standard of the series — that the work is available to an outside reader — ✅ closed: this English edition is complete — front matter, chapters 1–22, apparatus and appendices A–E

🔑 How to read this appendix. A debt is not a weakness of the work but its address. Every row states what exactly will settle the question and what may not be said until then. A work without such a list is not free of debts — it merely has no inventory of them.

💎 Five of the seven debts cannot be closed by text: they require an instrument. That is the honest boundary of a volume written before the experiment rather than instead of it.

The full text of the work. It is also open in the reader at 91-99-192-247.sslip.io/library.html, with bookmarks and a return to your place.