Perturbation Theory of the Tension Medium — Part III: The Last Door

Martin Scholl — Independent Researcher

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Abstract. Parts I and II identified the medium as a bundle of radial fall lines and proved that gravity gives them no sideways force: within all previously available machinery, $V(d) = 0$ and the sky's drum cannot sound. One computable sector remained — the quaternion field's own self-coupling — and this note walks through that door. The mediation audit leaves exactly one candidate messenger between two threads: the long-range fiber mode this corpus already requires for galaxy rotation (the screw's carrier) — a consistency, not an invention. Because every fall line is identically oriented, they carry like charge under that mode, and like charges under vector exchange *repel*: logarithmically, in the transverse plane. A bundle of identical, logarithmically repelling lines is a known system — the one-component plasma, Abrikosov's problem — and it *crystallizes*. **The drum's missing ingredient, a preferred transverse spacing, exists in this sector.** The price is one parameter, the line tension — and matching the lattice constant to the measured first peak returns $G\mu/c^2 \approx 7\times10^{-6}$, equivalently a formation scale of 3×10^{16} GeV: the canonical grand-unification cosmic-string tension, obtained from the microwave sky's spacing with no particle-physics input. Two further quarantine rows fall out unforced, including a lattice spacing at our own depth of ~7 Mpc — the observed mean separation of galaxies. All of it is stated with its flags up. Every symbol introduced before use.

1. The Mediation Audit

Two threads can only push on each other by exchanging something. Walk the corpus's own inventory. The weak fiber: massive (the 80 GeV stiffness), Yukawa-dead beyond 2.5 attometres — at megaparsec separations, exactly zero. The electromagnetic circle: massless, but the lines are dark and uncharged — zero. Ordinary gravity: Part II's exact zero. What remains is a mode this series was *forced* to postulate long before the peaks campaign existed: the long-range fiber carrier of the quaternion screw, required by galaxy rotation phenomenology at the $a_0 = cH$ scale, exiled there when algebraic torsion failed by ninety-six orders of magnitude. If the fall lines carry the screw-charge — and they are the natural flux lines of exactly that sector — then two lines interact through it. Nothing new has been added to the theory; a debt owed by one phenomenon has been presented to another.

2. The Sign, Derived

Every fall line runs the same way: radially outward from the observer — the hedgehog. Identical orientation means identical charge under the fiber mode, and like charges under vector exchange repel (the same rule that makes two electrons repel). For straight parallel lines with a massless mediator the transverse problem is two-dimensional, and the potential is logarithmic: $V(d) \propto +q^2 \cdot \ln(d)$. Repulsion, unscreened, between every pair.

3. Crystallization: the Drum's Scale Exists

A plane of identical, logarithmically repelling objects is one of the most-studied systems in physics — the one-component plasma, the Abrikosov flux-line problem, the Wigner crystal. Its behaviour is settled: when cool enough, it freezes into a triangular lattice with one preferred spacing, d^*, set by the line density. A lattice at the photosphere is an angular scale on the sky; a lattice's collective modes are a ladder; and the campaign already showed the measured ladder's quarter-offset matches the wall's boundary pair. After three campaigns of honest zeros, the missing ingredient — sideways scale selection — exists in the one sector the framework had not yet computed. Whether the bundle is in fact cold enough to crystallize (the coupling-to-temperature ratio, with T from the family law) is Part IV's first calculation, flagged now.

4. The Price, and What It Buys

One new parameter enters: μ, the mass per length of a fall line — equivalently the lattice density, since $\mu = \rho \cdot d^2$ *with ρ the booked medium density. Demand the lattice constant at the wall project to the measured first peak (d = 0.39 Mpc local), and the parameter is fixed:*

$\mu \approx 10^{22}$ kg/m, $G\mu/c^2 \approx 7\times10^{-6}$, formation scale $\approx 3\times10^{16}$ GeV

That is the canonical grand-unification cosmic-string tension — the single most famous benchmark number of the cosmic-string literature — arrived at from the angular spacing of the microwave drum, with no particle physics put in. Flags, at full mast: *(i)* this is one dial fitted to one number; its content is that the dial lands on a value another tradition independently made canonical — a quarantined convergence, not a derivation. *(ii)* In the standard framework, CMB data *exclude* cosmic strings above $G\mu \sim 10^{-7}$ — but those bounds treat strings as perturbations wiggling on an FRW background, with the wiggle gravity Part II showed this framework switches off; here the strings *are* the background. The bounds do not port; they must be re-derived inside this bookkeeping before the number is either celebrated or executed.

The GUT scale, in plain words. Since the 1970s physicists have noticed that the three quantum forces' strengths are not fixed: probed at shorter and shorter distances they drift (the running of the Free-in-Pairs note) — and their three drifting strengths head toward one another, nearly meeting at one energy: about 10^{16} GeV, a thousand trillion times the proton's rest energy. That meeting point is called the grand unification scale — GUT, for

Grand Unified Theory — the suspected summit where the three forces become one force. No accelerator will ever reach it directly; it is known only as the extrapolated crossing of three measured lines. A cosmic string "formed at the GUT scale" is a thread whose thickness is the summit's tiny wavelength and whose weight per length follows from it — and that weight is exactly the $G\mu \sim 10^{-6}$ benchmark. In this series' own language the statement is simpler still: $E = \hbar c/R$ puts the GUT summit at $R \approx 6\times10^{-33}$ metres — about six e-folds above the Planck floor on the ladder, a rung that had room but, until now, no named tenant. If the fall lines' tension is what the drum says it is, the fall lines are that rung's tenant: the threads of the mollusk were spun at the summit where the forces are one. Which would be, of course, the series' title once more.

Two unforced rows follow from the same μ, since the lattice spacing scales with the medium's density as $d^* \propto \rho^{(-1/2)}$. At our own depth, $d^* \approx 7$ Mpc — **the observed mean separation of galaxies.** Galaxies as beads on the fall-line lattice: stated once, quarantined. And through the structure window of Part II (the active-mass band at $z \approx 1$–20), the local spacing runs to ~17 Mpc — the lattice coarsens with depth in the same band where the medium's lateral gravity switches on. Either the crystal is the skeleton of the cosmic web, or these are the coincidences that die in public; the quarantine column exists for exactly this.

5. Part IV, Named

The door is open; what lies behind it is now ordinary hard work. *(i)* The crystallization criterion: coupling versus family-law temperature — does the bundle freeze at the wall? *(ii)* Lattice dynamics: the collective-mode ladder of a triangular line-crystal bounded by the wall's hard-soft pair — peak ratios, widths, and the second peak's 4% against the quarter-wave ladder. *(iii)* The polarization phase. *(iv)* The cross-constraint that could kill or crown it all at once: the same fiber mode must carry the galaxy screw *and* the lattice — one mediator, two measured phenomenologies, no freedom to serve one without the other. *(v)* The re-derivation of string bounds inside single-booking. The drum has not yet sounded — but for the first time since the campaign began, the theory owns a sector in which it *can*.

References

A. A. Abrikosov (1957); E. Wigner (1934); one-component-plasma crystallization literature ($\Gamma \approx 130$); cosmic-string tension benchmarks: T. W. B. Kibble (1976), A. Vilenkin and E. P. S. Shellard, *Cosmic Strings and Other Topological Defects* (1994); and the documents of this series (Parts I–II; the campaign chronicle; the dark-matter paper — the screw; the Allgemeine Feldtheorie; script: part3.py). *(Citations from memory; the literature-verification pass applies.)*