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A Conjectural Gravitational Reading of the Three-Kappa System

Dual-Phase Area and Effective Coupling in the Fracture–Berry–Tension Framework

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Abstract

The companion paper FBT01A identifies the three-κ system $(\kappa_0, \kappa_1, \kappa_2)$ as the complete scalar geometric readout of the six-dimensional symplectic carrier $(\mathcal{B}_6, \Omega)$ in the Fracture–Berry–Tension (FBT) framework. The present paper proposes a restricted physical reading of that system, focused only on effective gravitational coupling.

The central claim is conjectural rather than derived. Among the three scalar quantities, the reduced dual-phase area κ_1 is argued to be the most natural candidate for controlling an effective four-dimensional gravitational coupling. The argument is structural: κ_0 measures the total Liouville capacity of the full carrier and is therefore too coarse to isolate the internal contribution, whereas κ_2 is a local mixed-channel density and is therefore better interpreted as a scale-dependent modulation. By contrast, κ_1 is global on the internal dual-phase sector and thus is the most plausible bridge between internal geometry and an effective four-dimensional coupling.

On this basis, we formulate a gravitational closure conjecture of the schematic form

$$G_{\mathrm{eff}}\, \kappa_1 = F(\kappa_0),$$

which reduces to a constant-product relation once a normalization convention for the total Liouville volume is fixed. The paper makes no claim to derive Newton's constant numerically and deliberately avoids stronger assertions concerning Planck's constant, mass formulae, or phenomenology. Its aim is narrower: to isolate the gravitationally most natural role of κ_1 within the three-κ system and to state the resulting conjecture in the cleanest possible form.

Paper-specific keywords: Gravitational Closure Conjecture, Reduced Dual-Phase Area, Effective Gravitational Coupling.

Geometric keywords: Grassmannian $\mathrm{Gr}(3,6)$, six-dimensional symplectic manifold, canonical 4+2 decomposition, tension algebra $\mathfrak{S}_4 \cong \mathfrak{su}(2) \oplus \mathbb{R}$, T^2 dual-phase sector.

Framework keywords: discrete–continuous–quantum correspondence (DCQ), Fracture–Berry–Tension framework (FBT), six-bit binary configuration space, Spectrum–Chern duality, structural entropy $\ln 24$, SpaceTime emergence.

Contents

1 Introduction

The Fracture–Berry–Tension (FBT) framework begins from the claim that the minimal observable geometric carrier is a six-dimensional symplectic manifold

$$(\mathcal{B}_6, \Omega),$$

not a four-dimensional spacetime manifold taken in isolation. On the regular locus, this carrier admits a local 4+2 structure, and on the regular free locus it carries a principal T^2-bundle description over an effective four-dimensional base $\mathcal{M}_4$. These results were established in the foundational papers FBT0A and FBT0B.

The next geometric step was carried out in FBT01A, where the intrinsic scalar readout of this carrier was identified. Relative to the horizontal–vertical splitting of the tangent bundle and the associated decomposition of observable curvature, one obtains three distinguished scalar quantities:

$$(\kappa_0, \kappa_1, \kappa_2).$$

Here κ_0 is the total Liouville volume of the full carrier, κ_1 is the reduced dual-phase area, and κ_2 is the mixed-channel scalar density. In FBT01A these quantities were introduced and analyzed purely geometrically. No physical constant was assigned to them there, and the mathematical framework itself does not require such an assignment.

The purpose of the present paper is to ask a more limited question:

> *If one seeks a first physical reading of the three-κ system, which of its components is the most natural candidate for carrying an effective gravitational coupling?*

The proposal advanced here is that κ_1, the reduced dual-phase area, is the natural first candidate.

This proposal is not presented as a theorem of the current FBT programme. It is a structural conjecture. The guiding logic is the following. A four-dimensional effective gravitational coupling should not be read directly from the total six-dimensional capacity κ_0, because κ_0 measures the full carrier and does not isolate the role of the internal sector. Nor should it be read primarily from κ_2, because κ_2 is local, mixed, and naturally suited to describe modulation or running. By contrast, κ_1 is global on the internal dual-phase sector and therefore stands out as the most plausible bridge between internal geometry and effective four-dimensional coupling.

The present paper is deliberately narrow in scope. It does not attempt to identify Planck's constant, derive a mass formula, or claim phenomenological agreement. Its claim is much smaller:

> *Within the three-κ system of FBT01A, the reduced dual-phase area κ_1 is the most natural geometric candidate for the background strength of an effective gravitational coupling, while the mixed-channel density κ_2 is the most natural candidate for its local or scale-dependent modulation.*

The structure of the paper is as follows. Section 2 recalls the three-κ system in the form needed here. Section 3 explains why κ_1 is structurally privileged for a gravitational reading. Section 4 states the gravitational closure conjecture. Section 5 discusses the modulatory role of κ_2. Section 6 summarizes the proposal and its limitations.

2 Review of the Three-κ System

We briefly recall the geometric structures established in FBT01A.

Let

$$T^2 \hookrightarrow \mathcal{B}_6 \xrightarrow{\pi} \mathcal{M}_4$$

be the principal T^2-bundle description of the regular carrier. Choosing a connection yields a splitting

$$T\mathcal{B}_6 = H \oplus V,$$

where H is horizontal and V is vertical.

Relative to this splitting, the observable curvature decomposes as

$$\Omega = \Omega_{\text{space}} + \Omega_{\text{coupl}} + \Omega_{\text{phase}}.$$

Writing

$$\omega_4 := \Omega_{\text{space}}, \qquad \omega_2 := \Omega_{\text{phase}},$$

one has

$$\Omega = \omega_4 + \Omega_{\text{coupl}} + \omega_2.$$

The three scalar quantities extracted from this geometry are the following.

Definition FBT01C-2.1 (The three-κ system)**.** The scalar geometric readout of the FBT carrier is given by:

$$\kappa_0 := \int_{\mathcal{B}_6} \Omega^{\wedge 3}, \tag{1}$$

$$\kappa_1 := \int_{\Sigma_2} \omega_2, \tag{2}$$

$$\Omega_{\text{coupl}} \wedge \omega_4 \wedge \omega_2 = \kappa_2\, \Omega^{\wedge 3}, \tag{3}$$

where Σ_2 denotes a regular dual-phase torus fibre.

The key point for the present discussion is that these quantities do not all have the same geometric status.

Theorem FBT01C-2.2 (Different invariant status)**.** *Within the intrinsic symplectic* 4+2 *geometry of the FBT carrier:*

(i) κ_0 *is a global Liouville-volume invariant of the full six-dimensional carrier;*

(ii) κ_1 *is a global area invariant of the dual-phase sector;*

(iii) κ_2 *is a local scalar density measuring horizontal–vertical mixing relative to the Liouville form.*

Remark FBT01C-2.3. This distinction is not cosmetic. Any attempt to assign a physical role to the three-κ system must respect the fact that κ_0, κ_1, and κ_2 live at different geometric levels: full-carrier global, internal-sector global, and mixed-channel local.

3 Why the Dual-Phase Area is the Natural Candidate

We now explain why κ_1 is the most natural candidate for a gravitational interpretation among the three scalar quantities.

3.1 A selection criterion

If a scalar quantity is to serve as the geometric carrier of an effective four-dimensional gravitational coupling, it should satisfy three requirements:

(i) it should be sufficiently *global*, so that it can support a background coupling interpretation rather than merely a local fluctuation;

(ii) it should be sufficiently *internal-sector specific*, so that it can mediate between the hidden or dual-phase geometry and the effective four-dimensional readout;

(iii) it should not already be the most natural carrier of purely *local mixing* information, since that rle belongs to modulation rather than background strength.

This simple criterion already separates the three candidates.

3.2 Why not κ_0?

The quantity κ_0 is the total Liouville volume of the full six-dimensional carrier. It is indeed global, but precisely for that reason it is too coarse to isolate the internal contribution that should be responsible for an effective lower-dimensional coupling. It measures the total symplectic capacity of the compressed observable carrier, not a distinguished internal sector.

Accordingly, κ_0 is best understood as a normalization or capacity constraint on the full geometry, not as the primary geometric carrier of an effective four-dimensional coupling.

3.3 Why not primarily κ_2?

The quantity κ_2 is local by construction. Its rle in FBT01A was to measure the weight of the mixed curvature channel relative to the Liouville volume. This already makes it the most natural candidate for local response, scale variation, or effective modulation.

That same feature makes it poorly suited to represent the background strength of a universal coupling. A universal coupling should not first be read from the most local and most variable part of the geometry. Thus κ_2 is structurally secondary in any first gravitational interpretation: it is better viewed as a dressing or correction quantity.

3.4 Why κ_1 is privileged

The quantity κ_1 occupies the intermediate and structurally most interesting position.

It is global, unlike κ_2, but it is not a global invariant of the undifferentiated full carrier in the way κ_0 is. Rather, it is global *on the internal dual-phase sector.* It therefore has exactly the right character for an effective coupling candidate: stable enough to define a background scale, but specific enough to encode the influence of the internal geometry.

Proposition FBT01C-3.1 (Structural privilege of κ_1)**.** *Within the three-κ system of the FBT carrier, the reduced dual-phase area κ_1 is the unique scalar quantity that is both:*

(i) global enough to support a background coupling interpretation, and

(ii) specific enough to the internal dual-phase sector to act as a bridge between internal geometry and effective four-dimensional readout.

Argument. The quantity κ_0 fails property (ii), because it belongs to the full carrier rather than specifically to the internal dual-phase sector. The quantity κ_2 fails property (i), because it is local and scale-sensitive. The quantity κ_1 satisfies both properties by construction. □

Remark FBT01C-3.2. The point is not that gravity has been derived from κ_1. The point is that once one asks which scalar quantity is the most natural gravitational candidate, the internal dual-phase area is singled out by a clean process of elimination grounded in geometric status.

4 The Gravitational Closure Conjecture

We now state the main conjectural proposal of the paper.

The idea is that the effective four-dimensional gravitational coupling should be read from the relation between:

- the global six-dimensional capacity κ_0, and
- the reduced dual-phase area κ_1.

The simplest possibility is an inverse relation.

Conjecture FBT01C-4.1 (Gravitational closure conjecture). *Let $(\mathcal{B}_6, \Omega)$ be the FBT carrier with three-κ system $(\kappa_0, \kappa_1, \kappa_2)$. Then the effective four-dimensional gravitational coupling G_{eff} is controlled primarily by the reduced dual-phase area κ_1, with leading relation*

$$G_{\text{eff}}\,\kappa_1 = F(\kappa_0), \tag{4}$$

for some normalization-dependent function F determined by the global Liouville-volume convention of the carrier.

In particular, after fixing a canonical normalization of the total symplectic volume, this reduces to a constant-product form

$$G_{\text{eff}}\,\kappa_1 = C_{\text{grav}}, \tag{5}$$

equivalently,

$$G_{\text{eff}} \propto \kappa_1^{-1}.$$

Remark FBT01C-4.2 (Status)**.** This statement is conjectural. It is not derived from FBT0A, FBT0B, or FBT01A. Its justification is structural: κ_1 is the natural global internal quantity available in the three-κ system, and inverse coupling–internal-size relations are geometrically familiar from compactification intuition.

Remark FBT01C-4.3 (Normalization dependence)**.** The right-hand side of (4) should not be read as universal before a normalization convention for κ_0 is fixed. Different choices of symplectic normalization on the six-dimensional carrier shift the numerical value of $F(\kappa_0)$ or C_{grav}, even if the structural inverse relation remains unchanged. Thus the meaningful content of the conjecture lies first in the form

$$G_{\text{eff}} \propto \kappa_1^{-1},$$

not in any particular coefficient.

Remark FBT01C-4.4 (Kaluza–Klein analogy)**.** The relation

$$G_{\text{eff}} \propto \kappa_1^{-1}$$

is analogous in spirit to the familiar idea that effective lower-dimensional couplings depend inversely on the size of an internal sector. The present proposal differs in one important respect: the relevant quantity is not a metric radius or metric volume, but the dual-phase *symplectic area*.

4.1 A canonical representative

If one adopts the canonical normalization

$$\kappa_0 = (2\pi)^3,$$

then the function $F(\kappa_0)$ becomes a fixed constant. A convenient representative is then

$$G_{\text{eff}} \frac{\kappa_1}{2\pi} = \frac{\kappa_0}{3!},$$

which yields

$$G_{\text{eff}} \kappa_1 = 16\pi^4.$$

Remark FBT01C-4.5. This numerical representative is only a convention-dependent form of the conjecture. It is useful as a canonical example, but should not be mistaken for the primary content of the proposal.

4.2 Limits of the present claim

The conjecture is intentionally modest. It does *not* claim:

(i) a derivation of Newton's constant from first principles;

(ii) a proof that κ_1 is the only possible gravitational variable in any future extension of FBT;

(iii) a direct phenomenological fit to observational data.

Its only claim is that, within the currently available scalar readout of FBT01A, κ_1 is the most natural geometric candidate for the background effective gravitational coupling.

5 The Modulatory Role of κ_2

The previous section treats κ_1 as the primary carrier of effective gravitational strength. We now ask what rle remains for κ_2.

The answer suggested already by its geometric status is that κ_2 is the natural candidate for modulation or running.

Because κ_2 is the local scalar density extracted from the mixed curvature channel, it measures how strongly the four-dimensional sector and the dual-phase sector are locally coupled. Therefore, even if the leading background coupling is governed by κ_1, local or scale-dependent departures from that background are most naturally assigned to κ_2.

Conjecture FBT01C-5.1 (Modulatory rle of the mixed channel)**.** *Within the FBT framework, the mixed-channel density κ_2 does not primarily determine the background effective gravitational coupling. Instead, it controls the local or scale-dependent modulation of that coupling around the leading κ_1-controlled relation.*

A schematic form of such a correction would be

$$G_{\text{eff}}(\lambda, x) = \frac{F(\kappa_0)}{\kappa_1(\lambda, x)} \, \Xi(\kappa_2(\lambda, x)),$$

with correction factor Ξ satisfying

$$\Xi(0) = 1.$$

Remark FBT01C-5.2. No explicit flow equation is claimed here. The point is purely structural: once one distinguishes background from modulation, κ_2 is the natural place for the latter.

Remark FBT01C-5.3 (Infrared reading)**.** If the mixed channel is suppressed in an infrared regime, then $\kappa_2 \to 0$ suggests that the effective coupling tends toward its background κ_1-controlled value. This provides a plausible geometric interpretation of why an effective four-dimensional gravitational coupling could appear stable when horizontal–vertical mixing is weak.

6 Conclusion

This paper has proposed a deliberately restricted physical reading of the three-κ system introduced in FBT01A.

The core point is not that gravity has already been derived from the FBT framework. Rather, the claim is that among the three scalar quantities

$$(\kappa_0, \kappa_1, \kappa_2),$$

the reduced dual-phase area κ_1 is the most plausible geometric carrier of an effective four-dimensional gravitational coupling.

The logic is structural:

(1) κ_0 is too global and belongs to the total six-dimensional capacity of the carrier;

(2) κ_2 is too local and is better interpreted as a modulation or running quantity;

(3) κ_1 is global on the internal sector and therefore is the natural bridge between internal geometry and effective coupling.

On this basis, we formulated the gravitational closure conjecture

$$G_{\text{eff}}\, \kappa_1 = F(\kappa_0),$$

with constant-product form

$$G_{\text{eff}}\, \kappa_1 = C_{\text{grav}}$$

after a normalization is fixed.

The paper has also argued that κ_2 should not be viewed as the primary carrier of gravitational strength, but as the natural candidate for local or scale-dependent modulation of the κ_1-controlled coupling.

This is the maximal claim intended here. We have deliberately refrained from identifying Planck's constant, from proposing a mass formula, and from asserting phenomenological success. Those stronger claims would require additional structures and are better left to later work if the present conjectural relation proves robust.

In this limited but clear sense, the present paper may be read as the first conjectural physical note following FBT01A: it proposes that the geometric route from the three-κ system to physics should begin not with mass or quantization, but with gravity.

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References

References

[1] Zhai. X. Y., *FBT0A: First Principles of the Fracture–Berry–Tension Framework*, FBT Series, Preprint, 2024.

[2] Zhai. X. Y., *FBT0B: Moment–Map Reduction and Global Torus Structure of the Dual–Phase Sector*, FBT Series, Preprint, 2024.

[3] Zhai. X. Y., *FBT01A: Curvature Channels and the Three–Kappa System: A Geometric Foundation for Scale Dependence*, FBT Series, Preprint, 2024.

[4] Zhai. X. Y., *FBT01B: The Four Tension Gates: Algebraic Origin, Geometric Footprints, and Physical Manifestations*, FBT Series, Preprint, 2024.

[5] V. I. Arnold, *Mathematical Methods of Classical Mechanics*, 2nd ed., Springer, 1989.

[6] J. E. Marsden and T. S. Ratiu, *Introduction to Mechanics and Symmetry*, 2nd ed., Springer, 1994.

[7] D. McDuff and D. Salamon, *Introduction to Symplectic Topology*, 3rd ed., Oxford University Press, 2017.

[8] M. Nakahara, *Geometry, Topology and Physics*, 2nd ed., IOP Publishing, 2003.

[9] S. Kobayashi and K. Nomizu, *Foundations of Differential Geometry, Vol. I*, Wiley, 1963.

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