

c as the Light Sphere

— The Causal Sphere $r = ct$, Volume Restoration, and the Origin of the Inverse-Square Law — [Paper 61]

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— *From thinking to syncing.* —

ABSTRACT

Light emitted from a point spreads over a sphere of radius $r = ct$, whose radius equals c at unit time $t = 1$. Because this “light sphere” is a **Euclidean sphere in real space**, the rest energy $E = 4\pi c^2$ (Paper 12) reads as a **genuine metric area**---the “coordinate area vs. intrinsic” tightrope of velocity space (Paper 60) does not arise, since space is flat. The paper shows three things: (i) volume restoration $\int_0^c 4\pi r^2 dr = (4/3)\pi c^3$ equals the **volume of the causal ball** light fills in unit time, exactly the $n = 2$ shell (co-area) integral (Paper 01); (ii) the inverse-square law is realized *literally* as the **dilution of light over the light sphere** ($I \propto 1/(ct)^2 = 1/r^2$); (iii) this light sphere corresponds to the **boundary** $v = c$ of velocity space (Paper 60), so A (light sphere) and B (velocity space) are **two faces**---boundary light and interior curvature. No new physical law is claimed; “ c as radius” is a choice of unit time, and reading E as area is the $m = 4\pi$ representation.

1. Notation and Stance

Stance. This paper **claims no new physical law**. That light spreads as $r = ct$, and the light cone (Minkowski 1908), are known. The contribution is to situate $E = 4\pi c^2$ (Paper 12) on the light sphere and to **separate a choice of unit / a re-reading from known physics**. Here $4\pi = \int_{S^2} d\Omega$ (Paper 01).

2. The Light Sphere: $r = ct$, Radius c at Unit Time

Proposition 1 (The light sphere and its area)

Light emitted from a point at time t forms a sphere of radius $r = ct$ (the **light sphere**). At $t = 1$ the radius equals c and the area is $4\pi(ct)^2|_{t=1} = 4\pi c^2$. Being a **Euclidean sphere in real space**, $4\pi c^2$ is a **genuine, coordinate-independent metric area**.

Hence $E = 4\pi c^2$ (Paper 12) equals the **surface area of the causal sphere after unit time**. Whereas in velocity space (Paper 60) it was in question whether $4\pi c^2$ is coordinate or intrinsic, **the flat light sphere raises no such tightrope**.

3. Volume Restoration = the Causal Ball Light Fills

Proposition 2 (Causal reading of volume restoration)

$\int_0^c 4\pi r^2 dr = \frac{4}{3}\pi c^3$ equals the **volume of the region light can reach in unit time (the causal ball)**. This is exactly the $n = 2$ shell (co-area) integral (Paper 01); volume restoration (Paper 12) reads as **light filling space**.

4. The Origin of the Inverse-Square Law Is the Light Sphere

Proposition 3 ($n = 2$ as dilution on the light sphere)

Light of power P is diluted over the light sphere $r = ct$ of area $4\pi(ct)^2$: $I(r) = \frac{P}{4\pi(ct)^2} = \frac{P}{4\pi r^2} \propto \frac{1}{r^2}$. The **inverse-square law ($n = 2$) is realized literally as dilution on the light sphere**, and the distance r of $n = 2$ (Gauss flux conservation; Paper 01, Book 1) is grounded as the **light-sphere radius $r = ct$ (the causal radius)**.

Corollary 1 (r as the causal radius)

The r in the inverse-square law is at once a static distance and the **causal radius ct reached by light in time t** . The geometry of $n = 2$ (a sphere growing as r^2) is, on the light sphere, the **spreading of causality** itself.

5. The Light Sphere Is the Boundary of Velocity Space (Link to Paper 60)

Proposition 4 (*A* is the boundary of *B*)

Velocity space (Paper 60) is the ball of radius c , $\{|v| < c\}$ (hyperbolic, curvature $-1/c^2$), whose **boundary** $|v| = c$ **is light**. The light sphere $r = ct$ (radius c at $t = 1$) is the **realization of that boundary** $v = c$ **in real space**. Thus “ c as radius” has two faces:

- ***B* (velocity space, Paper 60)**: interior **curvature** (hyperbolic; measured by Thomas precession), $E = 4\pi/|K|$.
- ***A* (light sphere, this paper)**: boundary **light** (flat Euclidean sphere), $E = 4\pi c^2$, origin of the inverse-square law.

A and *B* are complementary faces of the same c , seen from “the boundary (light)” and “the interior (curvature of velocities).”

6. Stance and Caveats

- “ c as radius” is a **choice of unit time** $t = 1$ ($r = ct$, $r = c$ at $t = 1$). c is a velocity; this is only a choice of unit.
- Reading E as area is the $m = 4\pi$ representation (Paper 12). The physics is unchanged; only the representation changes.
- The light sphere is a **flat Euclidean sphere**, so $4\pi c^2$ is a genuine metric area---simpler than Paper 60 (hyperbolic, intrinsic), but treating a spatial section at unit time rather than an intrinsic curvature invariant. The two are complementary.
- Numerical agreement is not grounds for unifying quantities of different origin (Paper 48).
- **On the integration constant $+C$** . The volume restoration here is a **definite** integral $\int_0^c$, so the constant cancels between the limits and does not appear. Written as an **indefinite** integral, however, $\int 4\pi r^2 dr = \frac{4}{3}\pi r^3 + C$, and this C represents a **choice of baseline (zero-point)**. In gravitation, an integration constant of this kind is where the **cosmological constant** Λ can enter (the unimodular-gravity viewpoint; Weinberg 1989). Thus $+C$ can carry a “cosmic baseline,” and declining to set it to zero without thought is meaningful.

7. Conclusion

1. Light spreads as $r = ct$, radius c at unit time; being Euclidean, $E = 4\pi c^2$ is a genuine area (Prop 1). No coordinate/intrinsic tightrope.
2. Volume restoration $\int_0^c 4\pi r^2 dr = (4/3)\pi c^3$ is the causal-ball volume, exactly the $n = 2$ shell integral (Prop 2).
3. The inverse-square law is dilution on the light sphere, $I \propto 1/(ct)^2$, grounding the r of $n = 2$ as the causal radius ct (Prop 3, Cor 1).
4. The light sphere corresponds to the boundary $v = c$ of velocity space (Paper 60); A (boundary light, flat) and B (interior curvature, hyperbolic) are complementary faces of the same c (Prop 4).

This paper claims no new physical law. It shows that $E = 4\pi c^2$ reads most simply as the area of the light (causal) sphere, that volume restoration is the filling of space by light, that the inverse-square law is grounded literally as dilution on the light sphere, and that this light sphere corresponds to the boundary of velocity space. The “ c as radius” reading is completed by its two faces, B (interior curvature) and A (boundary light).

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