# EN_48: - THE WAVE

## Matter, energy, proper time, gravity and entanglement from one same geometry

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# 1. One single geometry

Before asking what a photon is, what a particle is, why gravity exists or what entanglement means, we can formulate a prior question:

**What geometric rules does a wave obey?**

We will start from a single space:

$U = 3S + T$ .

We will not build one geometry for matter and a different one for energy.

We will start from the same wave and study its two fundamental possibilities:

confined wave and free wave.

The photon does not need special rules either.

Like every wave, it is subject to the same geometric relations.

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# 2. Fundamental definitions

The magnitudes in this section are defined once and will keep the same meaning throughout the whole document.

Let $\lambda$ be the base wavelength associated with the wave considered.

The Planck and Einstein relations,

$E = \frac{hc}{\lambda},$

$E = Mc^2\,,$

allow us to write, for the wave associated with a mass $M$,

$\lambda = \frac{h}{Mc}\,.$

Let $L$ be the total length of the path when a finite contour exists.

We define:

$L = n\lambda\,.$

$n$ represents the number of cycles of length $\lambda$ contained in the path.

Let $R_{\mathrm{VED}}$ be the radius of the circular topological representation of that path.

Since:

$2\pi R_{\mathrm{VED}} = L,$

we obtain:

$R_{\mathrm{VED}} = \frac{L}{2\pi} = \frac{n\lambda}{2\pi}\,.$

The circumference does not mean that the confined wave necessarily has a circular shape in three-dimensional physical space.

It means that a path of length $L$ can be represented exactly by a circumference with the same perimeter.

We therefore use an $S^1$ topology that preserves the property we want to study: closure.

Let $R_{\text{Sch}}$ be the Schwarzschild radius associated with the same mass.

Let Ñ be the geometric constant that relates both representations:

$$\tilde{N} = R_{\text{VED}}\, R_{\text{Sch}}\ .$$

Finally, let $G(n)$ be the gravitational function of closure defined in Einstein–VED.

These magnitudes will not change meaning again.

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# 3. Observer and observed

We will use $t$ for the observer's time and $t'$ for the proper time of the observed system.

The apostrophe in $t'$ does not mean derivative.

$$t' = \text{proper time of the observed}\,.$$

In the same way, $ds$ represents the spatial differential in the observer's description and $ds'$ the corresponding proper spatial differential of the observed.

We can orient our coordinates locally in the instantaneous direction of propagation:

$$ds = dx, \qquad dy = 0, \qquad dz = 0\,.$$

This does not eliminate any spatial dimension.

We simply choose the $x$ axis in the local direction of propagation.

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# 4. The fundamental geometric relation

We start from Lorentz and from:

$v = \frac{ds}{dt}$ .

The temporal relation is:

$dt^{'} = dt\sqrt{1 - \frac{v^2}{c^2}}$ .

Equivalently:

$dt^{'2} = dt^2 - \frac{ds^2}{c^2}$ .

In natural units:

$c = 1$,

it becomes:

$dt^{'2} = dt^2 - ds^2$ ,

or:

$P_1 : \qquad ds^2 = dt^2 - dt^{'2}$ .

This will be our basic geometric relation.

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# 5. Every wave travels at $c$

The property common to the free wave and the confined wave is its local propagation speed:

$$P_2: \qquad v_{\text{onda}} = c\,.$$

In natural units:

$$v_{\text{onda}} = 1\,.$$

The photon, as an electromagnetic wave, is subject to this same rule.

We do not need to build a different geometry for it.

What will distinguish matter and energy will not be that a wave travels faster or slower.

It will be its condition of closure.

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# 6. The two faces of the wave

First consider a wave whose path has a finite length:

$$L = n\lambda,$$

with:

$$n < \infty\,.$$

There is then a spatial contour of return.

We will call it a **confined wave**.

$$P_3: \qquad n < \infty \Longrightarrow \text{confined wave}\,.$$

Now consider a wave that has no finite spatial contour of return.

This corresponds to the limit:

$n \to \infty$ .

Then:

$L = n\lambda \to \infty$ ,

and:

$R_{\text{VED}} = \frac{n\lambda}{2\pi} \to \infty$ .

Therefore:

$P_4: \qquad n \to \infty \Longrightarrow \text{free wave}$ .

Thus we have:

$$\text{WAVE}\{ \begin{array}{ll} n < \infty & \to \text{confined wave,} \\ [2mm] n \to \infty & \to \text{free wave}. \end{array}$$

In Einstein–VED:

matter⟷confined wave,

whereas:

free energy⟷free wave .

We are not introducing two fundamental substances.

We are describing two geometric configurations of the same wave.

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# 7. Confinement does not necessarily mean stability

A wave can have a finite contour and yet not close exactly in phase.

We write:

$n = k \pm \rho,$

where:

$k \in N^{+}$

is the nearest integer and:

$0 \leq \rho \leq \frac{1}{2}$

is the distance to that integer.

When:

$\rho = 0,$

we have:

$n = k$

and:

$L = k\lambda .$

The path contains exactly an integer number of cycles.

The wave returns in phase.

Therefore:

$P_5 : \qquad \rho = 0 \Leftrightarrow \text{stable closure} .$

For:

$0 < \rho \leq \frac{1}{2},$

there is a contour, but there is also a phase mismatch with respect to integer closure.

Therefore:

$P_6: \qquad \rho > 0 \Leftrightarrow \text{non-stable closure}\,.$

Thus we distinguish three situations that must not be confused:

$$\begin{array}{ccc} \rho = 0 & \rightarrow & \text{stable confined wave,} \\ [2mm]0 < \rho \leq 1/2 & \rightarrow & \text{non-stable confined wave,} \\ [2mm]n \rightarrow \infty & \rightarrow & \text{free wave.} \end{array}$$

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# 8. The proper time of a wave

Let us now return to a property shared by all waves:

$v_{\text{onda}} = c\,.$

By Lorentz:

$dt' = dt\sqrt{1 - \frac{v^2}{c^2}}\,.$

For the wave:

$v \rightarrow c\,.$

Therefore:

$dt' \rightarrow dt\sqrt{1 - 1}\,.$

Hence:

$P_7: \qquad dt' \rightarrow 0\,.$

We have not used quantum mechanics.

We have not yet introduced entanglement.

It is a consequence of applying Lorentz to a wave that propagates at $c$.

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# 9. The proper space of the wave

The wave continues to propagate at $c$.

Therefore:

$$\frac{ds'}{dt'} = c\,.$$

In natural units:

$$c = 1\,.$$

Hence:

$$ds' = dt'\,.$$

But we have already shown in $P_7$:

$$dt' \to 0\,.$$

Therefore:

$$ds' \to 0\,.$$

Thus we obtain jointly:

$$P_8: \qquad (ds', dt') \to (0,0)\,.$$

No speed greater than $c$ appears.

The result comes from:

$$v_{\text{onda}} = c$$

and:

$$dt' \to 0\,.$$

This is a geometric property of the wave that we will use next.

# 10. EPR: two descriptions of separation

Consider two correlated events $A$ and $B$.

For the observer they can be separated:

$\Delta s_{AB} > 0$ .

If we try to explain the correlation by assuming that a signal must leave $A$, travel that distance and arrive instantaneously at $B$, the question of a speed greater than $c$ appears immediately.

But this is not the only geometric description available.

We also have the wave's proper description.

By $P_8$ :

$(\Delta s^{'}, \Delta t^{'}) \to (0, 0)$ .

Therefore, Einstein–VED does not need to interpret the correlation as a signal that travels our observed distance with:

$v > c$ .

For the observer:

$\Delta s_{AB} > 0$ .

In the limiting proper geometry of the wave:

$\Delta s^{'} \to 0, \qquad \Delta t^{'} \to 0$ .

They are two different geometric descriptions of the same system.

# 11. Entanglement without superluminal communication

We can now formulate the result.

$T_{\text{EPR}}$:

If the correlation between events $A$ and $B$ belongs to the same wave structure for which:

$$(ds', dt') \to (0, 0),$$

then it is not necessary to introduce a physical signal that crosses the observed separation $\Delta s_{AB}$ with a speed greater than $c$.

The correlation can be immediate with respect to the limiting proper geometry because:

$$\Delta s' \to 0$$

and:

$$\Delta t' \to 0\,.$$

Therefore there is no contradiction with:

$$v \leq c$$

in the observer's spacetime.

The apparent paradox is born from demanding that the separation measured by the observer must also be the relevant proper separation of the wave.

Einstein–VED does not make that identification.

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# 12. Let us return to the other property of the wave

To obtain $P_8$ we used:

$v = c\,.$

Now we will use the second property:

$n\,.$

For a confined wave:

$n < \infty\,.$

For a free wave:

$n \to \infty\,.$

In Einstein–VED the gravitational response associated with closure is determined by:

$G(n)\,.$

The previous development of the framework establishes:

$G(2) = G,$

where $G$ is the observed universal gravitational constant.

It also establishes:

$\lim_{n \to \infty} G(n) = 0\,.$

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# 13. The free wave and gravity

By $P_4$, for a free wave:

$$n \to \infty .$$

By the property of $G(n)$:

$$\lim_{n \to \infty} G(n) = 0 .$$

Therefore:

$$T_G: \qquad \text{free wave} \Longrightarrow G(n) \to 0 .$$

Within Einstein–VED, energy propagating as a free wave does not by itself provide the gravitational response associated with confinement.

Gravity remains linked to the geometric condition of closure.

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# 14. Why the constant $G$ appears

We have:

$$G(2) = G .$$

This allows the universal gravitational constant to be interpreted as a particular value of the geometric function of closure:

$$G = G(n)\big|_{n=2} .$$

At the other extreme:

$$n \to \infty$$

produces:

$$G(n) \to 0 .$$

Thus, the same function connects the confined regime with the free-wave limit.

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# 15. Ñ: two geometries of the same information

Consider now the two geometric representations of the same mass.

The closure representation uses:

$R_{\mathrm{VED}}$ .

The gravitational representation uses:

$R_{\mathrm{Sch}}$ .

Einstein–VED establishes:

$\tilde{N} = R_{\mathrm{VED}}\, R_{\mathrm{Sch}}$ .

and:

$\tilde{N} = 4 l_P^2$ .

Therefore:

$R_{\mathrm{Sch}} = \frac{\tilde{N}}{R_{\mathrm{VED}}}$,

and:

$R_{\mathrm{VED}} = \frac{\tilde{N}}{R_{\mathrm{Sch}}}$ .

Thus we have a reversible relation between the two representations:

$U_{\mathrm{VED}} \leftrightarrow U_{\mathrm{Sch}}$ .

They are not two different masses.

They are two geometries from which we represent the same physical information.

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# 16. The free-wave limit seen from Ñ

For a free wave:

$$n \to \infty .$$

By definition:

$$R_{\text{VED}} = \frac{n\lambda}{2\pi} .$$

Hence:

$$R_{\text{VED}} \to \infty .$$

But:

$$R_{\text{Sch}} = \frac{\tilde{N}}{R_{\text{VED}}} .$$

If Ñ is constant:

$$R_{\text{VED}} \to \infty$$

implies:

$$R_{\text{Sch}} \to 0 .$$

Thus we arrive at the gravitational limit by two paths.

By $G(n)$:

$n \to \infty \Rightarrow G(n) \to 0\,.$

By Ñ:

$n \to \infty \Rightarrow R_{\text{VED}} \to \infty \Rightarrow R_{\text{Sch}} \to 0\,.$

Both descriptions converge in the same physical limit of the framework: when confinement disappears, the gravitational response associated with closure also disappears.

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# 17. The photon

We can now study the photon without introducing any new rule.

The photon, as a free electromagnetic wave, is subject to the rules we have already demonstrated for every wave.

First:

$v_\gamma = c\,.$

By $P_7$:

$dt'_\gamma \to 0\,.$

By $P_8$:

$(ds'_\gamma, dt'_\gamma) \to (0, 0)\,.$

Second, as a free wave:

$n_\gamma \to \infty\,.$

Therefore:

$R_{\text{VED},\gamma} \to \infty\,,$

$G(n_\gamma) \to 0,$

and:

$R_{\mathrm{Sch},\gamma} \rightarrow 0$ .

The photon is not an exception to the geometry of the wave.

It is precisely one of its limiting cases.

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# 18. One wave, two fundamental parameters

The whole development can now be reduced to two properties.

The first is:

$v = c$ .

It determines the limiting proper geometry:

$v = c \Rightarrow dt' \rightarrow 0 \Rightarrow ds' \rightarrow 0 \Rightarrow (ds', dt') \rightarrow (0, 0)$ .

From here arises the geometric interpretation of EPR.

The second is:

$n$ .

It determines the condition of closure:

$n < \infty \Rightarrow$ confined wave,

whereas:

$n \rightarrow \infty \Rightarrow$ free wave .

And for the free wave:

$n \to \infty \Rightarrow G(n) \to 0,$

$n \to \infty \Rightarrow R_{\text{VED}} \to \infty ,$

$R_{\text{VED}} \to \infty \Rightarrow R_{\text{Sch}} \to 0 .$

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# 19. The complete picture

We can represent the result as:

WAVE

$$
\begin{array}{ccc}
 & \text{WAVE} & \\
\text{[2mm]} & \swarrow \qquad\qquad \searrow & \\
v = c & & n \\
\text{[2mm]} \downarrow & & \downarrow \\
(dt^{'}, ds^{'}) \to (0,0) & \left\{ \begin{array}{c} n < \infty \\ n \to \infty \end{array} \right. & \\
\text{[4mm]} \downarrow & \left\{ \begin{array}{c} \text{confinement} \\ \text{free wave} \end{array} \right. & \\
\text{[4mm]} T_{\text{EPR}} & \left\{ \begin{array}{c} G(n) \\ G(n) \to 0 \end{array} \right. &
\end{array}
$$

And through the geometric representation of confinement and gravity:

$\tilde{N} = R_{\text{VED}} R_{\text{Sch}} .$

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# 20. Conclusion

The starting point of this work is not matter, energy, gravity, the photon or entanglement.

It is the wave.

The wave propagates at:

$$v = c\,.$$

and can appear in two configurations:

confined      or      free.

The confined wave has a finite path:

$$L = n\lambda, \qquad n < \infty\,.$$

The free wave corresponds to the limit:

$$n \to \infty\,.$$

Propagation at $c$ leads to:

$$(dt', ds') \to (0, 0)\,.$$

This provides in Einstein–VED a geometric interpretation of EPR that does not require superluminal communication between two points separated in the observer's spacetime.

The absence of closure simultaneously leads to:

$$G(n) \to 0$$

and:

$$R_{\text{Sch}} \to 0\,.$$

Finally:

$$\tilde{N} = R_{\text{VED}}\, R_{\text{Sch}}$$

relates the geometric representation of closure to its gravitational representation.

The photon does not need an exception to these rules.

As a free wave:

$$v_\gamma = c, \qquad n_\gamma \to \infty \ .$$

It therefore simultaneously gathers the two limits:

$$(ds'_\gamma, dt'_\gamma) \to (0,0)$$

and:

$$G(n_\gamma) \to 0\,.$$

Matter, energy, gravity and entanglement thus appear, within Einstein–VED, not as four independent problems, but as different consequences of studying one same wave under one same geometry.