A refinement of the ideas presented at the TM-2019 INAF conference (2019 - Turin, Italy)

notes on a common beat

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if a man does not keep pace with his companions, perhaps it is because he hears a different drummer

Henry David Thoreau

abstract

How could we **describe spacetime** and all the information within it?

What information are we considering? Where and how the *information is stored and evolves*?

Which assumptions should we make on space and time to even imagine possible answers?

Starting from an ICT perspective, the aim of this contribution is to investigate these open questions and propose a set of assumptions, as the ingredients needed for a description of a universe based on finite and discrete information.

Spacetime fabric is interpreted through a probabilistic space (developing as an imaginary distance *ict*) that emerges from a memory (Tk) storing the information of spatial correlation. Evolution is considered in discrete processing cycles of the spacetime memory, which identify a universal beat of reference. Entanglement becomes the fundamental information, stored and processed in the mentioned memory, from which space emerges in each cycle.

After defining the context, the contribution focuses on elementary particles. The relativistic energy and the wave function are interpreted from the perspective of a momentum in *ict* and Tk, connected to the particle mass, memory and beat in respect to the universal beat of reference. Following the assumptions, a physical interpretation of the wave-particle duality is suggested in the context of memory, entanglement and information.

The last section addresses the cosmological scales, looking for a possible physical realization of the proposed model and proposing how the different arrows of time should emerge.

a physical & The contribution points to a description of the Universe and of the idea of existence based on the concept of the *memory of a common beat*, as the fundamental degree of freedom from which the whole spacetime fabric could emerge in all its varieties and complexities.

connecting dots...

perstater past
memory
transfarmating

... picture the *assumptions*

- 0 engineering hypotheses
- o ingredients for a spacetime fabric based on memory and information

... sketches on an *elementary scale*

o describe the *momenta* that characterize elementary particles in the fabric
o suggest a physical interpretation

... project at *cosmological scale*

o deep dive the parallel on scaleso offer a view from infinityo outline a summary on time

... perspectives and open questions

engineering hypotheses for a toy universe

- *bottom-up* simplify the information needed to describe "what we see"
 - o elementary quanta of information are connections among entities in spacetime
 - o connections are links of correlation and rely on the sharing of a common *code*
 - the simplest code is a shared phase and a universal reference (common beat + universal beat)
 - o logical consistency among observables is needed from a global perspective
 - o emerging features arise from the most basic info interconnection and evolution

• *implementable* - bound the information needed to describe "what we see"

- o the universe could be described through information
- o information must be finite to be physically representable
- o finite information cannot describe the Real continuum, hence the universe is discrete
- o physical variables must be discrete and relative to global scales and units of reference

• *parsimony* - minimize the information needed to describe "what we see"

- o fixed memory buffer to store evolving information (reuse limited resources)
- o limited growth of information as time passes (no exponential growth)
- no precise reconstruction of spacetime at a given past instant info of the past states is not needed beyond the current state dependencies
- o no information about the future as it is still undefined and open



assumptions

the lost sense of Time

A full comprehension of Time still seems to be reached...

- o several research paths: physics, information science, neuroscience, philosophy, art, religion, ...
- o physical laws seem time *symmetric* in both classical and quantum descriptions
- o from a computational perspective, time seems *irreversible* at the most fundamental level
- o thermodynamic arrow of time seems related to increasing *entropy* and *causality*
- o macroscopic perception of the forward passage of time as *defined on average*
- o quantum temporal superposition studies point to undefined causal structures
- o analyses of temporal order & Bell's inequalities identify possible *causal inequalities*
- o objectivity and correlation in *Wigner's friend* experiment: are isolated systems science fiction?
- o the understanding of Time is at the root of quantum gravity ...

... maybe there is just a *thick present*

- o simple, bounded and minimized information to describe "what we see"
- o interconnected information as *potential* until collapse (decoherence as irreversible event and *memory knot*)
- o *superposition* of perspectives from a near past and a near future, worrying about potential only
- o assures *logical consistency* between *what it was* and *what it will be* (weaker than causality)
- o all possible *imaginary paths* should be weighted as possibilities in the *thick present*

spacetime from the evolution of the possible imaginary paths in a memory that stores correlation potential among imaginary points...

ingredients for spacetime

- The passage of time occurs synced on discrete cycles of duration 2T (as a phase going from -π to +π) that defines a universal beat of reference for all the *unbroken wholeness* of the spacetime fabric and a *thick present* lasting from (2k-1)T to (2k+1)T
- Time, as an axis and a *perceived flow*, is emergent, as there is only the current instant (*Coherent Now*) with all its associated potential, stored in a *memory* called **Absolute Time** (**Tk**)
- Space distance is discrete and imaginary (*ict*). It emerges from the info potential of correlations as *entanglement* among distant imaginary points (stored in Tk in each *Coherent Now*) and evolves as spacetime, updating its potential in Tk as cycles pass



 $c = \frac{L}{T}$

 $\hbar = \frac{ML^2}{T}$

 $G = \frac{L}{M}c^2$



Persistence (in a real memory) and **Transformation** (in an imaginary space) evolution cycles since the first beat

assumptions

Tk or the Absolute Time memory

- Stores **entanglement** (info of spatial correlation from which the imaginary space *ict* emerges) as *memory loops*
 - verifies *logical consistency* of the information *forward and backward in time,* **from –T and +T**
 - o TSVF-alike (forward and backward evolving wave)
 - o from logical consistency emerges causality
 - description from -T and +T leads to **flat** *ict/spacetime*
 - non-local correlations = info in Tk beyond flat *ict*
 - $\circ~$ equivalent to CTC developing in Tk
- Elaborates the information of correlation as a **computational neural network**
 - o phases its cycles on the universal beat of reference
 - optimally compresses the information of correlation maybe through a dual-tree **complex wavelet analysis** (with Hilbert pair 1/t and δ as separable filter bank)
 - exploits the **scale invariance** and fractal self-similarities of natural phenomena with a *log-perspective* on distance
- Manifests as the *gravitational field*
 - connects energy information persisting in Tk to the curvature of spacetime emerging in *ict*



elementary scales

particles momenta in Tk and ict

- The relativistic energy and the wave equation of an elementary particle could be described in terms of the *momenta* in Tk and *ict*
 - p_T *momentum in time* (in Tk) associated to the phase and **persistence** in Tk memory
 - p_s imaginary *momentum in space* (in *ict*) related to speed and phase **transformation** in respect to *ict* determine the **emergence** in *ict* of the elementary particle **from its Center of Mass** (CoM) perspective
- The momentum in time (in Tk)
 - is related to a Boltzmann distribution, leading to an emergence in *ict* space with **max entropy** (expected value *ir*_c)
 - represents the persisting information, the **scale** of the resonating wavelet in Tk and the *proper beat* or *tempo* of the particle emerging in *ict*



$$\beta = \frac{v_S}{c} = \sin(\tau_s); \quad \frac{1}{\gamma} = \sqrt{1 - \beta^2} = \cos(\tau_s)$$

$$\psi_E = Re^{\frac{iS}{h}}; \qquad p_{ST} = p_T + ip_S$$

$$p_T = \frac{E}{c}\cos(\tau_s) = m_oc = -\hbar\nabla ln(R) \qquad p_S = \frac{E}{c}\sin(\tau_s) = mv_S = \nabla S$$

$$E^2 = (p_Tc)^2 + (p_Sc)^2 = (p_{ST}*c)(p_{ST}c) \qquad (-p_{ST}*)\psi_E = \hbar\nabla_{ict}\psi_E;$$

$$\psi_E \xrightarrow{v_S = 0} R = \frac{p_T}{\hbar}e^{-\frac{p_T}{\hbar}r} = \frac{1}{L}\left(\frac{1}{n_c}e^{-\frac{n}{n_c}}\right) = \frac{R_m}{L} \qquad \begin{array}{c} p_{ST} \leftrightarrow \text{potential in } Tk \\ \psi_E \leftrightarrow \text{emergence in ict} \end{array}$$

$$\frac{p_T}{\hbar} = -\nabla ln(R) = \frac{1}{n_c L} = \frac{e^{-\varphi_c}}{L} = \frac{1}{r_c}$$

$$emergence information on a surface depending on the proper beat \\ \varphi: [0+, +\infty) \\ \varphi_c \qquad \text{ir = iLe} \varphi$$

elementary scales

the root of the matter

- The **wave function** describes the **correlation links** from the CoM to the points at *ir* where the particle could emerge
 - the **entanglement** correlation links could be seen as **bridges** to the location in *ict* through the memory Tk
 - **ER = EPR = CTC =** *memory loops*
- The particle is the **network** of imaginary points and connecting links described by the wave function
 - *Root of Existence* of the particle in Tk memory as bundle of potential bridges from the CoM
 - network of entangled imaginary points on a *common beat* in the emergence in *ict*
 - summarized view from a perspective at infinity as gradient in Tk from the CoM
- Anti-Matter is opposite in Tk
 - phases with **inverted hemicycles** along the pulse of Tk in the *Coherent Now*
 - seems developing in the *Coherent Now* in opposite direction in respect to the arrow of causality
 - has **opposite momentum in Time** in respect to normal matter (instable inverse pendulum)



elementary scales

events and gravity



Entropy grows with the complexity of the connections as more info stored in the memory of the gravitational field

• Particles

- o are *wavelets* and *roots* in the memory of the Absolute Time
- o are *networks* of imaginary points resonating at the proper scale
- o emerge with corresponding proper imaginary tempo in ict

• Events

- o are *observations* or measurements at a given cycle of Tk
- o are *interactions* with another entity and corresponding Root
- are *collapses* of the gravitational field at a specific $ic\delta(t-t_k)$
- o are like *memory-knots* of the occurred interactions
- o cause *updates* in the phases in *ict* of the CoM
- Gravity
 - o is a gradient toward regions with *slower beat* and *more info*
 - emerges as *curvature in ict at Tk* due to a mass pulsing with proper imaginary tempo on the beat of Tk
 - \circ is related to the perspective from -T and +T of *ict*
 - o is *real* as *potential* in Tk also with no collapses in *ict*
 - o comes from the *memory in Tk* of a persisting gradient of correlation
 - o is the proof *I was* in the previous cycle of Tk

cosmological projections

maximum entropy and compression

- Tk memory maximally compresses information in ict
- A Black Hole **maximally compresses** energy in *ict*

Shannon

- Emergence in *ict* occurs with **maximum entropy**
- A Black Hole shows on the horizon **maximum entropy**



$$\psi_{E} \xrightarrow{v_{s}=0} R = \frac{1}{L} \frac{p_{T}}{p_{0}} e^{-\left(\frac{p_{T}}{p_{0}}\right)\frac{r}{L}} = \frac{1}{L} \left(\frac{1}{n_{c}} e^{-\frac{n}{n_{c}}}\right) = \frac{R_{m}}{L}$$

$$\frac{1}{n_{c}} = \frac{L}{r_{c}} = \frac{m_{0}}{M} = |\nabla ln(R_{m})|$$

$$R(m_{0} = M; r_{c} = L) = \frac{R_{M}}{L} = \frac{1}{L} \left(\frac{1}{n_{c}} e^{-\frac{n}{n_{c}}}\right) = \frac{e^{-n}}{L}$$

$$R_{bh} = R(m_{bh} = n_{BH}M) \propto \prod_{n_{BH}} R_{M} = e^{-n_{bh}n}$$

$$\frac{m_{bh}}{M} = n_{BH} = |\nabla ln(R_{bh})|$$

$$r_{S} = m_{bh} \frac{2G}{c^{2}} = 2\frac{m_{bh}}{M}L = n_{bh}(2L)$$

entropy compressed information proportional to area (DoF) appears as most random

the black hole perspective

relate the mass-info in a Black Hole to a hypothetical *inner-Universe* emerging **beyond** its **singularity**

- radius (mass-info) → Absolute Time memory
- horizon → summarized view from $\pm \infty$ of *ict_{in}*
- \circ singularity \rightarrow every point in the inner imaginary space
- collapse \rightarrow inflation era from the *ict_{in}* perspective
- growth → growing Dark Energy (more space at ∞)





cosmological projections

the arrows of times



so... how could we describe spacetime?



... and what about the information within it?



... still so many open questions!

The true How of Tk

- algorithm for optimal *efficiency* in information compression and emerging entropy
 - o how to compress a full imaginary *ir* of the emerging Universe in a $(2L)^2$ at the horizon of the parent BH?
 - o logs and wavelet? Riemann sphere? Gamma function? Zeta function? Prime numbers theory? Golden ratio?

• algorithm for information *evolution* along Tk cycles in *ict*

- o superposition in *ict* as Feynman path in *ict* dimension?
- o expansion of the universe as memory of imaginary past time?
- interpretations and *fundamentals*
 - Einstein's field equations and metric derivation in the proposed model?
 - o spin interpretation in the proposed model?
 - o bosons as packets of information of timing, tense and direction in a telecommunication network or field?
 - o math from geometry and correlation in *ict* to gluon field, persisting information potential and gravity?
 - o any news on Wigner's friend? What about his arrival and his gravitational impact on the *isolated experiment*?

Observations or predictions

- cosmology and initial conditions
 - o early universe size and memory buffer size for elementary particles?
 - o particles' mass in relation to parent black hole radius?
 - o corresponding summary at infinity in the parent Black Hole horizon?
 - o fine structure constant in relation to the geometry of the parent Black Hole?
- *thought* experiments for tomorrow
 - o particles decoherence or decay exploiting the tricks in the algorithm?



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compactification on the boundaries?



metric from references and differences?



Apollonius circle - details



Schwarzschild metric - details



elementary spin from periods in Tk cycles?



forces as tenses for every storytelling?



Higgs Bosons - I HAVE

information of static as anchor of the root to the singularity and consequent inertia in the imaginary time freedom of action

Photons – I'm BEING

information of occurring transformation as local charge variation in ict at Tk Long distances – propagates on the boundary decreasing coherently as $1/(ict)^2$

Weak Bosons - I'm GOING TO BE

information of coming transformation in Tk as a cut or grafting of branches in the root Short distances – same global origin at infinity

Gluons - I AM

information of ict 3D orientation in respect to Tk to entangle in a single global root Short distances – same global origin at infinity

Gravitons - I WAS

information of persisting existence as local energy in Tk (spacetime quantum field) Short distances – same global origin at infinity for the unbroken wholeness of spacetime Long distances – propagates on the boundary decreasing coherently as 1/(ict)²

4d spacetime and quarks



annex

gluons and SU(3) rotation



charged leptons as springs?

- emerging superposition of potentials

 gravitational and electric potential φ_c ± φ_α
 scaling efficiently in spacetime emergence
 fine structure of mass and charge statics
 gradient where photons propagate
 electrostatic charge message I'm being (charged)
- electrostatic related to a potential in *ict*
 a little beyond the orthogonality of Tk and *ict* emergence on a fixed angle of perspective
 - \circ path along a log-spiral towards *ict*
 - Torricelli theorem on the spiral length and the external circle radius
 - $\circ energy-info \text{ gravitational potential} \rightarrow scattering radius \\ + charged spring electric potential \rightarrow classical radius$



... everything is connected?



mirror images of reality?

a physical perspective		a philosophical perspective
time is emergent as only the current instant exist space is imaginary and emerges with max entropy	поч	every instant is a unique <i>present carpe diem</i> and be imaginative
spacetime is a real potential in the memory of Tk ER = EPR = CTC = <i>memory loops</i>	memory	<i>consciousness</i> as logical consistent access to memory we are the living network of our connections
the unbroken wholeness of the entire Universe persistence is in the memory of a common tempo	common beat	losing the Ego for a greater sense of community connections are the sharing of a common code
a quantum energy from the study of the root and tempo of particles?		a fair global human society based on empathy, trust and collaboration?