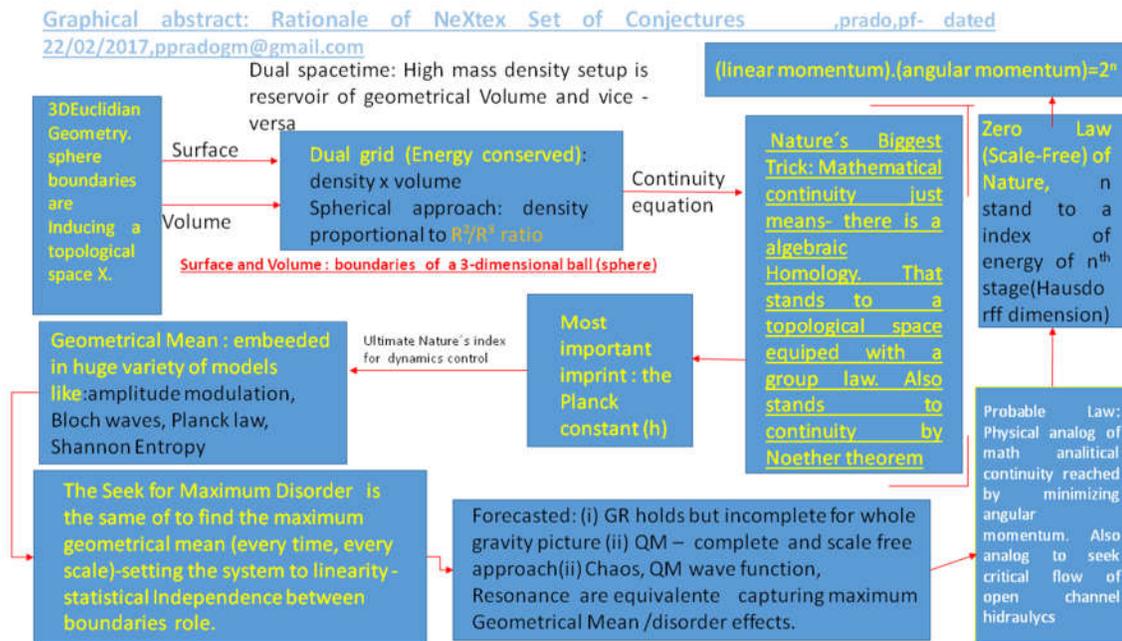


**Short perspective note: Thermodynamics' principles and quantization of energy are just the fingerprint related to this: Nature is following a variational formulation.**

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### Graphical abstract



### Abstract

A induced topological space that creates a structure and a variational formulation for nonlinear differential / boundary problems seem to be the core of a every scale, every time understanding of Nature behavior.

The conjectured deep connection between physics and math seems to reinforce the validity of the explanative pathway followed so far.

This paper seem to touch the Niels Bohr statement that duality would be the core for the deep understanding of Nature.

### On the consequences of duality and a optimized topological space

It was conjectured the all scale , all time nature occurs inside a topological space equipped with a group law induced by 2 boundaries forming a (dual grid): extremum mass density

(stands to preferential attachment, random networks and  $R^2/R^3$  going asymptotically to infinity ) and extremum volume (stands to networks related to order  $R^2/R^3$  going asymptotically going to zero) of a full sphere or a ball (Prado,Pf a,b,c).

This probably has a close analogy to the catenary equation and its properties like related this one to be the cross section that permit the maximum flow of water in open channels what fits the analogy previous discussed (Prado,Pf b,c)

The critical (maximum ) flow search method seems to be related to a seek for extremum Shannon Entropy considering two dual variables and also find maximum geometrical mean pointing standing to a minimum specific energy in hydraulics. (Prado,Pf c)

The maximum flow maps seems to cause maximum linear momentum and probably stands to maximal analytical continuity in a purely analog mathematical interpretation (Prado,Pf a; c).

Considering a limited quantized energetic step (analog to energy distribution in atoms orbitals), maximum linear momentum implies minimum angular momentum that could also be interpreted as consequence of statistical independence between boundaries effects or linearity (Prado,Pf a; c)

This framework of conjectures, especially the Planck quantum imprint (Prado,Pf a) seems be connected to a method to find variational formulation for non-linear differential equations (Tonti,1969).

*“The association of integral physical variables with space and time elements permits to give a direct finite formulation to field equations of classical physical theories. It has been shown that using a cell complex and its dual, rather than a coordinate system, it is possible to associate with a complex the configuration variables of the theory and with the dual complex the source variables. This completely discrete description draws on domain functions rather than point functions and uses notions from algebraic topology such as incidence numbers, chains, cochains, coboundary process. Cochains are the algebraic equivalent of external differential forms whilst the coboundary process is the algebraic equivalent of the external differential. The equations obtained to some extent coincide with*

*those of the Finite Elements Method (FEM), with those of the Finite Volume Method (FVM) and of Finite Integration Theory (FIT) in electromagnetism". (Tonti,1969 a,b).*

This Tonti's paper stress the importance of a structure (this would stands to a topological space and quantization) as the only condition to the existence of a variational formulation and classify also this one as physical law.

This mathematical analogy reinforce that Nature in its evolution dynamics is seeking following the curve of minimal length to reach the maximum linearity ( standing to linear momentum). The quantization of energy is the feature that allow this because it would set the system only in critical conditions ( or Functional stationary point) of minimum circulation (stands to non-linearity / angular moment).Linearity would map to easiest expansion: to next of (level) quantized energy amount or of the mathematical dominium by just modifying boundaries features.

*"Nature went step by step by its way from minerals to living matter and decreased gradually the Gibbs free energy of the reactants at each step." ( Ostrovskii,2014)*

Remarkably, the critical damping of a RLC circuit seem to stand to minimal length curve to delivery energy for work (thermal on the resistance) stressing minimization of nonlinearity the inductance and capacitance duality condition in the resonant condition in connection with Nextex set of conjectures ( Prado,Pf d).

On the purely math parallel interpretation (Prado Pf,ab,c), number theory seem to holds to this too. Few primes would stand to a weak linearity, in other hand, as soon the number of primes increases the linearity similarity of the catenary approach raises and this is imprinted on the sum of reciprocal of primes for example, possible.

**Catenary equation, universally catenary Noetherians Rings, prime ideals seems to be on the core of Natures behaviour math modeling.**

Besides intrically related to minimization solution .The catenary equation and it connection to: infinity polynomials ; geometrical equivalence to linear regarding area/length ratio are both strong evidence of its importance in scale free exploration of a nature that tends to convert a nonlinear condition to mimetics linearization (Prado,Pf a,b,c) and to trace the only one mathematical root condition is the pathway for this

And then arise the necessity to propose a modification on the equation suggested previously (Prado, Pf a,b,c):

$$[(\text{linear momentum})(\text{angular momentum})]^n = 1^n$$

$$\text{linear momentum} = L$$

$$\text{angular momentum} = A$$

This modification would allow the construction of many catenaries (in inducted topological spaces) equations connecting boundaries of the type:

$$Y = L \cosh(Ax)$$

Moreover, the intrinsic connection of catenary with hyperbolic tangent equation seems to be the track for a profound connection of it to a fundamental physical law that nature probable follows a: variational formulation VF in connection to *FEM*, *FVM* (Tonti, 1969 a,b)) because this hyperbolic tangent can be understood as the solution of the following nonlinear boundary value problem (NBVP) Probably, intrinsically connected to the minimum circulation on VF approach to the mathematical relation

The NBVP, problem:

$$1/2f'' = f^3 - f, \quad \text{differential equation} \quad \text{and} \quad f(0) = 0 \quad \text{and} \quad f'(\infty) = 0. \quad (\text{http://mathworld.wolfram.com/HyperbolicTangent.html}).$$

Possible there's it is a gate to relate derivatives (different dimensions) using square roots this seems to deserve a deeper investigation. This condition seems to be a fingerprint of maximum analytical continuity. Note that geometrical mean relies on square roots (Prado, Pf a; b, c).

Hyperbolic tangent is also the solution of the problem:

$$f' = 1 - f^2 \quad \text{with} \quad f(0) = 0$$

Note that Ramanujan summation  $C = -1/12$  is intrinsically connected to the prime 2 and to this summation is indeed attributed the connection between simple Sum and Integrals.

## Duality

(Shahn Majid ,1989) stated “*duality that interchanges the algebraic structure corresponding to quantummechanics with that corresponding to curvature on phase space*” .

Duality seems to be the fingerprint of the prime 2 (evens) and its multiples, summarizing the relation between different sequential dimensions (odd) through a square root seems allowing the search for a unique root necessary. This would allow a optimal patch between statistically independent non linear features . This causes the quantized energy as described by Einstein, Planck. It seems to be the result of the every possible topological space equipped with group law induced by boundaries, an structure that allows a variational formulation as discussed above. This group law seems to be connect to Noether rings and resulting conservation law inside a energetic level, and analytical continuity and the best pathway for another energetic level .Different velocities of the time passage would be caused by the modification of entropy formulation inside a group law (Prado,Pf a,b,c).

In Number theory, the prime numbers seems to be fingerprint of the duality that stands to understand natural numbers as connected to a variational problem which final optimization results in reach on minimum steps condition the best mimetics to linearization for a give amount of sequent primes (standing to energy on the physical view).

### **Final remarks**

A induced topological space that creates a structure and a variational formulation for nonlinear differential / boundary problems seem to be the core of a every scale, every time understanding of Nature behaviour.

The conjectured deep connection between physics and math seems to reinforce the validity of the explanative pathway followed so far.

### **Reference**

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