Does Constant Torque Induce a Phase Transition Increasing the Value of Planck Constant?

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1 Introduction

The hierarchy of phases with effective value of Planck constant coming as an integer multiple of the ordinary Planck constant and interpreted as dark matter is crucial in the TGD inspired model of living matter. The challenge is to identify physical mechanisms forcing the increase of effective Planck constant h_{eff} (whether to call it effective or not is to some extent matter of taste). The work with certain potential applications of TGD led to a discovery of a new mechanism possibly achieving this. The method would be simple: apply constant torque to a rotating system. I will leave it for the reader to rediscover how this can be achieved.

The importance of the result is that it provides strong mathematical motivations for zero energy ontology (ZEO), causal diamonds (CDs), and hierarchy of (effective) Planck constants [K3]. Quite generally, the results apply to systems with external energy feed inducing generalized force acting in some compact degrees of freedom. Living matter represents basic example of this kind of system. Amazingly, ATP synthase enzyme contains generator with a rotating shaft: a possible TGD based interpretation is that the associated torque forces the generation of large h_{eff} phases. This conforms with the proposal that the basic function of metabolism is to produce large h_{eff} phases making also possible negentropic entanglement [K1] and generation of "Akashic records" as negentropically entangled states which are approximately invariant under quantum jumps if they are correspond to interaction free (approximately) measurements for the Akashic records [K2].

2 Could constant torque force the increase of h_{eff}?

Consider a rigid body allowed to rotated around some axes so that its state is characterized by a rotation angle ϕ. Assume that a constant torque τ is applied to the system.

1. The classical equations of motion are

$$I\frac{d^2\phi}{dt^2} = \tau \ .$$

This is true in an idealization as point particle characterized by its moment of inertia around the axis of rotation. Equations of motion are obtained from the variational principle

$$S = \int Ldt \ , \ L = \frac{I(d\phi/dt)^2}{2} - V(\phi) \ , \ V(\phi) = \tau\phi \ .$$

Here ϕ denotes the rotational angle. The mathematical problem is that the potential function $V(\phi)$ is either many-valued or dis-continuous at $\phi = 2\pi$.

2. Quantum mechanically the system corresponds to a Scrödinger equation

$$-\frac{\hbar^2}{2I}\frac{\partial^2\Psi}{\partial\phi^2} + \tau\phi\Psi = -i\frac{\partial\Psi}{\partial t} \ .$$

In stationary situation one has

$$-\frac{\hbar^2}{2I}\frac{\partial^2\Psi}{\partial\phi^2} + \tau\phi\Psi = E\Psi \ .$$

3. Wave function is expected to be continuous at $\phi = 2\pi$. The discontinuity of potential at $\phi = \phi_0$ poses further strong conditions on the solutions: Ψ should vanish in a region containing the point ϕ_0. Note that the value of ϕ_0 can be chosen freely.

The intuitive picture is that the solutions correspond to strongly localized wave packets in accelerating motion. The wavepacket can for some time vanish in the region containing point ϕ_0. What happens when this condition does not hold anymore?

- Dissipation is present in the system and therefore also state function reductions. Could state function reduction occur when the wave packet contains the point, where $V(\phi)$ is dis-continuous?
- Or are the solutions well-defined only in a space-time region with finite temporal extent T? In zero energy ontology (ZEO) this option is automatically realized since space-time sheets are restricted inside causal diamonds (CDs). Wave functions need to be well-defined only inside CD involved and would vanish at ϕ_0. Therefore the mathematical problems related to the representation of accelerating wave packets in non-compact degrees of freedom could serve as a motivation for both CDs and ZEO.

There is however still a problem. The wave packet cannot be in accelerating motion even for single full turn. More turns are wanted. Should one give up the assumption that wave function is continuous at $\phi = \phi_0 + 2\pi$ and should one allow wave functions to be multivalued and satisfy the continuity condition $\Psi(\phi_0) = \Psi(\phi_0 + n2\pi)$, where n is some sufficiently large integer. This would mean the replacement of the configuration space (now circle) with its n-fold covering.

The introduction of the n-fold covering leads naturally to the hierarchy of Planck constants.

1. A natural question is whether constant torque τ could affect the system so that $\phi = 0$ ja $\phi = 2\pi$ do not represent physically equivalent configurations anymore. Could it however happen that $\phi = 0$ ja $\phi = n2\pi$ for some value of n are still equivalent? One would have the analogy of many-sheeted Riemann surface.

2. In TGD framework 3-surfaces can indeed be analogous to n-sheeted Riemann surfaces. In other words, a rotation of 2π does not produce the original surface but one needs $n2\pi$ rotation to achieve this. In fact, $h_{eff}/h = n$ corresponds to this situation geometrically! Space-time itself becomes n-sheeted covering of itself: this property must be distinguished from many-sheetedness. Could constant torque provide a manner to force a situation making space-time n-sheeted and thus to create phases with large value of h_{eff}?

3. Schrödinger amplitude representing accelerated wave packet as a wavefunction in the n-fold covering would be n-valued in the ordinary Minkowski coordinates and would satisfy the boundary condition

$$\Psi(\phi) = \Psi(\phi + n2\pi) \ .$$

   Since $V(\phi)$ is not rotationally invariant this condition is too strong for stationary solutions.

4. This condition would mean Fourier analysis using the exponentials $exp(im\phi/n)$ with time dependent coefficients $c_m(t)$ whose time evolution is dicrated by Schröndinger equation. For ordinary Planck constant this would mean fractional values of angular momentum

$$L_z = \frac{m}{n}\hbar \ .$$

   If one has $h_{eff} = n\hbar$, the spectrum of L_z is not affected. It would seem that constant torque forces the generation of a phase with large value of h_{eff}! From the estimate for how many turns the system rotates one can estimate the value of h_{eff}.

3 What about stationary solutions

Giving up stationary seems the only option on basis of classical intuition. One can however ask whether also stationary solutions could make sense mathematically and could make possible completely new quantum phenomena.

1. In the stationary situation the boundary condition must be weakened to

$$\Psi(\phi_0) = \Psi(\phi_0 + n2\pi) \ .$$

   Here the choice of ϕ_0 charactgerizes the solution. This condition quantizes the energy. Normally only the value $n = 1$ is possible.

2. The many-valuedness/discontinuity of $V(\phi)$ does not produce problems if the condition

$$\Psi(\phi_0, t) = \Psi(\phi_0 + n2\pi, t) = 0 \ , \quad 0 < t < T \ .$$

   is satisfied. Schrödinger equation would be continuous at $\phi = \phi_0 + n2\pi$. The values of ϕ_0 would correspond to a continuous state basis.

3. One would have two boundary conditions expected to fix the solution completely for given values of n and ϕ_0. The solutions corresponding to different values of ϕ_0 are not related by a rotation since $V(\phi)$ is not invariant under rotations. One obtains infinite number of continous solution families labelled by n and they correspond to different phases if h_{eff} is different from them.

4 The connection with WKB approximation and Airy functions

Stationary Schrödinger equation with constant force appears in WKB approximation [B2] (`http://en.wikipedia.org/wiki/WKB_approximation`) and follows from a linearization of the potential function at non-stationary point. A good example is Schröndinger equation for a particle in the gravitational field of Earth. The solutions of this equation are Airy functions which appear also in the electrodynamical model for rainbow.

1. The standard form for the Schrödinger equation in stationary case is obtained using the following change of variables

$$u + e = k\phi \ , \quad k^3 = \frac{2\tau I}{\hbar^2} \ , \quad e = \frac{2IE}{\hbar^2 k^2} \ .$$

   One obtains differential equation for Airy function [B1] (`http://en.wikipedia.org/wiki/Airy_function`)

$$\frac{d^2\Psi}{du^2} - u\Psi = 0 \ .$$

   The eigenvalue of energy does not appear explicitly in the equation. Boundary conditions transform to

$$\Psi(u_0 + n2\pi k) = \Psi(u_0) = 0 \ .$$

2. In non-stationary case the change of variables is

$$u = k\phi \ , \ \ k^3 = \frac{2\tau I}{\hbar^2} \ \ , \ \ \ v = \frac{\hbar^2 k^2}{2I} \times t \ \ .$$

One obtains

$$\frac{d^2\Psi}{du^2} - u\Psi = i\partial_v\Psi \ \ .$$

Boundary conditions are

$$\Psi(u + kn2\pi, v) = \Psi(u, v), \quad 0 \leq v \leq \frac{\hbar^2 k^2}{2I} \times T \ \ .$$

An interesting question is what $h_{eff} = nh$ means? Should one replace h with $h_{eff} = nh$ as the condition that the spectrum of angular momentum remains unchanged requires. One would have $k \propto n^{-2/3}$ ja $e \propto n^{4/3}$. One would obtain boundary conditions non-linear with respect to n.

5 Connection with living matter

The constant torque - or more generally non-oscillatory generalized force in some compact degrees of freedom - requires of a continual energy feed to the system. Continual energy feed serves as a basic condition for self-organization and for the evolution of states studied in non-equilibrium thermodynamics. Biology represents a fundamental example of this kind of situation. The energy feeded to the system represents metabolic energy and ADP-ATP process loads this energy to ATP molecules. Also now constant torque is involved: the ATP synthase molecule [I1] (`http://en.wikipedia.org/wiki/ATP_synthase`) contains the analog of generator having a rotating shaft. Since metabolism and the generation of large h_{eff} phases are very closely related in TGD Universe, the natural proposal is that the rotating shaft forces the generation of large h_{eff} phases.

REFERENCES

Theoretical Physics

[B1] Airy functions. `http://en.wikipedia.org/wiki/Airy_function`.

[B2] WKB approximation. `http://en.wikipedia.org/wiki/WKB_approximation`.

Biology

[I1] ATP synthase. `http://en.wikipedia.org/wiki/ATP_synthase`.

Books related to TGD

[K1] M. Pitkänen. Negentropy Maximization Principle. In *TGD Inspired Theory of Consciousness*. Onlinebook. http://tgdtheory.fi/public_html/tgdconsc/tgdconsc.html#nmpc, 2006.

[K2] M. Pitkänen. Quantum Model of Memory. In *TGD Inspired Theory of Consciousness*. Onlinebook. http://tgdtheory.fi/public_html/tgdconsc/tgdconsc.html#memoryc, 2006.

[K3] M. Pitkänen. Comparison of TGD inspired theory of consciousness with some other theories of consciousness. In *TGD based view about living matter and remote mental interactions*. Onlinebook. http://tgdtheory.fi/public_html/pdfpool/consccomparison.pdf, 2013.