

Biophysical Relativity: Implication for High Speed Biological Processes and Development

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ABSTRACT

Biological processes such as photosynthesis, enzymatic reactions or neuronal activity cannot completely be explained on the basis of classical physical approach so that quantum effects have been postulated in nanospace. The presented theory substantiates the theory of quantum biology as it postulates apparent time compression in nano-dimension which results in apparent relative increase of speed of biochemical or biophysical processes with regard to macroworld observers.

Key Words: biological relativity, time compression, nanospace, macroworld

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Introduction

During the last decades mankind learnt much about the molecular secrets of life such as photosynthesis, metabolism and enzymes, energy transfer or nervous function. However, some biological phenomena, especially concerning the speed of processes, can be hardly explained by means of pure mechanical (classical) physical considerations. A few examples shall illustrate the basic questions.

For example, some plants such as bamboos grow extraordinarily fast so that we cannot imagine the underlying process, which is surely associated with marked efficacy of photosynthesis (Engel *et al.*, 2007). A growth performance of 1 meter per day is not unusual for this plant (Farrelly, 1984). We may move backward two billions of years and ask, how primitive (bio-chemical) evolution could occur although the processes are highly improbable and – as some argue – contradict thermodynamic laws. How could this kind of biochemical self-organization – as already Fox postulated in 1959 – happen in measurable time?

For a few years the notion of free will is discussed between scientists and philosophers. One crucial issue of this discussion is, whether we are able to change our mind when the *Bereitschaftspotential* has already determined the way of thinking? Are we responsible for that what we do? A related aspect of this discussion is why our nervous system could react adequately, if external stimuli move much faster than neuronal transmission would allow? Is it possible for neurons to process indeed faster than we would expect (Koch, 1997; 2011; Kornhuber and Deecke, 2008)?

Even the everyday process of smelling cannot be explained by mere mechano-chemical (classical) approaches (Turin, 1996), but tunneling processes of electrons beyond structures of odorants are admitted. A similar paradoxical effect is supposed in some enzyme reactions, which lack the energy that is thermodynamically necessary, but, nevertheless, the enzymes do their work quite perfect (Masgrau *et al.*, 2006). How do inhalation anesthetics work and what is consciousness, which is transiently blocked by these agents? Hemeroff (2002) argues that quantum processes - faster than light in nanotubules - are the basis of consciousness and are modified by inhalation agents.

Theoretical aspects

Obviously, nature works much more rapid, than we prima vista would suppose. As speed

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is clearly limited to speed of light according Einstein's theory of relativity – an exception may be the tachyons, which only have an imaginary mass - it must be the time that changes and leads to a pseudo-increase of (biochemical) reaction velocity in observer's eye. The basic assumption is that in nanospace time is compressed (i.e. "faster") in contrast to moving systems, when time is dilated (i.e. "slower").

If we look in more detail into atomic dimensions we have to deal with phenomena which lead us towards a foreign unusual world, where time is much faster ("compressed") than we would intuitively expect. We imagine an electron orbiting around the nucleus with a certain velocity. If we strive downward to atomic dimensions we remember that an electron which orbits the nucleus with Bohr's radius has a certain probability to exist with regard to this radius. We may calculate the velocity of the electron on its orbit. This velocity, however, depends on the position and the probability to meet the electron. Far outside Bohr's radius the electron is detected with lower probability and does not really influence time. Say we meet the electron every 10th, 9th, 8th, round, then the "electron clock" gets faster and faster as we narrow Bohr's radius a_0 . Hence, time is "compressed" in the eyes of an external observer.

To substantiate this concept, we have to go back briefly to Schrödinger's wave function, which gives us a solution for the probability of an electron surrounding the nucleus – case of simple 1s-orbital. The probability of existence of the electron, $P(r)$, decreases smoothly from a maximum towards zero after having passed 2 to 4 times Bohr's radius. The highest probability per volume (probability density function) is just around Bohr's radius. The probability to meet the electron increases if we move in direction to the nucleus and decreases, on the contrary, with increasing distance r from the nucleus (Bader, 2011).

Imagine that we would try to measure time by means of this electron in the orbit itself and far away from the nucleus. We admit that the velocity of the electron keeps quite constant. Far away from the nucleus we would agree that the electron does not much influence our clock, as there is no change at all, $P(r)$ being almost zero. If we move mentally towards the nucleus, we find that time should

change as the electron clock becomes more and more real. We suppose that real time Tr (our observer's time) and the apparent time $Tapp$ differ in some way. $Tapp = f(Tr)$ and that this difference is in some way associated to the probability of the electron. The integrated probability to "meet" the electron on our journey to the nucleus is admitted to one in the center of the atom, the maximum of the probability density function is at a_0 , the radius of Bohr.

We empirically postulate that $Tapp = Kt * P(r)^n * Tr$, where n is a kind of shaping factor, Kt a "time constant" and r the distance with regard to the center. The probability of the electron of being in a certain volume (radial probability density) can be approximated by a peak curve as function of the radial distance r : $P(r) = C * r^2 * exp(-2 * r / a_0)$, where $C = 4r^2 / a_0^3$ (Serway and Jewett, 2005). Far away from the nucleus the probability decreases asymptotically towards zero. The maximum of $P(r)$ per volume of interest (radial probability density function) is given for Bohr's radius of about 5.24×10^{-11} m. The relation between apparent time $Tapp$ and real time Tr of the observer (far away from the nucleus) then becomes:

$$Tapp = Kt (C * r^2 * exp(-2 * r / a_0))^n * Tr.$$

In principle, the probability density functions of electrons can be calculated for s or p orbitals, even *spd* hybridization or pi-electrons of aromatic structures or actually metabolic cascades such as in photosynthesis or respiration. Moreover, similar considerations may be postulated for other particles such as neutrons, protons or – in the end – quarks ("quark-time"). Hence, every moving particle – may be translational or spin motion – can influence time compression.

Interpretation

What is the consequence of these theoretical relations? In real observer's "macroscopic life", both "times" are identical. When getting nearer to the nucleus, i. e., we move to nanospace, the apparent time is decreasing step by step and strives for minimum when $r = a_0$, i.e. Bohr's radius. As a consequence, molecular time-dependent phenomena increase apparently in speed as $\Delta x / \Delta Tapp > \Delta x / \Delta Tr$. That is, chemical or biochemical reactions, signal transduction processes



happen much faster for a macroworld observer compared to an “atomic world” observer.

We have to understand that the simple hydrogen atom with a clear spherical orbit allows us to visualize the solutions. However, probability distributions for p or d orbitals are much more complicated, although the principle should hold. Moreover, the theory does not necessarily depend on a specific orbit defined by solutions of the wave function. Even if electrons jump from one energy state to another, as postulated in photosynthesis or respiration cascades, time compression may be eminent.

What does this theory mean for biology and physics?

The Hameroff-Penrose theory (1996) postulates quantal phenomena in microcellular systems such as microtubules. The quantum-Zenon-effect, inaugurated by Stapp (2007), even supposes a change in velocity of particularly neurobiophysical processes. In analogy, John Eccles discusses fields of probability after synaptic activation following secretion of transmitters from synaptic vesicles (1996). Indeed, Hameroff's idea of very fast, even supra-light-processes in nanospace (with regard to a macroworld observer), is substantiated by this theory of time compression. Enzyme processes and biochemical reactions, thoughts and neuronal reaction may be apparently much faster for an observer outside the nanospace.

The theory goes beyond biophysical interpretation. What does it mean that apparent time is compressed when we move towards a postulated orbiting particle? With regard to life, the particle of interest are generally electrons as chemical bonding, reactions or biochemical processes are based on electron transfer. However we have not to speak exclusively about electrons. If there no

particles on a trajectory whatsoever, we may speculate that in the beginning, no time did exist at all and time now expands from dilation in the macroworld to time compression in nanospace.

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