Estimation of Possible Selectivity and Sensitivity of a Cooperative System to Low-Intensive Microwave Radiation

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There are many cases of extremely high sensitivity to low-level factors. In some cases the low-level factors may be benefitial. For example homeopathic pills, or manual therapy. In some cases they may be harmful, such as technogenic environmental factors. Other cases represent a very sensitive communication. For example, communication by odorants between some butterflies, or cases of so called extrasensory perception.

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It is interesting that high sensitivity is mostly observed for the living objects. The living objects are open systems. That means they exchange substances with the external world.

All living systems, even a single cell, posess a sort of free will. Speaking in physical language, they are multistable. The multistability meeans that system can have several different internal states, while the external conditions remaine the same. In other words, the external conditions cannot determine uniquely the internal state of a living object. It is namely this fact that is treated as a sort of free will.

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The effect of microwaves on living objects is studied experimentally for more then 20 years [1,2]. During the last 10 years microwaves are used for healing [3,4]. The microwaves traditionally belonge to physical factors and their effects have to be reduced to purely physical mechanisms. Till now such mechanisms has not been found. The problem is that microwaves are applied in a very low doses. At the level of a single organic molecule this low-intensive microwaves produce effect which is well jammed by thermal oscillations of the molecules. The common physics usually deals with gases, or liquids, or solids, and it has nothing to say in our situation. Our opinion is that the answer may be found in the internal complexity of the object the microwaves are acting upon.

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This paper is aimed to explain how the weak microwave radiation may produce a pronounced effect in a coherent system comprizing a large number of molecules. The following model chemical system is considered.

$$A + 2X \rightleftharpoons 3X \tag{1}$$

$$B + X \rightleftharpoons C^{*} \tag{2}$$

$$C^{*} \rightleftharpoons C^{\tilde{}} \tag{3}$$

Here X, A, B, C denote molecules of different species. $C^{*}$and $C^{\tilde{}}$denote active and non-active states of the same molecule C. The A, B, and C concentrations are maintained constant. Concentration of X is expected to be established spontaneously via the chemical reactions noted here.

This system is open. Indeed, as A, B, C can be produced or consumed, the chemicals have to be removed or added to the system in order to keap constant concentrations.

This system is multistable. It is established matheematicallly that under fixed conditions two different concentrations of X, are possible as its stable internal state: $[X] = x_1$, or $[X] = x_2$, $\quad x_1 < x_2$. Both x_1 and x_2 are self-sustaining due to positive and negative cooperativity presence in reaction (1). Switching between x_1 and x_2 states may happen due to external influencees, or internal fluctuation processes.

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If the reactor has a big volume, two stable concentrations may coexist in such a reactor, occupaing different parts of the volume. We consider the small enough reactor in wich only single stable concentration is possible. This is a coherent reactor. The coherent reactor responses to external influences as a single unit, namely, it switches from one stable state to another one in the whole volume at onse. The number of C-type molecules in the coherent volume is essential for sensitivity: the more molecules, the more sensitive the system is. This number is estimated for biologically realistic parameters as $N \sim 10^9 \div 10^{12}$.

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It is known that microwaves are able to shift equilibrium in some chemical reactions, but the shift may be very small. This is because molecular vibrations in this frequency band is damped by viscous friction. If the mw radiation power surfase density is $I = 1$ mW/cm^2 one may expect the concentration increment

$$\frac{\Delta[C^*]}{[C^*]} \sim 10^{-7}. \tag{4}$$

As we know, the system (1)–(3) is able to switch from its stable state to another one due to fluctuations. This process is characterized by a mean waiting time for first switching, $T_{x_1 \to x_2}$. If an external influence is added, the mean waiting time will change. How much it changes depends on system sensitivity. Mathematical treatment under some simplifying assumptions (for detailes see [5,6]) gives the figure:

$$\frac{T(\text{without field})}{T(\text{with 1 mW/cm}^2\text{ field})} \sim \exp(10^4) \tag{5}$$

Comparing (4) and (5), one may conclude that single receptor molecules are very little influenced by microwaves. But if a large number of such receptors are incorporated within a living-like multistable coherent system, the whole system may react very sharply.

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In connection with this conclusion there are two interesting observations:

The first one is the reductionism problem [7]. If we have here such a sensitive system, is it possible to reduce its properties to the properties of its parts. Theoretical basis for such reduction has been offered in this paper. But what may be seen in experiments? The C-type molecules realizing primary reception of microwaves show extremely small effect, whereas whole system manifests a very high effect. It seems incredible that the effects are in causal relation.

The second observation is that the model system that we have considered, has at least two common features with usual sensory systems, such as olfaction, taste and others [8]. Namely, in analogy with sensory systems this system is hierarchical. The first hierarchical level here is the C-type molecules, and the second one is the level of the whole system, including the cooperatively coupled X-molecules. Also, in analogy with known sensory systems, we have here a threshold-type behavior: a definite threshold must be overcome for switching.

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