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A Mathematical Model for the Signal of Death and Emergence of Mind Out of Brain in Izhikevich Neuron Model

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Abstract

AIM: In this paper, using a mathematical model, we will show that for special exchanged photons, the Hamiltonian of a collection of neurons tends to a constant number and all activities is stopped. These photons could be called as the dead photons. To this aim, we use concepts of Bio-BIon in Izhikevich Neuron model.

METHODS: In a neuron, there is a page of Dendrite, a page of axon's terminals and a tube of Schwann cells, axon and Myelin Sheath that connects them. These two pages and tube form a Bio-Bion. In a Bio-Bion, exchanging photons and some charged particles between terminals of dendrite and terminals of axon leads to the oscillation of neurons and transferring information. This Bion produces the Hamiltonian, wave equation and action potential of Izhikevich Neuron model. Also, this Bion determines the type of dependency of parameters of Izhikevich model on temperature and frequency and obtains the exact shape of membrane capacitance, resting membrane potential and instantaneous threshold potential.

RESULTS: Under some conditions, waves of neurons in this BIon join to each other and potential shrinks to a delta function. Consequently, total Hamiltonian of the system tends to a constant number and system of neuron act like a dead system. Finally, this model indicates that all neurons have the ability to produce similar waves and signals like waves of the mind.

CONCLUSION: Generalizing this to biology, we can claim that neurons out of the brain can produce signals of minding and imaging and thus mind isn't confined to the brain.

Introduction

Recently, Izhikevich has proposed a neuronal dynamical model which is a simple model that faithfully reproduces all the neurocomputational dynamical features of the neuron [1]. This model is obtained by reducing some Biological aspects of Hodgkin-Huxley (HH) neuron using bifurcation methods [2]. Until now, many discussions have been done on this subject. For example, in one research, authors have focused herein on the Izhikevich neuron model and compared the characteristics of Chaotic resonance in the chaotic states arising through the period-doubling or tangent bifurcation routes. They have found that the signal response in Chaotic resonance had a unimodal maximum concerning the stability of chaotic orbits in the tested chaotic states [3]. In another research, authors have presented a Multiplier less Noisy Izhikevich Neuron (MNIN) model, which was used for digital implementation of Biological neural networks in large scale. Simulation results have shown that the MNIN model reproduces the same operations of the original noisy Izhikevich neuron [4]. In another paper, authors have performed numerical simulations of synaptically coupled Izhikevich networks under the effect of general non-Gaussian Lvy noise. Firing dynamics of an all-to-all coupled Izhikevich network and two excitatory coupled Izhikevich networks with differing adaptation properties have been studied in response to applied Lvy noise [5]. And in one of newest works, authors have considered the effect of synaptic interaction (electrical and chemical) as well as structural connectivity on synchronisation transition in network models of Izhikevich neurons which spike regularly with beta rhythms. They have found a wide range of behaviour including continuous transition, explosive transition, as well as lack of global order [6].

In this paper, we show that in an Izhikevich Neuron model, neurons join to each other and build a stable system. In some conditions, exchanged photons between neurons join to each other produce a constant Hamiltonian. This leads to a stop in transferring information and the death of the system. To this aim, we show that a neuron has a structure similar to Bio-BIons. These Bio-BIons are formed from a page of Dendrite, a page of axon's terminals and a tube of Schwann cells, axon and Myelin Sheath that connects them. Previously, it has been shown that exchanged photons between sheets of a graphene system could produce a nano-Bion [7]. The same Bion can emerge along neurons. Hamiltonian, action potential and wave equation in this Bio-Bion is very similar to an action potential and wave equation in Izhikevich Neuron model. We also use the concepts in [8] and propose a new temperature model for oscillating neurons. For some temperatures and rotating velocity, total potential tends to delta function and system is dead. We can save the system by removing some neurons. For example, in a body, we can remove neurons of the brain and prevention of death. In these conditions, neurons of the spinal cord do tasks of brain-like minding.

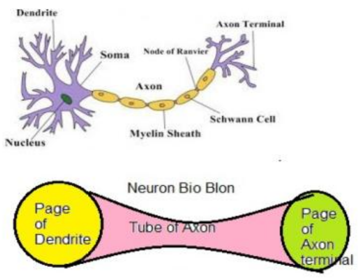

Figure 1: Similarity between the structure of a neuron and a Bio-BIon

The outline of the paper is as follows. In section II, we will construct c in a Bio-Bion. In section III, we will consider the dependency of Izhikevich parameters on temperature and frequency. In section IV, we will consider the origin of waves of death in the Izhikevich model. In section V, we will discuss the results of experiments on birds. We also show that birds without a brain can continue minding. The last section is devoted to conclusions.

in Constructing the Izhikevich Neuron Model Bio-Bion

The Izhikevich Neuron model which reproduce spiking and bursting behaviour of many known types of neurons are described by the pair of the differential equation:

$$C\frac{dV}{dt} = k(V - V_r)(V - V_t) - DU + S$$
$$\frac{dU}{dt} = a[b(V - V_r) - U] \quad (1)$$

where t is time, C is membrane capacitor, V is membrane potential, V_r is the resting membrane potential, V is the instantaneous threshold potential, U is the recovery variable, S is stimulus (synaptic: excitatory or inhibitory, external, noise) and *a, b, D* are some constants.

To consider the rotating neuron, we specialise to an embedding of the neuron world volume in Minkowski space-time with metric [9];

$$ds^2 = -dt^2 + dr^2 + r^2\left(d\theta^2 + sin^2\theta d\phi^2\right) + \sum_{i=1}^{6} dx_i^2 \quad (2)$$

Without background fluxes. Here, t is time, r is the radius of the page of Dendrite and θ is the angle of rotation. When neurons oscillate with frequency ω, a rotating velocity emerges, and this velocity produces an acceleration (a). We can write:

$$a = l_0\omega^2 \quad (3)$$

In this case, the relation between the world volume coordinates of the rotating neuron (τ, σ) and the coordinates of Minkowski space-time (t, r) are [9];

$$at = e^{a\sigma}\sinh(a\tau) \quad ar = e^{a\sigma}\cosh(a\tau) \quad (4)$$

where a is the acceleration of rotating neuron. We can suppose that the coordinate along the separation distance between Dndrite and axon's terminals ($x^4 = z$) depends on the $r = \pm\frac{1}{a}e^{\pm a\sigma}\cosh(a\tau)$ and by using equations (4), rewrite equations (2) as [9];

$$ds_I^2 = -dt^2 + \left(1 + (\frac{dz}{dr})^2\right)dr^2 + r^2\left(d\theta^2 + sin^2\theta d\phi^2\right) + \sum_{i=1}^{5} dx_i^2 =$$
$$\left(e^{2a\sigma} + \frac{1}{\sinh^2(a\tau)}(\frac{dz}{d\tau})^2\right)d\tau^2 - \left(e^{2a\sigma} + \frac{1}{\cosh^2(a\tau)}(\frac{dz}{d\sigma})^2\right)d\sigma^2 +$$
$$\frac{1}{\sinh(a\tau)\cosh(a\tau)}(\frac{dz}{d\tau}\frac{dz}{d\sigma})d\tau d\sigma + \left(\frac{1}{a}e^{a\sigma}\cosh(a\tau)\right)^2\left(d\theta^2 + sin^2\theta d\phi^2\right) + \sum_{i=1}^{5} dx_i^2 \quad (5)$$

Now, we can replace acceleration with it's equivalent temperature. Previously,it has been shown that temperature has the below relation with acceleration [9]:

$$v = a\tau$$
$$\rightarrow T = \frac{T_0}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{T_0}{\sqrt{1 - \frac{|a\tau|^2}{c^2}}}$$
$$v = a\tau = c\sqrt{1 - \frac{T_0^2}{T^2}} \quad (6)$$

Where T is the temperature of the BIon and T0 is the critical temperature. However, this relation is questionable. Based on this relation, the superconductivity phenomena depend on the system velocity!! You can move a system with special velocities to reduce its temperature to the less than of its critical temperature, and then the system shows superconductivity by itself!! It means that a physical phenomenon (superconductivity) depends on the system velocity, a result in direct conflict with the relativity law claiming that the physical laws are independent of the observer velocity. This relativistic relation for temperature is not a true relation, and in fact, the temperature's relation depends on the thermocouple apparatus used. A true thermocouple rejects this definition of temperature (For example, see [8], [10], [11]). Thus, to obtain a true relation between temperature and acceleration, we use concepts of BIon:

$$dM_{I-A/B} = T_{I-A/B}dS_{I-A/B} \rightarrow T_{I-A/B} = \frac{dM_{I-A/B}}{dS_{I-A/B}} \qquad (7)$$

Previously, thermo-dynamical parameters have been obtained in [12]:

$$\begin{aligned}
& dM_{I-A} = \frac{dM_{I-A}}{dz_{I-A}}dz_{I-A} \\
& dz_{I-A} = dz_{II-B} \simeq \Big(e^{-4a\sigma}\sinh^2(a\tau)\cosh^2(a\tau)\Big) \times \\
& \Big(\frac{F_{DBI,I,A}(\tau,\sigma)\Big(\frac{F_{DBI,I,A}(\tau,\sigma)}{F_{DBI,I,A}(\tau,\sigma_0)} - e^{-4a(\sigma-\sigma_0)}\frac{\cosh^2(a\tau_0)}{\cosh^2(a\tau)}\Big)^{-\frac{1}{2}}}{F_{DBI,I,A}(\tau_0,\sigma)\Big(\frac{F_{DBI,I,A}(\tau_0,\sigma)}{F_{DBI,I,A}(\tau_0,\sigma_0)} - e^{-4a(\sigma-\sigma_0)}\frac{\cosh^2(a\tau_0)}{\cosh^2(a\tau)}\Big)^{-\frac{1}{2}}} - \frac{\sinh^2(a\tau_0)}{\sinh^2(a\tau)}\Big)^{-\frac{1}{2}} \\
& \frac{dM_{I-A}}{dz} = \frac{dM_{II-B}}{dz} = \frac{4T_{D3}^2}{\pi T_{0,I-A}^4}\frac{F_{DBI,I,A}(\sigma,\tau)\Big(\frac{1}{a}e^{a\sigma}\cosh(a\tau)\Big)^2\Big(\sinh^2(a\tau)+cosh^2(a\tau)\Big)}{\sqrt{F_{DBI,I,A}^2(\sigma,\tau) - F_{DBI,I,A}^2(\sigma_o,\tau)}} \times \\
& \frac{4\cosh^2\alpha_{I-A}+1}{\cosh^4\alpha_{I-A}} \\
& dS_{I-A} = dS_{II-B} = \frac{4T_{D3}^2}{\pi T_{0,I-A}^5}\frac{F_{DBI,I,A}(\sigma,\tau)\Big(\frac{1}{a}e^{a\sigma}\cosh(a\tau)\Big)^2\Big(\sinh^2(a\tau)+cosh^2(a\tau)\Big)}{\sqrt{F_{DBI,I,A}^2(\sigma,\tau) - F_{DBI,I,A}^2(\sigma_o,\tau)}} \times \\
& \frac{4}{\cosh^4\alpha_{I-A}}
\end{aligned} \qquad (8)$$

using relation (8) in relation (7), we can obtain an explicit form of temperature in an accelerating neuron:

$$\begin{aligned}
& T_{I-A} = T_{0,I-A}\Big(4\cosh^2\alpha_{I-A}+1\Big) \times \\
& \Big(e^{-4a\sigma}\sinh^2(a\tau)\cosh^2(a\tau)\Big) \times \\
& \Big(\frac{F_{DBI,I,A}(\tau,\sigma)\Big(\frac{F_{DBI,I,A}(\tau,\sigma)}{F_{DBI,I,A}(\tau,\sigma_0)} - e^{-4a(\sigma-\sigma_0)}\frac{\cosh^2(a\tau_0)}{\cosh^2(a\tau)}\Big)^{-\frac{1}{2}}}{F_{DBI,I,A}(\tau_0,\sigma)\Big(\frac{F_{DBI,I,A}(\tau_0,\sigma)}{F_{DBI,I,A}(\tau_0,\sigma_0)} - e^{-4a(\sigma-\sigma_0)}\frac{\cosh^2(a\tau_0)}{\cosh^2(a\tau)}\Big)^{-\frac{1}{2}}} - \frac{\sinh^2(a\tau_0)}{\sinh^2(a\tau)}\Big)^{\frac{1}{2}}
\end{aligned} \qquad (9)$$

Above equations show the explicit relation between temperatures and acceleration in a neuron. However, to obtain the relation between temperature and rotating velocity, we should take a derivation of the above equations, put ($\omega = \frac{do}{dt}$) and obtain the below relation:

$$a \sim 2\pi T = \frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}} \qquad (10)$$

where T_0 is the temperature of non-rotating neuron and ω is the frequency. Also, ω_0 is the upper limit frequency of neurons. Substituting equation (10) in equations (5), we obtain:

$$\begin{aligned}
& ds_I^2 = \\
& \Big(e^{2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma} + \frac{1}{\sinh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}(\frac{dz}{d\tau})^2\Big)d\tau^2 - \\
& \Big(e^{2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma} + \frac{1}{\cosh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}(\frac{dz}{d\sigma})^2\Big)d\sigma^2 + \\
& \frac{1}{\sinh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}(\frac{dz}{d\tau}\frac{dz}{d\sigma})d\tau d\sigma + \\
& \Big(\frac{1}{\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}}e^{\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}\cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\Big)^2 \times \\
& \Big(d\theta^2 + sin^2\theta d\phi^2\Big) + \\
& \sum_{i=1}^{5} dx_i^2
\end{aligned} \qquad (11)$$

Above metrics correspond to thermal rotating neurons. These metrics depend on the temperature and rotating velocity of neurons. To obtain the spectrum of the rotating neuron, we should obtain the action. To this aim, we will use of the concept of BIon model for in [7]. For flat space-time, the action of a neuron is [9]:

$$\begin{aligned}
& S = -T_{tri}\int d^3\sigma\sqrt{\eta^{ab}g_{MN}\partial_a X^M\partial_b X^N + 2\pi l_s^2 G(F))} \\
& G = (\sum_{n=1}^{N}\frac{1}{n!}(-\frac{F_1..F_n}{\beta^2})) \\
& F = F_{\mu\nu}F^{\mu\nu} \quad F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu
\end{aligned} \qquad (12)$$

where g_{MN} is the background metric, $X^M(\sigma^a)$'s are scalar fields, N is number of exchanged photons between Dendrite and axon, σ^a's are the neuron coordinates, a, b = 0, 1, ..., 3 are world-volume indices of rotating neuron and M, N = 0, 1, ..., 10 are neuron dimensional spacetime indices. Also, G is the nonlinear field [9], and A is the photon which exchanges between Dendrite and axon. With the metric of equation (11), the action (12) should be re-written as:

$$\begin{aligned}
& S_{I,end1} = -\int dt\int_{\sigma_0}^{\infty} d\sigma\Big(\frac{1}{-}e^{\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}\cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\Big)^2 \times \\
& \Big(\sinh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau) + cosh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\Big) \times \\
& [1 + \frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}(\frac{dz}{d\tau})^2 + \frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\cosh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}(\frac{dz}{d\sigma})^2 + \\
& \frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}((\frac{dz}{d\tau}\frac{dz}{d\sigma})) - (2\pi l_s^2 G(F))]^{1/2}
\end{aligned} \qquad (13)$$

Using the method in ref [9], we can obtain the Hamiltonian from equation (13) for neuron:

$$\begin{aligned}
& H_{I,end1} = \int d^3\sigma\varrho_{I,end1} \\
& \varrho_{I,end1} = [1 + \frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}(\frac{dz}{d\tau})^2 + \frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\cosh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}(\frac{dz}{d\sigma})^2 + \\
& \frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}((\frac{dz}{d\tau}\frac{dz}{d\sigma}))]^{1/2}O_{tot,N} \\
& O_{tot,N} = [1 + \frac{k_3^2}{O_{tot,N-1}\Big(\frac{1}{\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}}e^{\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}\cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\Big)^4}]^{-1/2} \times ...O_{tot,1}
\end{aligned}$$

$$O_{tot,1} = [1 + \frac{k_2^2}{\Big(\frac{1}{\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}} e^{\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma} \cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\Big)^4}]^{-1/2} \qquad (14)$$

Now, to obtain the Hamiltonian of neuron, we should use of below replacement:

$$V + \frac{dV}{d\tau} = \frac{dz}{d\tau} \quad U + \frac{dU}{d\tau} = \frac{dz}{d\sigma} \qquad (15)$$

By substituting equation (15) in equation (14), we obtain:

$$H_{neuron} = \int d^3\sigma \varrho_{I,end1}$$

$$\varrho_{I,end1} = [1 + \frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}(V + \frac{dV}{d\tau})^2 + \frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\cosh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}(U + \frac{dU}{d\tau})^2 +$$
$$\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}((V + \frac{dV}{d\tau})(U + \frac{dU}{d\tau}))]^{1/2} O_{tot,N}$$

$$O_{tot,N} = [1 + \frac{k_3^2}{O_{tot,N-1}\Big(\frac{1}{\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}} e^{\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma} \cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\Big)^4}]^{-1/2} \times ...O_{tot,1}$$

$$O_{tot,1} = [1 + \frac{k_2^2}{\Big(\frac{1}{\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}} e^{\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma} \cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\Big)^4}]^{-1/2} \qquad (16)$$

where *N* is the number of terminals of Dendrite and axon. Above equation shows that Hamiltonian of an oscillating neuron depends on the frequency and temperature. By increasing temperature, more photons are exchanged between neurons and energy of neurons increases. Also, by increasing the number of exchanged photons, frequency of system increases and Hamiltonian grows. Also, the above Hamiltonian depends on parameters of Izhikevich neuron model.

The dependency of Izhikevich Parameters on Temperature and Frequency in Bio-Bion

In this section, we will obtain the exact dependency of parameters of Izhikevich neuron model on temperature and frequency. To this aim, we extract the wave equation from 10 equation (20):

$$\Big(\frac{\partial}{\partial\tau}[[\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}](V + \frac{dV}{d\tau}) + [\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}](U + \frac{dU}{d\tau})] -$$
$$[[\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}](V + \frac{dV}{d\tau}) + [\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}](U + \frac{dU}{d\tau})]\Big) \times$$
$$[\frac{\partial}{\partial\tau} + 1]\Big([1 + \frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}(V + \frac{dV}{d\tau})^2 + \frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\cosh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}(U + \frac{dU}{d\tau})^2 +$$
$$\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}((V + \frac{dV}{d\tau})(U + \frac{dU}{d\tau}))]^{-1/2} O_{tot,N}\Big) = 0 \qquad (17)$$

and

$$\Big(\frac{\partial}{\partial\tau}[[\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\cosh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}](U + \frac{dU}{d\tau}) + [\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}](V + \frac{dV}{d\tau})] -$$
$$[[\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\cosh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}](U + \frac{dU}{d\tau}) + [\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}](V + \frac{dV}{d\tau})]\Big) \times$$
$$[\frac{\partial}{\partial\tau} + 1]\Big([1 + \frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}(V + \frac{dV}{d\tau})^2 + \frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\cosh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}(U + \frac{dU}{d\tau})^2 +$$
$$\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}((V + \frac{dV}{d\tau})(U + \frac{dU}{d\tau}))]^{-1/2} O_{tot,N}\Big) = 0 \qquad (18)$$

Comparing equations (17,18) with equation (1), we obtain the explicit forms of parameters in Izhikevich model.

$$C = [\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}]O_{tot,N} + [\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}]O_{tot,N}$$

$$K = \frac{\partial}{\partial\tau}[\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}]O_{tot,N}$$

$$D = [\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}]O_{tot,N}$$

$$S = \frac{\partial}{\partial\tau}[O_{tot,N}[\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}]]$$

$$V_t = [\frac{\partial}{\partial\tau}[\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}]][\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}]^{-1}$$

$$V_r = [\frac{\partial}{\partial\tau}[\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}]][\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}]^{-1}$$

$$a = [\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\cosh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}][\frac{\partial}{\partial\tau}O_{tot,N}]$$

$$b = [1 + \frac{\partial O_{tot,N}}{\partial\tau}][1 + [\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}] \qquad (19)$$

Above equation indicates that all parameters of Izhikevich Neuron model could be produced in a Bio-BIon. Also, the exact form of these parameters and type of their dependency on frequency and temperature could be determined in a Bio-BIon.

Figure 2 shows the Membrane potential of Izhikevich Neuron model, which is produced in a Bio-BIon. This shape is very the same with results in [1], [2]. Neuron acts 13 like a Bio-BIon and transmits photons, Sodium and other charged particles which carry information.

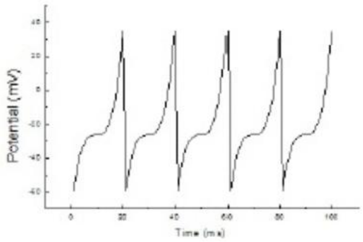

Figure 2: Membrane potential of Izhikevich Neuron model in a Bio-BIon

Signal of Death in Izhikevich Neuron Model

In this section, we will show that neurons can join to each other and produce a stable system. In these conditions, Hamiltonian of the system tends to a constant number, and no information is transferred. First, we rewrite equation (20) as:

$$H_{neuron} = \int d\tau \int d^3\sigma \varrho_{I,end1} = \int d\tau \int d^3\sigma Q(\tau,\sigma) O_{tot,1}....O_{tot,N}$$

$$Q(\tau,\sigma) = [1 + \frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}(V + \frac{dV}{d\tau})^2 + \frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\cosh^2(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}(U + \frac{dU}{d\tau})^2 +$$

$$\frac{e^{-2\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma}}{\sinh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)}((V + \frac{dV}{d\tau})(U + \frac{dU}{d\tau}))]^{1/2} O_{tot,N}$$

$$O_{tot,N} = [1 + \frac{k_3^2}{O_{tot,N-1}\Big(\frac{1}{\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}} e^{\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma} \cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\Big)^4}]^{-1/2} \times ...O_{tot,1}$$

$$O_{tot,1} = [1 + \frac{k_2^2}{\Big(\frac{1}{\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}} e^{\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\sigma} \cosh(\frac{T_0 ln^{-1}[1-\frac{\omega^2}{\omega_0^2}]}{[1-\frac{\omega^2}{\omega_0^2}]^{\frac{1}{4}}}\tau)\Big)^4}]^{-1/2} \quad (20)$$

Some of the neurons oscillate reverse to some others and emit some photons with opposite momentums. We can sum over Hamiltonians of all neurons:

$$H_{System} = [\Sigma_{m=1}^{M} H_{neuron,\tau,\sigma} + \Sigma_{n=1}^{N} H_{neuron,-\tau,-\sigma}] = \int d\tau \int d^3\sigma [\Sigma_{m=1}^{M} \varrho_{I,end1,M} + \Sigma_{n=1}^{N} \varrho_{I,end1,N}] =$$
$$\int d\tau \int d^3\sigma Q(\tau,\sigma) O_{tot,1}....O_{tot,N} + \int d\bar{\tau} \int d^3\bar{\sigma} Q(\bar{\tau},\bar{\sigma}) O_{tot,1}....O_{tot,N} =$$
$$\int d\tau \int \Sigma[dO_{tot,M} lim \frac{K^2}{K^2 + (O_{tot,M} - \bar{O}_{tot,M})^2}] = \int d\tau \int \Sigma[dO_{tot,M} \delta(O_{tot,M} - \bar{O}_{tot,M})] = 1 \quad (21)$$

Above equation shows that Hamiltonian of the neuronic system may be a constant number. In these conditions, this system is strongly stable, and there isn't any equation of state. This means that information couldn't be transformed and thus, the system has been dead.

Birds Without Brain In Izhikevich Neuron Model: Emergence Of Mind Out Of Brain

Until now, we have considered some conditions that Hamiltonian of the total system tends to one. To prevent this state, we can remove some neurons of the system. For example, in a system which includes brain and spinal cord, we can remove neurons of the brain. As a result, equation (21) can be re-written as:

$$H_{System} = H_{brain} + H_{spinalcord} = 1$$
$$\Longrightarrow H_{spinalcord} = 1 - H_{brain}$$
$$H_{brain} = [\Sigma_{m=1}^{M} H_{neuron,\tau,\sigma}$$
$$H_{spinalcord} = \Sigma_{n=1}^{N} H_{neuron,-\tau,-\sigma}] = \int d\tau \int d^3\sigma [\Sigma_{m=1}^{M} \varrho_{I,end1,M} + \Sigma_{n=1}^{N} \varrho_{I,end1,N}] \quad (22)$$

Above equation shows that Hamiltonian of the spinal cord depends on the Hamiltonian of the brain. Thus, after cutting the brain, the spinal cord could do some activities of brain-like minding.

Discussion

In this research, we have shown that neurons in the Izhikevich Neuron model may join to each other, and the total Hamiltonian of the system tends to a constant number. For some exchanged waves, transferring of information between neurons is stopped, and the system of neuron acts as a dead system. These waves are known as the waves of death. Also, we have considered the 15 origins of these waves and Izhikevich Neuron model in a Bio-Bion system. This system was constructed from a page of Dendrite, a page of axon's terminals and a tube of Schwann cells, axon and Myelin Sheath that connects them. Evolutions of parameters of Izhikevich Neuron model like membrane capacitance, resting membrane potential and instantaneous threshold potential depend on temperature and frequency of Bio-Bion. Our calculations in Izhikevich Neuron model show that before death, a signal is emerged in the brain and suggest to all parts of bod to stop their activities. If we remove this signal, other parts of the body could continue to their activities. To show this in experiments, we cut the brain of some birds suddenly and observe that their other parts of bodies continue to activity for a long time and we hope that control their life for more times. Also, until now, scientists believed that by cutting the brain, the mind is disappeared. However, our calculations show that Hamiltonian of the spinal cord depends on the Hamiltonian of the brain. Thus, after cutting the brain, the spinal cord could do some activities of brain-like minding. Also, our experiments show that birds without a brain can determine the best way to escape or passing barriers. This means that other neurons out of the brain have also a role in imaging.

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