Neurons and Electromagnetic Waves

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Abstract:

Based on the potassium channel "origami windmill" model, and the conservation law of cell membrane area and ion inequality equation of based on the potassium channel "origami windmill" model, and Maxwell's electromagnetic theory, it is theoretically proved that neurons can generate electromagnetic waves. The electromagnetic wave is an energy wave, never disappear. The neurons are equivalent to the built-in antennas of the brain, and information transmission between neurons is conducted wirelessly. The material basis for neurons to generate electromagnetic waves is the result of the exchange of cations on the inner surface of the cell membrane, especially Na^+ and K^+; The essence of consciousness should be electromagnetic wave. The conclusion that "neurons can produce electromagnetic waves" overturns the view that "electricity→chemistry→electricity" conducts information between neurons, and provides theoretical support for humans to finally solve the mysteries of the brain. At the same time, seven falsificationist methods are given. The brain is a huge gold mine, and it is too important to crack the mystery of the brain. It should be a joint operation of "multiple arms". It should not only be the work of brain scientists, but also the participation of physicists, chemists and mathematicians.

Keywords: neuron; electromagnetic wave; accelerated motion charge; LC oscillation circuit; antenna; the nature of consciousness

Neurons, composed of cell body, dendrites and axons, are the basic functional units of the brain. Since the late 17th century, the era of Luigi Galvani, people have known that the brain transmits information through electrical pulses. However, it was not until a century later that Santiago Ramón y Cajal described in his theory of dynamic polarization how information is conducted inside a single neuron - electrical signals are transmitted from the dendrites of neurons to the cell body, and finally to the axons. Later research proved that Cajal was right[1]. So, how do neurons communicate information with each other? It is generally believed that the nerve electrical pulse will be transmitted along the axon to the end, and the axon end will release the chemical neurotransmitter into the synaptic space, and then the neurotransmitter will act on the post synaptic dendrites or cell bodies, that is, "electricity→chemistry→electricity" conduction, which can be understood as "wired conduction"[2-3](Fig. 1).

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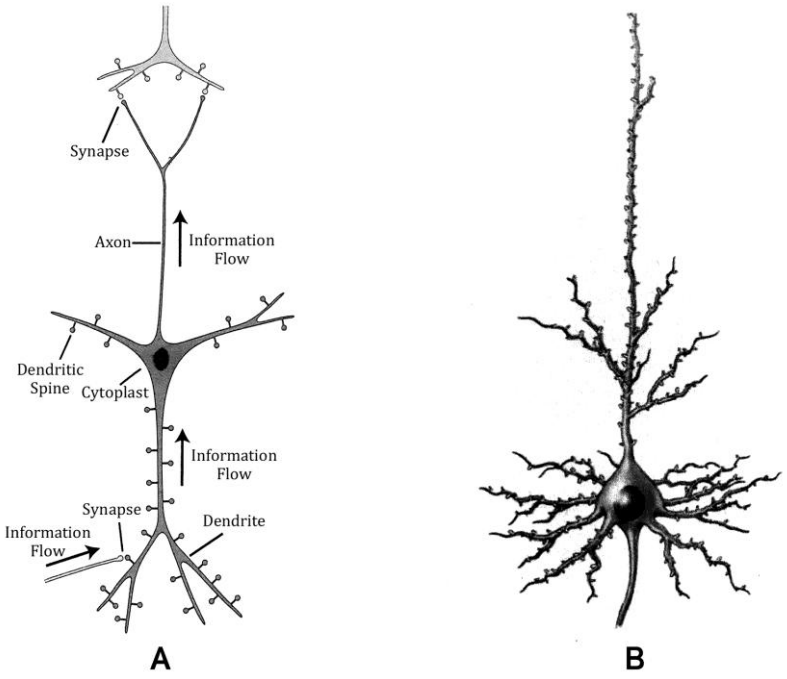

Fig. 1 Neuron, information flow and engineering antenna

Fig. A. Information flow of neurons The dendrites of neurons receive input information from other neurons, and then transmit it to the cell body, and then to the axons, which in turn transmit information away from the cell body;

Fig. B. Neurons and Engineering Antennas The shape of neurons is similar to whip antenna or Yagi antenna (fishbone shaped).

We believe that the conduction mode of "electricity→chemistry→electricity" may not be true. For example, in a simple reflection, when a person steps on a pushpin, the person's reaction from stepping on the pushpin to lifting his foot may be less than 1 second. At this moment, hundreds of millions of neurons in several regions of the brain need to be mobilized, and neuronal signals are sent from the brain to the spinal cord to "lift the foot" by controlling the muscles. If it is conducted by "electricity→chemistry→electricity", it is impossible to complete the task in one second. Our reasons are as follows: 1) If nerve axons are immersed in extracellular fluid, the electrical signals carried by them will be attenuated if they pass the "electricity→chemistry→electricity" conduction mode; 2) The so-called neurotransmitters cannot carry such complete "thought" information; 3) The position of the single or a few neurons that receive external information first is fixed. It is impossible to propagate information to different regions of the brain in an instant and activate hundreds of millions of neurons "synchronously" through the "electricity→chemistry→electricity" method.

Therefore, after our research, we believe that the transmission mode of information between neurons is likely to rely on electromagnetic waves. If it is an electromagnetic

wave, then we must find the opening source of the electromagnetic wave. Previously, we have established the potassium channel "origami windmill" model[4] (2019). Based on the potassium channel "origami windmill" model, the whole process of action potential generation in nerve fiber cells and cardiomyocytes was reasonably explained[5] (2020). On this basis, a new theory that can reasonably explain the mechanism of bioelectricity, the law of conservation of cell membrane area, and a new mathematical model based on the new theory, ion inequality equation, are also proposed[6] (2020), and Maxwell's electromagnetic theory(1873). All these have strengthened our confidence in writing this article and are the biophysical basis for us to explore whether neurons can generate electromagnetic waves. In addition, in order to explain the problem accurately, this paper is only based on the original data of the Hodgkin and Huxley experiments in 1939 - the measured action potential results of the giant axon of the squid with a microelectrode[7] (Fig. 2).

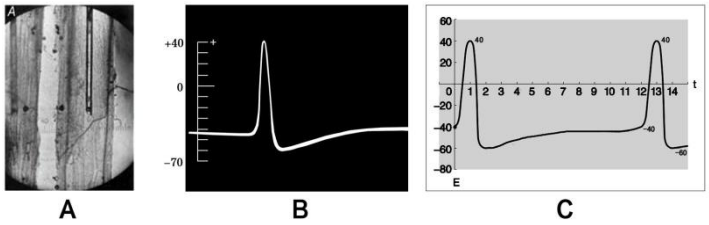

Fig. 2 Intracellular recording of giant axon action potential of cuttlefish

Fig. A Micrograph of the electrode inside the giant axon of Squid (diameter approx. 500μm). Two views of the same axon can be seen from the microscope designed by Huxley; **Fig. B** The first intracellular action potential recording; **Fig. C** The basic expectation of resting potential and action potential by using the ion inequality equation, resting potential: $N=-60+2t$, in which **t** is about 0~10ms; Action potential: $N=-40+170t-90t^2$, in which **t** is about 0~2ms.

1. Electromagnetic wave generation and emission principle

Only the accelerating charge can excite the electromagnetic wave that can separate from the opening source and move independently in space. Static charges can only excite electrostatic fields, and will not form electromagnetic waves moving in space. The field excited by the uniformly moving charge is carried by the moving charge and moves with the charge. It is called the self - fields. In the moving reference system, the self - fields is still a static field[8]. In engineering, the device that actually emits electromagnetic waves is the antenna. All antennas can be regarded as LC oscillators composed of an inductor and a capacitor in essence[9](Fig. 3).

When the switch and the power supply are connected, the capacitor is charged. After charging, the charge on the electrode plate of the capacitor reaches the maximum, and the electric field strength and stored electric field energy in the

capacitor also reach the maximum. Move the switch to disconnect the capacitor from the power supply and connect with the inductor L, and the capacitor will discharge through the coil. In the discharge process, the induced electromotive force generated by the coil prevents the current from increasing. The electric field in the capacitor can overcome the induced electromotive force. As the current in the circuit increases, it gradually changes into magnetic energy and is stored in the inductance coil. When the current reaches the maximum, all the electric field energy in the capacitor is converted into the magnetic field energy in the coil. At this time, the charge on the capacitor plate is zero.

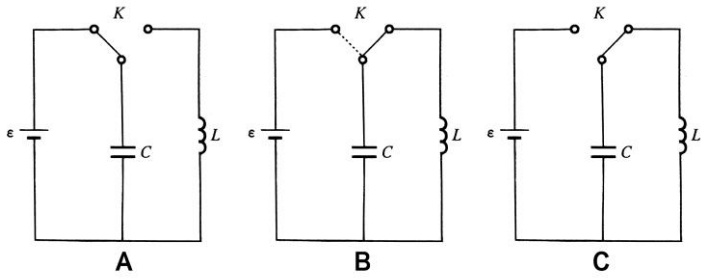

Fig. 3 Action potential equivalent circuit

Essentially, all antennas can be regarded as LC oscillators consisting of an inductor and a capacitor with lumped parameters. **Fig. A** Equivalent circuit during resting potential period (−60mV to −40mV); **Fig. B** Equivalent circuit of action potential rising phase (−40mV to +40mV); **Fig. C** Equivalent circuit of action potential falling phase (+40mV to −60mV).

However, due to the self induction of the coil, the current in the coil does not disappear immediately, but continues to flow along the original direction, charging the capacitor in the opposite direction, and the magnetic field energy in the coil is gradually transformed into the electric field energy in the capacitor, establishing an electric field in the opposite direction to the original in the capacitor. When the charge on the capacitor plate reaches the maximum, the magnetic field energy in the coil is all converted into electric field energy. After that, the above process is repeated, thus establishing an electromagnetic oscillation in the LC loop.

In order to make the above-mentioned LC oscillator have significant electromagnetic radiation, the electromagnetic field cannot be confined between the two polar plates of the capacitor and in the inductor coil, and the LC oscillator must be transformed into an antenna(Fig. 4).The two plates of the capacitor are gradually pulled apart and eventually replaced by "sky" and "earth". At the same time, the inductance coil is gradually straightened and finally becomes a straight line. The oscillating circuit composed of a straight line directly excites the variable electromagnetic field in the surrounding space. Through the alternating excitation of electric field and magnetic field, the electromagnetic wave emitted from the antenna

is formed. In the electromagnetic wave transmission technology, the electromagnetic wave generated by the oscillating current carrying the signal is transmitted with the signal to be transmitted. The technology that makes electromagnetic waves change with various signals is called modulation. The methods of modulation include amplitude modulation, frequency modulation, or transmitting digital information with electromagnetic waves[9].

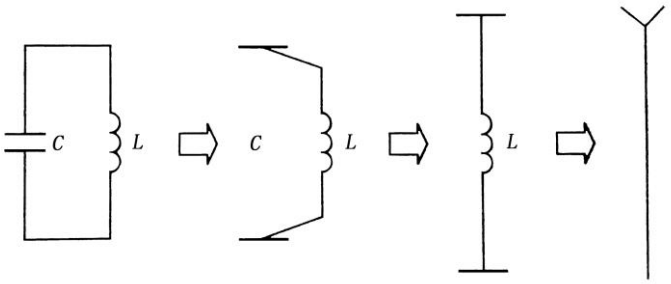

Fig. 4 LC oscillator transformed into antenna

In terms of engineering technology, in the process of transforming the LC oscillator into an antenna, the two plates of the capacitor are gradually pulled apart and finally replaced by "sky" and "earth".

2. Neurons can generate electromagnetic waves

We know that the electrical signal transmitted inside a single neuron is transmitted from the dendrite of the neuron to the cell body, and finally to the axon. Its circuit is approximately equivalent to Fig. 3, but not completely equivalent. It should be noted that the understanding of "neurons and electromagnetic waves" cannot be completely limited by the capacitance in engineering technology, and the information flow, electrical signal and current cannot be completely equivalent, especially in the flow "direction".

"When the switch and power supply are turned on", it is equivalent to the resting potential period (−60mV to −40mV) in the neuron, and the capacitor is charged by 20%. It is the process of Na^+ entering the cell from the outside through dendrites in a uniform linear motion. It is a self - field and will not form electromagnetic waves moving in space[6,9] (Fig. 3A). "Move the switch and connect with inductor L at the same time", which is equivalent to the action potential in the neuron. In the rising phase of the action potential (−40mV to +40mV), its equivalent circuit should be Fig. 3B, it is equivalent to continuing to charge 80% of the capacitor. It is a process in which extracellular Na^+ enter the cell through the dendrites in a uniform accelerated linear motion; The equivalent circuit of the action potential falling phase (+40mV to −60mV) is shown in Fig. 3C, which is equivalent to the discharge process. The discharge is completed by 100%. It is a process in which extracellular K^+ enter the cell through dendrites in a uniform accelerated linear motion[6].

Compared with extracellular, it is the process of Na^+ (in the rising phase) and K^+ (in the falling phase) entering the cell from the outside, the process of information flow entering the cell body, and this process still occurs in dendrites. But relative to the cell, it is the process of K^+ (in the rising phase) and Na^+ (in the falling phase) accelerating from the cell to the outside, and the process of information flow out of the cell, which occurs in the axon. See the attached table: corresponding relationship with the whole process of neuronal action potential. Na^+ and K^+ complete the acceleration of electric charge together by relay, and the whole process of neuron action potential meets the necessary conditions for generating electromagnetic waves.

Table Corresponding relationship with the whole process of neuronal action potential

potential / Counterpart	Resting potential	action potential	
		rising phase	falling phase
Voltage variation	−60mV～−40mV	−40mV～+40mV	+40mV～−60mV
Sports mode	Na^+ enters the cell through dendrites with uniform linear motion	Na^+ uniformly accelerates into, K^+ leaves with uniform acceleration, the replacement ratio is 3:2:1	K^+ enters with uniform acceleration, Na^+ leaves with uniform acceleration, and the replacement ratio is 2:3:1
Charging and discharging	20% of charging process completed	80% of charging process completed	100% of discharge process completed
Neuron site	Occurs in dendrites	Na^+ accelerates from dendrite to cell body K^+ accelerates to leave the cell body from the axon	K^+ accelerates from dendrite to cell body Na^+ accelerates to leave the cell body from the axon
Charge change	Charge: 0～100G +40mV cell inner membrane ion saturation, 300G Na^+		Charge: 100G～0 −60mV cell inner membrane ion saturation, 200G K^+
Origami windmill	Uniform rotation	Uniformly accelerated rotation	Uniform deceleration rotation
Electromagnetic wave	The static field does not generate electromagnetic waves	An accelerating charge can produce electromagnetic waves	

The neuron is equivalent to the "antenna" in engineering technology, and the shape of the neuron is more like a whip antenna or a Yagi antenna (fishbone shaped), as shown in Fig.1B. Therefore, neurons can not only transmit electrical signals, but also receive electrical signals. When an electromagnetic wave propagates in space, if it encounters a conductor, it will cause the conductor to produce an induced current whose frequency is the same as that of the electromagnetic wave that excites it. Therefore, the electromagnetic wave can be received by using the conductor existing in the electromagnetic wave propagation space. When the natural frequency of the receiving circuit is the same as the frequency of the received electromagnetic wave, the oscillating current generated in the receiving circuit is the strongest. The principle of the transmission of electrical signals between neurons in the "brain" should be the

same. It should be noted that the axon itself is "cell membrane".

−60mV to +40mV, or +40mV to −60mV, the difference is 100mV, which can also be understood as:100G (G is constant, $G = 1.25 \times 10^3 ions/mV$) positive charge enters the cell through dendrites in a uniform and uniformly accelerated linear motion, and then leaves the cell through axons in a uniformly accelerated linear motion. Relative to the position of +40mV, the cation on the surface of the cell inner membrane is saturated, all of which are Na^+, with a quantity of 300G, which is 100G more positive charge than the position of −60mV; Relative to the position of −60mV, the cation on the surface of the cell inner membrane is saturated, all of which are K^+, with the amount of 200G, which is 100G less positive charge than the position of +40mV. It conforms to the law of equal charge[6,9].

Although the direction of information flow in the dendrites and axons of neurons has not changed, the number of charges on the surface of the cell inner membrane has been reversed instantaneously during the transformation of the rising and falling phases of action potential. The change from 0 to 100G to 100G to 0 is equivalent to an instant reversal of the charge number on the two plates of the capacitor, or an electromagnetic shock. Like a river, the flow direction of the river has not changed, but the water level has changed. The instantaneous fluctuation difference is 100G, not plus or minus 100G.The accelerating motion electric charge is like "sailing against the current". Therefore, in theory, neurons can generate electromagnetic waves.

Falsificationist method: 1) It can overturn the potassium channel "origami windmill" model; 2) It can overturn the conservation law of cell membrane area; 3) It can overturn the ion inequality equation; 4) It can overturn Cajal's Theory of Dynamic Polarization; 5) It can be proved that: in the falling phase of cell action potential, K^+ flow out rather than inflow; 6) It can be proved that the neurons cannot be equivalent to the "antenna" in engineering; 7) It can be proved that the information between neurons in the "brain" is indeed transmitted through the way of "electricity→chemistry→electricity". As long as any of the above seven experimental schemes is true, the conclusion that "neurons can generate electromagnetic waves" is not true.

3. Neurons transmit information wirelessly through electromagnetic waves

In fact, the two neurons are not directly connected. There is an obvious gap between the two neurons, which is about one fortieth of a micron wide. This gap is called the synaptic gap. When an electrical pulse reaches the front of a synapse, it releases a small packet of chemicals (called vesicles) into the synaptic fissure. The previous general view was that these small chemical molecules were rapidly diffusing in the fissure, some of which were combined with molecular gates on the postsynaptic cell

membrane to open these special gates, and allow charged particles to flow into or out of the postsynaptic membrane, so as to change the transmembrane local potential. The whole process was considered as an "electricity→chemistry→electricity" process, and a "wired" transmission of information[2]. This may not be true.

The peak potential in the axon is not like the current in the wire. In the metal wire, the current is carried by a mass of electrons. In neurons, the electrical effect depends on the charged ions entering and leaving the axon, such as K^+ and Na^+. The final charge is determined by the difference between the number of ions entering and leaving. The propagation speed of electrical signals from dendrites to axons is determined by the speed of ion exchange on the cell inner membrane, so it is impossible to approach the speed of light as the current in the metal wire. In the middle of the 19th century, Helmholtz finally measured the speed of signal transmission from dendrites to axons, and found that it rarely exceeded 30 feet per second, which was about one-third of the speed of sound transmission in the air. For the axon without myelin sheath, its speed is generally 5 feet per second, which seems quite low. It is equivalent to walking 1.5 mm per millisecond, which is equivalent to 1.5 meters per second[2].

Because the nerve axon is immersed in the extracellular fluid, its insulation is so poor. If the transmission mode of "electricity→chemistry→electricity" is adopted, the electrical signal carried by it impossible not be attenuated. However, it is an iron fact that the occurrence of neuronal action potential does not decline with distance[10].The transmission of neurotransmitters in extracellular fluid takes time, even if it is conducted in the way of dominoes, time is not allowed. Therefore, we believe that the information transmission between the electromagnetic wave generated by a single neuron in the "brain" and other neurons should be "wireless", which is radio wave, equivalent to the mass sending of information on our mobile phones. The neuron receiving the signal is activated by the electric field induced by the magnetic field, reaching the action potential threshold of −40mV, and the activated neuron can be regarded as a new electric field "opening source", which almost "synchronously" generates a new magnetic field. According to the superposition principle of electromagnetic waves, hundreds of millions of activated neurons synchronously "generate electricity" or "generate force" to complete the task of "lifting feet" at the moment of "stepping on the pushpin", which is not the work of a single neuron. Through the "electricity→chemistry→electricity" conduction mode, it is impossible to "synchronously" activate hundreds of millions of neurons, and the electrical signal impossible not be attenuated. When a neuron receives a signal, it will "modulate" the

signal and send it to all neurons in the brain, but not all neurons can make a positive response.

Our research conclusion has seriously impacted the view of "electricity→chemistry→electricity" transmission of information. The background wave of the neuron (Fig. 2C) is equivalent to the natural frequency in the LC oscillation circuit. This background wave also exists when it is not stimulated by the outside world, and its frequency is generally 1~5Hz. One of its functions may be to maintain the normal operation of our autonomic nervous system, such as heart rate, respiration, digestion, blood pressure, metabolism, etc; Another main function of this background wave may be "carrier", which can carry "thought" information after modulation. When a neuron receives an external stimulus signal, its firing frequency will increase to a large value (equivalent to "modulation" in radio engineering), typically 50~100Hz or higher. In a short time interval, the firing frequency can be as high as 500Hz[2], and the upper limit of the maximum firing frequency is about 1000Hz[10].Another possible role of neurotransmitters is to be recycled by neurons. Similar to the role of Na^+, neurotransmitters are used to "reconstruct" background waves.

What is the wavelength of the electromagnetic wave generated by the neuron?The propagation speed of electromagnetic wave in various media is different, because electromagnetic wave is shear wave, and its propagation speed in solid is about 4~8km/s, which should be equivalent to the propagation speed of electromagnetic wave in our "mind". The relationship between wavelength, wave velocity and frequency: $c= \lambda f$. Where **c** is the speed of light, **λ** is the wavelength and **f** is the frequency. Because "when the electromagnetic wave propagates in space, if it encounters a conductor, it will cause the conductor to produce an induced current, and the frequency of the induced current is the same as the frequency of the electromagnetic wave that excites it", the frequency of the background wave in the "brain" is generally 1~5Hz, and the frequency of the information carried is 50~1000Hz. Calculated according to the frequency of 500Hz, and the average propagation speed in the "brain" is 6 km/s, its wavelength is λ=12m, belonging to the long band of electromagnetic wave.

If the electromagnetic wave generated in the "brain" leaves the "brain source", the speed of propagation in space can be understood as the speed of light. Medium and long waves can bypass obstacles and spread on the earth's surface. Although the ionosphere reflects long, medium and short waves, and the longer the wavelength is, the easier it is to reflect, the absorption of the ionosphere to electromagnetic waves also increases with the increase of the wavelength[9].Therefore, if the electromagnetic

wave generated in the brain leaves the "brain source", its final destination should be the same as the electromagnetic wave in engineering technology. Some are reflected by the ionosphere, some are absorbed by the ionosphere, and some "escape" to space through the ionosphere. Electromagnetic waves are energy waves and never disappear.

4. Quantitative expression of neurons and electromagnetic waves

The biophysical basis for the conclusion that neurons can generate electromagnetic waves is the conservation law of cell membrane area, the ion inequality equation, and Maxwell's electromagnetic theory.

4.1 Conservation law of cell membrane area

According to the conservation law of membrane area, bioelectrical activity is a process in which different cations displace each other on the inner surface of the cell membrane. Cl^- has been surrounded by the cell membrane at the beginning of the formation of the cell membrane, which determines the "positive" and "negative" action potential of the cell; The amount of Na^+, K^+ and other cations exchanged on the inner surface of the cell membrane determines the amplitude of the action potential. The proportion of exchange follows the principle that the membrane area is equal and the number of ions is not equal.

Conservation law of membrane area and mathematical expression:

$$S_{\mathrm{A}}(t) + S_{\mathrm{B}}(t) = S_0$$

Among them, A and B are two kinds of ions that are mutually replaced on the inner surface of the cell membrane; S_A and S_B are the area of cell membrane occupied by two ions, and S_0 is the internal surface area of cell membrane.

When the initial time is all A or B, S_A (0)=S_0, S_B (0)=0 or S_B (0)=S_0, S_A (0)=0. It can also be deduced from the above formula:

$$\frac{N_{\mathrm{A}}}{N_{\mathrm{B}}} = \frac{{r_{\mathrm{B}}}^2}{{r_{\mathrm{A}}}^2}\frac{V_{\mathrm{A}}}{V_{\mathrm{B}}} = \frac{{r_{\mathrm{B}}}^2}{{r_{\mathrm{A}}}^2}\frac{\mathrm{d}V_{\mathrm{A}}}{\mathrm{d}t} = -\frac{\mathrm{d}V_{\mathrm{B}}}{\mathrm{d}t}$$

4.2 Ion inequality equation

The kinematical equation is quoted, which can not only reflect the essence and law of cation exchange on the inner surface of the cell membrane, but also reasonably avoid the expansion force of the cell membrane and the driving force of ions, thus completing the expression of the mechanism of bioelectricity from qualitative to quantitative. A complete process of cell bioelectricity should include two parts: resting potential and action potential, and action potential includes rising phase and

falling phase.

Mathematical expression of cell resting potential and uniform linear motion:

$$N = N_0 + Vt$$

Mathematical expression of action potential and uniform speed linear motion:

$$N = N_0 + V_0 t - \frac{1}{2}at^2$$

Finally, it can be simplified as:

$$N = N_0 + 170t - 90t^2$$

4.3 Electromagnetic wave equation

Neurons generate electromagnetic waves, which conform to Maxwell's electromagnetic theory. The existence of electromagnetic wave is contained in Maxwell's electromagnetic theory. Not only changing the magnetic field can excite the electric field, but also changing the electric field can excite the magnetic field. Maxwell equations in integral form describe the relationship between field quantity and field source in a region as a whole, but cannot describe the local relationship between field source and field quantity at a point in space. However, Maxwell equations in differential form can be directly obtained from Maxwell equations in integral form by applying Gauss theorem and Stokes formula in mathematics. The corresponding relationship between the two is:

$$\oint_L \boldsymbol{E} \cdot \mathrm{d}\boldsymbol{l} = -\int_S \frac{\partial \boldsymbol{B}}{\partial t} \cdot \mathrm{d}\boldsymbol{S} \Rightarrow \nabla \times \boldsymbol{E} = -\frac{\partial \boldsymbol{B}}{\partial t}$$

$$\oint_L \boldsymbol{H} \cdot \mathrm{d}\boldsymbol{l} = \int_S j \cdot \mathrm{d}\boldsymbol{S} + \int_S \frac{\partial \boldsymbol{D}}{\partial t} \cdot \mathrm{d}\boldsymbol{S} \Rightarrow \nabla \times \boldsymbol{H} = \boldsymbol{j} + \frac{\partial \boldsymbol{D}}{\partial t}$$

$$\oint_S \boldsymbol{D} \cdot \mathrm{d}\boldsymbol{S} = \int_V \rho \mathrm{d}V \Rightarrow \nabla \cdot \boldsymbol{D} = \rho$$

$$\oint_S \boldsymbol{B} \cdot \mathrm{d}\boldsymbol{S} = 0 \Rightarrow \nabla \cdot \boldsymbol{B} = 0$$

Departing from the excitation source (ρ=0, j=0), the electromagnetic field quantities E and H satisfy the wave equation:

$$\nabla^2 \boldsymbol{E} - \mu_0 \varepsilon_0 \frac{\partial^2 \boldsymbol{E}}{\partial t^2} = 0 \ , \ \ \nabla^2 \boldsymbol{B} - \mu_0 \varepsilon_0 \frac{\partial^2 \boldsymbol{B}}{\partial t^2} = 0$$

The propagation speed of electromagnetic wave in vacuum is the speed of light:

$$u = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} \equiv c \qquad u = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} = 2 \cdot 99\,792\,458 \times 10^8 \text{ m/s} \equiv c$$

5. Conclusion and discussion

Theoretically, neurons can generate electromagnetic waves. The information transmission between neurons is transmitted through wireless. The material basis for neurons to generate electromagnetic waves is the result of the mutual replacement of cations on the inner surface of the cell membrane, especially Na^+ and K^+. The conclusion that "the information transmission between neurons is transmitted through wireless" overturns the idea of "electricity→chemistry→electricity" transmission of information between neurons, providing theoretical support for humans to finally solve the mysteries of the brain and reveal the essence of consciousness. The essence of consciousness should be electromagnetic wave.

In the dynamic polarization theory, Cajal described how information is transmitted within a single neuron, but he did not doubt the "electricity→chemistry→electricity" transmission mode between neurons. Francis Crick believed that all aspects of brain behavior came from the activity of neurons, but Crick's work did not find that the neurons were "antennas". In fact, is there a so-called ionosphere in our "mind"? Could it be cerebrospinal fluid? Because our brain is suspended in the cerebrospinal fluid. Is it possible for the electromagnetic wave in our brain to pass through the "cerebrospinal fluid" and float in the air?

Also, the phospholipid bilayer of the cell membrane is a light oil liquid that can flow[10]. Can it be regarded as the "ionosphere" of the cell? A single neuron is equivalent to a person with independent thinking. Is the information exchange between neurons with reservations that between human beings? Are animals and people alike able to generate electromagnetic waves in theory? What does it mean that cells in other parts of the body have LC oscillatory circuits but no "antennas"?The brain waves we usually speak of are not electromagnetic waves, but the wave patterns measured are just the maps of voltage fluctuations with time. Brain waves, electroencephalogram, artificial intelligence (AI), etc. have not really touched the mystery of the brain.

From the perspective of human historical development, the main goal of brain research is not only to understand and treat various brain diseases, although this is very important, but also to master the true essence of the human soul[2].The brain is a huge gold mine, and it is too important to crack the mystery of the brain. It should be a joint operation of "multiple arms". It should not only be the work of brain scientists, but also the participation of physicists, chemists and mathematicians.

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