Physical Consciousness Outside the Brain: Parasite Fermion Model for Substance of Consciousness

Takashi Taneichi

ABSTRACT

Conventionally, consciousness is thought to be a result of the brain's neuronal activity, and much research activity is focused along this line of thought; however, circumstantial evidence has not yet been obtained. As an alternative, I posit that the multidimensional picture of the universe can be important in seeking the origin of the consciousness outside the brain. Herein, I hypothesize the existence of a new particle called the parasite fermion. This is a material particle that exists in the extra dimension, i.e., outside our four-dimensional universe. Further, the differences in material properties of the parasite fermions and the particles that exist in our universe, termed as host fermions, and the mechanism that causes these differences are reviewed in this paper. Moreover, it is hypothesized that the aforementioned mechanism renders the parasite fermion invisible, although they exist around us. The question is what happens if we apply the parasite fermion concept to the mind–body problem. In the regard, the parasite fermion model has the possibility to help clarify the origin of conciseness being outside the brain.

Key Words: brane world, mind-body problem, multi-dimensional universe, quantum field theory

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Introduction

Is the concept of "consciousness as an independent substance from the brain, i.e., dualism" a trap? Let us consider the possibility of the existence of consciousness independent of the brain not theoretically but as something with material basis. Therefore, this would be a research topic for modern physics. Which function of the brain gives us "heart"? To answer this question, modern neuroscience examines the relation between the state of consciousness (emotions, feelings, thoughts, and so on) and the state of the brain. Functional magnetic resonance imaging is such an example, which has highlighted the functioning of several neuronal processes. Nonetheless, to date, the fact that neuronal activity is the root cause of consciousness has not been proven in any form. However, research on cases that suggest survival after death is advancing, especially in North America and Europe; for example, the research on "reincarnation" by late Dr. Ian Stevenson and Dr. Jim Tucker at the University of Virginia, *Division of Perceptual Studies* (Tucker, 2013). These authors' collected more than 3,000 reincarnation cases in more than 40 countries around the world (Stevenson, 1960; 1974). The subjects began speaking about their past life

Corresponding author: Takashi Taneichi
Address: International Research Institute (IRI), 1108-2 Sonno, Inage, Chiba 263-0051, Japan
e-mail ✉ sanshiro201@dream.bbexcite.jp
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memories when they were 35 months old, stopped speaking about them around the age of 6 or 7, and then forgot about their past life and even the fact that they had been talking about their past life memories, and it was observed that the subjects tend to have high IQ. Further, the researchers were also able to identify the persons that find mention in the subjects' description of past life memories in their cases in 35 countries. However, people who are convinced about survival after death invariably seek explanation for metaphysical phenomena and nonphysical principles. This study starts with the following question: Is it really inevitable to describe the survival of memory, self and/or consciousness after death in that way? Can't we really deal with it within the confines of modern physics?

Physics of Multidimensional Universe

Superstring theory is one of the leading candidates for the next-generation standard model and a self-contained model of the universe because it unifies the current standard model and general relativity. Superstring theory expresses the 16 types of standard theory particles and (the undiscovered) graviton that mediates gravity (17 particles total) as diverse string vibrations. An important feature of the Superstring theory is that it describes this world using ten dimensions. However, both current standard model and the theory of relativity employ four dimensions in total, three dimensions of space and the dimension of time, to describe our world. The problem here is the fact that in reality, we only recognize the three dimensions of space and one dimension of time. To overcome this problem, the brane-world model was proposed. Brane is derived from the English word "membrane." It depicts the four-dimensional space floating as a membrane in a ten-dimensional space.

The "hierarchy problem" has long troubled physicists (Arkani-Hamed, 1998). In physics, the four basic interactions are electromagnetic, gravity, and strong nuclear and weak nuclear interactions. The key point in the hierarchy problem is that gravity is the weakest of the four forces by several tens of orders of magnitude. Further, one cannot dismiss this occurrence as accidental as there are strong implications when the quantum effect in vacuum is taken into consideration.

One of the brane-world models proposed to solve the hierarchy problem is the ADD (***A**rkani–Hamed, **D**imopoulos and **D**vali*) model (Arkani-Hamed, 1998). This model explains that while the three forces other than gravity are constrained to act within only the brane space we live on, gravity can exert its influence in the extra dimensional space (Figure 1); thus, only gravity becomes thinner and weaker. As the influence of gravity extends beyond the brane on which we live, it appears to be weak. Thus, as per the ADD model, gravity is not originally weak, but the mechanism by which it functions leads us to perceive it as a weak force. This explanation is helpful but causes a dilemma. Specifically, the extra dimensional space becomes enormous, and this reduces the energy scale of the extra-dimensional space from that of the standard model, in case the number of extra dimensions is 2, by 14 orders of magnitude. Hence, the hierarchy problem is not solved but is rehashed in a different form. This is the second hierarchy problem. The obvious question then is if we can construct a model in which every energy scale is in a not-so-different form. The RS (***R**andall and **S**undrum*) model (Randall, 1999) was proposed to answer this question. In this model, two four-dimensional branes exist across one extra dimension, i.e., in the five-dimensional space. Figure 2 shows the weak brane where we live and the gravity brane in which the gravitons gather. This model features a distorted extra dimensional space that spans these two branes. This distortion is the natural outcome of the theory of general relativity. In the gravity brane, the graviton density is high and the gravitational interaction is extremely strong. If one moves toward the direction of the weak brane, the graviton density is reduced exponentially and a weak force of gravity is experienced. Unlike the ADD model, the RS model does not assume a large extra-dimensional space; therefore, neither the first nor the second hierarchy problem occurs.

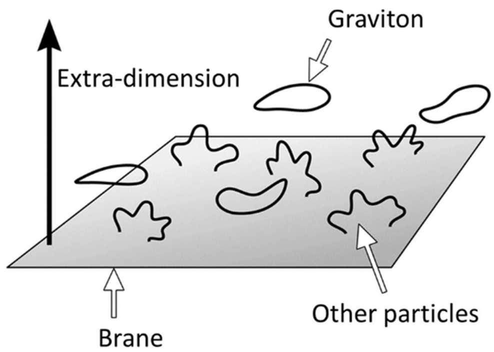

Figure 1. Open strings bound to the brane and free closed strings.

Another hierarchy problem

Our interest is to determine the validity of the assumption of whether "consciousness" has a material basis and exists outside the brain. Physicist Sir Roger Penrose and anesthesiologist Stuart Hameroff at the *University of Arizona* presented a concept called "ultra microconsciousness" along with the famous "Orch-OR" theory. They claim that the substance of consciousness is smaller than an elementary particle. However, even if we talk about material particles, is it possible to expect the primary cause of complex functional manifestation of consciousness in such a minute substance? For example, Penrose and Hameroff argue that they can explain near-death experience, by the ultra microconsciousness; however, the senses of sight and hearing are functional when a near-death experience actually occurs. Thus, the following question arises: are particles smaller than the elementary particles equipped with nerves and sensory organs related to sight and hearing? The reason Penrose and Hameroff were obsessed with "minute" particles is, of course, for the rationalization of the fact that the substance of consciousness is not yet been observed. We have to say, however, that their assertion that the substance of consciousness being smaller that the elementary particles is as unreasonable and unnatural as their Orch-OR theory, which has not been commonly accepted by the scientific community.

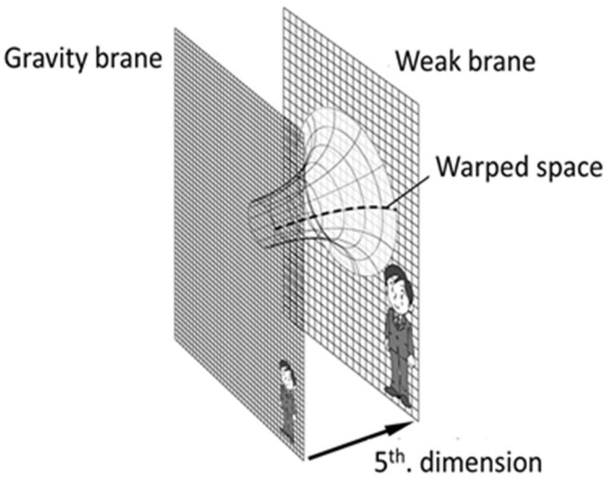

Figure 2. Two typed of branes in the RS model.

To explain the extracerebral consciousness, Raymond Smythies, a neuroscientist at the University of California (Smythies, 2003), proposed the use of the brane model. Is it possible, for example, to assume the existence of two branes: one on which we live and "the other brane" on which consciousness, as we know it in our brane, is in fact an entity existing on the other brane? If this is true, what is the relation between the consciousness and the brain? The difficulty of ultra microconsciousness originates from the fact that they sought the material basis of consciousness in the world that we live on. In this regard, if we assume, as Smythies did, that the substance of consciousness is on the brane world that is separate from the one that we live on, the substance of consciousness does not have to be ultramicro. Therefore, we are not able to observe the substance of consciousness because it is at a brane space different from the one on which we exist. Smythies called the brane space on which we live as a "physical space–time" brane and the brane space with the substance of consciousness (he calls this as consciousness module) as "phenomenal space–time" brane. Further, he termed the association between the brain and consciousness as a "causal chain." For example, if we consider sight, the causal chain is matter → photon → retina → brain → interbrane exchange → visual field (consciousness module) (Figure 3). The flow up to the brain is the flow of visual information as we know it; however, beyond that, the information transits from the physical space–time to the phenomenal one. This transition is the (information) intersection between branes. Visual information is transmitted to the consciousness module through this process, and we perceive it at this stage.

Given the above description of the different branes, a key question arises: "*Can the intersection between branes be appropriately described theoretically as a physical process*?" First, in the ADD model, even if there are multiple branes, only gravitons exist, or exert influence, outside the branes.

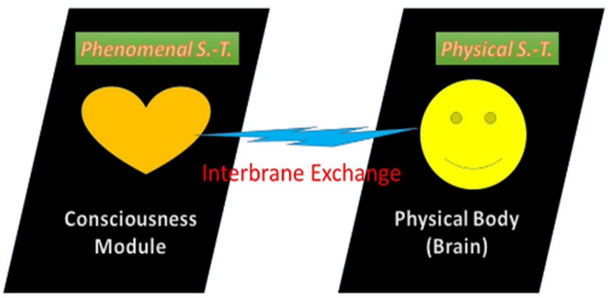

Figure 3. Schematic of the "Interbrane exchange."

Otherwise, we must constantly sense the high-dimensional space (greater than four dimensions). However, the gravitons are undiscovered particles. In this regard, in Japan, the KAGRA project aims to conduct experiments in the future to observe the gravitons. The graviton detector employed in this project is the Michelson interferometer with a base-line length of 3 km. The expected number of detected events with this scale of experimental equipment will not exceed a few events per year. It is impossible to believe that our brain, which is about 10 cm in radius, is transceiving these faint signals. What about the RS model? In this model, light can traverse between branes but it is required to be high-energy electromagnetic gamma rays exceeding the typical energy value of gamma rays by six orders of magnitude. Furthermore, it is impossible to believe that our brain is capable of transceiving such high-energy gamma rays. This energy gap that must be overcome, when considering the intersection between branes as reality, is called the third hierarchy problem.

Parasite fermion model

In my previous paper, the *parasite fermion model* was proposed (Taneichi, 2013). The formulation of the model is given in the Appendix. Atoms or molecules comprise quarks and leptons at the elementary particle level, which follow Fermi–Dirac statistics. Those quarks and leptons are categorized as fermions. When we describe the brane model using quantum field theory, a brane is expressed as an entity called a scalar field, and it is possible to assume that fermions bond to the field via the Yukawa interaction. Let us call this type of fermion that directly bonds to the scalar field as the host fermion. All currently known fermions are in this category. In this model, I consider a different type of fermion, the parasite fermion. This fermion cannot directly bond to the scalar field via the Yukawa interaction. Instead, it indirectly localizes near the scalar field by bonding to the host fermion through fermion interaction (see Appendix). The parasite fermion is literally a parasite to the host fermion. Thus, the parasite fermion does not exist on our brane space, although it is a material particle. While the parasite fermion could be the substance of consciousness, it does not have to be ultramicro. Because the parasite fermion does not exist on the brane space that we live on, it cannot be observed even if it is large. However, through fermion interaction, it can interact with a normal substance (host fermion). From this, the brain and consciousness can be inferred to comprise host and parasite fermions, respectively. These fermions exchange information and thus the third hierarchy problem does not appear.

Thus, by considering fermions that do not bond with scalar field directly but localize near the field, it is possible to think of them as material particles that do not exist on the brane on which we live, though they do have an influence on this brane. However, there exist certain problems with the parasite fermion model. This model does not answer the fundamental question of how our consciousness forms from a group of elementary material particles. In addition, if this model is correct, what is the mechanism by which the consciousness, hypothesized to be composed of parasite fermions, dwells within the brain during the growth of a fetus and finally releases the bond with the body (brain) in the event of death? Above all, what type of experiment can prove the existence of parasite fermions and, if true, the fact that they are the ingredients of consciousness separate from the brain? At this stage, answers to these questions are unavailable.

Then, what is the implication of this model? Let us again consider how scientific research progresses. In the process of generalization through the verification of hypotheses based on natural phenomena, observations and reproducible test results are essential. Reproducibility implies that results obtained from a certain experiment can be reproduced, within a certain error range, by any other researcher conducting the experiment under the same conditions. Scientists such as Dr. Ian Stevenson (1918-2007) and Dr. Jim Tucker, who argue in favor of survival after death (Stevenson, 1960; 1970; Stevenson *et al.,* 2005), are similar to psychics who often appear on TV concerning such issues. The basis of their argument is their own near-death experience (van Lommel *et al.,* 2001), personal spiritual experience, or the experience of being at someone else's death; each and every one of these experiences is sudden and temporary and only told in past tense. In other words, there is no reproducibility, and verification experiments are impossible. Therefore, it is difficult to convince people to recognize these phenomena, including reincarnation, as scientific ones. These scientists use their own rationality, but when there is no reproducibility or verification, such arguments cannot be treated as a scientific truth. But now, we have the parasite fermion model that allows survival after death to possibly become one of the implications of the model. If so, a new approach of verifying this theory should be the next step.

This type of fermion existence can present a substantial modification in the conventional viewpoint of several branches of science, such as the mind–body problem. Materialism reduces the existence of mind into an assemblage of chemical and biological actions inside the brain. Modern scientists hoping to explain the mechanism of the manifestation of mind, search the origin of consciousness in the intra-brain phenomena, such as neuronal firing. The best proof for the aforementioned idea would be the manifestation of thoughts, sense, or emotions within an artificially prepared apparatus that realizes neuronal firing inside it. This is essential to ensure reproducibility or results. Such apparatus, of course, has not been realized up to now. Neuroscientists agree that the mechanism with which images appear and then disappear in our brains, which is material, and with which consciousness dwells in the brains is mysterious. Although they claim that neuronal firing is most probably the mechanism by which our consciousness comes into existence, they also confess that the connection between consciousness and the brain remains elusive. Of course, there are also researchers who are searching for a mechanism other than neuronal firing to explain the origin of consciousness; however, the results of the research that has been undertaken up to now have not been illuminating. I propose that it is too early to draw conclusions in any way. This is because the connection between neuronal activity—or any other mechanism assumed to be the origin of consciousness so far—and the manifestation of our consciousness is moot, and no circumstantial evidence exists until now. In such a scenario, the concept of parasite fermion possibly allows searching for the origin of the consciousness outside the neural network and the brain. If the study of the consciousness, based on natural sciences, is about to embark, all possible hypotheses regarding the mind–body problem must be included. In this respect, nonconventional multidimensional existence schemes of matter particles would serve as one of such possible hypothesis that successfully resolves the mind–body problem.

Appendix

The model considered herein follows the brane model in which the brane is a topological defect in the 5D bulk, called the domain wall. The bulk is assumed to be flat and is given by

$$ds^2 = g_{AB} = \eta_{\mu\nu} dx^\mu dx^\nu - dz^2. \quad (1)$$

Here g_{AB} and $\eta_{\mu\nu}$ are the five-dimensional and the Minkowski four-dimensional metric tensors, respectively. A and B range from 0 to 4, and μ and ν are between 0 and 3. x^μ is the four-dimensional and z is the fifth-dimensional coordinate(s), respectively. The brane is assumed to be localized at the origin of z. The total Lagrangian density is

$$L_{\text{total}} = L_\Phi + L_\Psi + L_{\text{int}}, \quad (2)$$

where

$$L_\Phi = \frac{1}{2} g^{AB} \partial_A \partial_B \Phi - V(\Phi), \quad (3)$$

$$L_\Psi = i\bar{\Psi}_1 \Gamma^A \partial_A \Psi_1 + i\bar{\Psi}_2 \Gamma^A \partial_A \Psi_2, \quad (4)$$

and

$$L_{\text{int}} = -\kappa \bar{\Psi}_2 \bar{\Psi}_1 \Phi \Psi_1 \Psi_2 - \lambda \bar{\Psi}_1 \Phi \Psi_1, \quad (5)$$

for $\Gamma^\mu = \gamma^\mu$, where γ^μ are the Dirac matrices. The domain-wall solution can be obtained from the equation of motion for the real scalar field Φ derived from the Lagrangian. Potential $V(\Phi)$ has the form that yields the antikink solution

$$V(\Phi) = \frac{\chi}{4} (\Phi^2 - \eta^2)^2, \quad (6)$$

where χ and η are constants of the potential. Two types of matter fields are considered. Ψ_1 is a fermion field that couples to the scalar field Φ through the Yukawa interaction with coupling constant λ. Further, Ψ_2 is a fermion field that interacts with Ψ_1 through a fermion coupling term whose coupling constant is κ and is localized around the brane via fermion coupling. Ψ_1 is the "host fermion" which relates to the visible matters around. All fermions that have been experimentally observed in the past fall in this category. Ψ_2, on the other hand, is what I call a "parasite fermion" and the parasite fermion field can be localized around the brane only when it couples to the host fermion field through fermion coupling. From the Lagrangian density, one can obtain the equation of motion for Ψ_2

$$i\gamma^{\mu}\partial_{\mu}\Psi_2 + \gamma^5\partial_z\Psi_2 - \kappa\overline{\Psi}_1\Phi\Psi_1\Psi_2 = 0. \tag{7}$$

Here $\Gamma^4 = -i\gamma^5$ was used. Using the left- and right- handed 4D spinors $\psi_{2\mathrm{L/R}}$ that satisfy $\gamma^5\psi_{2\mathrm{L/R}} = \mp\psi_{2\mathrm{L/R}}$, the field is expanded and combined with the variable separation method as

$$\Psi_2(x,z) = f_{2\mathrm{L}}(z)\psi_{2\mathrm{L}}(x) + f_{2\mathrm{R}}(z)\psi_{2\mathrm{R}}(x). \tag{8}$$

Here x are the four-dimensional coordinates. Substituting Eq. (8) into Eq. (7) yields

$$m_2 f_{2\mathrm{L}} + \partial_z f_{2\mathrm{R}} - \kappa\overline{\Psi}_1\Phi\Psi_1 f_{2\mathrm{R}} = 0 \tag{9a}$$

And

$$m_2 f_{2\mathrm{R}} - \partial_z f_{2\mathrm{L}} - \kappa\overline{\Psi}_1\Phi\Psi_1 f_{2\mathrm{L}} = 0. \tag{9b}$$

m_2 is the apparent 4D mass of the trapped fermion that satisfies

$$i\gamma^{\mu}\partial_{\mu}\psi_{2\mathrm{L/R}} = m_2\psi_{2\mathrm{R/L}}. \tag{10}$$

Equations (9a) and (9b) yield

$$-\partial_{zz}f_{2\mathrm{L}} + W_{\mathrm{L}}f_{2\mathrm{L}} = m_2^2 f_{2\mathrm{L}} \tag{11a}$$

and

$$-\partial_{zz}f_{2\mathrm{R}} + W_{\mathrm{R}}f_{2\mathrm{R}} = m_2^2 f_{2\mathrm{R}}, \tag{11b}$$

where

$$W_{\mathrm{L}} = \kappa[\kappa(\overline{\Psi}_1\Phi\Psi_1)^2 - \partial_z(\overline{\Psi}_1\Phi\Psi_1)] \tag{12a}$$

and

$$W_{\mathrm{R}} = \kappa[\kappa(\overline{\Psi}_1\Phi\Psi_1)^2 + \partial_z(\overline{\Psi}_1\Phi\Psi_1)]. \tag{12b}$$

∂_{zz} is the second-order differential with respect to z. The stationary states of $f_{2\mathrm{L/R}}$ obtained from Eqs. (11a) and (11b) show the localization profiles of the left- and right-handed fermion fields that are defined by the potential $W_{\mathrm{L/R}}$. Analytical solutions for Ψ_1 are used (see, for instance [35]). In the case of $m_1 = \frac{1}{\xi}\sqrt{2\varepsilon - 1}$, m_1 is the effective mass of the trapped host fermion Ψ_1, ξ is the thickness of the domain wall defined by the potential (6) that satisfies $\xi = 1/(\eta\sqrt{\chi/2})$ and is set to units of the z-coordinate, and $\varepsilon = \lambda\eta\xi$, the profile of W_{L} is shown by the solid line in Figure 4. The profile of $|f_{2\mathrm{L}}|^2$ is shown schematically by the dotted line in Figure 4. Four x-dependent (z-independent) terms that appear through $\bar{\psi}_{1\Theta}\psi_{1\Theta'}$ (Θ and Θ' = L or R) are all assumed to be equal.

We can see that the effective potential approaches zero asymptotically, implying that the m_2 zero mode is localized near the brane (remember that the eigenvalues of $f_{2\mathrm{L}}$ are mass squared). There are also light modes that are oscillatory at the infinity of z. These results imply that at least one mode of Ψ_2, the m_2 zero mode, is localized distantly from the brane, in contrast to the host fermions that are localized on the brane. The difference in the existence scheme results in differences in how we, the residents of the brane, access the fermions. The host and parasite fermions interact through the fermion interaction, but the strength of the interaction depends on how the parasite fermion is localized, i.e., the distance from the brane and the width of the probability density $|f_{2\mathrm{L}}|^2$.

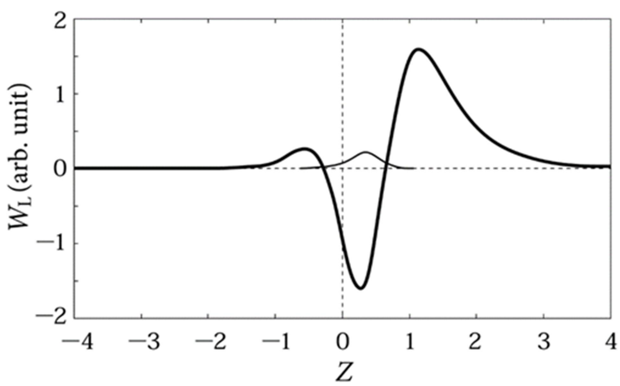

Figure 4. Potential W_{L} as a function of the extra dimensional coordinate z.

The bound states of the parasite fermions are shown to exist without assuming the existence of another brane at a distance from our brane in the extra dimensional direction. The bound states apparently result from fermion fields bound to another brane. The visibility of the bound states depends on how far the bound fermion is from our brane, if we assume that it is impossible for photons to propagate across the bulk. However, oscillating components of continuum of light modes make it possible for residents of the brane to see the parasite fermions irrespective of the distance of the stable point of the potential from the brane. Fermions and gauge bosons in our brane can interact with the parasite fermions through the interaction with the oscillating components of the non-zero modes or overlap with the zero mode at the brane. Thus, the parasite fermions can plausibly be assumed to be observed if they exist.

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