Article

Reissner's Fiber, Quanta & Consciousness

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ABSTRACT

Reissner's fiber, a strategically located, glycoprotein, thread-like structure, consisting of 2-5 nanometer fibrils which runs through the center of the cerebral ventricles and central canal of the spinal cord is a unique site for investigating the interaction between quanta and consciousness. An intriguing possibility is that the degeneration of Reissner's fiber which is typically unconsciously perceived during the period of early separation and individuation of the ego, mirrors the primal origin of our religious and mystic and traditions which witnessed the destruction of the unity of man, God and the cosmos. The "subtle anatomy" from ancient Hindu, Jewish and Chinese mystical traditions, which describes a cosmic energy within a hollow tube in the spine, may not be merely a metaphor for man's quest for God, but a description based on introspection of the degenerating. The emerging fields of quantum biology and epigenetics now offer the possibility of rediscovering lost secrets and reawakening dormant potentials of human consciousness.

Key Words: Reissner's fiber, degeneration, quanta, consciousness, quantum biology.

1. Introduction

The ethereal properties of quantum superposition and non-locality have inspired new explorations of the perennial mind brain problem. One of the earliest solutions to the measurement problem of quantum mechanics was that consciousness collapses the wave function (London, 1939; Stapp, 1993). Neuroscientists have now joined physicists in the development of quantum biophysical models of the relationship between mind and matter.

Sir John Eccles (Eccles, 1994) proposed a quantum mechanical model of free will based on the effects of conscious intention on the region of quantum uncertainty within the 5 nanometer membranes surrounding synaptic vesicles (Beck, 1996). Quantum tunneling between helices comprising neural ion channels has also been proposed as the site of action of the will. (Chauncey, 1992)

Stuart Hameroff and Roger Penrose have developed a model of consciousness based on orchestrated objective collapses of quantum coherent electrons within hydrophobic pockets of tubulin proteins comprising microtubules operate at the interface between mind and matter. Quantum coherences involving nuclear spins (Hu, 2002) or phonons resulting from dipole oscillations (Frohlich, 1983) in neural membranes have also been proposed as correlates of consciousness.

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David Bohm proposed that the holism of quantum field theory points toward an enfolded, holographic, implicate order which unfolds into our explicate world of mind and matter. Karl Pribram has linked Bohm's ideas with a holographic model of the brain organized around oscillations of dendritic fields. He believes that these new pathways will lead to a new convergence of science and spirit which could heal mankind's strife.

During past forty years I have been investigating a little-known, constantly growing, thread-like glycoprotein complex consisting of 2-5 nanometer fibrils called Reissner's fiber as a site of quantum behaviors. I was first led to this enigmatic fiber through an exploration of the possibility that the parallels between esoteric traditions and modern physics are based on expanded states of consciousness produced by the activity of the "subtle body" described since the dawn of history. Yoga, kabbalah, and acupuncture as applied Taoism each describe a pycho/sexual/spiritual energy--*kundalini*, *chi*, and *shekinah* respectively-- which travels through a passageway through the center of the brain and spinal cord. This passageway corresponds to the central canal of the spinal cord and the third and fourth cerebral ventricles. The caudal end of the central canal is a triangular dilation called the terminal ventricle which is surrounded by hormone secreting and sensory cells. The cephalic end of the third ventricle is the pineal gland which has photosensory and hormone secreting properties.

Based on this anatomical correspondence I explored the possibility that ordered water or liquid crystals within the central canal and cerebral ventricles are the substrate of quantum coherence and entanglement. As I was preparing to investigate this hypothesis using time-resolved fluorescent microscopy of the cerebrospinal fluid in the exposed fourth ventricle of a frog, I serendipitously came across an article about Reissner's fiber (Wile, 1991).

Astounded that this remarkable, conspicuous, strategically located structure, which seemed to materialize from the reflections of ancients symbols and quantum biophysical speculations, was absent from textbooks, I explored its history.

2. History of Reissner's fiber

Reissner's fiber was discovered in 1860 when Ernst Reissner observed a threadlike structure in the central canal of a lamprey. Three years later, in 1863, Karl Kutschin confirmed Reissner's discovery, naming it "Reissner's fiber."

In 1868, however, Ludwig Stieda asserted that the spinal fluid and the chemicals used to preserve specimens had coagulated, creating a viscous thread—which had been mistakenly identified as a biological structure. Although Reissner's fiber is a small, sharply-defined thread in fresh specimens, anatomists at that time were quick to embrace Steida's skepticism. Nothing could dissuade them—Viault in 1876, Rohon in 1877, Sanders in 1878 and 1894, and Gadow in 1891—from seeing Reissner's fiber as anything more than an artifact.

In 1876, a twenty-year-old neuroscientist, Sigmund Freud, just starting his career, brushed by the fiber. He was investigating another of Reissner's discoveries--Reissner's cells. They are located in the core of the spinal cord, millimeters away from the fiber. Freud used lampreys and corresponded with two scientists, Kutshcin and Steida, who were sparring over the nature of Reissner's fiber. But none of Freud's writings refer to the fiber.

In the spring of 1899, Porter Sargent, a twenty-seven-year-old Harvard doctoral candidate, examining lengthwise sections of the spinal cord of a lamprey, observed a glistening fiber in the central canal. Perplexed that Reissner's fiber was not mentioned in his texts, he wrote, "It is remarkable that so peculiar and conspicuous a structure as Reissner's fiber, which is of such great importance in the nervous anatomy as to persist throughout the vertebrate series, should have remained so little known for forty years after its discovery."

In 1904, Sargent published his research, providing anatomical and experimental evidence to support the hypothesis that the fiber is a "highly specialized conduction path," transmitting signals faster than "ordinary axis cylinders." He concluded his paper by announcing that his next paper dealing with the fiber's "significance in higher vertebrates" was "well advanced."

However, shortly after a contentious defense of his doctoral thesis, Sargent abandoned his research to become a "poet, educator and world traveler." Porter Sargent's final publication in 1950 was titled, *Is Poetry a Secretion?* The title's allusion to brain activity was as near as Sargent would come to divulging his youthful incarnation as a serious scientist.

Although Sargent's hypothesis of high speed transmission of signals through Reissner's fiber was generally accepted, it competed with widely divergent views about its nature and function. While Sargent sometimes characterized the fiber as an axon, this term was still imprecise. Robert Albert von Kölliker himself, the discoverer of the axon, who coined the term in 1896, wasn't able to decide if Reissner's fiber was an axon, artifact, or a crystallization of biological secretions.

In 1909, George Nicholls attempted to refute Sargent's hypothesis by showing the fiber isn't a nerve. With Sargent no longer competing in the scientific arena, Nicholls' false characterization of Sargent's ideas prevailed.

Nicholls followed his faulty refutation of Sargent's hypothesis by mischaracterizing of the fiber as a coalescence of cilia and proposing the mistaken hypothesis that Reissner's fiber is "a rubber band" regulating the flexure of the body. Nicholls also observed the fiber coils in the terminal ventricle. He dismissed this coiling as an artifact resulting from breakage. He referred to Reissner's fiber's coiled ending as the "terminal plug." His later investigations of humans established the conclusion that both Reissner's fiber and its primary source, the subcommissural organ, regress during infancy.

Sargent's hypothesis of novel, highly specialized, high speed conduction through Reissner's fiber drifted to the fringes after Nicholls falsely claimed to have refuted it by showing the fiber is not a nerve. As science's theoretical models and technologies focused on the electrochemical activity of neural membranes Reissner's fiber became disconnected from the new science of neurophysiology.

As Reissner’s fiber faded into scientific oblivion, it was “rediscovered” by Theos Bernard, the first American ever initiated into Tantric Yoga practices by the highest lama in Tibet. In his memoir of his travels to India and Tibet, titled *Heaven Lies Within Us*, published in 1940, Bernard wrote, “Inside this central (*Sushumna*) *nadi*, the Yogi identifies an invisible *nadi* known in the West as the *fibre of Reissner,* but which is known here as *Chittra* (the Heavenly Passage, in Sanskrit).”

Seven years later, at the age of thirty-nine, while searching for a “rare manuscript” in the hill of Spiti, India, Bernard was rumored to have been attacked by Lahouli tribesman. He was never seen again. His identification of Reissner’s fiber and the innermost *nadi* vanished with him.

In 1954, Dr. Masashi Enami, a Japanese neuroendocrinologist at Gunma University made two important discoveries: a biologically active substance in the cells surrounding the terminal ventricle, and a new Reissner's fiber pathway.

First, using extracts from cells surrounding the terminal ventricles of fish, Enami discovered a substance that influences sexual behavior and buoyancy. Ten years later, the substance Enami had discovered was isolated (Fridberg,1968). It was found to be a potent constrictor of blood vessels and named urtotensin (Ames, 1999). Second, examining the brains of eels, Enami found a new branch of Reissner’s fiber traveling above the floor of the third ventricle, from the hypothalamus to the subcommissural organ, just below the pineal gland. Shortly after his discovery of a new branch of Reissner's fiber, days before a scheduled presentation in San Francisco of a paper integrating Reissner's fiber, the terminal ventricle, the subcommissural organ and the hypothalamus, he died.

In 1960, a North Korean scientist began investigating the possible neuroanatomical basis of acupuncture meridians. Injecting radioactive phosphorous (P^{32}) into acupuncture points on a rabbit’s abdomen, Professor Kim Bong Han traced its flow along the meridians. Injections at other sites dispersed without any discernible difference between the meridians and the surrounding tissues.

The most conspicuous and strategically located structure labeled by Bong Han’s injections was Reissner's fiber. Apparently unaware that Ernst Reissner had discovered it one hundred years earlier, Bong Han named his “discovery” the central Bong Han duct.. (Consistent with Bong Han’s characterization of the fiber as duct-like were the observations of G. Erbl-Roth. In 1951, this German researcher succeeded in collecting fresh specimens of the fiber from mammals. She found that the fiber was hollow, and developed techniques to make injections into the fiber’s core.)

At the time, in 1964, the North Korean government praised Bong Han’s theory as a “monumental theory in global science.” Bong Han was an instant hero, rising to the fourth highest position in the North Korean government.

But in 1965, North Korea purged Bong Han from the government, discrediting his work, claiming he’d withheld details of his methodology. They reported that his results were irreproducible.

After decades of neglect, a group from Seoul National University (Kwang-Sup, 2009) has developed novel methods using modern technology to reexamine Bong Han's claims. Recently they reported a novel threadlike structures in the cerebral ventricles and central canal (Lee, 2008).

In 1961, a group of Spanish pathologists (Gomez et. al.,1961) examined the brain of a recently deceased sixty-year-old victim of a car crash. Contrary to what they'd learned in the textbooks, the victim had a fully-developed subcommissural organ. Nevertheless, researchers continued to accept Dendy and Nicholls' 1912 conclusions about the universal regression of the subcommissural organ in adult humans.

In 1969, a Japanese neuroscientist, Kunio Kohno, turned up the magnification on Reissner's fiber's hitherto invisible internal structure with an electron microscope. He revealed a marvelously intricate network of five-nanometer fibrils and tiny spheres surrounded by three-layered membranes. Kohno dismissed the internal structures he'd discovered as "cell detritus."

In the 1970s, a group of German neuroscientists (Hess, J. 1972) showed that Reissner's fiber binds neurotransmitters. Curiously, while neurotransmitters play a vital role in the electrochemical activity of neural synapses, these scientists concluded, disparagingly, that Reissner's fiber's binding of them detoxifies the cerebrospinal fluid.

In 1982 Dr. D. H. M. Woollam, neurosurgeon and Director of Studies in Medicine at Emmanuel College in Cambridge, England, proposed that Reissner's fiber could be a possible site for future neurosurgical treatment of hydrocephalus. He proposed that the fiber "has an important function and that its presence is by no means for purely ornamental purposes," and that the significance of the surrounding cerebrospinal fluid "will return to the exalted position it occupied in the 1,700 years of Galenical medicine." Thirty years later, his vision is no closer to reality.

During the past decade a group of substances associated with Reissner's fiber, spondins, have been discovered. They play a crucial role in the guidance and differentiation of developing nerve cells.

Reissner's fiber has been observed in human embryos and fetuses (Dendy, 1910). While Reissner's fiber is currently thought to degenerate shortly after birth in humans, it is possible that is has merely eluded detection or exists as a rare anomaly. The fiber is very fragile and undergoes rapid post-mortem disintegration. It is too small to be detected by current imaging devices.

Reissner's fiber's fragility, fineness, rapid post-mortem degeneration, inaccessibility, non-cellular structure, and apparent early degeneration in humans, combined with the vicissitudes of previous investigators, have made this spectacularly strategic structure an enigma for over 150 years. It remains largely outside the methods and theories of neurobiology.

3. Recent Development

During the past seven years I have assembled an interdisciplinary team of neuroscientists and physicists at Boston University to investigate Reissner's fiber. First we developed a transgenic zebrafish in which the expression of green fluorescent protein is under control of the promoter for F-spondin, an extra-cellular matrix protein associated with Reissner's fiber. This effective visual tool has allowed for detailed anatomical localization of F-spondin and helps us focus on Reissner's fiber in living animals. This tool has been incorporated into ongoing research on morphogenesis, biological clocks and temporal perception.

Next we developed a new tool for studying ultra-weak optical fields potentially emitted by Reissner's fiber: a super-conducting single photon detectors providing input to a time-correlated single photon counting system with picosecond resolution. Specially designed nanopositioners and a confocal microscope allow us to focus on the fiber. Femtosecond pulsed infrared lasers can stimulate the fiber. Due to the reduced photobleaching and phototoxicity of infrared imaging, we will be able to investigate photon dynamics (relaxation and internal excitations) for extended periods, allowing us to document time-dependent oscillatory processes under natural conditions.

The goal of our research is to find evidence of quantum coherence and entanglement associated with Reissner's fiber to establish the fiber as a site of the interaction between quantum mechanics and consciousness.

Reissner's fiber could provide a new relationship with the quantum world. The fluid-filled cavities of the ventricles and their surface could function as a quantum feedback and control system analogous to a quantum cavity apparatus. Ordered water and liquid crystals within the ventricles could be a cavity resonator. The ventricular surface could be a detector for feedback loops to the brain.

The triggerings of our external sense are generally assumed to be the sole generators of our perpetual experience. Neurobiological features of the Reissner's fiber apparatus suggest that it too may be capable of generating percepts. The ventricular surface and the external sensory organs share a common embryological origin. The cells on the inner surface form an inner directed sensory system while the cells on the outer the surface form our external senses.

1913, Daniel Tretjakov observed that cilia and nerve endings lining the ventricles come in contact with Reissner’s fiber. He claimed to have discovered a “central sense organ” attuned to the fiber it surrounded.

In 1921, W. Kolmer proposed that the subcommissural organ (the main source of Reissner's fiber), Reissner’s fiber, and cilia and cerebrospinal fluid-contacting neurons located along the walls of the brain and central canal form an integrated sensory system that he named the *sagittal organ*. He compared Reissner’s fiber to the gel-like substance of the inner ear (tectorial membrane) which lies beneath a thin sheet of cells (*Reissner’s membrane*). Just as the vibrations of the hair cells and the tectorial membrane transmit signals to the auditory nerve to produce the sensation of sound, so, too, do vibrations of the cilia that touch Reissner's fiber transit signals to the cerebrospinal fluid contacting neurons to produce sensory experiences.

Competing with these hypotheses of an inner-directed sensory system attuned to Reissner's fiber was Eric Agduhr. His 137-page manuscript dealing with the "central sensory organ in vertebrates" concluded that Reissner's fiber and the cerebrospinal-fluid-contacting neurons aren't part of an integrated system. Based on his dissections of 206 species of vertebrates, Agduhr proposed an "ependymal sensory organ" independent of Reissner's fiber.

Nine years after Agduhr published his criticisms, Kolmer countered with new research based on observation of lizards, snakes, and Rhesus monkeys. But it was too late. Science had already passed its judgment, and the hypothesis that a sensory system perceives Reissner's fiber faded away.

Recent research of a group of specialized circumventricular organs, (including the pineal gland, subcommissural organ, area postrema, organum vasculosum of the lamina terminalis, subfornical organ, median eminence, and the posterior pituitary), have revived interest in the sensory capabilities of the ventricular surface (Jurzak, 1999). Advances in molecular biology have revived the hypothesis that cilia and cerebrospinal fluid-contacting neurons have a sensory function. (Vigh, 1983,1998; Vigh-Teichmann, 1983). An interesting group of cerebrospinal fluid-contacting neurons are projected from the raphe nucleus. These serotonergic fibers are thought to play a key role in the mechanism of action of LSD (Agajanian,1978). Interestingly the psychoactive properties of LSD are correlated with the energy of its outermost electron orbitals, a quantum mechanical property, rather than its ability to bind to serotonin receptors (Snyder, 1968).

4. Possible Quantum Connections

While the correspondences between the Reissner' fiber apparatus and the subtle anatomy, and the parallels between modern physics and ancient esoteric traditions bring us closer to a possible convergence between science and spirit, the demonstration that the Reissner's fiber apparatus functions as quantum feedback and control system would not prove it. The ultimate validation of the hypothesis that Reissner's fiber can realize the mystics' vision of direct experience of the Absolute would be direct, immediate experience of the fiber's uncollapsed wave function. Here we would have direct knowledge, an "immaculate perception" of reality in itself rather than reconstructed sensory reality. Quantum reality lies at the boundary of nothingness and infinity, time and eternity. It corresponds to what yogis, kabbalist and acupuncturists call *Brahmin, Ein-Sof* and the *Tao,* respectively.

Such knowledge is precluded by the current paradigm of modern physics. Quantum mechanics dismisses questions about the reality of quanta prior to a measurement as meaningless. Quanta collapse, decohere or split into parallel universes when they are observed. The equations of quantum mechanics do not directly correspond to reality.

The limits of quantum uncertainty become more formidable when quantum mechanics encounters gravity at distances shorter than 10^{-33} cm. and durations less than 10^{-44} seconds, Planck units. Here quantum fluctuations churn the space-time continuum into a "quantum foam."

Cosmologists extrapolating back to the origin of the Big Bang have rediscovered the mystics' understanding of eternity, not as time extending infinitely into the past, but as a "place" beyond space and time from which they were both created. An analysis of black holes has shown that a bit of information is equivalent to a square Planck unit, and that the three spatial dimensions of the universe can be holographically encoded on a two dimensional surface. String theorists hypothesize that at least six dimensions are compacted and thereby hidden in a region smaller than a radius of a Planck unit.

"There is no quantum world. There is only an abstract quantum description," said Bohr. Besides, added Heisenberg, "The use of classical concepts is finally a consequence of the general way of thinking. There is no use in discussing what could be done if we were other beings than we are."

Einstein disagreed. "It sounds like a system of delusions of an exceedingly intelligent paranoiac, concocted of incoherent elements of thought," replied Einstein. "The Bohr-Heisenberg tranquilizing philosophy—or religion?—is so delicately contrived that, for the time being, it provides a gentle pillow for the true believer from which he cannot very easily be aroused. So let him lie there…most of them simply do not see the risky game they're playing with reality."

In 1935, Einstein, in collaboration with Boris Podolsky and Nathan Rosen, published an article, titled "Can Quantum Mechanical Descriptions of Reality Be Considered Complete?" It proposed a simple thought experiment: Two quanta interact, entering a state of quantum entanglement, then fly apart. If the predictions of quantum mechanics are correct, then the measurement of one quantum instantaneously determines the properties of the other. Neither quantum is real before it's measured. Quantum uncertainty can't be explained as a disturbance of a pre-existing reality. Rather is the random creation of a new reality.

For thirty years the Einstein-Podolsky Rosen (EPR) experiment languished as physicists turned away from the philosophical conundrums of quantum theory. But in the late 1950s, a young Irish physics graduate student, J. S. Bell, began to rouse physicists from their dogmatic, metaphysical slumber. In 1964, using only simple algebra, Bell developed a way to analyze data from experiments using entangled quanta.

In the early 1980s physicists carried out the experiments. They showed that it is impossible to get a more complete understanding of the results by adding signals traveling less than or equal to the speed of light, non-local hidden variables.

Ironically, tragically, physicists used Bell's analysis of the EPR experiments to claim quantum mechanics draws the final boundary of human knowledge. They mistakenly believed that quantum mechanics could go beyond its boundaries *only* by adding something to it.

Einstein and Bell, however wanted to complete quantum mechanics with revolutionary new idea, not by adding things to it.[1],[2] "Suppose," Bell wondered, "when formulation beyond all practical purposes is attempted, we find an unmovable finger obstinately pointing outside the subject, the mind of the observer, to the Hindu scriptures, to God." "The new way of seeing things will involve an imaginative leap that'll astonish us," he exulted.

5. The Plausible Connections to the Mystical

The imaginative leap created by Reissner's fiber would astound us. It would create a new circuit in the brain and open the doors of perception. Everything would appear as it is, infinite.

According to esoteric traditions, mankind's dream-like oneness with God was broken thousands of years ago. The unity of language, ideas and experience fragmented. The secrets of the subtle body were lost.

If the Reissner's fiber apparatus corresponds to the "subtle anatomy," then it probably degenerated during this evolutionary transition. The conjectured perceptions of the Reissner's fiber apparatus were witnessings of this degeneration.

This evolutionary transition from our lost oneness with God was the commission of the" metaphysical original sin" of separating ideas and sensory experience (Einstein, 1949). We yearn to atone for this sin with the theoretic unifications of science. The spiritual teachings of esoteric tradition, developed from faded, fragments of our lost oneness, illuminate a parallel path. Both converge upon a union with God.

Carl Jung proposed that our personal unconscious is attuned to that lost oneness which exists in the collective unconscious. This can be explained biologically by the ontogenic recapitulation of Reissner's fiber's phylogeny.

During embryological development, Reissner's fiber regulates neurogenesis by its effects on the surrounding neural stem cells and the extra-cellular matrix (Monnerie, 1997). It guides the developing circuitry of the brain (Burstyn-Cohen, 1999). Its vibrations imprint the fields and molecules of memory (Naumann,1993). This imprinting of our unconscious resonates with the

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[1] "It is my opinion that the contemporary quantum theory of certain definitely laid down concepts, which on the whole are taken over from classical physics, constitute an optimum formulation of certain connections. I believe, however, that this theory offers no useful point of departure for future development. I think it is not possible to get rid of the statistical character of the present quantum theory by merely adding something to the latter, without changing the fundamental concepts about the whole structure."

[2] Nathan Rosen agreed. He wrote, "If quantum mechanics is replaced by another theory, this is likely to involve revolutionary changes in concepts and principles. . . It appears that such a theory won't be obtained from simple modifications, such as hidden variables."

collective unconscious. Prenatally we re-experience our lost oneness with God, our separation, and the yearning and vision of our way back.

Further plausibility of the hypothesized connection between Reissner's fiber and God come from the life of Jesus. Reissner's fiber's endpoints at the preoptic region of the hypothalamus, subcommissural organ and terminal ventricle are the sites of the production and regulation of hormones--anti-diuretic hormone, aldosterone (Palkovits, 1965; Van der Wal, 1965) and urotensin, respectively--which control thirst, and salt and water balance (Gilbert, 1956, 1964; Severs, 1991). Reissner's fiber's control of these hormones might have allowed Jesus to survive for forty days fasting in the Judean desert. Moses, whose revelation of the Torah at Mt Sinai was proclaimed by Jesus to be unalterable by even a single one dot or iota (Matthew 5:18), and Elijah who was prophesized to herald the messiah, are the only other figures in the Bible to have survived for forty days fasting in the desert. Reissner's fiber's hypothesized quantum coherences might explain the image on the Shroud of Turin. Frank Tipler has proposed that quantum coherences coupled with electroweak tunneling can explain the miracles of Jesus, his resurrection, and the creation of the image on the Shroud by a burst of neutrinos. Orchestration of the highly improbable coherences required for these events could have been directed by Reissner's fiber.

Using the emerging science of epigenetics we can reawaken our dormant Reissner's fiber genes. New generations of imaging devices can provide us with objective feedback of Reissners fiber and reconnect us to our inner directed feedback systems. We can take the last steps toward realizing the mystical quest for meaning, love and Truth, illuminated by the light of science.

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