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## Water Electrolyzers and the Zero-Point Energy

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### Abstract

The gas emitted from popular water electrolyzer projects manifests unusual energetic anomalies, which include vaporizing tungsten when used in a welding torch and running internal combustion engines on small quantities of the gas. Some claim to run generators in closed loop fashion solely on the gas from the electrolyzer, which is powered solely from the generator. Most investigators believe the energy is from burning hydrogen. A hypothesis is proposed that the dominant energy is not coming from hydrogen, but rather it is coming from charged water gas clusters, which activate and coherently trap zero-point energy.

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### 1. Introduction

The water electrolyzer projects are popular with inventors and hobbyists worldwide. There are thousands of videos posted on *YouTube* under the search, *water fuel*. Nearly everyone believes their electrolyzers produce a mixture of hydrogen and oxygen gas known by various names such as HHO, hydroxy, oxyhydrogen, and Brown's gas. Brown [1] is famous for investigating the welding applications of the gas and discovered intriguing energetic anomalies [2]. The gas exhibits a cool flame, ~130 degrees C, yet it can vaporize tungsten, a feat beyond today's commercial welding torches [3]. The academic community has yet to explore or explain this anomaly. Burning hydrogen cannot account for it.

Perhaps the most popular application of the water electrolyzers is to boost an automobile's gasoline mileage [4, 5]. An energy anomaly manifests here as well for the boosters typically produce only a few

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(5-20) liters of uncompressed gas per minute. Yet many claim significant increase in miles per gallon (20 – 50%). Burning hydrogen cannot account for it.

Even more surprisingly some investigators have claimed to run gasoline generators on 5 to 6 liters per minute of the uncompressed gas, and the generator's electrical output was stable on the order of a kilowatt [6 – 8]. Such claims appear remarkable, considering the low efficiency of typical internal combustion engines (~20%). Burning hydrogen certainly cannot account for this.

This paper will explore the hypothesis that the dominant energy coming from the water electrolyzers is not from hydrogen, but rather it is from another source which might be far more energetic: charged water gas clusters, which activate and coherently harvest zero-point energy (ZPE). Others have proposed a coherent water zero-point energy interaction. Prevenslik [9] introduced a model where a collapsing nano bubble coherently activates a standing wave from the ZPE whose continuously increasing resonant frequency acts like an ultraviolet to x-ray laser which coincides with the dissociation frequency of the water's hydrogen-oxygen bond to yield charge separation. He applied the model to explain steam electricity, waterfall ionization, sonoluminescence, and thundercloud charge separation. If Prevenslik is correct, it implies the zero-point energy significantly contributes to lightning formation. Appendix A summarizes the author's hypothesis [10, 11] on how the zero-point energy might coherently participate in self-organized collectives involving ionized matter or plasma.

To further support the ZPE hypothesis, another phenomenon that exhibits energetic anomalies similar to Brown's gas is discussed in Appendix B: plasma charge clusters. Plasma charge clusters are a form of microscopic ball lightning that have been experimentally observed and extensively studied by Ken Shoulders [12]. He named them "electrum validum" (EV) meaning "strong charge," and later renamed them "exotic vacuum objects" (EVO) when he became convinced that they coherently coupled to the ZPE to account for the excessive energy they manifested [13]. The observed energetic anomalies in their interaction with high melting point ceramics are similar to those exhibited by the Brown's gas welding torch.

## 2. Brown's Gas Anomalies

Brown's gas exhibits energetic anomalies that have not yet been addressed by the scientific community. The most frequently observed anomaly occurs in welding applications. Here the burning gas exhibits a cool flame measured to be about 130 degrees C, cool enough to quickly pass one's hand through it [3]. The flame does not boil water by direct contact, yet when it interacts with metal, it readily melts it. It has been shown to even sublime (and oxidize) tungsten. Commercial welding torches cannot vaporize tungsten.

Recent university studies by Eckman [14] confirmed the low temperature of the Brown's gas flame as well as its ability to sublime and oxidize tungsten. A mass spectrometer was used to determine the constituents of the gas, and he discovered the gas contains little hydrogen of either mono-atomic or diatomic form. Instead he found the gas to be predominantly clusters of water in a gaseous form that contained excess electrons. This observation matches the literature that discusses an observed form of water clusters known as "hydrated electrons" [15], where experiments have determined that the excess electrons are trapped in the interior of the cluster. Eckman suggests that at the heart of the cluster there exists a linear isomer of the water molecule where the excess electrons are held in the d orbitals of the oxygen atom. Here the cluster might be a form of Rydberg matter where nearby molecules in the cluster shares the high-energy band electrons. Eckman's hypothesis was inspired by a preliminary x-ray diffraction image showing a linear water molecule shape, but further studies must be completed to confirm it. The Rydberg matter hypothesis offers a coherent storage mechanism to hold excess energy in a gaseous charge water cluster.

Wiseman [2] has gathered a repository of research about Brown's gas. Perhaps the most astounding anomaly claimed involves replication of Yull Brown's experiments to alter the radioactivity of americium [16]. The experiment involves impinging the welding flame onto a mixture of aluminum and iron (akin to

thermite) on which sits the americium sample. The flame triggers a small explosive event, after which the americium sample exhibits little radioactivity. There are similar experiments involving EVO strikes [17] as well as high-energy plasmoid strikes [18] into pure metallic targets that manifested transmutation into elements whose isotopes are not readily found in nature (see Appendix B). Just like plasmoid strike events, could the abrupt explosive interaction of the Brown's gas charged water clusters with the thermite alter the nuclei of the radioactive sample? Such experiments would have to be extensively and carefully repeated by the academic community before concluding that element transmutation is occurring. If such events could be repeatedly demonstrated, it might imply a coherent ZPE interaction with atomic nuclei to account for an energy density sufficient to influence the nucleus.

The charge water gas hypothesis gains further support from observation of electrolyzer bubbles between the parallel plate electrodes. When the plates are separated over a cm, near the cathode are observed the hydrogen bubbles and near the anode are observed the oxygen bubbles as in standard electrolysis. However, in the gap between them are observed a third set of bubbles that contain the more highly energetic gas that Wiseman [19] suggested to be “electrically expanded water,” which is essentially the same as the charged water gas cluster hypothesis here. This is the pure form of the gas, which is the source of the energetic anomalies. Suartt and Gourley [20] have filed a patent, where they further separate the electrodes so that they can harvest just the middle set of bubbles, and eliminate hydrogen from the mix. The pure gas still exhibits all the welding anomalies, and they are able to safely store it under pressure because it contains no hydrogen. With the electrodes so widely spaced, Suartt and Gourley had to add extra electrolyte to their water and conduct appreciable current to generate the gas, which prevents them from exhibiting any net energy gain. Nonetheless, they have developed a technique to harvest the pure form of the gas for repeatable study that might be intriguing to the scientific community: a form of water that “burns” with coherent energetic content sufficient to vaporize tungsten.

### 2.1. *Vibrating The Water*

Another technique for making the pure form of the charge water cluster gas might have been invented by Ohmasa [21]. Ohmasa subjects the water to mechanical vibration at ~100 Hz by a set of paddles to dramatically lessen its surface tension. Even if detergent is added to the water, it will not form visible bubbles during vibration. Ohmasa states that bubbles are forming at nano scales, which are not visible to the naked eye. When the water is electrolyzed, he produces abundant gas that exhibits all the anomalies of Brown's gas, yet it apparently contains little free hydrogen for he can likewise safely store the gas under pressure for long periods of time (over two years), after which the gas still exhibits its energetic form when ignited. Ohmasa was able to run an internal combustion engine with just the gas, while blocking any extra air intake into the engine. Ohmasa claims that vibrating the water lowers its surface tension to make nano bubbles, which yields a superior, more energetic form of the water gas from the electrolyzer.

It appears that Chambers [22] inadvertently discovered an efficient means to vibrate water in an electrolyzer. Chambers used a toroidal coil (1500 turns of wire on a ferrite core) under water in his electrolyzer, and drove it at ~19 Hz. The gas from the electrolyzer exhibited a superior burning characteristic that allowed him to directly use it to fuel a 1 KW Honda generator without needing to adjust the timing on its internal combustion engine. Chambers believed his electrolyzer was producing parahydrogen via the coil's magnetic field because the gas would burn slower than natural hydrogen. When he did not use the coil, the electrolyzer emitted gas that would burn faster, which he assumed was orthohydrogen. It is unlikely that the coil's magnetic field influenced the water since the field lines are effectively confined inside the ferrite toroid. In view of Ohmasa's discovery, we can now infer the actual purpose of the coil: The alternating magnetic field has a corresponding alternating vector potential surrounding the coil, which in turn induces an oscillating, toroidal electric field around the coil. The charged water clusters created in the electrolyzer would then oscillate with the electric field causing the

water to vibrate at the drive frequency. Like Ohmasa discovered, the result of electrolyzing water while it is vibrating produces a superior, more energetic form of water gas.

Many inventors and hobbyists have tried using toroidal coils to make a better gas. Eardley (private communication) used ten ½ inch diameter ferrite toroidal coils with 25 windings of 4 gauge wire on each and mounted them on a circuit board as two groups of five coils, each group connected in series. He drove one group with low frequency pulsed DC square waves at 12 volts, 30 amps and the other group at 35 amps (because that was the maximum rating of the coils). He drove his electrolyzer with pulsed DC square waves at 12 volts, 10 amps. The electrolyzer consisted of 25 parallel plates (304L stainless steel, 16 gauge, 8 inch x 11 inch, with 1/8 inch rubber gaskets separating the plates). The electrolyzer emitted sufficient gas to run a lawn mower engine. To investigate the quality of the gas, Eardley filled balloons with the gas emitted from the electrolyzer. It is interesting to note that when the toroidal coils were activated, the gas in the balloon was heavier than air, and the balloon would drop. When the coils were inactive, the electrolyzer gas would be lighter than air, and the balloon would rise. Eardley also isolated the heavier-than-air water gas by storing it overnight in a paper bag. Since the bag is porous to hydrogen, any free hydrogen vents away. The next day he opened the bag, and the residual water gas would not disperse. When lit, it would implode back to liquid water with a distinctive pop. Eardley surmised that the heavier-than-air water gas contained little free hydrogen, and he would then contain the gas under medium pressure (~50 psi) in order to drive larger internal combustion engines.

Eardley recently tried experiments where the water was constantly circulated through the gaps between the electrolyzing plates via a small pump (powered at 12 volts, 8 amps toggled off and on each second to maintain a circulation water pressure of ~25 psi). He could then avoid using the toroidal coils entirely. Eardley found that rapid water circulation produced the most gas of all his experiments, and the gas appeared white like fog. He then was able to reduce his total input power to ~200 watts. It appears that charging water that is rapidly flowing multiple times through the inter-electrode gaps integrates the energy content of the water, and yields a more powerful water gas.

Originally for the electrolyte Eardley added a mixture of potassium carbonate (2 teaspoons) plus a little sodium hydroxide (1/2 teaspoon) per gallon of pure water made by reverse osmosis. The potassium carbonate reduces the surface tension of the water, but it is emitted from the electrolyzer along with the water gas. To recover it, Eardley recycled the engine's exhaust water back to the electrolyzer. Later, when Eardley used the water pump instead of the toroidal coils, he found he could omit the potassium carbonate from the solution. However, he still continued to recycle the engine's exhaust water. Recycling the exhaust water appears to offer an added benefit: There still might exist energetic charged water clusters in the water after discharge in the engine. If so, the clusters would exhibit behavior akin to the "black" EVO [23], a plasmoid-like form that seems to be dormant, but can be re-activated with a voltage pulse (see Appendix B). Recycling the exhaust water might allow an effective energy recapture and integration for the system.

Perhaps the simplest means to produce an abundance of charged water gas clusters has been discovered by the inventors and hobbyists whose electrolyzers have very small gaps between the electrodes (less than 1 mm). Here any free hydrogen or oxygen atoms produced on the electrodes tend to join the water clusters forming in the middle. The primary motivation for the small gaps is to reduce or eliminate the use of electrolyte in the water, which allows a significant reduction in drive current and thus input power. It is electrolyzers of this type that have resulted in the claims of excessive energy production.

## *2.2. Conditioning the Electrodes*

Since water (especially distilled water) does not readily conduct electricity, inventors have learned that they must "condition" their electrodes, which are typically 316L stainless steel. The result of conditioning creates a rough, microscopic sharp pointy surface, which induces high electric fields around the points and facilitates microscopic electric discharges into the water. If the electrodes are not properly

prepared, no current will flow, and the electrolyzer will fail to produce any bubbles whatsoever. This is a frequent occurrence for hobbyists when they first begin their research, and they typically add electrolyte (potassium hydroxide or sodium hydroxide) to the water and are then happy to produce gas bubbles. Since most researchers believe they are making hydrogen with their electrolyzers, they naturally want to supply a large drive current to follow Faraday's law, which essentially states you need to supply one electron for each hydrogen atom you wish to dissociate from the water. The inventors that properly condition their electrodes produce an abundance of gas that appears to exceed Faraday's law, but the law is not actually violated because the gas abundance is not from hydrogen production.

Techniques for electrode conditioning have gradually improved as researchers have been sharing their results. Lawton, who was replicating the electrolyzer of Meyer, developed a long protocol by conditioning his electrodes in tap water [4, p114]. He would run a repetitive, hourly sequence of low current to high current for about a month. During the conditioning a reddish brown crud (likely iron oxide) would discharge from the electrodes and the water would have to be periodically replaced. Gradually, a whitish grainy surface would accumulate on the electrodes. The whitish material has not yet been analyzed but it could be salts, carbonates, or silicates present in the tap water. Ravi [24] who replicated Lawton's electrolyzer was frustrated with no gas production whatsoever until he followed Lawton's conditioning protocol, after which he was able to produce abundant gas using only 0.5 amps of current. Tap water is a poor medium for scientific replication because the water's mineral content is unknown.

Boyce developed a technique that conditioned his electrodes in a mixture of distilled water and potassium hydroxide that took about three days [4, 5]. He first roughened the electrodes by cross-hatching them with sandpaper. Then he conditioned them in the electrolyte solution with DC current. The electrodes would likewise emit a brownish crud, and the water would have to be periodically cleaned. After three days the electrode would exhibit a grayish white surface and then would be ready for use. All researchers stressed the importance of not touching the electrode surface once it is conditioned because it would damage their charge emitting properties

Zigouras (private communication; [panacea-bocaf.org](http://panacea-bocaf.org); [25]) discovered a straightforward technique for preparing stainless steel electrode plates. He media blasted them with 40-grit silicon carbide and then cleaned them with an ammonia-based cleaning solvent. No further conditioning was needed. Zigouras stressed it was important to media blast the surface at 45 degrees and not straight on. The microscopic craters from the media blasting would then have sharp edges. Zigouras also had a very tight gap between his plates, 0.6 mm, which allowed him to convert water sucked through the plates nearly instantly into energetic water gas by means of high current. Zigouras exhibited one of the fastest gas producing electrolyzers on the web, and his approach to conditioning the plates offers the opportunity for easy replication.

Eardley (private communication) prepared his 304L stainless steel plates by having a plating company immerse them in hydrochloric acid for 30 minutes, a harsh descaling technique called "pickling." The plates are rinsed with water, and then immersed in a bath of potassium hydroxide solution where they are electrolyzed at 10 amps for about 45 minutes until they no longer discharged brownish crud. Afterward Eardley immerses the plates in vinegar for 30 minutes, and washes them in a dishwasher using standard (dishwasher) detergent. The hydrochloric acid (especially with residue ferric chloride) aggressively erodes the surface of the stainless steel leaving a microscopically rough, pointy surface that supports electric discharge characteristics apparently favorable for charge water cluster formation. The surface yields abundant gas production from the electrolyzer, and the water remains crud free. Eardley's protocol for preparing stainless steel electrodes offers consistent repeatability for manufacturing high quality electrodes.

Conductive materials that already have a rough dendritic surface might make good candidates for electrodes. Mixed metal oxide titanium has been used in standard commercial electrolysis without any need for preparatory conditioning. It has been successfully tried in some booster water electrolyzer projects [5], but so far only with large inter-electrode gaps, which requires electrolyte solution and high

current. (Since most researchers believe they are making hydrogen, they typically add electrolyte to produce large currents and see no reason to have small gaps between the electrodes.) Other rough materials such as sintered stainless steel have been discussed as good candidates, but so far not yet tried. Most hobbyists use 316L stainless steel because it is cheap, and it has a track record on the worldwide web with many claims of success.

### *2.3. Powering Generators*

There are numerous projects on the web that demonstrate powering small motors and portable generators exclusively from the water electrolyzer's output gas. Ohmasa [21] shows it in his video, and Chambers' [22] patent mentions running a 1 KW Honda generator. The goal is to produce enough gas at minimal electrical input to the electrolyzer to make the system self-running where the rectified output from the generator is the sole source of input power to the electrolyzer. This would dramatically prove the existence of a new energy source. At first glance this goal appears ludicrous because the generator's internal combustion engine is only about 20% efficient, and there are other energy losses throughout the closed loop system as well. The net energy content of the hypothesized charged water gas clusters would have to be extraordinary (over 5x the input power) to overcome these losses to manifest a self-running system. Yet there have been announcements claiming to have done so.

Steve Eaton has claimed to have successfully run a closed loop, generator electrolyzer system that produces six liters of gas per minute that even exhibited some excess power to drive external loads [6]. He teamed with Sokol [26] of Hybrid-Tech Corporation to publish the plans so that others could replicate his results. The electrolyzer cell consists of 27 pairs of 16-inch long cylindrical stainless steel electrodes (1/2 inch outer diameter) with tight spacing (under 1/32 inch). A spiral wrapping of polystyrene line maintains the gap between the cylinders, and it guides the gas into a helical flow as it travels up the gap between the electrode tubes. The power needed to drive the electrolyzer was 12.5 volts, 30 amps DC. The electrolyzer used a weak electrolyte solution (one gram of potassium hydroxide per gallon of distilled water). The gas output was sufficient to run a 3.25 KW Troy-Bilt generator, which not only provided all input electrical power to the electrolyzer, but also had excess power to light a few light bulbs. Construction of the electrode assembly is not easy, and so far no one has claimed a replication success.

In Germany Oliver and Valentin have claimed to run a small 1 KW generator in a closed loop fashion using three Anton cells [7]. The commercially manufactured Anton cell consists of seven parallel-plate stainless steel electrodes, whose 1 mm spacing is maintained by neoprene gaskets. The electrolyte solution consisted of 3% potassium hydroxide in distilled water. Approximately 900 watts of input power was required to produce a gas output of 6 liters per minute. Oliver and Valentin had to provide their own timing circuit to properly fire the generator spark plug and avoid igniting a waste spark. The system ran for about 40 seconds in closed loop fashion, but the system was not stable and still requires further circuits to regulate the power fed to the electrolyzer from the generator. An open source project has been started in Germany to promote replication.

Perhaps the most spectacular claim is from Frederick Wells, who claims to have successfully run a truck on just the water gas from his electrolyzer without depleting his battery [27]. Wells is now engaged in an "open source" public project to build a self-running generator, electrolyzer system [8]. His cylindrical electrode assembly is designed to vibrate at acoustical frequencies, which helps to disrupt the water's surface tension (much like Ohmasa's vibration technique) to produce abundant gas.

### *2.4. Driving With Pulsed Dc Waveforms*

A number of investigators have found that using pulsed DC square waves to drive the electrolyzer have enhanced gas production. Chambers patent describes exploring the spectrum from 1 to 250 KHz for the square wave frequency. Many researchers have found that driving the electrolyzer with a square wave around 40 KHz yields good results [4]. Most agree that the best drive frequency has to be experimentally

discovered for each electrolyzer because there is no one simple frequency that manifests a full system resonance. Zigouras (private communication; panacea-bocaf.org; [25]) discovered that he had to gradually and continuously alter the drive frequency by a few KHz centered near 40 KHz to optimize gas production. As a waveform improvement, Lawton discovered that a high voltage spike on the leading edge of the square wave increased the energy content of the output gas [4, p125]. Even though successful gas production occurs with a simple DC drive, using pulsing techniques have helped to reduce the need for large input currents.

### 2.5. Summary

This paper was motivated by the apparent success of the researchers and hobbyists in the “HHO community.” They have been demonstrating unusual energy anomalies and have been trying to explain them in terms of hydrogen production. Those that are scientifically trained realize that hydrogen cannot account for what is claimed, and thus the discussion groups on the web are engaged in vituperative argument. In a sense, both sides are right: hobbyists appear to be demonstrating energetic anomalies and hydrogen is not the source.

The hypothesis offered is that the single-duct electrolyzers are producing charged water gas clusters, which is the dominant energetic component instead of hydrogen. The electrolyzers that yield the largest energy anomalies appear to make more charged water clusters and less hydrogen. From the study of the disclosures by many inventors, the following characteristics seem to make favorable electrolyzers:

1. Clean, rough electrode surface
2. Small gap between the electrodes
3. Circulate or vibrate the water
4. Minimum electrolyte (typically potassium hydroxide or sodium hydroxide)
5. Driving electrolyzer with pulsed DC square waves
6. High voltage spike on the leading edge of the square wave
7. Recycling the exhaust water back to the electrolyzer

Turbulent water flow through narrow inter-electrode gaps appears to augment the energy content of the emitted gas.

### 3. Conclusion

Since hobbyists typically do not have the equipment to measure the constituents of the gas produced from their electrolyzers, the academic community can help resolve what is happening by an orderly research program. Since the one energetic anomaly that is well established is the vaporization of tungsten by the Brown’s gas welding torch, the first step is to confirm this. The second step is to analyze the content of Brown’s gas, and then use the appropriate techniques to produce the pure form of the charged water gas. Analyze the gas to show there is no hydrogen content, and then reconfirm that it still exhibits the welding torch anomalies. At this point the scientific community would have a pure energetic anomaly to study: a form of water that appears to “burn” with an extraordinary coherent energy content.

The second phase would be to investigate the energy content of the pure water gas. If it runs a generator, then the generator’s output power and the electrolyzer’s input power can be measured. If excess energy is measured, then a closed loop system can be attempted. If a closed loop system involving a (internal combustion engine) generator can idle for a significant time, then a new energy source would be demonstrated. At this point it would be valid for the academic community to consider the zero-point energy hypothesis as a possible explanation.

It is the author’s hope that the scientific community would be willing to engage in such a research program. It just might be that the HHO community has inadvertently discovered a surprisingly simple means to tap the zero-point energy.

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## Appendix A. Can the Zero-Point Energy Become an Energy Source?

Considering that the zero-point energy might be an energy source is an unusual hypothesis. Most of the scientific community outside of the field of physics, know little about it. The majority of the physics academic community would likely reject the hypothesis as too radical a paradigm shift [28]. However, experts in the field of zero-point energy research realize it is an open question [29, 30]

The zero-point energy of vacuum is comprised of fluctuations of intense electromagnetic field energy at the scale of the Planck length,  $10^{-33}$  cm. The Planck length is twenty orders of magnitude below the size of the elementary particles. The name “zero-point” refers to absolute zero degrees Kelvin meaning that the energy is integral to the pure “fabric” of space in the absence of light, heat and matter. Historically the energy was discovered at the birth of quantum mechanics where the modeling required an underlying jitter to all quantum mechanical systems. Dirac showed that the source of the jitter was electric field fluctuations inherent to the fabric of space itself, which could birth electron-positron pairs that spontaneously pop in and out of existence in our three dimensional space [31]. Wheeler’s theory of *Geometrodynamics* [32] showed that the huge energy densities would alter the space-time metric creating Planck size, black hole - white hole pairs that channel electric flux through microscopic channels he named “wormholes.” Wheeler’s theory implies that the source of the ZPE is effectively electric flux from higher dimensional space that orthogonally penetrates our 3-space brane. As the electric flux passes through our 3-space it produces a seething, chaotic turbulence called the “quantum foam,” which manifests behavior akin to turbulent plasma at the sub-quantum scale.

There is a tremendous energy density in the chaos of the quantum foam. Can it possibly be harvested as an energy source? At first the answer appears to be no because the fluctuations are chaotic and appear to be random in their behavior. However, in 1977 Prigogine [33, 34] won the Nobel Prize in chemistry for showing that under certain conditions, a system may evolve from chaos into self-organization. Three conditions are required for a chaotic system to exhibit self-organization: The system must be 1) nonlinear, 2) far from equilibrium, and 3) have an energy or matter flux through it.

A good example of self-organization would be vortex formation during hydrodynamic turbulence. Another example would be vortex or vortex ring pair production arising in turbulent plasma. Bostick [35] studied plasma vortex rings called “plasmoids” and noted that they tended to form in pairs of opposite helicity, which conserved angular momentum. Plasmoid pair production in turbulent plasma and electron-positron pair production arising in the quantum foam might both exhibit archetype self-organization, the creation of macroscopic order from an underlying microscopic collective. The archetype self-organization supports Nobel Laureate, Laughlin’s thesis [36], where he contends everything at its foundation arises from the self-organization of collectives including the laws of physics themselves. Collectives in the quantum foam are maintained by the orthogonal electric flux that passes through them, much like the flow of a stream maintains a whirlpool. Jennison [37] and Turtur [38] offer models involving this concept. Modeling elementary particles as collectives is dramatically different from modeling them as point entities or Planck length strings. Laughlin’s thesis involves a paradigm shift from today’s popular particle theories. Such a paradigm shift might be further supported if even larger, macroscopic collectives could be shown to exist.

### A.1 Can Macroscopic ZPE-Matter Collectives Exist?

The zero-point fluctuations intimately interact with all elementary particles via vacuum polarization. Quantum Electrodynamics describes a coherent cloud of vacuum energetic activity surrounding all particles that gradually declines with distance. There is no real separation of the particle from its vacuum polarized cloud [39]. In order to theoretically calculate the values for a particle’s observed mass and charge, a mathematical renormalization is used to subtract out the high frequency energetic fluctuations to yield the finite values experimentally observed.

The different elementary particles have different descriptions of their vacuum polarization [40]. Electrons, especially those in the conduction band of metals are described as a smeared charge cloud that is effectively in thermodynamic equilibrium with the vacuum fluctuations. No net energetic yield could arise from such a system, which explains why no energy anomalies are observed in standard electrical and electronic circuits. However, an atom's nuclei have steep lines of vacuum polarization converging onto it. This might offer the capability to induce coherence in the zero-point fluctuations by abrupt motion of the nuclei. Exotic coherent vacuum effects are observed in heavy ion collision experiments [41], but no researchers have attempted to measure excess energy anomalies. However, energetic anomalies are observed when a large number of nuclei abruptly surge in plasma experiments involving the ion-acoustic mode. The energetic anomalies include run-away electrons, high frequency voltage spikes, and excessive heating. The energetic anomalies are often observed in conjunction with the formation of vortices and plasmoids [42]. Here might be evidence for an organized collective involving plasma particles and ZPE coherence.

## Appendix B. Plasma Charge Clusters

Shoulders [12] has extensively studied micron size, plasmoid-like forms resembling microscopic ball lightning that exhibit excessive energy anomalies. He creates them from an abrupt discharge from a known capacitor at a known voltage through a sharp pointed electrode. In the abrupt discharge the microscopic tip of the electrode blows off yielding a pure unipolar discharge event, similar to exploding wire experiments. The plasmoid form travels along grooves on dielectrics, and when it contacts a metallic surface, it explodes emitting an electromagnetic pulse (EMP) and bores a crater into the target material. The measured EMP is greater than the input energy from the capacitor, and its ability to bore through high melting point ceramics like aluminum oxide convinced Shoulders that the entity contained excessive energy, and thus he named them “exotic vacuum objects” (EVO) to reflect his hypothesis that the excess energy was from coherently coupling the vacuum's zero-point energy into the plasmoid form.

Shoulders [23] speculates that he might be observing the fundamental mechanism by which the vacuum can manifest charge creation. The EVO typically manifests a charge of 100 billion electrons and contains about 100,000 ions. It manifests a charge to mass ratio ( $e/m$ ) the same as the electron. The ratio appeared even when Shoulders created positive EVO (a rare event), and this event proved that the EVO was not a simple collection of electrons (or positrons) because when the positive EVO decayed, it did not manifest 0.5 MEV gamma rays characteristic of electron-positron annihilation. Another unusual characteristic is that when on a dielectric, the EVO can sometimes stop emitting light and go dark. He has named these entities “black EVO,” and he can excite them back into the visible, light-emitting state with a small voltage pulse.

It was the detailed study of the boreholes in aluminum oxide that convinced Shoulders the EVO hold their energy in a coherent form, not as heat. The sloshing characteristic of the melt from the borehole implied that the EVO captured and entrained the liquid ceramic. It was as if the EVO directly disrupted the ceramic's atomic bonds to produce the liquid melt, and the unscarred ceramic next to the borehole showed that heat could not be the cause of the melt. This observation seems similar to the Brown's gas welding behavior.

Perhaps the biggest anomaly associated with EVO phenomena is transmutation of elements. Shoulders [17] analyzed the material in the crater of EVO strikes and discovered new elements that were neither in the cathode emitter or anode target material. Moreover, the new elements had unusual isotopic content not readily found in nature. Shoulders is not alone in this discovery. The Proton-21 Laboratory in the Ukraine [18] has conducted super nucleo-synthesis experiments where they strike very pure copper or tungsten targets with large plasmoids (~1 cm diameter), and likewise observe the creation of multiple new elements of unusual isotopic content. So far these results have been ignored by academia in the United States, but they are continuously studied in Russia [43]. If these experiments could be replicated and

confirmed in the U.S., the possibility for a new technology to alter and remediate radioactive waste might arise.

Shoulders [17] offers an easy protocol for generating a plasmoid like phenomena the manifests unusual energetic anomalies. He is willing to help any university seeking to replicate his research.