Cold Fusion in the Context of a Scientific Revolution in Physics: History and Economic Ramifications

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The cold fusion phenomena are several of a larger group of anomalies in physics. These anomalies are discerned because they are contradictions of the basic ideas of Q. M. and Relativity theory. The present development of the field of cold fusion and the elucidation of these anomalies are a part of a scientific revolution in the field of physics. This is not the first time the basic ideas of an established paradigm have been contradicted. There have been similar revolutions in the field of physics of the kind described by Thomas Kuhn every 80 years since 1506 when there was the beginning of the Copernican Revolution. Understanding cold fusion and the CF field in the broader historical context is helpful for understanding the development of the field and the significance of the phenomena technologically and economicly.

1 Introduction: Seven Paradigm Shifts

There have been 7 "crisis periods" and "paradigm shifts" in physics since 1500. Kuhn wrote about both of these features in his book. There was such a shift recently. The various kinds of phenomena now collectively termed "cold fusion" are a part of a "crisis period" in physics. In the *Structure of Scientific Revolutions*, Kuhn[1] described crisis periods as ten or twenty year periods of time during which the fundamental ideas of an established paradigm are challenged by the discovery of anomalies which are phenomena that contradict the hypotheses. The current revolution is following the pattern of the past revolutions that was described in his book.

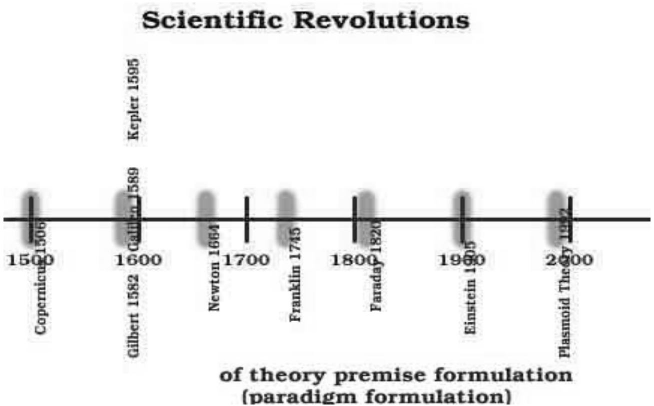

Figure 1. Chart of scientific revolutions in physics after 1500.

Scientific revolutions have occurred in an approximately 80 year periodicity since 1500. All the important theories in physics can be grouped according to the following 7 paradigms. The basic beliefs of the founders of the paradigm were more or less the basic ideas of their followers, though there were often small variations among their followers in basic assumptions. Some scientists such as Tycho Brahe and Priestley (b. 1733) stand out as having physical views that can be described as selective combinations of the hypotheses of two paradigms. In Priestley's case, for example, this was a combination of Faraday's and Newton's ideas

Since Copernicus was telling people that the Earth revolves around the Sun in 1506, he had to convince people by explaining why they all didn't just fall off the round Earth. He explained his own way of thinking which was that everything on the Earth had a proper position to which it strived – the people, the chairs. This striving was called Impetus. So that the reason a person came down to the Earth when he jumped up was because his body strove to go back to its proper position. Likewise for the planets; Copernicus thought that they also strove to maintain their positions. So his explanation for gravity was impetus.

Galileo, Kepler and Gilbert taught that the reason we and other things stick to the earth is because of magnetism. They thought that everything was magnetic and that the parts of the earth, the rocks and etc. stuck together magnetically. Gilbert in particular also emphasized that electricity had a role in the Earth's cohesion and in meteorological processes, but among the followers of this paradigm, gravity was mainly thought to be magnetism. In the 1590s, Kepler and Galileo corresponded and shared ideas, and about 1600, they wrote that they agreed with Gilbert's theory in his book.

Newton didn't believe this. He talked about a force that he called gravity. He thought that atoms had an intrinsic force called gravity that drew them together. This was his explanation for both the positions of the planets and for why people stuck to the Earth. So Galileo and others with that idea talked about one main magnetic force that kept everything together, and Newton and his followers talked of two forces, gravity and magnetism.

Franklin kept Newton's understanding of atoms and their force of gravity, but added the ideas that electricity was a fluid and that heat was a fluid and each of these fluids had certain intrinsic behaviors. So to the two forces discussed by Newton, Franklin added two new forces. A characteristic of these two forces was that they were conserved in systems, and this idea was important for the development of heat and electrical technology during the Industrial Revolution which followed a few decades later. He seems to have thought that magnetism was a fluid also, and Aepinus developed this idea.

Faraday didn't agree with Newton and Franklin that atoms were hard and compact, but thought that atoms were point atoms. A way to think about this is that he thought that forces around an atom had a point of highest intensity at the center of an atom. He thought of heat as the vibration or motion of atoms, and he thought of electricity and magnetism as being aspects of the lines of force from atoms. He tried to show that gravity could be explained in this way, but wasn't able to. He wanted to show the interconversion of the known forces, magnetism, electricity, and gravity, and of heat and motion, and of gravity. Maxwell followed up on his work by writing a mathematical theory of fields that was internally consistent. But again, he failed in the area of explaining gravity with these ideas. They had the notion that energy and mass were distinct things.

Einstein explained that the mass in atoms changed the time and space around atoms to make them fall together. This was his explanation for gravity. He thought that the entire mass of everything like atoms might convert to energy. This was different than Maxwell and Faraday. He also explained that light and other forms of energy was not just a wave phenomena, but was quantized, somewhat particle-like. But he also couldn't explain both gravity and the forces with the same general idea. Somewhere along the way, physicists postulated that the entire mass of atoms can't convert entirely to energy, but only a small fraction of the mass could do so. Einstein probably had to intuit this idea even though he believed that mass converts to energy, because atoms and his surroundings seemed stable, and there was no known example of atoms converting to energy in entirety.

A new paradigm that is being proposed takes all phenomena to be variations of the same basic thing: plasmoid. Galaxies, stars, atoms and particles are plasmoids of different sizes and kinds. Plasmoids have typical behavior. A broad class of plasmoids has been called ball lightning, and the existence of microscopic plasmoids points to the development of a new atomic physics, with the basic assumption that both atoms and atomic processes are plasmodal so that atoms may convert entirely to light or electricity given the right circumstances. Understanding matter this way helps to understand atomic and plasmoid object interactions. However, these assumptions must be tested and experiments done to elucidate plasmoid behaviors, especially concerning time and motion change associated with plasmoid behavior.

2 Broad Overview of the History of Physics' Periodicity

After Copernicus conceptualized both a new astronomy and a new physics explaining natural phenomena from a heliocentric standpoint in 1506, there have been revolutions in physics every 80 years: the Galilean, about 1593; the Newtonian, 1664; the Fluid paradigm about 1745 that was originally formulated by Franklin; the Classical Field theory, 1820 that was rudimentarily formulated by Faraday and developed by Maxwell; the Quantum Mechanics and Relativity theories, about 1905, and the Plasmoid theory, about 1992. From 1506 to now, physics developed in an 80-year, three-generation pattern.

In Generation 1 individuals formulate a paradigm's basic premise which is comprised of a handful of basic and simple hypotheses which are axioms for the theory. Later generations may reject or modify basic hypotheses, but the basic framework of theories of the same paradigm are recognizably similar. In Generation 2, people who were born about the time when the theory was formulated and learned about the anomalies and perhaps also about the founder's new theory while young continue the development of the theory to the point when it can be said that the theoretical development had matured. An example of this process is Schwinger, Tomonaga, and Freeman's development of QED when they matured in their scientific careers about 1945. They were born about 1905, when Einstein published his seminal papers. In Generation 3, people who grew up learning about the well developed theories as they were growing up invent important technologies that are applicable to experimental research and perform experiments that both support and contradict their own theories of physics. People in this generation also develop technology and invent products that enable industrial revolution. Theoretical formulators like Einstein usually do their basic paradigm formulation work when they are in their 20s. Franklin and Gilbert were older, but as Thomas Kuhn described they were relatively new to the field and inexperienced.

Copernicus was born in 1473 and while young he learned about the anomalies and the problems of the established physical theories of his time. In 1506, when he was 33, he started to circulate letters describing his heliocentric ideas. He described a general theory to explain the known phenomena of planetary motion, meteorological phenomena, lodestones and rubbed amber, and the fall of objects. The young people who accepted his ideas developed the Copernican paradigm in the two routes of astronomy and earth-based physics when they reached middle age (about 1546).

Some younger theorists, including Rheticus (b. 1514) and Reinhold (b. 1511), focused on studying Copernican astronomy. Both men were impressed by his ideas and contributed their best work in their 40s. Rheticus published *Narratio Prima*, which was about *De Revolutionibus*, in 1540 when he was 26. In 1551, when he was 40, Reinhold published a set of astronomical tables that were computed by the mathematical methods developed by Copernicus. By the early 1550s, other theoreticians of their generation developed much of the physics of earth motions of that paradigm. For example, Benedetti (b. 1530) developed a physics of motion on the earth and statics according to Copernican-type ideas. He published *Demonstratio* in 1554. So about 40 years after the inception of the Copernican paradigm, Copernican theory was well developed in its two major fields. Consistently, over the past 500 years, the time between formulation of the basic hypotheses of a premise and the general physics theory's development has been 40 years. About another 20 years is required before a crisis period begins, and then about another 20 before the time of the next theoretical formulation.

Men of the next generation performed the important experiments that tested the theory. Most of these men were Copernicans, though one of these men, Tycho Brahe (b. 1546), was not a Copernican. He espoused a theory that was a mixture of Copernican ideas and earlier ideas. His theory could be regarded as a mixture of two or more sets of postulates. Brahe used the tables that Reinhold published as a guide or template for testing Copernicus's theory to discern several important anomalies, such as the extra-lunar orbit of comets and the incorrect predictions about planetary motion. Simon Stevin (b. 1548) believed and taught Copernican theory and verified Benedetti's prediction that objects of the same substance but of different weights would fall at the same rate in vacuum. Sarpi (b. 1552), along with many others who in the late 1500s accepted Copernican ideas, believed that the earth was a magnet, based on their study of magnets and the discovery of the magnetic dip by Norman (date of birth unknown) as described in 1581 in *The New Attractive* and by Georg Hartmann (b. 1489). They understood that magnetism originated in the earth, that the earth drew objects, and that the reason for the orientation of compasses was not extraterrestrial. These ideas contradicted Copernicus's idea of impetus. There was thus a crisis period in physics during the late 1500s, extending from about 1575 to 1795.

In the late 1500s, Gilbert, Galileo, and Kepler formulated similar sets of hypotheses based on the experimental work of the preceding generation of experimenters. Galileo and Kepler were enthusiastic about Gilbert's theory when they read the De Magnete, which was published in 1600. Gilbert (b. 1544) formulated his premise in about 1582. In the preface to the De Magnete, Edmund Wright wrote that Gilbert had held back his magnetic philosophy for almost 18 years. Gilbert postulated what he called magnetic form and electrical effluvia.

In 1589, at age 25, Galileo (b. 1564) formulated his first postulates of motion. He laid a foundation of a physics of motion of that time, but Descartes and others completed this theory. Later, after a series of experiments, he believed that objects tended to remain in their state of motion. But initially, people who formulated this paradigm believed that objects had a tendency to rest.

Kepler (b. 1571) attended the University of Tubingen where Maestlin, who taught a theory similar to Copernicus's, taught and performed experiments. Around the year 1595, Kepler formulated a heliocentric theory for astronomy. Later, he understood that the planets follow elliptical orbits. There is evidence that he hypothesized that planets had a tendency to rest about 1604 or 1605[2]. He thought that objects on the earth had a tendency to rest as well. By 1600 he thought that the sun emanated a magnetic vigor that caused the planetary rotations. He idealized outside force, the tendency of bodies to rest, and fall as a magnetic phenomenon.

Those of the next generation who developed similar theories of this genre include Gassendi (b. 1592), Mersenne (b. 1588), Desargues (b. 1591), Descartes (b. 1596), Roberval (b. 1602), Etienne Pascal (b. 1588), Castelli (b. 1578), and Cavalieri (b. 1598). They defined gravity as magnetic effluvia or form, or electric effluvia, or as a vortex of particles. Descartes developed a highly influential philosophical physics that was nearly impossible to test and published his ideas in the early 1640s.

Experimenters of the next generation such as Torricelli (b. 1606), Boyle (b. 1627), Hooke (b. 1635), Von Guericke (b. 1602), and Blaise Pascal (b. 1623) found some important anomalies during the crisis period of 1640-1664. Von Guericke put Descartes' "plenist" theory, which denied the existence of the vacuum, to the test. He devised and constructed various models of pumps to produce a vacuum. The anomalies to the early paradigm that were discovered, such as the property of the vacuum and that sound did not travel through a vacuum, were important for Newton's formulation of new hypotheses about the nature of matter and motion.

Their contemporaries in the mid-1600s, such as Borelli (b. 1608) and Huygens (b. 1629), tried to comprehend the anomalies according to the older Galileo-Descartes paradigm that they already accepted, but it was Newton who formulated the set of postulates for the next paradigm. But the development of theories of this earlier genre did not end with Newton. In Continental Europe, scientists such as Leibniz, the Bernoullis, Euler, Nollet, and Dufay continued development of ideas based on theories similar to those of Galileo and Descartes. These theorists described gravity, electricity, and magnetism as vortices, the mechanical motion of tiny invisible objects, following Descrates. Most educated Continental Europeans accepted a theory of this genre until the mid-1700s, but the Newtonian paradigm was accepted mainly in Britain. There was a similar divergence in thinking in the mid-1800s among theoreticians in Britain and the Continent as is described in this article.

In 1664, at the age of 22, Newton (b. 1642) formulated the basic premise of his theory. He attempted to lay a uniform theoretical foundation for the whole of known phenomena. His work proved successful for mechanics and gravitation. After 1664, there followed a two-generation process that required about 80 years to complete. People of the next generation who developed the theories of the paradigm include Boerhaave (b. 1668), Hauksbee (b. 1666), Gravesande (b. 1688), Stephen Gray (b. 1666), and Desaguliers (b. 1683). When they reached middle age in the early 1700s, they taught others who verified predictions of Newtonian theory or found anomalies in this paradigm. Boerhaave was born in the Netherlands. He was born about the time that Newton first formulated his theory. He learned about the important experiments of Hooke and Boyle, and believed Newton's basic ideas. Like Newton, he thought that light was corpuscular and that the corpuscles of light were different sizes.

During the crisis period of 1725–1745, Martine (b. 1702), Van Musschenbroek (b. 1692), and Von Kleist (b. 1700) made discoveries of electrical and heat anomalies that led to Franklin's fundamental theoretical formulation. George Martine showed experimental anomalies of the Newtonian premise concerning heat. In 1745 and 1746, Von Kleist and Van Musschenbroek independently produced the anomalous Leyden jar to store electricity generated from Hauksbee-type machines. Some of the researchers were Newtonians and others accepted the earlier paradigm.

When he formulated is premise in the middle of the 1700s, Franklin (b. 1706) was among the oldest of the formulators of premises. He may have been as old as 39 years old when he formulated his theory. According to Constraint I described later, he was able to formulate a novel premise because he was inexperienced and had not apprehended an earlier general theory when he understood the anomalies. Kuhn wrote the same thing about Franklin in his book. Sometime about 1745, maybe even before he learned about the Leyden jar in 1745, Franklin originated novel hypotheses about what he called the "matter of heat" and the "matter of electricity." Before the year 1745, he conducted scientific research on heat and the effect of the sun on warming different color materials and also invented an efficient kind of furnace design that was called the Franklin stove that he wrote was 50 or 66% more efficient of firewood. Because of this earlier, innovative work on heat, it is uncertain when he had developed this general premise. The 4th paradigm was developed and contradicted by the next two generations.

The ideas about the particulate nature of the fluid of heat and about their mutual repulsion, tendency to reach equilibrium in matter, and the permeability of matter to this fluid is the basic caloric theory that Lavoisier, Cleghorn, and other scientists of the second generation espoused. Caloric is the French term for the fluid of heat. He postulated that atoms had an affinity for the particles of heat. The ideas in his description of the basic chemistry involved in the evaporation of salt-water were the basis for caloric chemistry. Franklin's ideas on the indestructibility of the particles of electricity and heat meant that these fluids were conserved in systems, which is the basis for the conception of latent and specific heats. The properties of these hypothetical fluids to flow and to reach equilibrium in bodies are the basic ideas behind the innovations in steam engine technology by Watt and others, and some writers like Cardwell have emphasized how the caloric theory of heat was very different in basic concepts from Boerhaave's theory of heat.

Aepinus (b. 1724) was among the first of the 2nd generation physicists to help develop the paradigm to its full form. He began the theoretical development work of describing the new theory mathematically near the time of his middle-age. In this work he proposed primarily a theory of magnetism that held postulates very similar to the postulates of Franklin's electrical theory. In fact, he listed his postulates one by one and showed how each one matched a postulate of Franklin's premise. Coulomb (b. 1736), LaPlace (b. 1749), Hauy (b. 1743), Lavoisier, and many other French people who apprehended a theory similar to Franklin's began to perform electrical, magnetic, chemical and heat experiments and develop the premise of the paradigm further.

Gay-Lussac, Biot (b. 1774), Carnot, Ampere (b. 1775), Savant (b. 1791), Arago (b. 1786), Berthollet, Poisson (b. 1781), and Fourier (b. 1768) were among the scientists of the 3rd generation who accepted and extended the new paradigm. Thomas Young verified Franklin's description of light as a wave during the period 1801-1804. When the third generation scientists learned about the electromagnetic effect and Faraday's experiments, they began to change their physics of fluids to fit the evidence.

Meanwhile, others of their generation, notably Davy (b. 1778), Thompson (b. 1753), and Oersted began to discover major anomalies in the crisis period that started about 1800 and lasted until about 1820. Davy hypothesized that atoms were point atoms. Both Davy and Benjamin Thompson hypothesized that a body's heat was due to the motion of its particles and tested this idea experimentally. Then in 1820, Oersted (b. 1777) startled the world by discovering the electromagnetic effect. Scientists had sought for a relationship for decades.

Davy and Thompson formed the Royal Institution where Faraday was hired and worked for Davy when he was very young. There they taught their new hypotheses about point atoms and heat to Faraday. When in 1820 he learned about the electromagnetic effect, he understood both electricity and magnetism as properties of an idealized kind of phenomena he called lines of force, understood atoms as point-atoms, and heat as the motion of the point-atoms. He formulated the basic postulates of his theory in 1820. His new understanding enabled him to invent two of the important technologies of the 19th and 20th century, the electric motor and the electric generator. He wrote the fundamental laws of electrochemistry. As he experimented with metals according to his theory of point atoms, he invented several types of industrially important steel alloys, and laid the basis of scientific metallurgy. His new conception enabled him to conceive how forces propagate and how material is organized, so that he could conceive and produce electromagnetic devices, invent important industrial steel alloys, chemicals, organic chemicals such as benzene, and several kinds of glass.

People who accepted his theory when they were young included Maxwell and perhaps Thomson (b. 1824). Maxwell developed the Field theory when he matured, about 1864, 44 years after the initial formulation by Faraday. Because of Limitation 2, the theorists did not test their theories by themselves or develop most of their new inventions to the point that they started important industries. The men and women of the third generation started to introduce the economically important new inventions and to discover major anomalies around 1880. Some of them were Curie, Alexander Bell, Thomas Edison, Lenard, Thomson, and Michelson.

In 1905, Einstein laid the basis for both the theories of Quantum Mechanics (QM) and Relativity. His basic framework of hypotheses included the concept of quanta of energy; mass-energy equivalence; his concepts on time, space, gravity, mass, and inertia; and other basic concepts of early 20th century physics. Einstein is recognized as being the first to think of quanta of radiation as something real, not just a mathematically useful construct.

Because of Limitation 1 described later, those of the next generation developed his ideas when they were in their 30s and 40s. Some of these people were Bohr (b. 1885), de Broglie (b. 1892), Dirac (b. 1902), Heisenberg (b. 1901), Pauli (b. 1900), and Schrodinger (b. 1887). Schrodinger and de Broglie developed a premise for physics that differed from that premise developed by those of the Heisenberg school. QM was almost fully developed in 1948 through the work of Tomonaga (b. 1906), Schwinger (b. 1918), and other physicists who developed QED theory. Because of Limitation 2, the theoreticians who developed the theories could not produce new industries and economically important inventions or disprove their own theories by experimentally finding major anomalies.

It was mainly middle-aged experimenters born about the time of the development of the paradigm in the 1940s who validated important experimental predictions and ideas of the Einstein paradigm and contradicted it. During the crisis period of the 1970s and 1980s, they used newly invented technologies based on QM theory such as atomic clocks, lasers, and various types of electronic microscopes.

In conclusion, it seems that in the history of science we may find these general principles that were described by Kuhn: 1) That scientists who accept a general paradigm never become fluently functional in developing a new paradigm and 2) that the best experimental physicists who find major anomalies are not in the forefront of the theoretical development of a paradigm. A theory can be constructed using these that the development of a paradigm in physics is a three-generation process working through two constraints.

3 General History of the Recent Crisis Period

Since the 1970s, experimental physicists who work according to quantum mechanics have been discovering anomalies to quantum mechanics. There are ball lightning, cavitation and sonoluminescence phenomena, water memory, superconductivity, and astrophysical anomalies. Some of the leaders of this research have been Andre Lipson (b. 1956), Pons and Fleischmann, Matsumoto, Ken Shoulders, and Deryaguin. Atoms show anomalous changeability and motion. They show the anomalous ability to not only fuse and break up at slight changes in condition, but also anomalous relative motion, so that atoms in solids move around as if they are transparent to each other or as if they are a fluid or a gas. What is happening is that the atoms change state from we has been regarded as their normal stable state in a solid or fluid or gas, and behave like BL. This is why atoms may pass through each other and move around as if in fluid flow.

In 1992, it was apparent that BL-like objects were emitted from CF experiments. It was hypothesized that materials converted to microscopic BL in electrodes used for CF research and that these caused the markings the plastic sheets found by Matsumoto. Matsumoto read this idea, and started researching the relationship between BL and CF. In 1992, the structure of BL was speculated to be an example of the structure of atoms, and research was begun to determine whether all phenomena including astrophysical and meteorological phenomena are the same thing, called “plasmoids,” the term used by Winston Bostick. It was determined that tornadoes and ball lighting can be identified as kinds of the same basic phenomena, and this supported the assumption that weather could be described in terms of plasmoid behavior. In 1996, while performing microscopic investigation of Miley’s Run #8, a researcher found marking like those of microscopic

BL. The "strange" radiations reported by Urutskoev leave markings on detectors much like the BL reported by Matsumoto. These objects can be classified as a kind of microscopic BL. In nature, BL and whirlwinds may leave ditches or areas of discoloration on the ground.

A series of international BL conferences started in 1986. Egely researched the excess energy and anomalies properties of natural BL. Dijhkuis researched radioactivity and particle emission from BL, and conducted experiments on BL-like discharge objects. Egon Bach's *UFO's from the Volcanoes* provides evidence of BL generation during geological process. In the late 1990s, the BL and CF fields merged in Russia. At the last international conference on BL in St. Louis in 2001, George Miley and Dan Chicea sent abstracts, and microscopic BL in CF was a scheduled topic of discussion and lecture.

In 1983, Lipson suspected the acceleration of deuterons by the electric fields in cracks generated by the fracture of deuterated dielectric crystals such as LiD. He published about this in 1986 in the journal *Soviet Physics Technical Physics*. According to Lipson[3] this work followed the discovery of X-ray emission during mechanical fracture, which followed Deryaguin's discovery of fast electron emission from fractured solids in 1953. In the early 1990s, Lipson began research on neutron emission from HTSCs, and discovered the effect that the superconducting phase transition coincided with neutron emission. In 1996 he suspected that palladium and other materials may contain cores with high hydrogen density and superconducting properties even at high temperatures, and CF reactions due to high energy phonons and phase transitions.

Both HTSC work and CF started about the same time, so both Celani and Lipson and his group were prepared to start research on the relationship simulteanously. Mueller (b. 1927, same as Fleischmann) and Bednorz (b. 1950) discovered superconductivity of 33 K in a layered, ceramic material. Recently, working with Carlos Castano and others working with George Miley, Lipson has shown that a hydrogen cycled PdH_x ($x \cong 4.0 \times 10^{-4}$) single crystal showed evidence of superconductivity below 30 K. They suspect finding minute amounts of the diamagnetic phase of condensed hydrogen or superstoichiometric hydride ($x >> 1$) inside the dislocation nanotubes, a quasi-metallic metastable hydrogen phase at room temperature, like that predicted recently by Ashcroft. By using small-angle neutron scattering (SANS), Heuser discovered that dislocation cores caused by H2 gas cycling Pd films are sites of high hydrogen absorption and concentration. The two fields are merging.

Fleischmann (b. 1927) and Pons (b. 1943) began research on the fusion of atoms in metal electrodes in 1986. They had known about prior research in this area dating from early in the century such as the work of Bridgman in the 1930s, and Fleischmann followed up on certain anomalous phenomena he had observed in the course of this research as an experimental chemist.

In the 1960s, Deryaguin (b. 1902) and others started a controversy about the strange properties of water. They said that water had polymer-like qualities, and used the word "Polywater." He claimed this water had been discovered by another Soviet scientist, N. N. Fedyakin. Much like CF, most scientists around the world did not accept the existence of this anomaly. But lately, like CF, the subject is again gaining in general popularity, as shown by Josephson's recent lectures. Lipson studied the association of cavitation and cold fusion in the early 1990s.

In the 1950s, Winston Bostick researched plasmoids that were emitted from electrodes during discharge. He wrote important and widely read articles on this topic, such as the article call "Plasmoids" that was published in *Scientific American*[4]. Some astronomers adopted this way of looking at the universe and researched the astrophysical objects as plasmoids. It was known early on that electrical discharges to produce plasmoids were associated with a low level of deuterium fusion reactions, and in the 1960s this topic and the topic of exploding wires in general were studied by researchers for the militaries of the US and USSR.

Ken Shoulders studied the plasmoids and determined a number of anomalous phenomena associated with them, such as their high energy density, life-span, method of production, and their effects in interaction with materials. Shoulders wrote that he and Bostick had a working relationship, and that he (Shoulders) determined that plasmoids contain smaller things he called by various names such as EVs, NEVs and charged clusters. The objects behave like BL in many ways.

It is evident that there is no longer a reason to think of matter and energy in terms of nuclei bound together in the center of atoms, since it is obvious that BL-like phenomena are compact and like matter in many ways, and yet may convert entirely to electricity and light, as far as it is known. The microscopic BL produced by Matsumoto passed through materials to reach the plastic sheets, as did those produced by Savvatimova. At the basic level of analysis, the structure of plasmoids may be thought of as energy, since some BL converts entirely to electricity and light. This paradigm is unlike Q.M. that describes that certain basic particles are basically inert, "hadrons," and gravity and light by distinct hypotheses. What needs to be researched further is the relationship between the presence of BL-like plasmoids and atomic reactions and time.

4 Paradigm Change and Economic Results

Paradigm changes in physics have led to similar patterns of productivity growth, industrial revolutions, and economic depressions. The productivity grew at an 80 year periodicity in the most advanced industrial economies, with productivity growth lows during the industrial revolutions and productivity growth increasing (accelerating) the fastest about 30 years after the dips in the 1820s and 1830s and the 1920s and the 1930s. During these “technological acceleration” times there were major economic depressions in the most technologically advanced economies, and another depression would be expected in the next few years if the past pattern holds. During the industrial revolutions, there were less severe depressions or recessions in the most advanced economies. The past pattern helps us to understand how the new science will impact technology and economics.

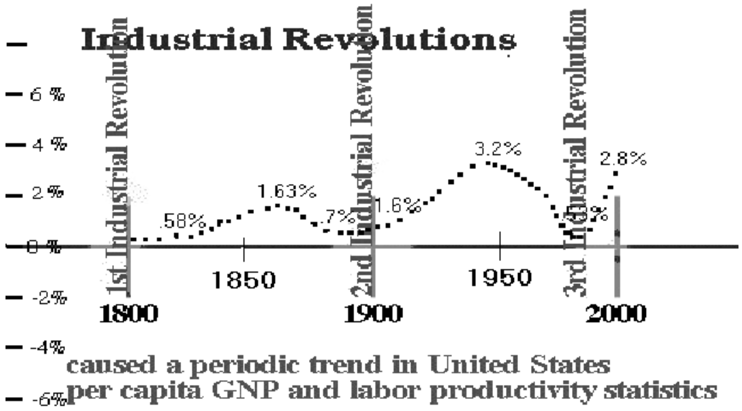

Figure 2: The three industrial revolutions resulted in an 80-year periodicity of productivity growth in the United States. Growth dips happened around 1800, 1895, and 1975. Growth accelerations started in 1830, 1920, and 2000. The growth accelerations were associated with technological acceleration depressions. The growth dips were associated with industrial revolution depressions. Statistics for this chart come from Paul Romer[56] and estimates for productivity growth after 1980. Paul Romer’s chart in the working paper shows a gradually increasing trend of per capita GDP from 1800 onwards until after 1830.

Recently published statistics on the productivity acceleration in Britain show that at the beginning of the 1st Industrial Revolution, 1760-1830, output per capita grew .5% per year on average[7]. By comparison, per capita output increased at an average rate of nearly 2% per year from 1830-1870. As Crafts wrote[8], the acceleration of growth of output in Britain from the late 1700s until about 1820 was a gradual process. But in the 1820s and afterwards, Britain achieved growth in real output of 2% per year. Romer’s graphs showed a jump in American productivity starting about 1840, rapid acceleration around 1850, and a dip lasting from about 1890 to 1905.

Jesus willing, once a generation of researchers who are now teenagers who were born sometime about 1992 reach their middle age, the most productive time of their careers, they will help to complete the development of the new paradigm. This would be sometime about 2032. By then, there may be practical and profitable manufacture of plasmoid-type equipment. It isn’t possible to know when most scientists will accept the plasmoid theory. But if the past pattern continues, it will not be until the third generation of people who accept the new paradigm matures sometime about 2052 that the important industries of the paradigm will begin. The maturation of experimental scientists and the availability of technology designed according to the principles of the new paradigm will lead to the discovery of basic anomalies to the theory; and around 2072, when a young or inexperienced person might understand the anomalies in a new way, there will be the 8th scientific revolution, Jesus willing.

If the past pattern plays out, there may be an industrial revolution depression about 2062 because of the combined effects of the depletion of the technological potential of the Q.M. paradigm, the small size of the highly productive Plasmoid theory industries, trade competition against the most advanced economies due to the trade competition from follower countries that will have the chance to catch up because of the lack of innovation in the mature industries, and the transfer of labor and resources from the old to the new industries. All of these played a role in the depressionary periods in the advanced economies in 1900 and 1980.

There may be another depression associated with this new science about 2102. During the times of technological acceleration in the dominant industries of advanced economies, there have been severe depressionary periods. In Great Britain, this depressionary period lasted about 20 years or so, from about the late 1820s to 1844. Since the U.S. was catching up technologically, the depression was less severe, and much shorter, and happened mainly during the 1840s. However, when the U.S. was technological leader during the 1930s, there was an 11 or 12 year long depression period that only ended with American entry into the world war. By comparison, Britain’s depressionary period in the 1930s was less severe, because it was the technological follower in that paradigm.

In *Technological Acceleration and the Great Depression*, Waters[9] explained how the increase of the rate of technical progress from 1% per year to 2% per year during the 1920s, figures he obtained from widely accepted prior research, led to the conditions of the 1920s and the 1930s of high investment and high and increasing business and consumer debt, and the shift to higher consumption due to the availability of new products. He thought that the connection between productivity growth and the Great Depression was mainly the financial consequences of what he called a "technological acceleration”. But the labor displacement and unemployment due to automation and the labor efficiencies arising from the establishment of oligopolies in each of the industries probably played the major role. This drop in labor employment meant a shift in consumption and non-payment of debt. The decrease of introduction of new kinds of products in the late 1920s and the 1930s meant a decrease in consumption as well, since once people had acquired the standard products of the times, such as automobiles or radios, they had satiated their demand somewhat.

5 Conclusion

The past pattern of history shows that the fields of cold fusion is a part of a scientific revolution in physics, and that most of the major inventions of this paradigm may only happen after about 40 more years, and the IR may be associated with an economic depression. The theory of this paradigm may be well developed about 2032 when the younger generation of theorists mature. The “technological acceleration” periods and the industrial revolution periods have been the economic depressionary troughs in the most advanced economies. The pattern of scientific and industrial revolution is the cause of the Kondratiev pattern of economic depressions. During the last few years, the fields of cold fusion, superconductivity, ball lightning, and cavitation have been merging. Simple hypotheses for a new paradigm have been formulated, but there is a need for tests and the experimental determination of relationships.

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