Warm Fusion research and development project

WHITE PAPER

A brief history of Deuterium fusion research and its relation to the commonly-overlooked Fifth Force of Nature, the Quantum Force.

Executive Summary

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The well-understood but often-overlooked Fifth Force of Nature, the Quantum force, is proposed to be utilized to bring about Deuterium fusion under mild ambient conditions with very little supporting infrastructure needed.

There is no radioactive waste generated; the output of the process is heat, at a magnitude appropriate for heating residential or industrial hot water, or homes or commercial buildings. The need to use fossil fuel or the power grid to do this could be vastly reduced, leaving those energy sources free for more appropriate uses.

The process is controlled by an external input, which dials-up the reaction-rate from zero to whatever-is-needed, within the scale of design of a unit. Heat is only generated when needed. The process is fail-safe; if it were to attempt to go out-of-control, it is self-extinguishing by its inherent nature.

A single charge of a few liters of gaseous Deuterium could provide hot water for a house for decades.

There is enough Deuterium in all the oceans of the world to provide for a significant portion of the energy needs of Mankind for the indefinite future.

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BACKGROUND

There are commonly considered to be four forces in Nature: The Gravitational force, the Electromagnetic force, the Nuclear Weak force and the Nuclear Strong force. These vary in strength over a range of forty orders of magnitude. The Nuclear Strong force has only the range of an atomic nucleus; the Nuclear Weak force may have only the range of a small atom, but the Electromagnetic force never entirely dies-off. As for the Gravitational force, well, that's what holds a planet to a sun, a sun to a galaxy and a universe together.

Man had immediate use for the Gravitational force early-on but was unaware of the others. One day in the sixteen-hundreds Isaac Newton tells of seeing apple fall, and that got him thinking about Gravity. Newton's laws of motion and their relation to the Gravitational force were a fundamental advance in human knowledge. Once a basic principle was observed and understood, Man could make use of it and could build the tools with which to apply it.

THE FIFTH FORCE OF NATURE
The Quantum Force

There is actually a fifth force in nature, but its discovery awaited the development of the physical and mathematical tools of a more advanced civilization. Even so, it was not widely recognized as a fifth fundamental force. We will call it the Quantum force for sake of easy conversation. It includes both an attractive and a repulsive component.

Early efforts to describe mathematically how hot things radiate energy, using the (classical) tools of mathematical physics then available, gave impossible results in that the predicted behavior of a hot object was completely different from what was experimentally observed. About a hundred years ago, a mathematical physicist, Werner Heisenberg, found that if one assumed energy came in discrete units (called quanta) instead of as a homogeneous sea or continuum of energy, a theory could be formulated that agreed exactly with what was experimentally observed, and correctly predicted the results of future experiments.

This was the beginning of the Quantum Theory of matter, and of the understanding of the dual nature of matter. Sometimes a particle behaves as a wave and sometimes a wave behaves as a particle. An appropriate experiment allows either to manifest as the other. Many experiments by many people over more than a century have confirmed this dual nature of matter.

Particles actually have a "wavelength", called the de Broglie wavelength. It depends on the mass and the velocity of the particle. A particle behaving as a wave is described by its "wave function", which is basically the probability of the particle being-somewhere at-some-time. Think of it as a measure of the space over which its presence extends for some time. When the wave functions of two or more particles overlap to a degree, there is an increased probability of an interaction occurring. If the particles happen to both be Bosons, there is an increased probability of their being in the same quantum state, in some form of "togetherness" which in the case of Deuterons can include fusion.

Within these understandings, it has been found that there are two different sets of rules that particles obey. These rules are called Statistics and describe the probability of two or more particles finding themselves in the same exact location and condition. These are the two faces of the Quantum force; one is repulsive and one is attractive.

The Repelling Quantum force

The repulsive half of the theory was published in 1926 by Enrico Fermi and Paul Dirac. It gave the mathematical basis for electrons and other members of this class of particles, which they called Fermions. All Fermions want to be in different quantum states, meaning no-two-in-exactly-the-same-location-and-orientation (quantum state); this behavior was given the name, The Pauli Exclusion Principle. If they find themselves on the same atom at the same orbital energy level, two electrons will seek to have their spins opposite (one “North” pole pointing up and the other with its “North” pole pointing down). A third electron is excluded from that exact orbital energy level and is forced to go to a higher unoccupied energy level.

The entire structure of atoms and the chemical properties of all the elements are due entirely to the fact that electrons are Fermions and all maintain themselves in different quantum states within each atom.

Mankind had a great deal of interest in this area because making different chemical compounds and purifying both elements and their compounds had a great deal of utility. Thus, this area received a great deal of study.

While the mutually-repulsive force of Fermions received much attention, the second half of the Quantum force, the attractive force, had little apparent utility and so received little attention as our modern civilization developed…with one notable exception.

The Attracting Quantum force

In the early twentieth century two physicists, Satyendra Bose and Albert Einstein, published the mathematical basis of a different class of particles which they called Bosons. These have exactly the opposite behavior of Fermions, in that Bosons all want to be in the SAME quantum state; they all want to be together—to achieve oneness or as close as possible. This interesting behavior extends to waves as well as particles, includes electromagnetic radiation (light) and ***because photons are Bosons, is the reason that a laser works***: Stored energy is released as first, one photon, then a second with its natural affinity for its fellow falling in beside it in lock-step, then more irresistibly joining in-phase and we have coherent radiation of photons manifesting as if a single photon of the energy-in-unison of all the photons together. This is an example of the Attractive-force component of the Quantum force.

Lasers are in-use everywhere, yet there is a lack of common apparent examples of the Attractive aspect of the Quantum force in nature, thus it attracts little attention, having no seeming other utility.

We only see the example of Fermions in individual quantum states within a single atom and so it is temping to assume that the range of either Quantum force is only on an atomic scale. This is not the case; the Quantum force for at least Bosons can extend much further, to interatomic distances. It is a question of how much time particles may spend at some distance from each other.

A brief history of hydrogen fusion research

The history of hydrogen fusion research extends back many decades. Initially researchers sought to mimic the hot conditions of a sun, to bring about fusion on a (physically large) laboratory scale. This used ionized gas, so hot that the electrons and the nuclei of atoms were broken apart into a mixture, called a Plasma. Such work continues to this day but is difficult, as the positively-charged Deuterons naturally repel each other and are moving so fast that their wave-functions become very small and have very little opportunity for overlap, thus for fusion to occur. This kind of experiment gives essentially no opportunity for the Quantum force to manifest. Fusion has occurred in these experiments but not on a practical scale, despite the billions of dollars spent over seventy years by mainly American and Russian researchers.

The original "Cold Fusion" experiment actually worked. It took place at the Berkeley Radiation Laboratory "The Hill" in the fifties. At that time discoveries of nuclear physics were released immediately in mimeographed form, blue-ink-on-white-paper as those of us with long memories may recall. The ink faded after a few decades, but was adequate for hot-off-the-press scientific reporting. One copy of the report of the first cold-fusion event was obtained by an adolescent teenager fascinated by nuclear physics, Steve Smith, wandering around the various laboratory buildings on The Hill and acquiring information about such new discoveries as-they-happened.

At that time there was a liquid-Deuterium bubble-chamber in operation, a research tool that allowed study of the decay of pi mesons produced by high-energy nuclear accelerators. In one instance a negative pi meson (mass about 279 times that of an electron) was seen to decay into a negative mu meson (mass about 200 times the mass of an electron); the mu meson in turn decayed into an electron, but in this case, in its brief lifetime of only about two microseconds, kicked an electron away from its residence-in-orbit around a Deuterium nucleus, and took the place of the electron. The mu meson, with 200 times the mass of the electron, fell into an orbital radius 200 times smaller. The mu-mesic atom (as it is called) could now get much closer to another Deuteron. In other words, their de Broglie wave functions now had much greater overlap, and in the brief lifetime of the muon there was enough of a probability of the two Bosons becoming one.

A fusion reaction between two Deuterons was observed and documented.

This is the classic example of the Attracting quantum force that we propose to further study and harness for commercial use.

A “Cold Fusion” experiment was attempted in the nineties by two electrochemists, Pons and Fleishman, who proposed to compress Deuterium into palladium wires in an electrolytic cell. Unfortunately, their well-intentioned experiment had two fatal flaws, both due to their lack of familiarity with the broader fields of physics. Their geometry was not viable for the events they sought to create, and the experimental conditions did not allow for any overlap of the wave functions of the Deuterons, thus fusion reactions could not occur and their few claimed “events” were not reproducible. We believe that feasible adjustments to the experimental conditions t would allow attaining the results sought by Pons and Fleishman, but with a set-up that could be scaled.

Proposed area of study

The scale on which we propose to study this force and the interactions between Deuterons is not at the expensive-to-realize temperatures of liquid Hydrogen or Deuterium, hundreds of degrees below zero, nor at the expensive-to-realize temperature of hot plasma, millions of degrees, but in the practical range of ambient conditions. The geometry of our contemplated experiments is not what has been used in the past by the fusion experiments that did not work, but rather based on what-does-work for such nuclear reactions as understood in the broader field of physics. In addition to having a viable geometry, we propose to manipulate experimental conditions so as to take advantage of the Quantum force, which has never before been done, simply because (we believe) everyone has just been looking in the other direction. Our method of doing this is to use the basic definition of the wave-nature of the Deuteron particle, and manipulate the experimental conditions so as bring about a useful probability-of-overlap of their wave functions, thus resulting in fusion on small and easily controllable scale. Experimental configuration details are considered proprietary.

Theoretical

Theoretical calculations can be done, to estimate the probability of fusion for two Deuterons being a distance apart for a time, in various experimental circumstances. This may be a very small number statistically, but only a very small number is needed. The theoretical work can guide the sequence of experimental design. In turn, experiments along planned lines can give results that are amenable to further theoretical analyses, thus guiding the overall work-plan towards a successful attainment of the goal.

Exemplary calculations

One gram of D-D fusion releases 10exp 12 joules. The goal is some few hundred to few thousand joules per second over many years. There are just-about 3 x 10exp7 seconds in a year. For example, heating water at 1KW (that's one joule/second) with 3.x 10exp7 seconds/year, requires 3 x 10exp10 joules.

One gram of DD reacting by fusion thus would give 30KW for a year, or 1 KW for 30 years.

By comparison, a 30-gallon water heater would produce hot water (about 70C/150F) with 1KW of energy input in about four hours.

Contract management and related matters

Steve Smith, has performed successfully on past similar Government contracts, most recently for the Missile Defense Agency on HQ-0006-10C-7024. He has a DCAA-approved accounting system in-place and has fully satisfied all DCAA audits.

Funding requirements

The proof-of-principle work may be accomplished in a 24-36 month time frame, with a budget that may be discussed with interested parties having the means to commercialize the technology once demonstrated.

Biographical information

STEVE SMITH, President and Chief Scientist, Whisker-Tough Development and of Smith and Co, Richmond, CA

CURRENT POSITION: Since 1972, Steve Smith has been president and Chief Scientist of Smith and Co. The company currently operates in a 20,000 square foot facility, and manufactures its own specialty epoxies and polyurethanes that are sold internationally for applications in the marine and construction industry. In 2005, Steve and his company were recruited by Bill Rollins (Raytheon Missile Systems) and Charlie

Minter (Navy Best Manufacturing Center of Excellence) to be the principal investigator for a new coating technology to be called Whisker-Tough. This eventually led to a series of government SBIR (Small Business Innovation Research) contracts from the Missile Defense Agency. This $2M effort spanned 10 years, and resulted in the creation of another company, Whisker-Tough Development. It was created with an accounting system to meet the requirements of the Defense Contract Audit Agency, which governs all federal contracts for the Department of Defense. As an SBIR development project, all technology is owned by the Small Business: **Steve Smith, dba Whisker-Tough Development**. This work has involved sub-contracts to two different aerospace companies, plus consultants who are Subject-Matter-Experts in their field (retirees from Raytheon and Boeing), plus Subject-Matter-Experts from the University of California, University of Arizona, and Auburn University.

EDUCATION and PAST EXPERIENCE - Steve Smith received both a BA and Masters in Physics from San Francisco State University. His graduate work included research in plasma physics and related areas. Steve worked as Chief Engineer at Pacific Instrument Company (a manufacturer of custom transformers and inductors for the Aerospace industry). and then later at Space Microwave Laboratories, being involved with power supplies for high-power microwave tubes such as are used in Defense systems. He published one book and numerous papers in this area During this time period he became involved with the special adhesives and encapsulants used in such designs. In 1972, he started Smith and Co. to provide high quality adhesives, sealants, and coatings to the marine industry. At the same time he worked as a consultant to Fairchild Semiconductor and other aerospace companies, until 1987 when Smith and Co. became his sole focus. Steve Smith has eleven patents. Prior to starting the development of the Whisker-Tough™ Conformal Coating in 2006, Steve had developed and manufactured his own line of 29 proprietary coatings and adhesives, most of which are based on polyurethanes and epoxies. These are marketed internationally, and are privately labeled for a number of distributors.

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