Entropy Driven Absolute Negative Pressure Systems for the Future of Electric Power

Daniel Deeks
The Clean Energy Solution
Sea Cliff, NY USA
ddeeks@optonline.net

Abstract— The world around us contains an abundant supply of ambient heat with the average temperature of our planet being approximately 289K. Since the age of Hero of Alexandria, we have relied on use of absolute positive pressure, that is $\delta S/\delta V > 0$, (where S is entropy and V is volume) systems to power our societies. Absolute positive pressure systems, whether Carnot or Sterling are energy dissipative systems which can't efficiently extract heat energy.

The key is not to extract this heat (Bose energy) but to directly convert/transfer it at cryogenic temperatures to a magnetic field and usable DC electric current (Fermi Energy), using absolute negative pressure systems (i.e., $\delta S/\delta V < 0$). These are entropy driven energy collective systems which transfer vast quantities of Bose energy to Fermi energy. The transmission of resultant Fermi Energy across the cryogenic to ambient temperature gradient does not incur the loss normally associated with the transmission of Bose energy across the same temperature gradient. Further, because of the vast quantities of Bose to Fermi energy conversion that occurs, these systems are self sustaining at their cryogenic operating temperatures. This paper will discuss the physical and scientific principles, and associated engineering and technologies of absolute negative pressure systems that could be used and developed to provide new sources of energy.

Keywords—bubble, cavitation, negative pressure, energy source, magnetostriction, metastability, Bose, Fermi, energy transfer

I. The Future Of Electric Power - Metastability

A physical body experiencing absolute negative pressure spontaneously contracts in volume to maintain or increase its entropy. But a physical body can only contract so much, this demonstrating that the processes we are discussing are metastable processes. Metastable processes are only stable within limited bounds[1], [2].

The processes that we are investigating are macroscopic metastable quantum systems / processes, in which the decay time is continually being reset [2]. These system processes will be discussed at a high level only in this paper. References cited include a thorough and complete treatment of the topics and concepts discussed herein. The first processes that we shall investigate is Sonoluminescence (SL), i.e., the emission of light via cavitation.

II. Sonoluminescence (SL)

This cavitation may be caused by heat (heating element or focused laser), or motion induced. The transmission of heat occurs as a longitudinal wave (i.e., phonon) through a medium and the temperature of the medium can be thought of as standing waves (oscillation) within the medium, as shown in Figures 1a and 1b.

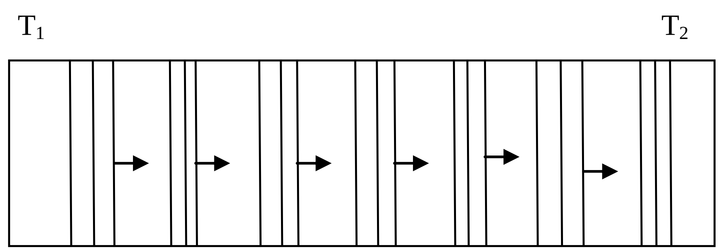


Figure 1a. The transmission of heat in a medium from temperature T_1 to T_2, where $T_1 > T_2$.

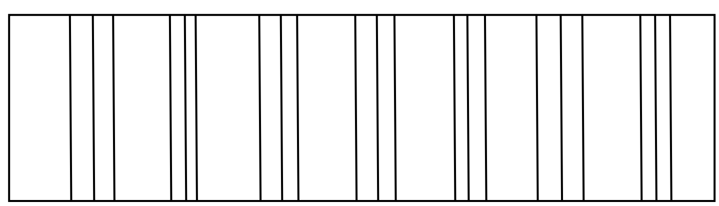


Figure 1b. The medium at a temperature T, the heat thought of as standing wave oscillations.

These longitudinal heat waves or phonons can be treated as sound waves, hence the sono in sonoluminescence. When a bubble (cavity) forms and expands in water (or

This research was sponsored by Daniel H. Deeks

a media with sufficient surface tension), the expansion velocity of this gas bubble is normally held in check by the externally applied hydraulic pressure of the media and the bubble expands with normal positive pressure, as shown in Figure 2.

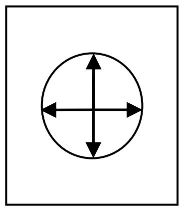


Figure 2. Bubble expansion under normal positive pressure

Under specific and bounded conditions, the velocity of expansion is not held in check by the externally applied hydraulic pressure, and the bubble expands so rapidly that the momentum causes a bubble expansion pressure that temporarily exceeds the internal gas pressure of the bubble and the externally applied hydraulic pressure of the media. This expansion of the bubble should be viewed as a sponateous contraction of the media that the bubble is contained in, i.e.,the media is under an absolute negative pressure~~.~~ As seen in Figure 3. For this media, $\delta S/\delta V < 0$, where S is entropy and V is the volume of the media.

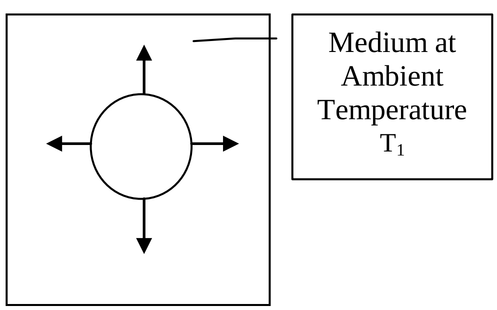
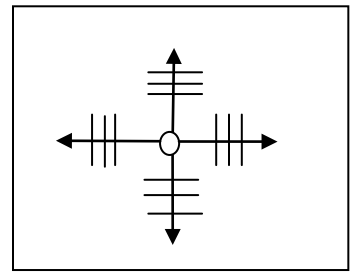
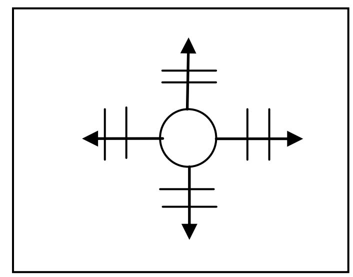


Figure 3. The medium containing the bubble spontaneously contracting.

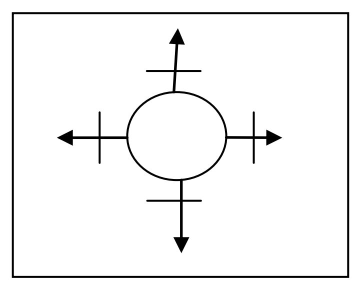
We now consider what this effect has on the phonons, having a average temperature $T_1 \sim 373K$. As the media contracts, energy in these heat waves are transferred into the contraction of the media, as seen in Figure 4. For example, as water is only very slightly compressible, this effect can only occur in a very limited delta volume range.



a) The medium begins to spontaneously contract.



b) The heat waves, phonons contained in the medium begin to be absorbed into the contraction of the medium.



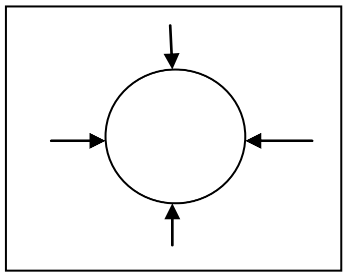
c) The phonons in neighborhood of the bubble are absorbed into the contraction of the medium.

Figure 4. a), b), c), Show the absorption of the phonons into the contraction of the medium. The phonons being heat follow Bose statistics while the contraction of the medium can be thought of as raising the energy of the electron shells in the medium which follow Fermi statistics. Depending on the medium this increase in shell energy can be view as a localized crystalline phase change and/or increase in the degeneracy of electron gas of the local medium.

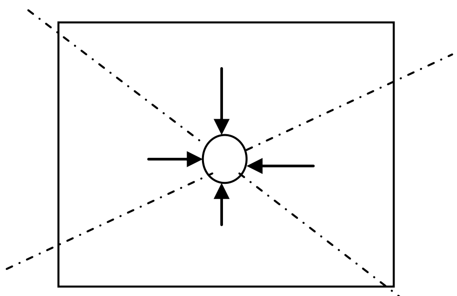
At some point, the expansion velocity of the bubble drops to zero and the bubble containing a vapor of

This research was sponsored by Daniel H. Deeks

rarified pressure is now subjected to the contracted/compressed pressure of the media. The bubble now collapses, releasing what is refered to in the literature as a black body light associated with a body at very high tempertures [3]~~.~~, as shown in Figure 5.



a) The bubble collapses



b) This Fermi Energy of the contracted medium is now released as a very high temperature black body emission and / or transferred to any constraining magnetic field.

Figure 5. The temperature of the black body associated with these emissions is in excess 35,000 K while the water is still at the boiling point or less.

A key physical point of such systems is that they are entropy driven absolute negative pressure phenomena. Meaning that they are entropy driven energy collective transfer processes. Machines that are currently being used to generate electricity are positive pressure systems are dissipative by definition. As shown in Figure 6, these "black body emissions are dependent on the externally applied hydraulic pressure (Applied Pressure Fig 6.) and magnetic field intensity the sample is subjected to [3]. The onset of SL is indicated as solid circles and the cut-off pressures as squares. The dotted (dashed) curve is a parabolic fit to the derived onset (cut-off) pressure points. Sonoluminescence is observed in the area between the two sets of curves. No luminescence occurs in the region below the onset points and bubbles disappear in the region above the cut-off points.

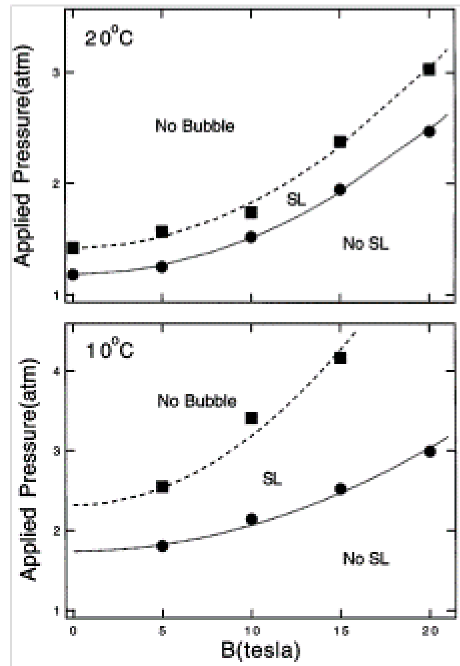


Figure 6. The derived phase diagram from amplitude sweep data at 20 ± °C and 10 ± °C[3].

Thus any device or technology that utilizes negative pressure (i.e. cavitation) to transfer Bose to Fermi energy should observe and detect these "black body emissions" as they are a critical way of monitoring the metastable process. In negative pressure energy transfer devices in operational ranges, or in transfer devices that do not exhibit these emissions, a laser may be used to check for the presence of the metastable bubble, from which a cavitiation rate can be determined.

III. NEGATIVE PRESSURE MAGNETOSTRICTION

Another negative pressure phenomena is magnetostriction cooling, where the rapid application of a strong magnetic field to a bulk sample causes a spontaneous contraction and cooling of this bulk sample. The heat energy of the bulk sample is transferred to the magnetic field thus cooling the bulk sample. Attempts

This research was sponsored by Daniel H. Deeks

historically have been made to use magnetostriction without cavitation as a way to generate electric power, i.e., to convert Bose to Fermi energy. All of these past methods involved modulating the magnetic field, which causes a hysteresis change in the magnetic core producing the magnetic field which is very energy and time extensive. If cavitation is included into this process, hysteresis is no longer required.

IV. Negative Pressure magnetostriction with Cavitation

The TOKOMAK at Princeton has demonstrated interesting phenomena, that was seen and documented there. The nuclear fusion reactor could not reach the temperature necessary for nuclear fusion because the cooling media, metallic lithium, was experiencing the effects of negative pressure bubbles, which were transfering bose heat energy directly to the confining magnetic field or magnetostriction with cavitation [4].

Reference [4] discusses the computer simulation of the bubbles, gives the known negative magnetic pressure bounds for this process, and more importantly describes the power conversion density that the process is able to convert.

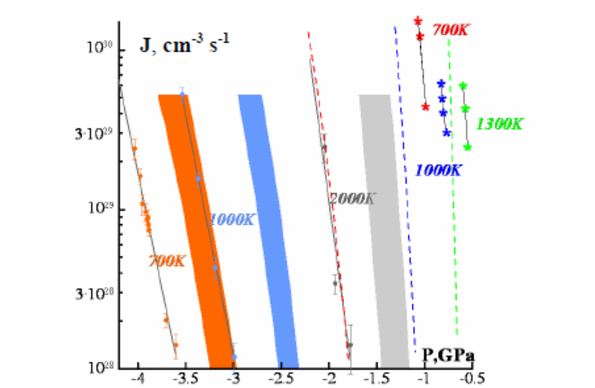


Figure 7. Pressure dependences of caviation rate [4].

Figure 7 from this paper [4] shows the cavitation rate, J. The rate values range from 10^{28} to over $3x10^{29}$ $cm^{-3}s^{-1}$. In this paper, we are currently discussing details the effect we are considering for both metallic Lithium (Li), shown as lines with stars, and metallic Lead (Pb), shown lines with circles .

The surface tension of Li is about order of magnitude less than that of lead, as shown in Figure 8 (below right). The energy of a lead bubble is ~50 GeV, we shall use the value of ~5GeV for a bubble formation in lithium.

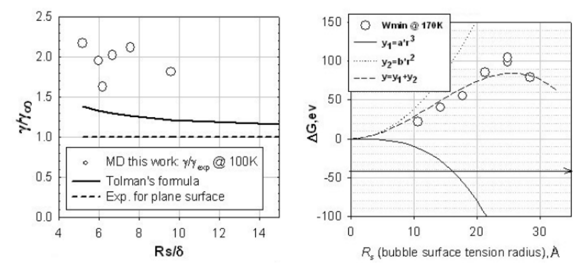


Figure 8. Surface tension and free energy calculated[4].

Since 1 eV = $1.602x10^{-19}$ J or 5Gev= $5x10^{9}$ $x1.602x10^{-19}$ = $8x\ 10^{-10}$ J, the low end of the power transfer density (the capiticity to convert Bose to Fermi Energy per unit volume) is therefore $8x\ 10^{-10}$J x 10^{28} cm^{-3} s^{-1} = $8x10^{18}$W cm^{-3}.

Both sonolumination and the lithium negative pressure energy transfer phenonmenon are usually observed in the liquid state of the medium. From Fig 7 [4] for metastable bounds for the lithium phenomena, we see that it’s negative pressure ranges from about -1 to -0.5 GPa, where 1 GPa = 145K psi. At these pressures, a solid metal will flow like a liquid.

Further at the cryogenic temperatures that we wish to operate at, lithium experiences a Martensitic transformation, to a multi-crystalline phase state containing mostly BCC (i. e. body centered cubic) and 9R Hex crystalline phases. Phase transition to this multi-crystalline phases, at normal nominal pressures, results in fractures, fissures, and internal stresses in the gross lithum sample. This can be prevented by pre-pressurizing the sample so that the majority of the

This research was sponsored by Daniel H. Deeks

lithium sample is in the 9R Hex state when the sample is cooled to the operating temperatures of the system. Normally, we think of a metal as being hard and firm yet lithium is actually very compressible. The paper "New high-pressure phases of lithium" [5] details that compressibility. Figure 9, from that paper, shows this compressibility. Note again that we are dealing with pressures in the 1GPa range.

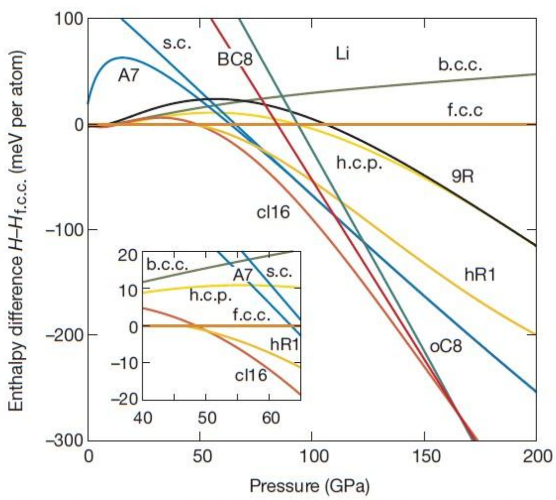


Figure 9. Calculated enthalpy differences (relative to face center cubic) for Li in various cystal structures, as a function of pressure[5].

It is this compressibility that allows us to cavitate solid metallic lithium at cryogenic temperatures.

V. THE ART OF NEGATIVE PRESSURE ENERGY TRANSFER

The first generation patent US Patent "Apparatus For Storing Energy" 5,113,661 was granted in April 15, 1992 and basically described the process.

The current second generation Patents include:

- US - 7,581,403
- China - ZL2007010494140
- Australia – 2008200129
- Russia - 2451246
- Pending Indian and Canada

In the current prototype, the cavitation volume is a sphere 0.2 mm across the volume or (4/3) π $(0.01\text{cm})^3$ = $4.19\text{x}\ 10^{-6}\ \text{cm}^3$. The power transfer capacity of the prototype is thus about $3.4\ \text{x}10^{12}$ W.

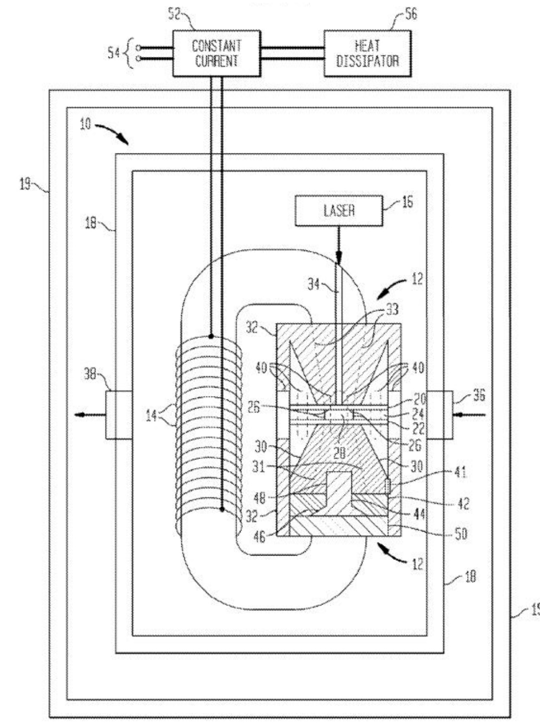


Figure 10. Schematic diagram of typical device[6].

Figure 11.Magnetic core with lithium sapphire cell installed, but without superconducting coil .

The schematic of the device, as shown in the patent, which details the physics of what is occurring in Figure 10 [6]. We must therefore limit the heat flow through the device by designing the sapphire windows, 20 and 22 in Fig 10 [6] above, of the lithium containment cell to have a much low thermal transfer capability. In the current prototype unit the sapphire limits the heat transfer capacity to approximately 15 kW, ~7.5kW per sapphire window, continually as long as the metastable process is being reset and maintained within its metastable bounds

This research was sponsored by Daniel H. Deeks

[2]. It should be mentioned that the vacuum walled containment vessel is designed to limit transfer through its walls via radiative heating to approximately 870 Watts @100°C.

Thus the thermal energy that the system is able to convert / transfer is much greater than the heat that the system absorbes and the system is self sustaining at its cryogenic temperature.

To begin, the system is brought down to evacuated liquid nitrogen temperatures, approxiamtely 68-70 Kelvin, which is below T_c, the critical temperature of the HSII Superconducting coil, as shown 14, in Figure 10 and Figure 12 below.

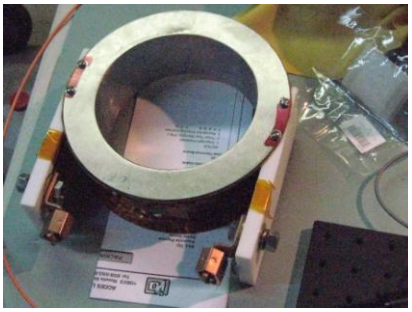


Figure 12. HSII Superconducting Coil

The system being evacuated and nitrogen cooled, at start up, requires only a carbon vane vacuum pump for initial unconnected unit cool down, as seen in Figure 13.

Figure 13. Carbon vane vacuum pump.

For multi-interconnected unit configurations, becaue of the system's large cryogenic cooling capacity, a working unit can be used to cool other units down to their cryogenic operating temperature. An operational unit can be used to cryogenically cool other cryogenic devices and systems. This approach is a key critical technology for both energy use and the widespread, inexpensive use for other superconducting / cryogenic technologies.

When temperatures below T_c are reached, a very strong magnetic field is generated by the superconducting coil, as seen in 14 in Figure10 and Figure 12, the magnetic circuit passes this field through the sappfire cell containing metallic lithium. The laser 16 in Figure 10. creates bubble(s) in the metallic lithium in a similar manner, as described above for sonoluminescence, with a few major differences.

Ambient heat within the heating/cooling Nitrogen media is passed over the sapphire windows containing the cavitating lithium, which transfers heat to the sapphire windows. This heat from the nitrogen is passed through the sapphire window and into the cryogenic cavitating lithium. The cavitation converts this heat into an increase in the confining magnetic field. The Martensitic heat of reversion for cryogenic metallic lithium also aids in cooling the bulk lithium sample.

Figure 14. The device during a test run.

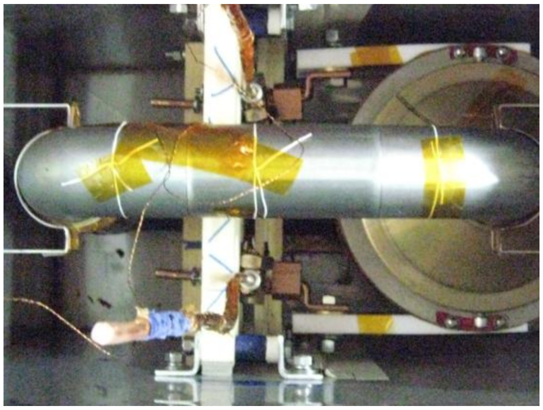


Figure 15. Top view of Magnetic Circuit with power and sensor leads installed.

This research was sponsored by Daniel H. Deeks

This increase in magnet field /current must be drained to maintain the bounded parameters range needed for this metastable process. Thus, when a useful load is not present, it therefore necessary to vent the excess current via a series of enamled noninducive ceramic resistors, as shown 56 in Fig 9, "HEAT DISSIPATOR" [6], Fig 16, which is also used to establish the output reference voltage of the device. The current reference voltage configuration of the prototype device is about 60VDC.

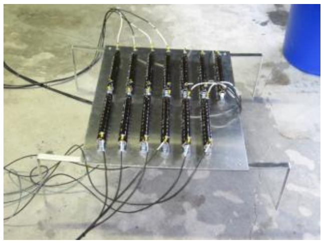


Figure 16. Heat dissipator resistors.

There are currently three resistive states for the prototype for this resistor bank:

- Free Run – Resistance Bank Bypass
- Idle Rum - Low Resistance
- Brake Mode – High Resistance

Note that Brake Mode is the default state of the system for safety.

The different resistive states are controlled by a bank of DC Solid state relays, as shown in Figure 17.

Figure 17. FET relay bank.

There are also two DeHaas current sensors and the computer controlling the system is running Window XP and MSVS 6.

On September 28, 2014 the lithium inside the sapphire cell was successfully cavitated at cryogenic LN2 temperatures using a 915nm fiber coupled laser at a power setting of 150Watts and using optics that produced a spot size of approximately 0.23mm incident on an optical dopant of solid Boron Four Carbonate, B4C, acting as a heating element embedded inside the lithium sample Fig 18 and Fig19.

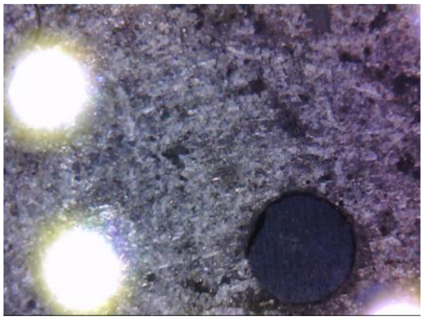


Fig 18. B4C dopant before incident cavitation

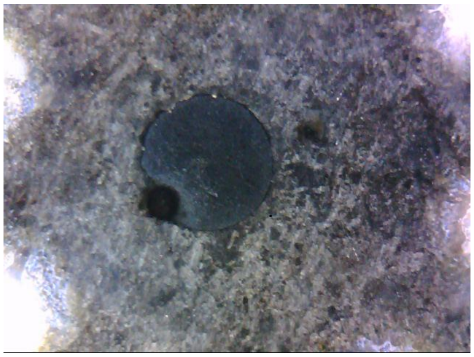


Fig 19. B4C and Lithium after caviation

As can be seen from Fig 19. 150Watts is excessive and a lower power setting that does not destroy the B4C yet still cavitates the lithium sample is necessary.

VI. THE DISTRIBUTED POWER GENERATION IS OVER THE EXISTING GRID WITH NO MODICATIONS.

A car utilizing this technology can run from the ambient heat in the air, and when parked can power the home, office, or factory, or these may be power directly. All that is needed is a commerically available AC inverter. The energy units are modular and can be grouped together without limit. The excess energy transferred can being passed to the grid to areas of high electricity demand and/or used to decompose water and store the hydrogen to be sent on existing natural gas distribution pipeline systems. The only lifetime limiting component in the system is the superconducting coil that may age anneal after 15 or 20 years. The estimated mass production cost per unit is approximately $5000.00

This research was sponsored by Daniel H. Deeks

(US), excluding profit margin. As an energy source, we believe this approach is far cheaper than coal, always available unlike solar, and requires very low maintainence, unlike wind power with delaminating composite blades.

VII. Conclusion

We have provided a basic overview of the physical and scientific principles, and associated engineering and technologies of absolute negative pressure systems that could be used and developed to provide new sources of energy. Optical problems that have prevented successful tests of the prototype have been solved. Testing with these optics and determining the black body curve for the lithium cavitation are currently are ongoing.

The physical phenomena witnessed and documented at TOKAMAK Princeton, N.J. is a collective process that transfers ambient Bose energy from its surroundings to Fermi energy in the form of DC electric current, a laser activated variation of such a process operating a cryogenic temperatures is an extremely attractive alternative to the present practice of using dissippative processes to generate electric power.

VIII. Acknowledgment

I would like to thank Ronald Pirich of LIFT, Vic and Bob Nigro of VKS, Tom and Tony Figlozzi of PMC, Peter Wang of Apollo Instruments, Jason Kellenberger of APW, Mike Sweeting of A&M Pump and Motor, Michael Dotzler of Coherent, Klaus Burckhardt of INSACO and Edwin Diaz of Edmund Optics for their technical support, assistance and guidance.

References:

[1] Hermann Grabert, Peter Olschowski and Ulrich Weiss, “Quantum decay rates for dissipative systems at finite temperatures”, Physical Review B vol. 36, Num. 4, pp 1931-1951, 1 August 1987

[2] R.E. Parrot and J. Lawrence, “Persistance of exponential decay for metastable quantum states at long times” , Europhys. Lett 57 (5), pp. 632-638, 1 March 2002

[3] J. B. Young, T Schmiedel, and Woowan Kang, “Sonoluminecence in high magnetic fields”, vol. 77, number 23, Physical Review Letters pp 4816-4819, 2 Dec.1996 Copyright American Physical Society 1996

[4] Z. Insepov, T. Bazhirov, G. Norman, and V. Stegailov, “Computer simulation of bubble formation” Joint International Topical Meeting on Mathematics & Computation and Supercomputing in Nuclear Applications (M&C + SNA 2007) Monterey, California, pp 1-24, April 15-19, 2007, Copyright 2007 American Nuclear Society, LaGrange Park, IL

[5] M. Hanfland, K. Syassen, N. E. Christensen, and D.L. Novikov, “New high-pressure phases of lithium”, letters to nature, NATURE, vol. 408, pp 174-178 , 9 Nov. 2000, www.nature.com

[6] D. H. Deeks, US Patent “Apparatus For Storing Energy”, 7,581,403

This research was sponsored by Daniel H. Deeks