J. Condensed Matter Nucl. Sci. 38 (2023) 147–160

Research Article

Synchronization of Vacancy-Loaded Deuterons Enables Successful LANR Mass-Energy Transfer

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Abstract

Unlike hot fusion, LANR is relational and productive rather than confrontational and destructive. Rather than one D hitting the other as a target, there is no conventional "coulomb barrier", but instead synchronous interaction(s) follow application of an electric field intensity. Analysis of the pulsing coupled atomic deuteron oscillators is difficult, and here we have used equivariant bifurcation theory. A mathematical solution of this, such as a toroidal breather mode, reveals much. Most importantly, such synchronization of deuterons may obviate, i.e. circumvent, the function of the 'coulomb barrier'. We have observed that successfully driven LANR components emit unique RF emissions, with sidebands and pulsations which may herald energy-mass interactions. The final product of these processes is fusion of two deuterons with production of *de novo* helium-4, and generation of the observed "excess heat".

Keywords: Deuteron fusion, synchronization fusion, toroidal breather mode, deuteron synchronization, coupled oscillators, equivariant bifurcation theory, coulomb barrier elimination.

1. Introduction: Energy-Matter Redistribution

In successful LANR (lattice assisted nuclear reactions), pairs of loaded deuterons -located in periodic vacancy sites-combine synchronously. Unlike hot fusion, this is relational and productive rather than confrontational and destructive. Thus, here, rather than one D hitting the other as a target, there is no conventional "coulomb barrier", but instead synchronous interaction(s) follow application of an electric field intensity.

LANR/CF is quite real [Figure 2]. There are thirty-four years of solid sterling evidence heralding that the excess heat in CF/LANR is real AND comes from a nuclear origin [Figures 2, 3, 4, 5]. By the reactions described herein the important result is successful fusion of two deuterons within the lattice, with local production of *de novo* helium-4, and generation of the observed "excess heat". We previously observed unique radiofrequency ["RF"] emissions, sidebands and pulsations [1], [2], [3] from successfully driven [4], [5], [6], [7], [8], [9] lattice assisted nuclear ["LANR/CF"] components and systems. This paper will show further how successful LANR occurs by deuteron ion synchronization using analysis of the pulsing coupled atomic deuteron oscillators made using equivariant bifurcation theory.

These pulsing RF sidebands at the deuterium line [D-L] reveal interactions between them, and since ICCF-21 we have attempted to examine if a video or mathematical solution exists. One solution involves the toroidal breather

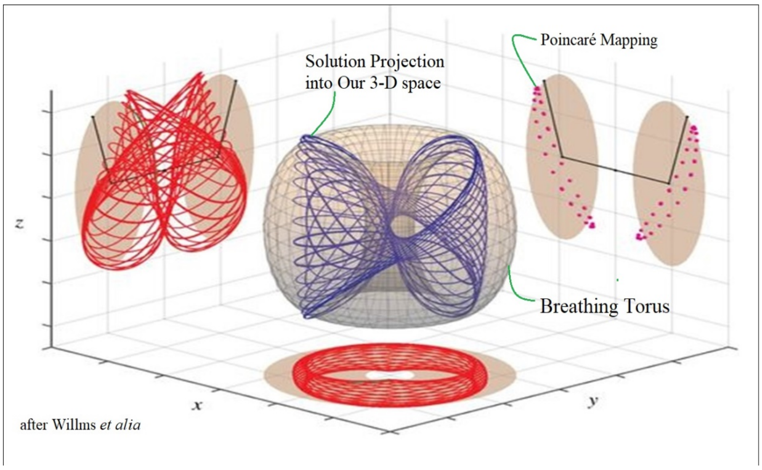


Figure 1. Toroidal Breather Mode Shows Path of Synchronized Deuterons.
Shown is a mathematical analysis of how the coulomb barrier is avoided; this is the "Synchronous deuteron fusion phase space". Projections are shown on the left and bottom side walls which are the stable solutions; two planar projections which are red colored. The Poincaré map for $y=0$ is magenta; on the right coordinate plane is a one-dimensional closed curve.

mode, which is revealed by equivariant bifurcation theory. This solution may explain how these systems circumvent the coulomb barrier which they clearly do and have done for more than three decades. Such an explanation transforms what is (wrongly) expected, leaving many of the skeptics' arguments essentially moot.

Deuteron synchronization is the process which enables mass-energy transfer resulting in the observed excess heat for LANR. The deuteron synchronizations are heralded by the unique antiStokes spectra [Figure 3, bottom] and by these unique RF emissions at 327.37Mhz or these reactions [Figures 4, 5]. These spectra and RF emissions occur only during observed real LANR.

Most importantly, it is proposed in this paper that the appearance of successful excess heat ["XSH"] only occurs after deuteron ion synchronization which leads to subsequent mass/energy transfer within the highly loaded metal lattice.

These curves in Figure 3, on the bottom, confirm that there are two driven LANR states, but only one (1) gives excess heat. The figure is the overlaid coherent Raman Spectra of the same preloaded ZrO_2PdD NANOR®-type CF/LANR component in three different electrical drive modes [NANOR ® type component 7-6]. The spectra are dual wavelength coherent electric-driven volume-enhanced reflection spectroscopy. The plots show the reflected optical intensity as a function of wavelength, initially from two incident coherent optical beams but also with reflected backscatter from the core along with the initial optical beams. The three modes (responses) shown are the not driven ["off"] state, the unwanted electrical avalanche mode, and the optimal operational state, the "Desired Active Mode", where "excess" energy is being released. Attention is directed to the fact that these curves confirm that there are two (2) electrically driven LANR states - but only one (1) gives excess heat.

2. Background – CF/LANR is Absolutely Real

2.1. Background – Successful LANR is Heralded by Deuteron-Line Sidebands

As previously reported, electrically driven lattice assisted nuclear reaction (LANR) systems, both aqueous and dry preloaded nanomaterial, emit very narrow bandwidth hyperfine radiofrequency (RF) emission peaks at 327.37 MHz,

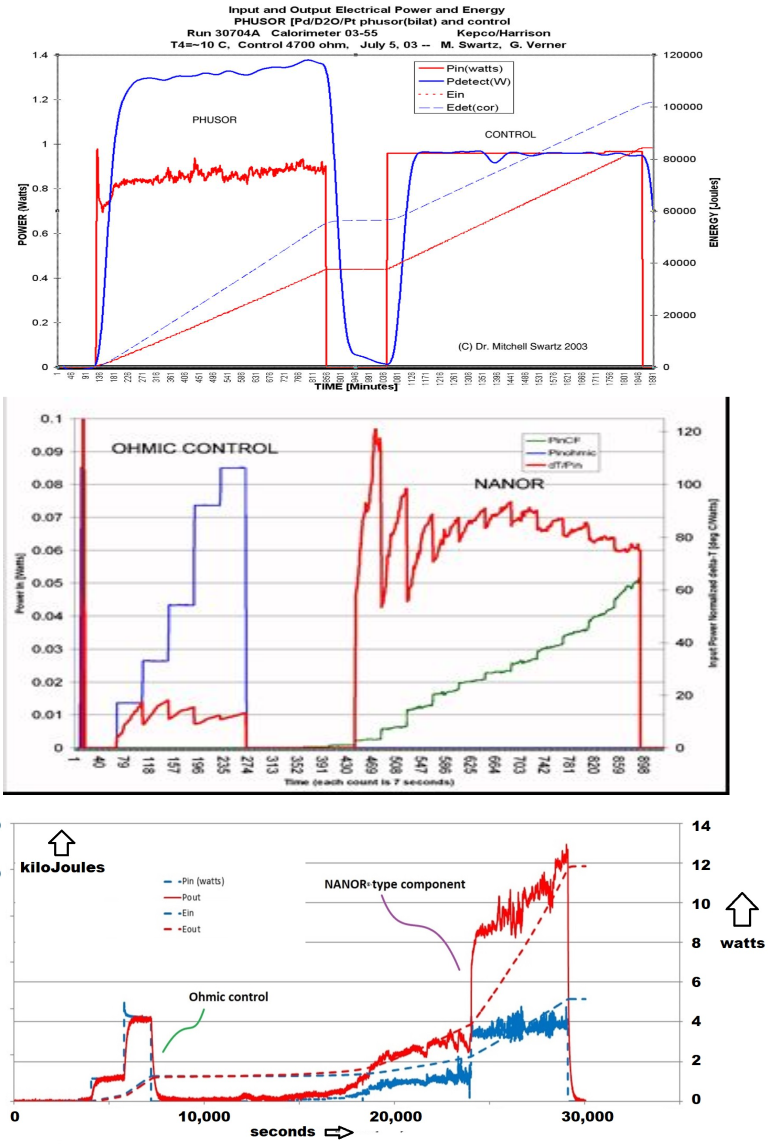


Figure 2. Successful LANR Excess Heat.
This figure shows results of two successful aqueous and dry, preloaded LANR experimental runs. To prove they are real, these demonstrations have both ohmic controls, and time integration. Reproducible Excess heat (XSH) results are shown with clear comparisons to ohmic controls. The ohmic control was second in the aqueous run, and preceded the input to the dry two preloaded NANOR® - type components, below it.
Excess heat was not seen in any of the electrically driven ohmic controls.

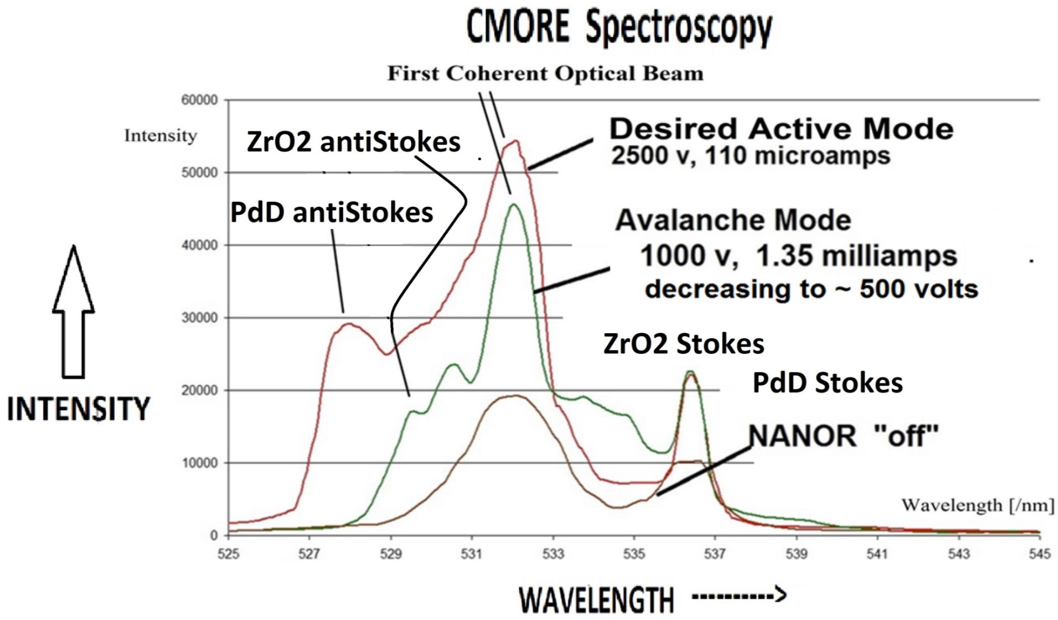


Figure 3. Successful LANR Excess Heat and the use of Coherent Raman Spectroscopy to Prove the Presence of a Working Active LANR system.
Results from preloaded NANOR®-type LANR component before, during, and after XSH. Shown for the single dry preloaded component – in two electrical drive states and "off" – are the unique antiStokes signatures, including the one that ONLY appears with active LANR systems.

located very close to the theoretical Deuteron-Line (DL; 327.348 MHz) region [Figures 4 and5]. They exhibit a large $Q > 1.2 \times 10^6$.

Figure 5 shows a radiofrequency [RF] Deuterium Line [DL] spectrum of a nickel cathode LANR system, driven at ~40 volts, 200 milliAmperes. The 'waterfall' plot shows intensity as a function of frequency. The largest amplitude pulsatile RF line on the right hand side, marked by a star.

The deuterons in the highly-loaded lattice couple together to form a phased array which is then perceived as a very high Q radiofrequency (RF) emission near the deuterium line (DL). At higher applied driving voltages, a superhyperfine line structure of sidebands appears, and that reveals the active site and much more.

Most relevant here, at least some of their emitting RF radiation superhyperfine line peaks, heralding the inverted population, were observed to be pulsing with periods of several minutes (star, above right). Their appearance is unlike everything else examined over the last six years from Earth or galactic origin. It is ONLY associated with an active XSH-producing CF/LANR system.

A close up of this is seen of some of the sidebands shown in Figure 5. These observations have been taken as a sign of possible real time mass-energy transfers within the high loaded active XSH-producing PdD lattice.

In summary, it was learned that successful cold fusion is fueled by deuterons, and in these active LANR systems this occurs by weakly coupled identical oscillators of deuteron ions located in vacancies.

It is clear that the loaded deuterons must work together from their vacancy sites to enable the desired XSH-producing reactions within the loaded Group VIII metal. It is unclear how the coupling occurs, what is its strength, whether it is uniform, and what would make them couple in phase to produce the observed maser action.

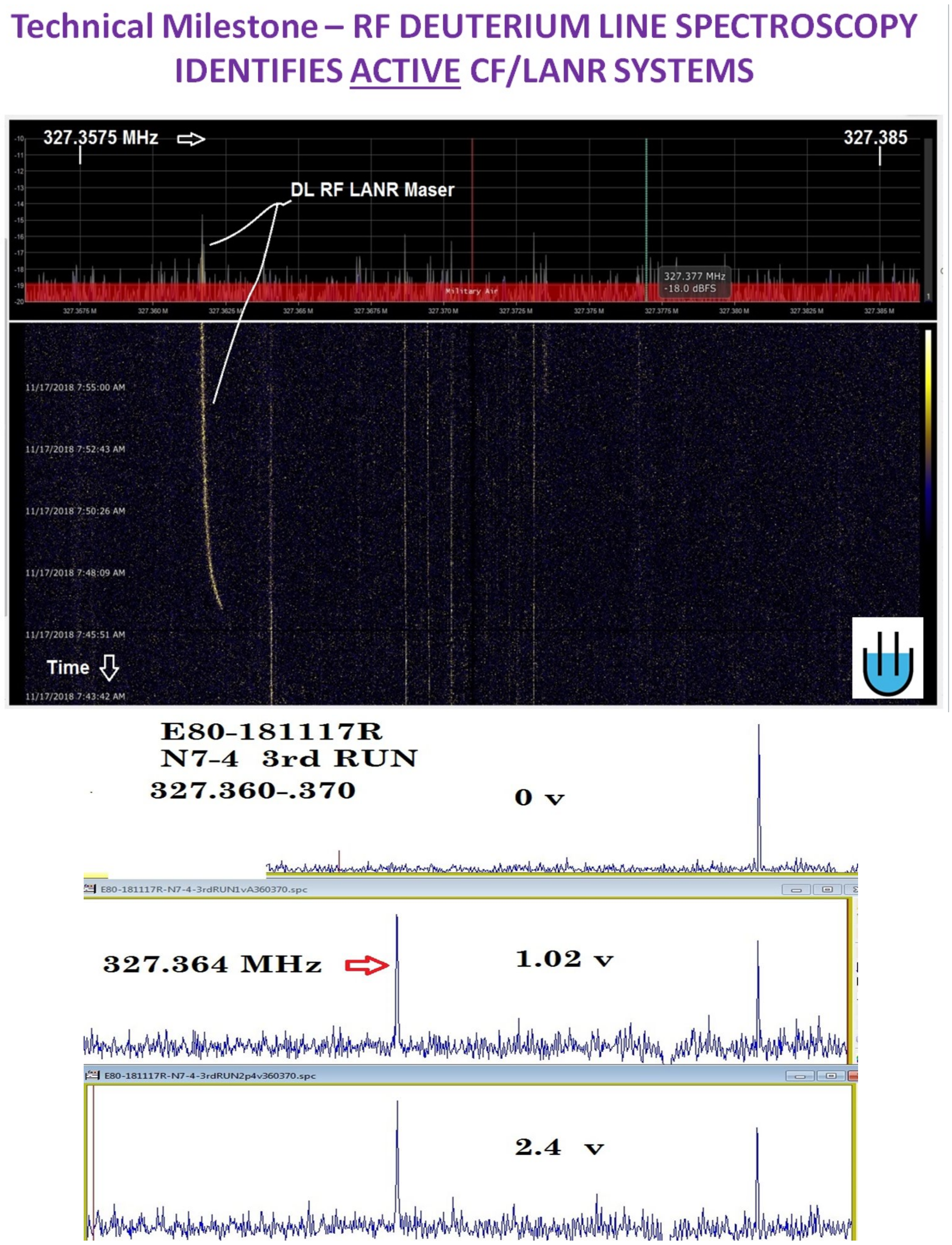
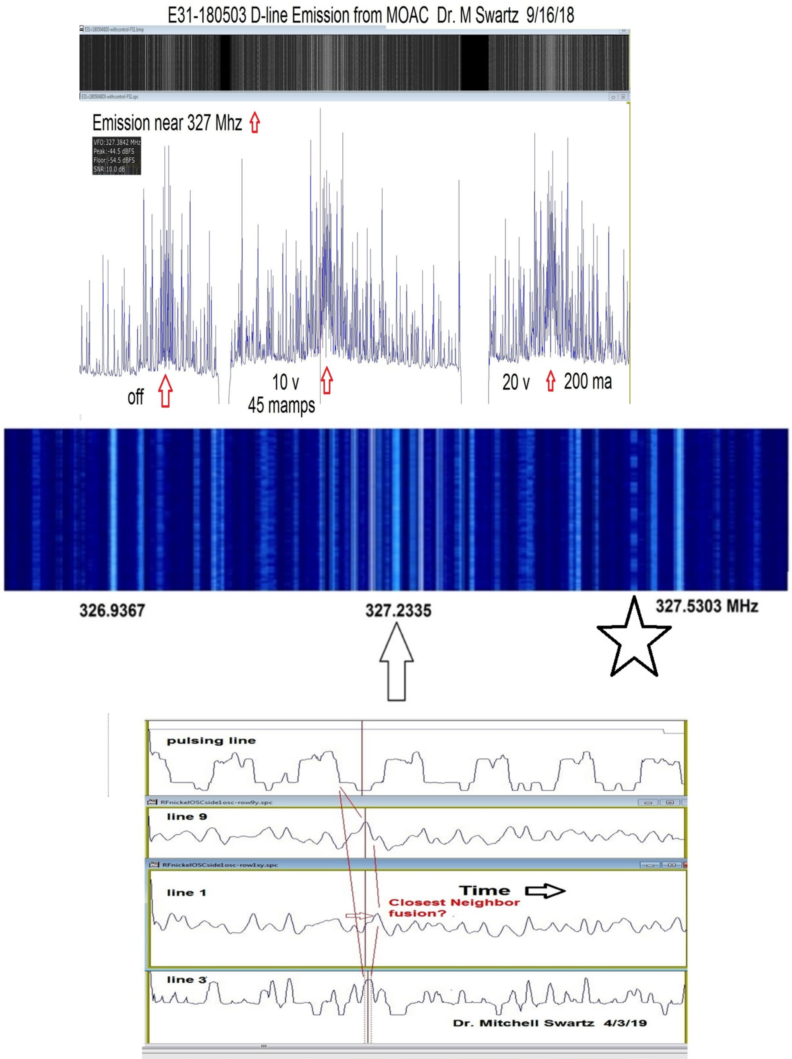


Figure 4. Successful LANR has a RF Maser Emission near 327 MHz.
Active electrically-driven LANR systems, both aqueous and dry preloaded nanomaterial, emit a hyperfine radiofrequency (RF) maser emission ~327.37 MHz [near the theoretical Deuteron-Line (DL; 327.348 MHz)]. The LANR maser exhibits a large $Q > 1.2 \times 10^6$, and a positive Zeeman effect.



Amplitude of Pulsatile RF superhyperfine lines, time-matched from active Ni LANR.
One important implication is that in active CF/LANR systems, the loaded deuterons work together from their vacancy sites and enable the desired XSH-producing reactions within the loaded metal while emitting RF radiation at the Deuterium-line heralding the inverted population.

Figure 5. Pulsatile RF Emissions in Some Superhyperfine [“SHF”] Deuterium-Lines.
The discovery of the existence of Superhyperfine [“SHF”] Deuterium-Lines was observed at higher voltages. LANR RF maser emissions include superhyperfine lines [SHFL, or sidebands]. A very small number are pulsatile; one is marked by a star (above).
(top) – Amplitude of Pulsatile RF line and 3 other time-matched RF lines.
This figure shows the superhyperfine lines for an active working LANR system [nickel hydrogen loaded LANR system; 40 volts, 200 mA].
(middle) - This ‘waterfall’ plot (time goes down) shows intensity as a function of frequency The arrow identifies the center line; the star identifies one pulsatile line.
(bottom) – Pulsatile RF Emissions are shown, taken from a Background of the other RF Superhyperfine [“SHF”] Lines. Here, the pulsing interactions were compared, as in an ancient movie projector.

One important implication is that in active CF/LANR systems, the loaded deuterons work together from their vacancy sites and enable the desired XSH-producing reactions within the loaded Group VIII metal while emitting RF radiation at the Deuterium-line heralding the inverted population.

This can be seen in Figure 5 for CF/LANR in the aqueous system.

Is this the first intralattice "movie" of what occurs in successful LANR.

2.2. **Synchronous Behavior is Important & Ubiquitous - Localized Coupled Oscillators**

Mechanical, biological, and astronomic coupled synchronous systems have been studied for centuries [Figure 6]. Two years after Christiaan Huygens in 1663 proposed to the Royal Society that his pendulum clocks might solve the "longitude problem" in navigation; he observed that pairs of his pendulum clocks were weakly coupled through a heavy beam above them, and they synchronized to each other in about 30 minutes. Of note here, the frequency of the two pendula became identical but their displacements were opposite in direction ["anti-phase synchronization"].

3. Experimental: Solutions, Including by Hopf Fibration

Understanding these clock synchronization(s) took centuries, occurring far long after Huygens' original publication ["*Horologium oscillatorium"].* The solution(s) - even for the simplest pendula - has required understanding permutations, nonlinear engineering, Lagrangian mechanics, and the existence of numerical computations. Most difficult to explain was the anti-phase synchronization.

3.1. **Developing The Solutions for the Coupled Oscillators For/In CF/LANR**

The solutions for coupled localized oscillators such as Huygens' clocks were first characterized by non-dimensional methods to transform their conventional physical system parameters to their normal equivariant form parameters. The equivariant bifurcation theory, the equivariant center manifold theorem, and the equivariant normal solutions ["forms"] were examined as to their relevance with these coupled localized oscillator systems.

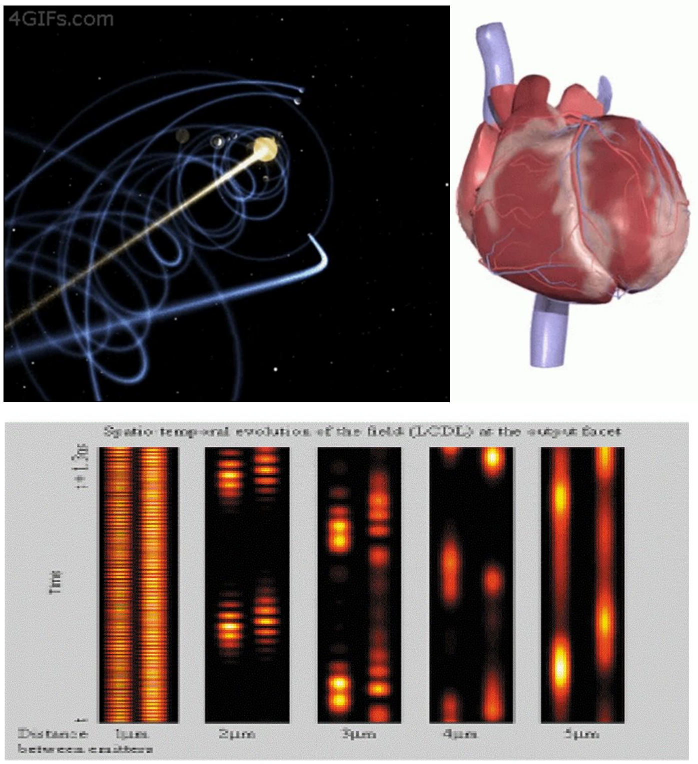
A subgroup of possible solutions is used here to better analyze what is observed with CF/LANR coupling in the loaded PdD lattice resulting from the interactions between the local oscillators in FCC vacancies. Specifically, Hopf fiber bundle topologic ["Hopf Fibration "] solutions are used in physics and medicine – from coupled oscillators to human circadian rhythms and even the sleep-wake cycle.

Here, we consider the solution of the deuteron synchronization trajectory for/to fusion for two deuterons in their periodically-located vacancies using Hopf Fibration principles. These Hopf Fibration solutions are analyzed in 4 dimensions (x,y,z, and time). In Hopf fibration, the 4D issue is simply handled by a pair of complex numbers. Simply put, Hopf fiber bundle solutions use a 4-dimensional (4D) hypersphere to map the result to inputs; the deuterons' trajectories. The "shadow" of the 4D hypersphere is mapped onto a toroid's surface which is located within our own 3-dimensions. This allows the coupled oscillators' interaction(s) to be seen, followed and studied.

****** A new Phase Space for Fusion Deuterons**

As the dynamic deuteron synchronization flows, in our 3D space, over the two-dimensional torus-shaped surface, a phase space is defined. The author calls this entire surface 3D (the shadow of the 4D processes) the "**Synchronous deuteron fusion phase space**". From the trajectory on the 3D-torus over this phase space, the deuterons can then be followed for possible quasi-periodicity, further synchronization, phase-locking, and fusion.

Mathematically, the onset of these oscillations is said to occur from their rest state. An electric field (or more) is applied for loading and to drive the desired LANR reactions. Thereafter, the synchronization is a smooth process and follows what is known as double Hopf bifurcation which can be examined as an equivariant bifurcation using normal form theory. Near the double Hopf bifurcation, the deuteron synchronization of the loaded PdD driven by the



Example of spatiotemporal evolution of the field amplitude of the two laterally coupled diode lasers with five different distances between emitters [after H. Lamela]

Figure 6. Widespread Examples of Synchronous Behavior.
(top) Synchronous Behavior is seen in orbital physics, groups of animals such as fireflies, and medicine. The earliest science may habeen the study of coupled pendulum clocks.
(bottom) Shown is an example of synchronous coupling of two laterally coupled diode lasers [with five different distances between emitters; after H. Lamela, ref. 10].

applied electric field intensity, would have several emerging states including: the rest state, the in-phase and anti-phase periodic solutions, mixed-mode periodic solutions, mixed-mode 2-torus solutions, and modulo-2π and chaotic breather solutions. Most importantly, and relevant for CF, the latter three solutions, especially the breathers enable exchange energy between the two oscillators. This would indeed be the equivalent of surmounting the "coulomb barrier".

For both Huygens' clocks and CF coupling in the loaded lattice the coupling must be the same even with permutation of the clocks or deuterons if there is simultaneous reversal of the displacements and velocities. One implication is that the theoretical motions have more symmetry than the physical systems do.

Attention is drawn to the fact that in CF's highly vacancy-D-loaded Pd the deuterons are identical. They are bosons. Therefore, interchange *like the pendula* is reasonable, making the simplest of loaded ZrO_2PdD systems having a simple permutation symmetry called Z2, also called "Huygens symmetry" when referring to his pairs of clocks. This means that the clocks, here deuterons, could be interchanged without a change in the system.

Most importantly for LANR/CF, 'permutation' symmetry can create a phase space which permits in-phase coupling (unlike Huygens' clocks which were ultimately anti-phase). In-phase periodic solutions have Huygens symmetry. Given the maser appearance and actions, there is at least some in-phase synchronization in the coupling of active CF/LANR oscillators.

Anti-phase periodic oscillations such as actually observed by Huygens have odd-Huygens symmetry. This different and now resolved 'paradox' has been better clarified by the Equivariant Hopf Bifurcation Theorem. It shows that for the Huygens' clocks, their anti-phase oscillations have a spatio-temporal symmetry which combines the permutation symmetry discussed above but with a half-period temporal phase shift.

4. Results – Superhyperfine line Pulsatile LANR Behavior Heralds A Synchronization Pathway

4.1. Successful LANR Is Driven by Forced Turbulent Deuteron Oscillator Flow

In successful LANR, deuteron fusion is initiated by electrically-forced turbulent oscillator flow. The deuterons are located in periodic vacancies in the highly loaded lattice. These ionized deuterons are identical bosons, and can interchange amongst themselves without any change in the system [a permutation symmetry called Z_2 ["Huygens (clock) symmetry"], and during successful LANR exhibit a well-defined frequency at the RF Deuterium-line.

Together, these also importantly creates the opportunity for synchronization because the deuterons are operating as a high-Q RF maser [tight range of frequency, free of noise] as required for deuteron synchronization.

STEP 1 – LOADING (a mostly reversible step)

**** Successful CF/LANR is a Multi-step process ****

The path to cold fusion (LANR) begins with loading [requiring highly-loaded vacancy-localized] deuterons, driven by the applied electric field intensity. This starts as a smooth low-level process, and continues until the "double Hopf bifurcation". This early loading of PdD is a reversible reaction. The mathematics have been covered extensively [12].

STEP 2 – Loaded Deuterons Interact on the Pathway to Cold Fusion (LANR)

Highly-loaded PdD is less reversible, because as the volume expands it changes the Pd, including forming dislocations and vacancies. The loaded deuterons interact through Band States (S. Chubb, and T. Chubb, and Kim) and other interactions (Bass, and others), and through optical interactions which provide activation energies (and more; Cravens, Letts, Swartz).

With full loading, these synchronizations of nonlinear dynamic now-coupled boson ionized oscillators in their periodic array continue. In their active state, the deuterons begin to emit antiStokes photons (Fig. 2) heralding a large acoustic phonon population ["phonon gain"].

In summary so far:

- ❑ Fusion requires highly-loaded deuterons in vacancies. So continued loading of PdD is necessary, but must be carefully done. Non-reversible reactions are wrought with changes to the lattice structure including dislocations, fractures, fissures and irreversible volume changes.

- ❑ Fusion requires highly-loaded deuterons in vacancies. So, therefore, continued loading of PdD is necessary, but must be carefully done. Non-reversible reactions are wrought with changes to the lattice structure including dislocations, fractures, fissures and irreversible volume changes.

- ❑ Deuteron Synchronization, continually driven by the applied electric field intensity, is electrically-forced turbulent oscillator flow, and initially starts as a smooth low-level process.

- ❑ In or near the active state, the deuterons can produce antiStokes photons heralding the large acoustic phonon population ["phonon gain"] and a further rise in the energy available for the synchronized deuterons.
- ❑ This process continues increasing energy of the coupled deuterons until the "double Hopf bifurcation".

4.2. **The Key Point: Fusion in Active LANR is Enabled by Deuteron Synchronicity**

STEP 3 - Toroidal Breather Mode (TBM) Enables/Solves Deuteron Synchronicity

With Hopf Fibration analysis, deuteron coupled oscillators are examined on a dynamically throbbing two-dimensional torus-shaped surface ["Synchronous deuteron fusion phase space"] as they interact.

This toroidal breather mode (TBM) solution [Figure 1] results from, and reveals, deuteron synchronicity - a *sine qua non* for fusion. The breathing torus, itself, on which the trajectories flow, is shown in Figure 1 with its cross sections which are located at $x=0$, $y=0$ and $z=0$ and are colored brown. The necessary 4D solutions (x,y,z,t) are handled by two complex numbers which project onto our three dimensional space as the blue central volume. It shows the deuterons' interaction trajectory.

Analysis of the Double Hopf Bifurcation ...

At the double Hopf bifurcation, the synchronized deuterons have several possible emergent paths through it. The deuterons, most likely, can return to the original rest state. Most of the possible states examined which follow actually are not allowed. Possible paths include in-phase and anti-phase periodic solutions, mixed-mode periodic solutions, mixed-mode 2-torus solutions, and the modulo-2π and chaotic breather solutions. There are three solutions which enable exchange of energy between the coupled deuteron oscillators with these important couplings interacting in-phase with spatiotemporal symmetry. The pulsing coupled deuteron oscillators may herald the "toroidal breather mode" [TBM] which may explain successful CF/LANR systems and components.

... and IF/when an Excited-4He* Synchronized-State is Obtained

Once an excited-4He* State is obtained by these synchronized processes, there are several ways it can go. First, it must be seen where this is energetically. Figure 7 shows a table with present the energies of the Helium ground, and upper energy states. The CF/LANR reactions of Pd/D_2O/Pt which form *de novo* He, first involve an energy gap of between 20 MeV and 24 MeV from the ground state. This megavoltage energy difference is not "low energy", but instead is capable (under some conditions) of generating penetrating ionizing radiation. The energy is so large that it is also sufficient to create 'pair production'. There is no doubt that the result of successful CF/LANR is high energy, it is NOT 'low energy' [13].

4.3. **STEP 4 – Final Irreversible Step Culminating in Deuteron Fusion**

Any emission of penetrating gamma radiation is spin forbidden. Gamma emission IS seen in hot fusion because the spin-restriction is 'lifted' [overcome] in hot fusion because of the much higher temperature(s).

Looking at the energy map of the system [Figure 8], it becomes clear why the emission of neutrons is energy forbidden. This occurs because the neutron emission band is energetically located ~1 MeV above energy level of ^{4}He* (already at quite high energy). The large energy, compared to k_B*T, makes neutron emission not really allowed, since k_B*T is 1/25 eV ["room temperature" [13].

Normally important Bremsstrahlung emissions are not seen with CF/LANR. This occurs becase Bremsstrahlung is very Temperature-dependent [Figure 9], decreasing by 18 orders of magnitude, becoming absolutely negligible when considered at low (cold fusion, ie room) temperature [Swartz, M, G. Verner, "Bremsstrahlung in Hot and Cold Fusion", *J New Energy*, 3, 4, 90-101 (1999)].

Helium Nucleus Energy States

State	Energy (MeV)	Total Angular Momentum (J)	Parity (π)	Isospin (T)	Criteria $E < d\text{-}d$ Isospin Conserved
	25.95	1	−	1	No
	25.28	0	−	1	No
	24.25	1	−	0	No
	23.64	1	−	1	No
	23.33	2	−	1	No
Third	21.84	2	−	0	[a]
Second	21.01	0	−	0	[a]
First	20.21	0	+	0	[a]
Ground	0	0	+	0	[a]

[a]States below $d + d$.

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Figure 7. Energy of the Helium Ground, and Upper Energy States.
This table shows the energies of the Helium ground, and upper energy states.

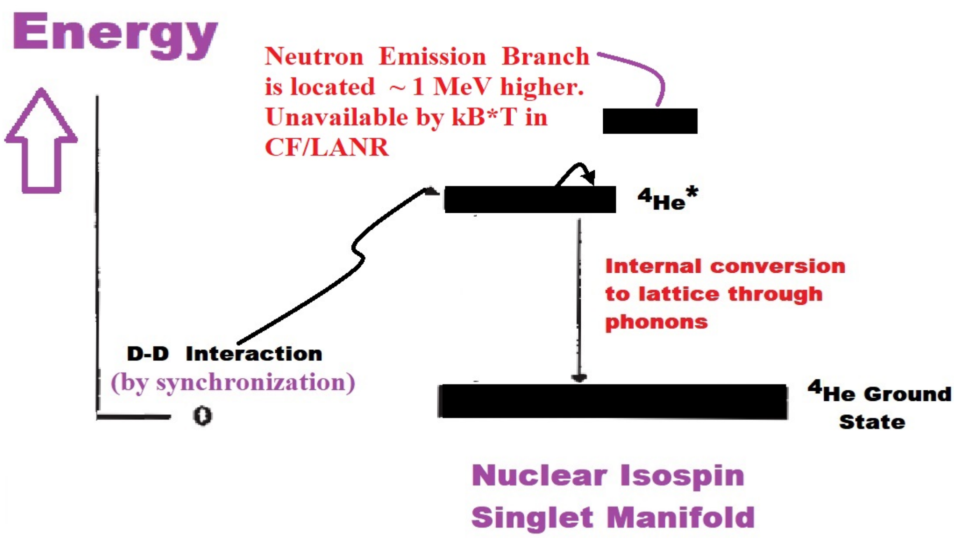

Figure 8. Energy Levels of Helium.
Shown are the energy levels of helium 4. Above the ground state, is the relevant excited state, and the neutron emission branch located 1 Mev above that.

Radiation Dose Delivered

This marked decrease in the exit of ionizing Bremsstrahlung radiation must be reflected in the radiation dose delivered. This can be calculated from the x-ray beam dose equation [20], here modified as the x-ray dose in Grays (at 1 meter) delivered per coulomb of electrical input.

$$D/Q = 1.50 * V_{max}^{2.8} * Z^{1/2} \quad \text{(Grays/Coulomb)} \tag{10}$$

V_{max} here is dominated by $k_B T$ because the applied electrical field intensity, assuming homogeneous distribution over the system is insignificant by comparison. This most important result from equations 10 and 11 is the correct calculation of the derived value of the bremsstrahlung delivered dose at a distance of 1 meter for conventional fusion systems (Table 1). The radiation dose (Grays) per coulomb at 1 meter drops from ~3.1×10^{19} Grays (hot fusion) to 1.4-3.3×10^{-4} Grays for cold fusion.

Figure 9. The impact of lower temperature in Bremsstrahlung.
The roles of temperature have generally been ignored. However, when examined it is shown that they quite important [14].

The final critical IRREVERSIBLE (~ 20+ MeV) transition occurs coherently by PHUSON energy transfer, enabled by lossy spin bosons processes through optical phonons (Hagelstein), acoustic phonons (Swartz) and magnons (Swartz). This is what causes the observed excess heat.

4He* [via a necessary PHUSON-coherent transfer]
====> 4He + more phonons <= phonon enabled

Nota Bene: With LANR success, only *de novo* and relatively low-momentum helium nuclei are formed.

In summary, synchronous D behavior and the applied electric field intensity enable formation of ^{4}He*. Pd and D enable these processes.

The PHUSON is the quasiparticle which enables the end reaction to occur. It coherently couples the megavoltage energy of the ^{4}He* to the loaded PdD lattice. This energy transfer then appears as "excess heat", and locally yields ground state *de novo* ^{4}He. Phonons (acoustic and optical) enable the transfer of energy from ^{4}He*to the lattice [13].

5. Conclusions: Synchronous, Non-Confrontational Fusion

In successful LANR, pairs of loaded deuterons located in a periodic vacancy sites combine synchronously. Unlike hot fusion, this mechanism of fusion is relational and productive, rather than confrontational and destructive [Figure 10].

Unlike hot fusion, in LANR rather than one D hitting the other as a target, there is no conventional "coulomb barrier" because the deuterons as bosons work in synchrony. Therefore, synchronous interaction CAN – and do – occur, and XSH is observed for these working active LANR systems.

Fortunately, successfully driven lattice assisted nuclear reaction [CF/LANR] components emit unique very narrow-bandwidth hyperfine radiofrequency [RF] signals near the deuterium line [DL; ~327.37 mHz] along with informative sidebands and novel pulsations [1,2,3]. Their incredibly high Q heralds a large inverted population. The sidebands reveal much, and the pulsations portend energy-mass transfer(s).

Some of the pulsations (Figure 5, cf. star) appear coupled with periods of minutes; and when synchronized, may enable mass-energy transfer. In Ni and Pd vacancy-loaded deuterons are identical bosons, and thus can interact and interchange. This analysis requires equivariant bifurcation theory [4], [5]. The pulsing superhyperfine lines herald deuteron synchronous interactions and appear to be 2D representations of the fusing deuterons -- a "shadow" of mass-energy transfer.

Figure 10. Shown are the important differences between hot fusion and LANR.
(top) In hot fusion, one D hits the other as a target. This is brute targeting, and therefore both confrontational and destructive. Thus, there is the conventional "coulomb barrier" and 3*10**19 Grays are produced at 1 meter for 1 coulomb.
(bottom) In successful LANR, deuteron synchronization is driven by the applied electric field intensity into electrically-forced turbulent oscillator flow. From this, pairs of loaded deuterons -located in periodic vacancy sites- combine synchronously. This result is relational and productive. Thus, here, rather than one D hitting the other as a target, there is no conventional "coulomb barrier", but instead synchronous interaction(s) follow application of the electric field intensity. With cold fusion, 3*10 ** -4 Grays are produced at 1 meter for 1 coulomb.

The deuterons can return to their ground state or, as described by the toroidal breathing mode [TBM] solution, they can surmount, circumvent and make moot the imagined "coulomb barrier". The result is fusion with loss of two deuterons, production of *de novo* helium-4, and the generation of the observed excess heat.

Mathematically, synchronization of the local deuteron oscillators in FCC vacancies smoothly proceeds to the "double Hopf bifurcation" driven by the applied electric field intensity. Of the many possible states which follow, only three solutions -- especially the "toroidal breather mode" [TBM] -- enable exchange of energy between the coupled oscillators.

These important RF-detected LANR couplings, like those of the Huygens' clocks, interact in-phase with spatiotemporal symmetry. It is proposed that in LANR they combine as shown below.

Most importantly, the TBM solution is the way by which interacting vacancy-loaded deuterons in highly loaded Group VIII alloys make moot and circumvent the need for surmounting the “coulomb barrier”.

Acknowledgments

The author gratefully acknowledges, and thanks, for their helpful comments, editorial assistance, ideas, suggestions, and much support for this effort: Gayle Verner, Alex Frank, Thomas Farina, Raymond Kurwzeil, Aaron Kleiner, Joshua Gyllinsky, Michael Staker, John Wallace, Andrew Meulenberg, Brian Josephson, Isidor Straus, Peter Hagelstein, Florian Metzler, Dennis Cravens, David Nagel, Dennis Letts, Frank Gordon, Pamela Mosier-Boss, Lawrence Forsley, Louis DeChiaro, Brian Ahern, Jeff Driscoll, Christy Frazier, Win Cuthbert and Carl Page. This effort was supported by JET Energy Inc. NANOR® and PHUSOR® are registered trademarks. The technology described here is protected by patents pending.

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