The only conventionally viable Cold Nuclear Fusion theory?

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What is meant in this context by “conventionally viable”?

1. **Every** concept & technique used is found in **standard** works on Quantum Mechanics and Solid State Physics & Nuclear Physics.
2. A practitioner of accepted scientific usages will find **nothing** legitimately **objectionable**.
3. Straightforward calculations actually PREDICT that under appropriate conditions Cold Fusion **must** occur despite Huizenga’s alleged requirement of ‘3 miracles’ that are required.

The late physics Nobel Laureate **Julian Schwinger** in his **NEAL** theory (Nuclear Energy in an Atomic Lattice), presented at **ICCF1** in March 1990, **eliminated** 2 of Huizenga's 3 allegedly insuperable difficulties**:**

1. By citing relevant **QM Selection Rules** he demonstrated that in a periodic lattice the Branching Ratio difficulty becomes irrelevant because the reaction studied in Hot Fusion is specifically **forbidden**.

2. By heuristic calculations of a sort commonly accepted in QED he demonstrated that the excess heat could plausibly be absorbed as lattice phonons.

3. **The major problem to be solved** is posed by the **Coulomb Barrier** between charged particles of the same sign.

But already in September 1989 Los Alamos National Lab (LANL) Hot Fusion researcher **Leaf Turner** had sent a letter to *Physics Today* proposing that the accepted QM phenomenon of **Resonant Tunneling** could demonstrate that in a **periodic lattice** of deuterons (embedded in a host metal lattice, which is a scaffolding that is of secondary importance to the Deuteron Lattice) external stimuli could force deuterons into sufficiently close proximity that the strong nuclear force would dominate the reaction.

In **June, 1991**, Dr. Robert W. Bass, who had sat next to Dr. Turner for 2 weeks once when visiting LANL in the 1970s, followed his former colleague's suggestion re Resonant Tunneling and presented an improvement in Schwinger's **NEAL** theory which **confirmed Schwinger's 1990 claim** that "a single parameter combines, albeit crudely, the effects of all the forces at work within the lattice," and **proved** that a Host Lattice & Embedded Particle combination are compatible with Cold Fusion **if & only if** the Schwinger Ratio is closer to an **ODD** than an even integer.

Bass's theory **correctly** **predicted** the strictly **empirical** Schwinger Ratio for $Pd{\bullet}D_{1.0}$ with **99.7% accuracy!** So in a **June, 1991 Patent Application** Bass used his theory to predict the Schwinger Ratio for 6 other cases *re* which he could not find measured data, covering 7 cases:

($Pd{\bullet}D_{1.0}$, $Pd{\bullet}D_{2.0}$, $Pd{\bullet}H_{1.0}$, $Ni{\bullet}D_{1.0}$, $Ni{\bullet}H_{1.0}$, $Ti{\bullet}D_{2.0}$, $Ti{\bullet}H_{2.0}$)

& predicting

(9.00, 3.00, 7.57.8.74, 7.35,3.00, 2.52) ≈

≈ (9, 3, 8, 9, 7, 3, 2.5)

Cold Fusion:
experimental "facts" assumed herein:

•Deuterons in Palladium and Nickel lattices can fuse to create Helium nuclei and heat in the form of lattice vibrations

•Protons in Nickel lattices can fuse to create Deuterium nuclei and heat in the form of lattice vibrations

Initial theoretical "implausibility:" Problem of the COULOMB BARRIER

•**Princeton University's Albert Einstein Professor of Science, P. J. E. Peebles, in his book on *Quantum Mechanics* (Princeton University Press, 1992, pp. 52-60), presents the mainstream argument and calculation:"…the 'tunneling rate' through the [repulsive] coulomb barrier [is] very slow. … That is why, despite the fact that there are many unresolved problems in condensed matter physics, people are confident that, if conventional quantum mechanics is valid, the deuterium fusion reaction rate in solids at room temperature is exceedingly slow." But Peebles earlier had wondered if he were "overlooking" any significant points in his calculations (which presumably echo Koonin, Baym *et al*, though he gives no specific citations). As a mathematician trained in nonlinear mechanics it was plain to me that Peebles *was* overlooking the periodicity of the lattice and presenting a local two-body analysis of what requires a global and many-body treatment.**

Rabinowitz ACID TEST

- **After co-authoring a survey of 173 published Cold Fusion theories [*Int. J. Theor. Phys.*, vol. 33 (1994), pp. 617-670], Mario Rabinowitz [private communication] stated that no CF theory of which he was aware, or could foresee based upon the survey, could explain why heavy water works in a Fleischmann-Pons type of electrolysis experiment with a palladium cathode, whereas ordinary water does not. Specifically, he predicted that if one divided by two the mass of the deuteron in the theory presently advocated herein , to study replacement of deuterons in a Pd lattice by protons, then it would predict an enhanced CF reaction, exactly contrary to empirical reality.**
- **Nevertheless, the presently advocated QRT theory passes the Rabinowitz Acid Test not only in the cited case, but in a total of 7 different particle/host-lattice pairs, 4 of which had not been published when this criterion was made public by Bass in June 1991.**

A new (albeit simplified) model

Contribution of Turner (September 1989):

Periodic array* of potential barriers can be *resonantly transparent

Contribution of Schwinger (1990):

A certain *dimensionless ratio* of lengths “sums up, albeit crudely, *all* of the forces at work in the lattice”

Contribution of Chubb (1990):

***Bloch’s Theorem* is fundamental principle of solid-state physics**

Contribution of R. Bush (1989):

***Duane’s Rule* enables quantization of linear momentum in lattices, a key step in determining the spectrum of Resonantly Transparent energy levels**

Contribution of Lamb & Parmenter (1989):

Coulomb-Madelung potential augmented by Fermi-Thomas-Mott enables inclusion of electron screening

Use these five concepts as inputs for new model

Basic model

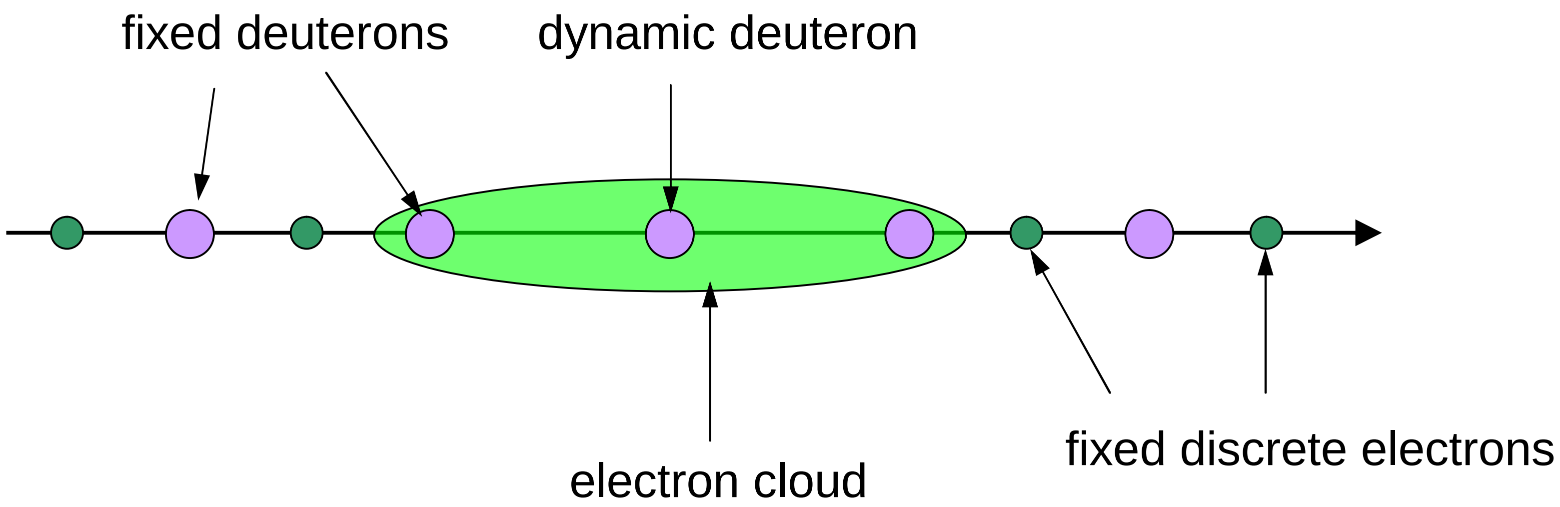
Would like to calculate dynamics of deuterons, host metal atoms and electrons in 3-D as route to completely understand phenomena …

But need simplifying approximations to make progress!

Some important approximations:

- **1-D approximation for 3-D physical system**
- **Host metal atom potentials neglected**
- **Neglect nuclear potentials**
- **Coulomb potentials adapted to 1-D problem**

What about the electrons?



Hybrid description:

Fixed point charge model away from area of interest

Quantum distribution near area of interest

Schwinger Ratio $\sigma = L/\Lambda$

Potential $V(r) \equiv V(-r) \equiv V(r + 2.L)$ for $-\infty < r < +\infty$.

Bound deuterons at $r = \pm k.L$, (k = 1, 2, 3, …) and an excited deuteron near $r = 0$.

“Averaged” electrons fixed between every pair of bound deuterons that are a distance L apart.

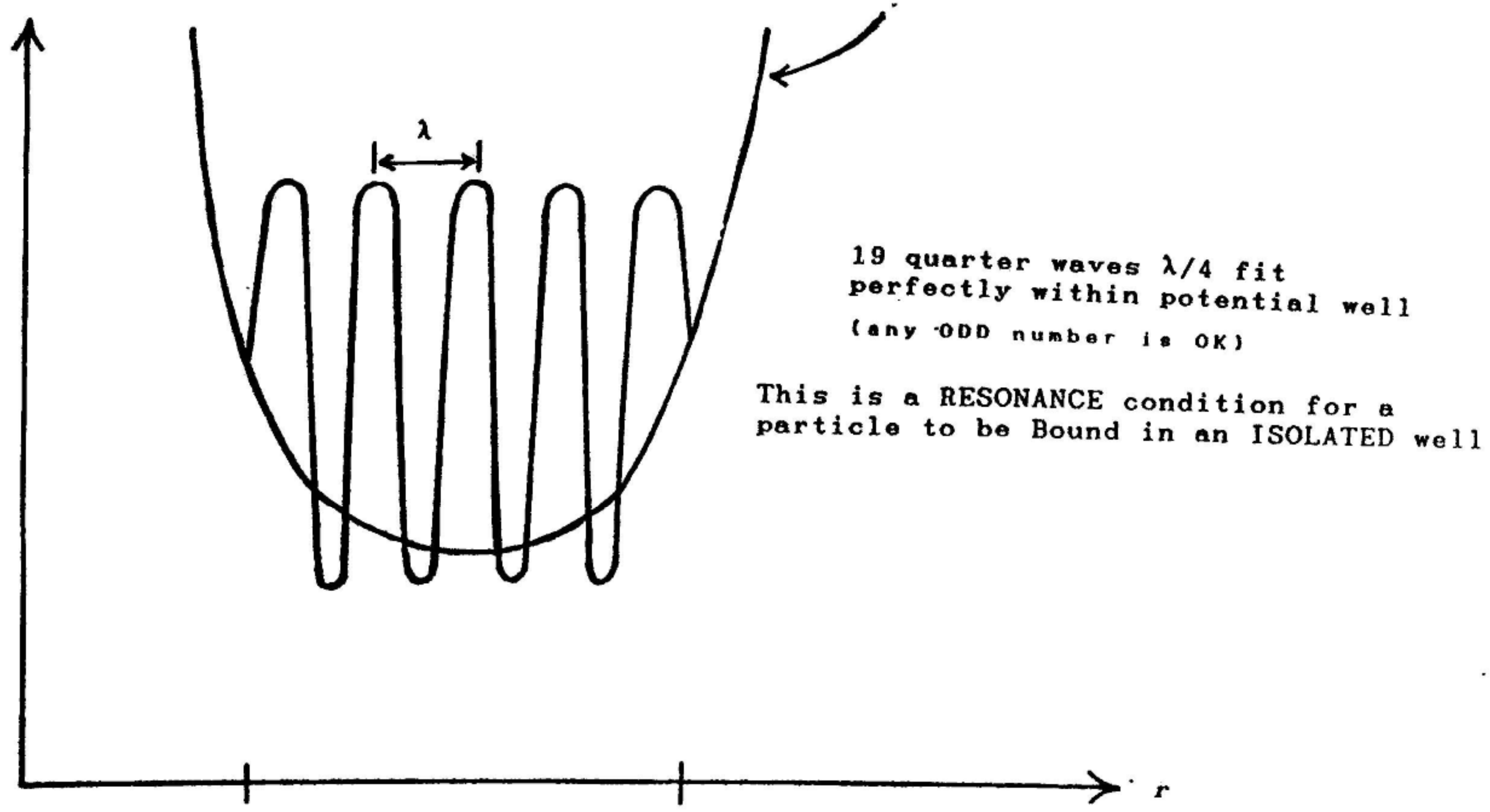
THREE electron charges in a uniform cloud smeared out between $-L$ and $+L$.

[Required for linear Lattice to be electrically neutral.]

Λ = *rms amplitude* of Zero Point Fluctuations (ZPF) of bound deuterons.

QRT Criterion for Resonant Transparency of the Coulomb Barrier

- following Turner in using standard QM (as in Bohm's classic book) Bass proved that the YES/NO answer is equivalent to whether or not $\sigma_{QRT} \equiv \sigma/\pi$ is closer to an **ODD** integer than to an **EVEN** one, whose physical interpretation is whether the de Broglie wave of an excited particle fits into the potential well between two adjacent bound particles.



WAVE-MECHANICAL TRAPPED PARTICLE

Free particle is Bound (in an Excited State) when the well-width
is an ODD multiple of one-quarter of the particle's
de Broglie wavelength

FIG. 3B

$L_w = 2L = 20 \cdot (\lambda/4)$ (20 is EVEN)

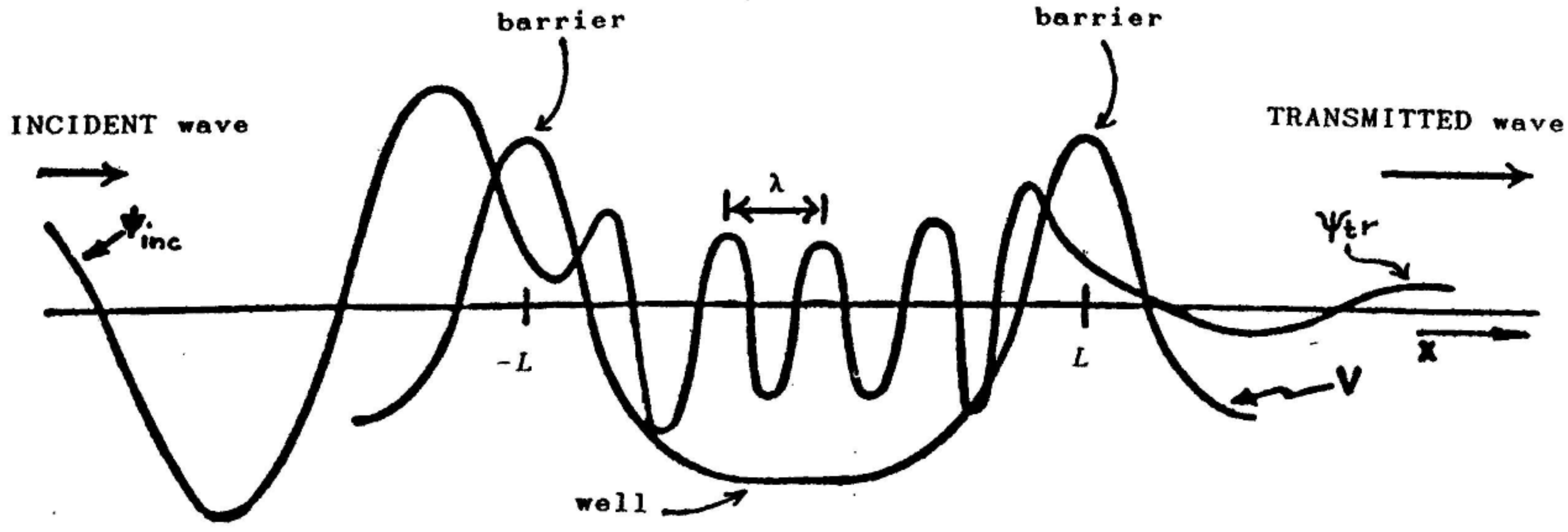


FIG. 5
[after BOHM]

Potential 'BARRIER-WELL-BARRIER' Configuration

WELL-WIDTH $L_w = 2L$ is <u>EVEN</u> multiple of Quarter-Wavelength ($\lambda/4$):

NO RESONANCE!

Intensity of Transmitted Wave LESS than Intensity of Incident Wave
(after many transmissions, wave is completely attenuated)

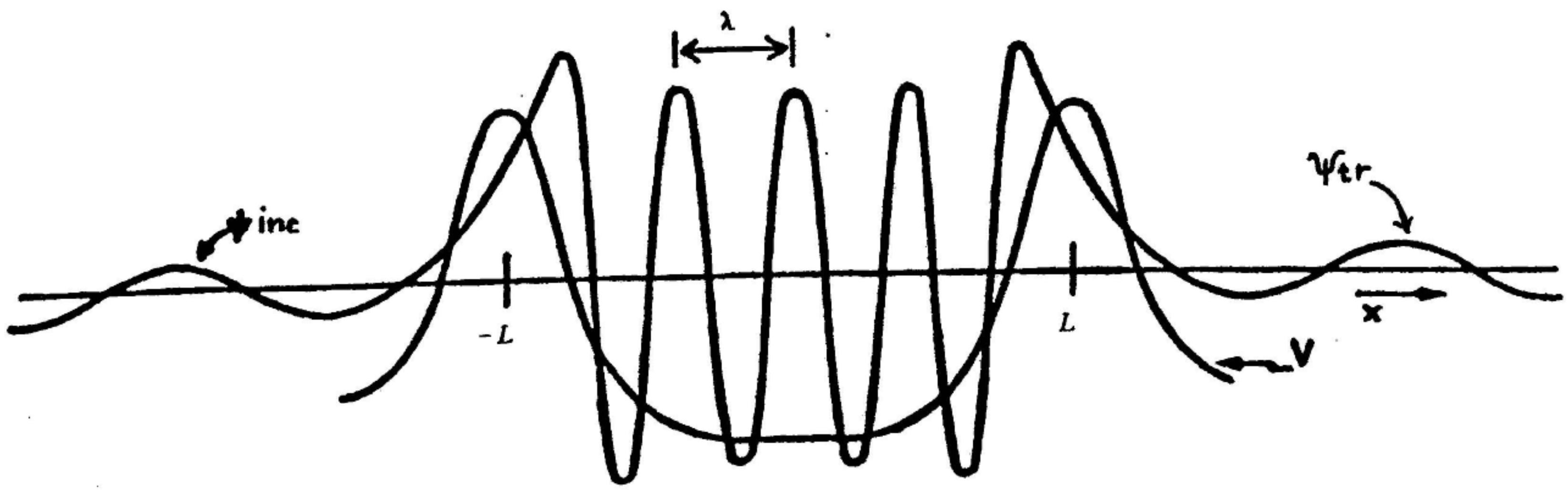


FIG. 6

[after BOHM]

Potential 'BARRIER-WELL-BARRIER' Configuration

WELL-WIDTH L_w = $2L$ is ODD multiple of Quarter-Wavelength ($\lambda/4$):

PERFECT RESONANCE!

Intensity of Transmitted Wave EQUALS Intensity of Incident Wave

Perfect Resonant Transmission = Resonant TRANSPARENCY

(note similarities & differences with FIG. 3B)

Analytical Proof of Schwinger's Conjecture

- Robert T. Bush's conjectured **spectrum of resonant transparency** of the Coulomb Barrier on either side of an excited particle is a function of basic constants of physics & mathematics, and of NOTHING ELSE but the dimensionless Schwinger ratio σ

Additional Confirmation

- using empirical data from Chubb & Chubb and Bockris, Bass successfully applied the preceding σ_{QRT} test not only to the above 3 pairs, but to 4 new pairs which had not been published in 1991, thereby showing the presciently predictive power of Schwinger's Conjecture, with a Confidence Limit of $100.(\,1\ -\ (1/2)^7\,) =$ **99.2%** that this is NOT a coincidence!

Schwinger/Turner/Bush/Chubb/Lamb-Parmenter/Bass theory, which is related to work of **Kim** & Zubarev, and **Li** *et al*) of Resonant Transparency of Coulomb Barrier in Periodic Lattices

Quantum Resonance Triggering (QRT principle)

Coulomb/Madelung/Fermi-Thomas/Mott Potential $V = V(r) \equiv V(r + 2.L)$, $-\infty < r < +\infty$.
Bound Positively-Charged Particles at $r = \pm k.L$, $k = 1,2,3, \ldots$

Averaged electrons at mid-points between bound particles,
except for $-L < r < L$, where three unit-charges are smeared out as an electron cloud.

Schwinger Ratio $\sigma = L/\Lambda$, Λ = rms amplitude of Zero Point Fluctuations (ZPF)

Potential validated by predicting Schwinger Ratio σ within one-third of one percent of measured reality, i.e. predicted accuracy 99.7%!

QRT Principle: A host-lattice pair is suitable for Cold Fusion (in the sense that the so-called "Coulomb Barrier" is actually a resonantly transparent mirror), if and only if the Schwinger Ratio divided by π, namely σ/π, is closer to an ODD than an Even integer.

DECISIVE TEST: Consider 4 possibilities, wherein host lattice is either Palladium or Nickel, and embedded positive particles are either Protons or Deuterons. Then host-particle **pair** is suitable for Cold Fusion if and only if it satisfies the QRT Principle, which turns out to be the case for Deuterons in Palladium or Nickel and for Protons in Nickel but NOT to be the case for Protons in Palladium! Thus the QRT Principle predicts **non-obvious** truth in 4 out of 4 cases!

ABSTRACT & SUMMARY

- The late physics Nobel Laureate, Julian Schwinger, had opined, in a 1990 paper given at ICCF1 and still accessible on my website at www.innoventek.com that what I am calling, in his honor, the **Schwinger Ratio** is **all-important** in understanding Cold Fusion. His exact words are**:** "Inasmuch as the **single parameter** **R_o/Lambda** combines, albeit crudely, the effects of **all the forces** at work **within the lattice**, the difficulties encountered in reproducing the cold fusion phenomenon become more understandable."
- Robert W. Bass has published **FOUR** different proofs, **in varying degrees of oversimplification**, that **a critical YES/NO answer as to whether or not Cold Fusion will work with a particular Host Lattice and a particular embedded Particle** is **whether or not** the Schwinger Ratio of this particular Host-Lattice/Particle combination is closer to an ODD or an EVEN integer

Since 2006 the following papers have been available on my website www.innoventek.com

Article 13: **Bass, presentation to MIT Cold Fusion Colloquium**

Article 15: **Generalized cause and effect demonstration protocol, pp 1009-1012, *Proc. ICCF10*, World Scientific, 2005**

Article 16: **Optimal laser wavelength for resonant transmission through the Coulomb barrier, pp. 1013-1017, *Proc. ICCF10*, World Scientific, 2005**

Article 17: **Julian Schwinger, "Nuclear energy in an atomic lattice," *Proc. 1CCF1*, March 1990**

Article 18: **R.W. Bass, "Experimental evidence favoring Brightsen's nucleon cluster model," *J. New Energy*, Feb. 1997**

Article 19: **Francesco Celani et al, "Preliminary Results with 'Cincinnati Group Cell' of Thorium Transmutation Under 50 Hz AC Excitation," *Proceedings ICCF7*, April 1998**

Article 20: **Robert W. Bass & Wm, Stan Gleeson, "Theoretical & Experimental Results re Low Energy Nuclear Reactions (LENR/CF)," *Trans. American Nuclear Society,* Vol. 83, pp. 355-56, Nov. 2000**

Article 23: **Robert W. Bass, "Parmenter's Fundamental Breakthrough Contributions," *Infinite Energy*, Issue 21, 1998, pp. 45-49 & 59**

Article 30: **Robert W. Bass, "Bi-Resonant Transparency of Quadruple Potential Wells & Correct Prediction of Schwinger Ratio from Madelung Forces," *ICCF-4*, December 5-9, 1993**

Article 31: **Robert W. Bass, "Bass-Merriman Debate & Shortest Derivation of Bass's [Host-Lattice/Particle] Schwinger-Ratio-Odd [rather than Even] predictive Cold Fusion criterion"**

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ITEMS \CF AUTHORS	Bass	Bush	Chubbs	Kim	Parmenter	Rabinowitz	Schwinger	Turner
ZPF/LV (Zero Point Fluctuations & Lattice Vibrations, rms amplitude *Lambda* for bound nuclei)	X	X	X	X	X	X	X	X
Schwinger Ratio *Sigma* = *L* / *Lambda*, embedded Lattice Period *L*								
Conjectured Definitive Significance of *Sigma*							X	
Provided *Lambda*			X					
First Principles Derivation, Validated *Sigma* Predictn.	X							
Phonons: Heat Mediation & Inverse-Mossbauer-Effect Ion Excitation & De-excitation	X	X	X		X		X	
Chain Fusion	X						X	
QRT Ion Excitation: Resonant Non-Elastic Collision Criterion (*Sigma* / *Pi* = ODD integer)	X	X						
Globally Valid Potential *V*(*r*) : OK near collision	X		X	X	X	X		
Velocity Distribution								
Fusion Rate Enhancement				X	X			
Resonant Line-Broadening	X	X						
Periodic *V*(*r*) = *V*(*r*+*L*) in Solid-State Lattice	X	X	X			X		X

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Floquet-Bloch Theorem: grad(log(*psi*)) Required Spatially Periodic of Lattice Period *L*	X	X	X					X
Effective **Delta-Mass:** from Periodic *V*(*r*)					X	X		
Electron **Screening:** Fusion Rate Enhancement	X		X	X	X	X	X	
Madelung Forces: Fusion Rate Enhancement	X		X		X		X	
3-D Mossbauer Analysis			X		X			
Conduction Electrons in Host Lattice => *Lambda*	X		X		X			
Duane's Rule: for Inelastic Collisions & Resonant Transmission	X	X	X					
Excitation Energy Levels for **Resonant** Transparency of Coulomb Barrier	X	X			X			X
Nuclear Well Considered	X				X			
Heat vs **Loading** Prediction		X						
Heat vs **Current** Prediction (Bush TRM Fine Structure)	X	X						
QRT: Host-Lattice OK for Deuterons vs Protons Validated **Predictions!**	X							

ANNOUNCEMENT

At ICCF1, I proposed to use the Engineering Technique of **"Black-Box, Hidden State Variables *Identification*"** wherein Input/Output signals are used to find a Linear Time-Invariant (**LTI**) Dynamical System which comes closest to **"predicting"** the measured **Output Signals**, given **solely** the **model** and the **Input Signals**. My recent collaboration with Mitchell Swartz proved that this "ID approach" is feasible, but also uncovered difficulties which I had not anticipated. Yet a week ago I made a real breakthrough in LTI System ID technology and so offer to provide FREE Data Reduction Services to anyone who would like to provide me with historical records of I/O data signals, such as Voltage, Current, Temperature, Excess Heat Power, etc.

For more **details** regarding my 1991 & 1994 calculations and MATLAB computer codes used, consult my website www.innoventek.com,

where in the near future I intend to post **several more** of my old papers in hopes of stimulating someone younger to carry on where I left off.

Potential collaborators may reach me at:

donquixote@innoventek.com

Prologue

This may be my last presentation at a Cold Fusion conference for several years, or until AFTER I have retired from my present challenging & demanding full-time aerospace job in Electromechanical Control Systems Analysis & Synthesis.

What I am claiming now is **NOT** to have the **"best"** **final theory** of Lattice Induced Nuclear Reactions (**LANR**), but the **"best"** **STARTING POINT** theory.

There are half-a-dozen theoreticians presently active in this field who have the expertise to IMPROVE the present theory in different directions, but to the best of my present knowledge there are **no other theories** which: **[a]** **pass** the "Rabinowitz Acid Test" in predicting Cold Fusion will work during electrolysis of heavy water with Palladium Cathodes but not with ordinary water, whereas either will work with Nickel Cathodes; **[b]** **predict** a relevant **empirically-measured parameter** with 99.7% accuracy; **[c]** **prove** that while the Coulomb barrier is indeed "resonantly transparent" at certain energy levels of an excited charged nucleus, it cannot get past the strong force potential well and so **must** fuse [which was demonstrated in the improved version of what I had presented at ICCF4 that I offered at ICCF5].