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Commercializing a Next-Generation Source of Safe CO_2-free Energy

Electroweak neutron production via $e + p \rightarrow n + \nu$ and capture during lightning discharges

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Introduction: 'bare bones' of Widom-Larsen

First step requires input energy:

$$Energy_{E\text{-}field} \rightarrow e^{-*} + p^{+} \rightarrow n + \nu_e$$

$$Energy_{B\text{-}field} \rightarrow e^{-} + p^{+} \rightarrow lepton + X$$

Electroweak neutron production

Afterwards neutron capture:

$$n + (Z, A) \rightarrow (Z, A+1)$$

$$(Z, A+1) \rightarrow (Z + 1, A+1) + e_{\beta}^{-} + \nu_e$$

β^- decay of neutron-rich products

- ✓ **Prior to advent of Widom-Larsen theory, astrophysicists thought that "*neutronization*" only occurs during supernova detonations**
- ✓ **No "new physics" in any of this: all we did was integrate many-body collective effects with modern electroweak theory under the 'umbrella' of the Standard Model; vast experimental data**
- ✓ **Without many-body collective effects, none of this could occur at substantial rates under moderate temperatures and pressures!**

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Widom-Larsen theory: LENRs in lightning

- ✓ **We started by analyzing and explaining the case of LENR transmutations observed in high pulsed-current exploding wires with cylindrical geometries; collective many-body *magnetic* effects (B-fields) dominate therein; this differs from condensed matter chemical cells wherein micron-scale, nuclear-strength local E-fields and local breakdown of Born-Oppenheimer are very much more important**
- ✓ **Once you understand LENRs in such a case, lightning discharges are conceptually just a big exploding wire up in the sky! Moreover, LENRs in solar flux tubes and flares are a direct extension of the very same thinking**

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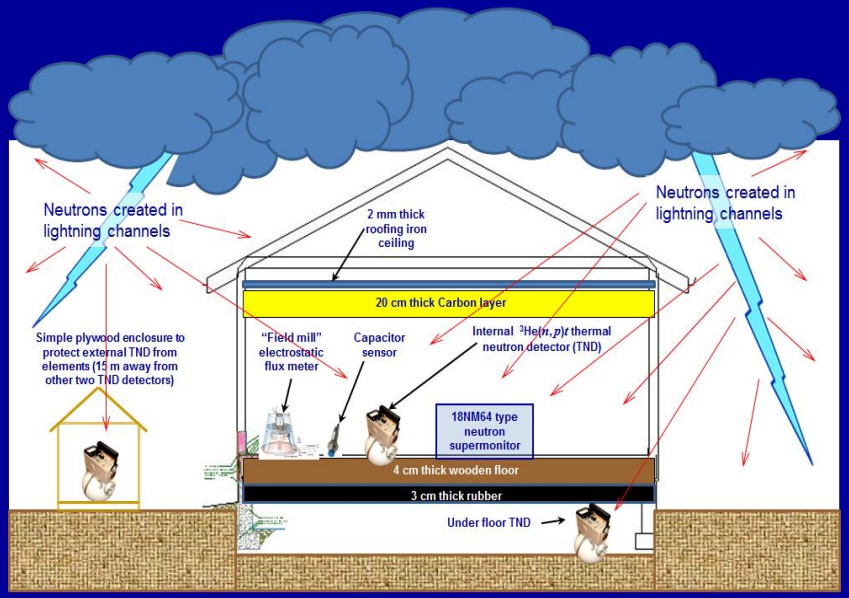
New Russian data confirms Widom-Larsen

- ✓ **2012 - Gurevich *et al*. publish new data reporting neutron bursts in lightning exactly as predicted by Widom-Larsen**
- ✓ **Size of these neutron fluxes is too large to be accounted-for by previously very popular photonuclear mechanism (fusion had been excluded as a viable possibility years ago)**
- ✓ **Our theoretical work is the only mechanism that can readily explain Russian data**

***"Strong flux of low-energy neutrons produced by thunderstorms,"* A. Gurevich *et al., Physical Review Letters* 108 pp. 125001 - 4 (March 2012)**



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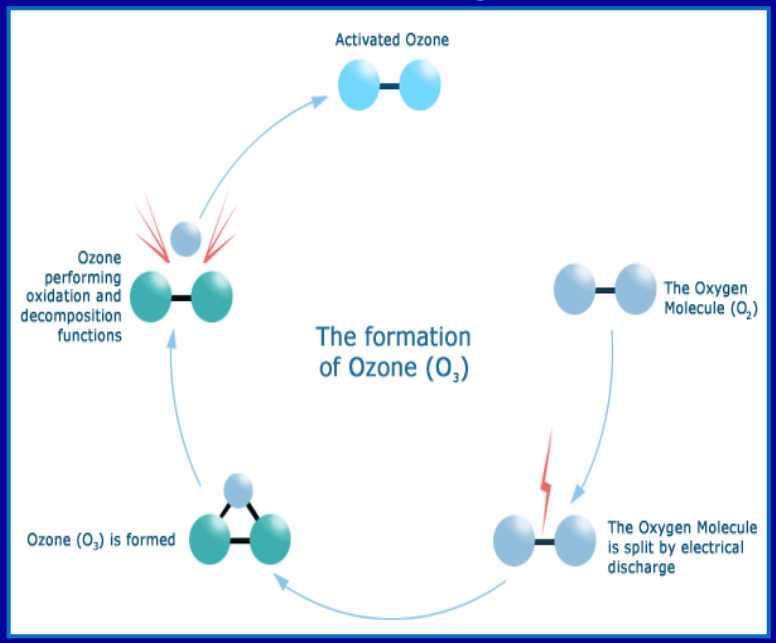
Isotopic fractionation in atmosphere

- ✓ **Numerous published reports with measurements showing very substantial variations in atmospheric Oxygen and Nitrogen isotopic ratios**
- ✓ **Until now, these variations all were explained by invoking various types of chemical-only isotope fractionation processes**
- ✓ **However, captures of LENR neutrons produced in lightning can also produce same results; *thus mimic chemical processes***

Lightning creates much ozone

$O_2 \rightarrow O_3$



Opportunities to capture LENR neutrons during discharges

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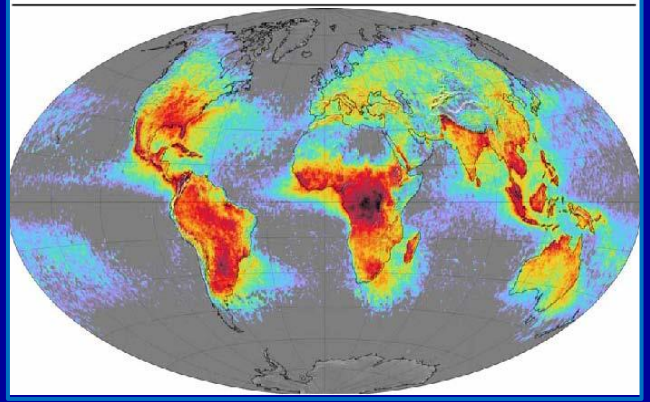
Neutron capture on gaseous N_2, O_2 & Sulfur

- ✓ **By volume in Earth's atmosphere, Nitrogen amounts to ~78%, Oxygen ~21%; Sulfur compounds also present in air as well-dispersed molecular aerosols, e.g. SO_2 in volcanic clouds**
- ✓ **All of these elements are potentially exposed to LENR neutrons which could be captured during lightning**
- ✓ **Lightning has occurred in Earth's atmosphere since condensation from presolar nebula ~4.5 billion years ago**
- ✓ **LENRs were active in Earth's past and are occurring today over our heads!**

Table 1–2 Principal gases of dry air

Constituent	Percent by Volume	Concentration in Parts Per Million (PPM)
Nitrogen (N_2)	78.084	780,840.0
Oxygen (O_2)	20.946	209,460.0
Argon (Ar)	0.934	9,340.0
Carbon dioxide (CO_2)	0.036	360.0
Neon (Ne)	0.00182	18.2
Helium (He)	0.000524	5.24
Methane (CH_4)	0.00015	1.5
Krypton (Kr)	0.000114	1.14
Hydrogen (H_2)	0.00005	0.5



Map: lightning flash frequency

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Chemical fractionation process vs. LENRs?

- ✓ **Chemical fractionation invoked to explain many isotopic data for 60 yrs**
- ✓ **Although not *explicitly* mentioned, underlying fundamental assumption is that no significant amounts of non-stellar nucleosynthesis has occurred in any solar system materials since condensation of the presolar nebula**
- ✓ **Caution: if LENRs occur in lightning, it implies longtime assumption that *all such isotopic variance can only be result of chemical processes* is not necessarily true for all such data**

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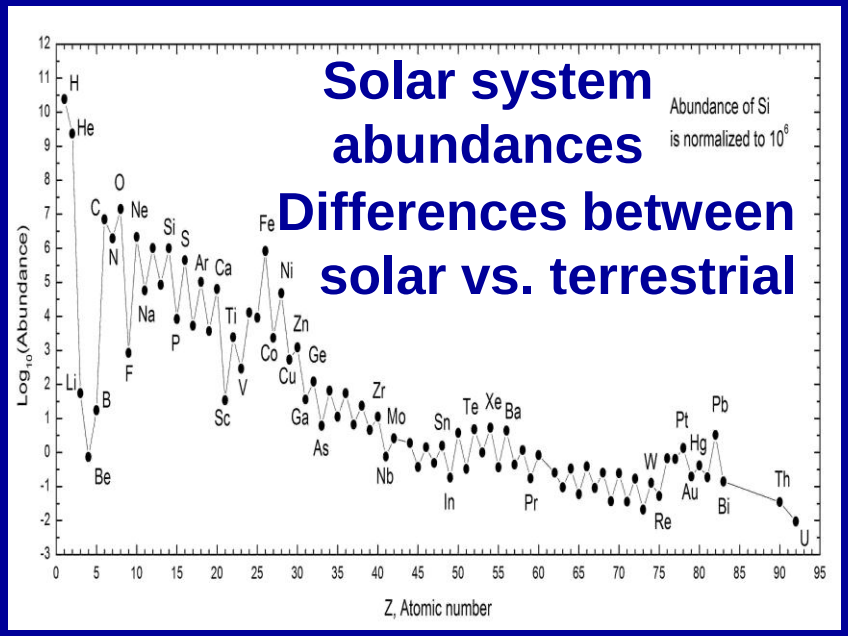
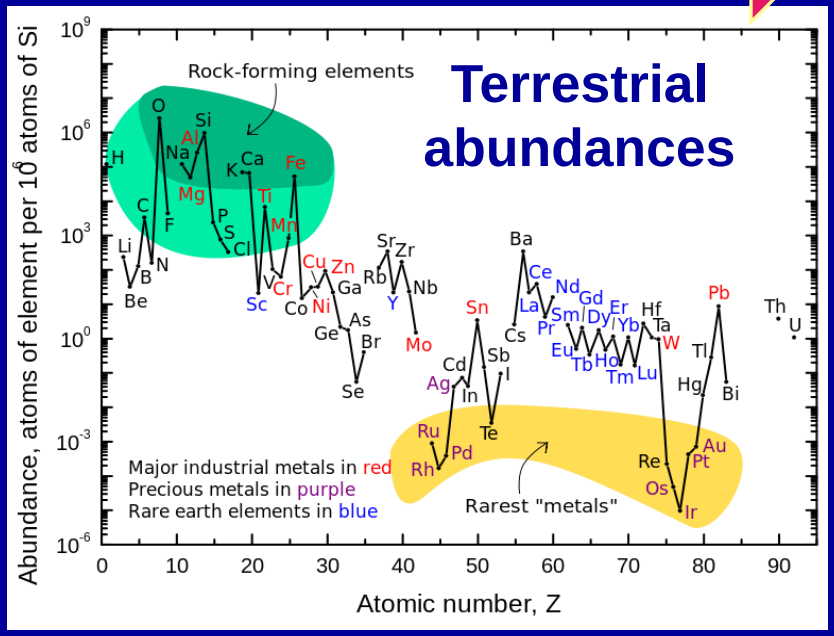
LENRs in terrestrial geochemical evolution?

- ✓ **If lightning-driven LENRs have been occurring in solar system for past ~4.5 billion years, should see telltales in isotopic record**

Is it a mixture of earlier stellar and more recent LENR processes?





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NASA Genesis Mission published results

- ✓ **To get better fix on true chemical and isotopic composition of the Sun, NASA's 2001 Genesis probe was designed to collect and return (2004) samples of 'pristine' solar wind for analysis**
- ✓ **See paper: "*Solar composition from the Genesis Discovery Mission,*" D. Burnett and Genesis Science Team, *PNAS* (2011)**
- ✓ **Quoting: *"…Several well studied natural processes exist which fractionate isotopes relative to the assumed Standard model values, but none of these explain the variations shown on Figure 3 … origin of the discrepancy [in O] is unknown."***
- ✓ **Burnett *et al*. (*ibid.*) concluded, *"…variations in $^{15}N/^{14}N$ [ratio] are much larger than O [ratio] and cannot be explained by well studied mechanisms of isotope fractionation."***

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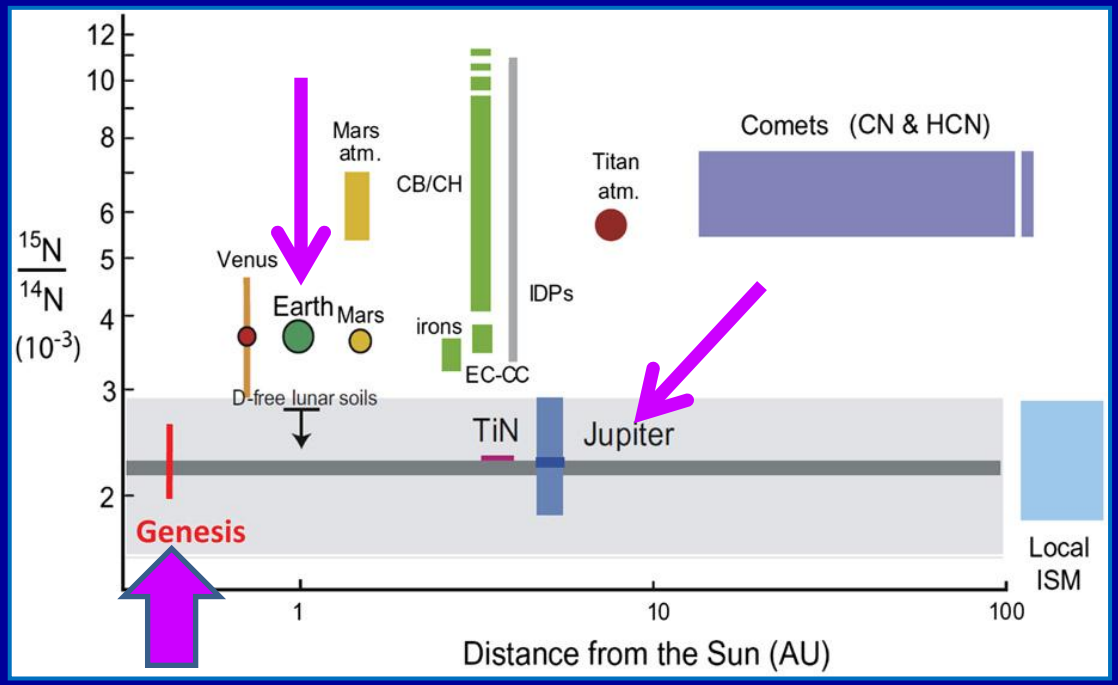
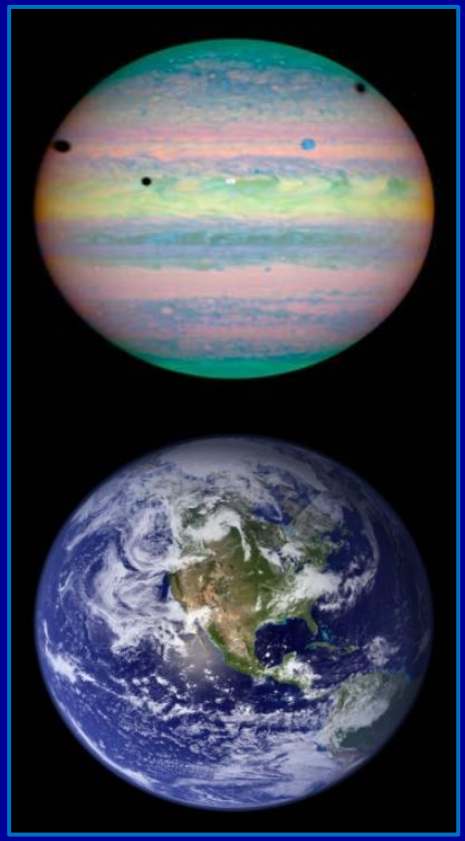
NASA Genesis Mission published results

Chemical fractionation process cannot explain this $^{15}N/^{14}N$ data

Except Jupiter, $^{15}N/^{14}N$ is larger further from Sun





Adapted from Nitrogen isotopic data found in Figure 3. Burnett *et al.*, *PNAS* (2011)

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LENRs in chemical evolution of solar system

- ✓ **Under right conditions, huge electric current pulses in lightning discharges can drive electroweak neutron production & LENRs**
- ✓ **This process is effectively star-like nucleosynthesis and will tend to create progressively higher-Z chemical elements over time**
- ✓ **If lightning-driven LENR nucleosynthesis has in fact been occurring in solar system since era of the presolar nebula, then puzzling isotopic and elemental anomalies reported in NASA Genesis Mission data might be explained by LENR processes**
- ✓ **Many exciting opportunities to collect important new data await experimentalists who have access to good mass spectroscopy**
- ✓ **Need <u>many more</u> good experimental measurements of isotopes**

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Many opportunities await in future research

- ✓ **New, potentially important areas of R&D opportunity have been identified by applying the WLT many-body collective paradigm**
- ✓ **Other potentially revolutionary technological possibilities and yet-to-be answered scientific questions are outlined in Lattice's online documents at http://www.slideshare.net/lewisglarsen**
- ✓ **We believe that what is apparent so far has only scratched the surface of total universe of opportunities that might be unearthed by exploiting and further elaborating the conceptual power of the new paradigm utilized in our theory of LENRS**
- ✓ **Many fruitful and potentially very important lines of inquiry await talented experimentalists, theoreticians, and technologists**
- ✓ **Vastly more scientists studying interdisciplinary LENRs needed!**

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Example: an opportunity for future research

Travel to the remote Catatumbo River in Venezuela

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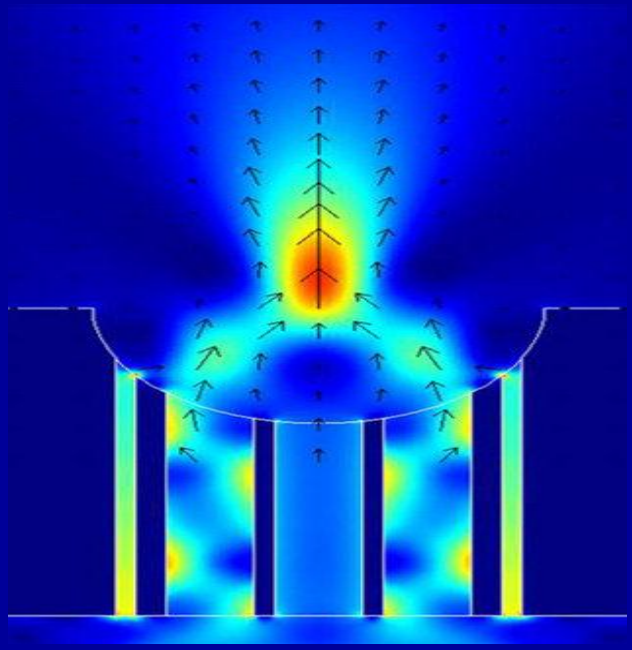
Two key references to Widom-Larsen theory

Suggestion: please start with Pramana, then EPJC

"Ultra Low Momentum Neutron Catalyzed Nuclear Reactions on Metallic Hydride Surfaces"
A. Widom and L. Larsen
***European Physical Journal C - Particles and Fields* 46 pp. 107 (2006)**

"A primer for electroweak induced low-energy nuclear reactions"
Y. N. Srivastava, A. Widom, and L. Larsen
***Pramana - Journal of Physics* 75 (4) pp. 617 - 637 (2010)**



Concentrating E-M energy in a resonant electromagnetic cavity

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Photo: Lloyd DeGrane (Chicago)

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Final thought: Robert Laughlin on many-body collective effects

"I am increasingly persuaded that all physical law we know about has collective origins, not just some of it."

"… I think a good case can be made that science has now moved from an Age of Reductionism to an Age of Emergence, a time when the search for ultimate causes of things shifts from the behavior of parts to the behavior of the collective … Over time, careful quantitative study of microscopic parts has revealed that at the primitive level at least, collective principles of organization are not just a quaint sideshow but everything --- the true essence of physical law, including perhaps the most fundamental laws we know … nature is now revealed to be an enormous tower of truths, each descending from its parent, and then transcending that parent, as the scale of measurement increases."

"Like Columbus or Marco Polo, we set out to explore a new country but instead discovered a new world."

Robert Laughlin, "*A Different Universe - Reinventing Physics from the Bottom Down,*" Basic Books, 2005, pp. xv and 208
Nobel prize in physics (1998) for contributions to our understanding of the fractional quantum Hall Effect

Welcome to New World of collective many-body LENR nucleosynthesis!