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

Low Energy Neutron Reactions (LENRs)

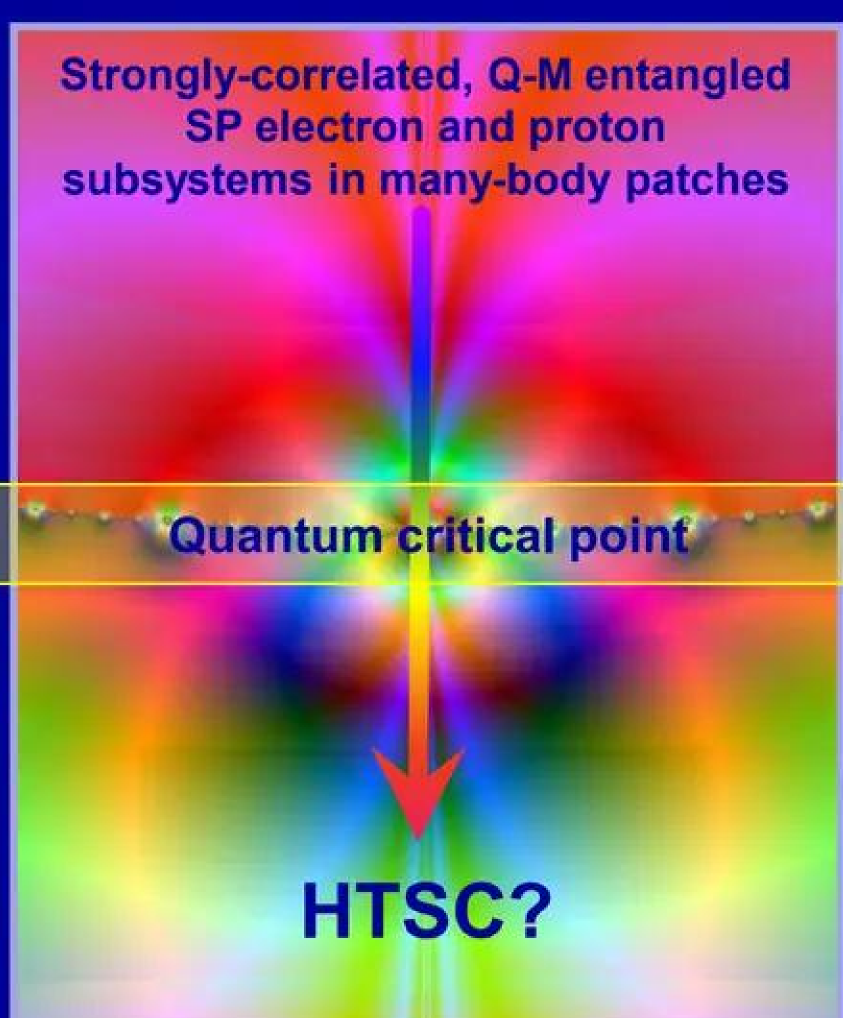
Addendum to August 23, 2012 Lattice presentation re:

Evanescent HT or RT superconductivity in heavy-electron 'patches'?

September 5, 2012: Shukla & Eliasson posted an excellent new paper on arXiv:

"*Clustering of ions at atomic dimensions in quantum plasmas*"

Supports our speculative conjecture about Cooper pairing of protons in Widom-Larsen 'patches'



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September 11, 2012
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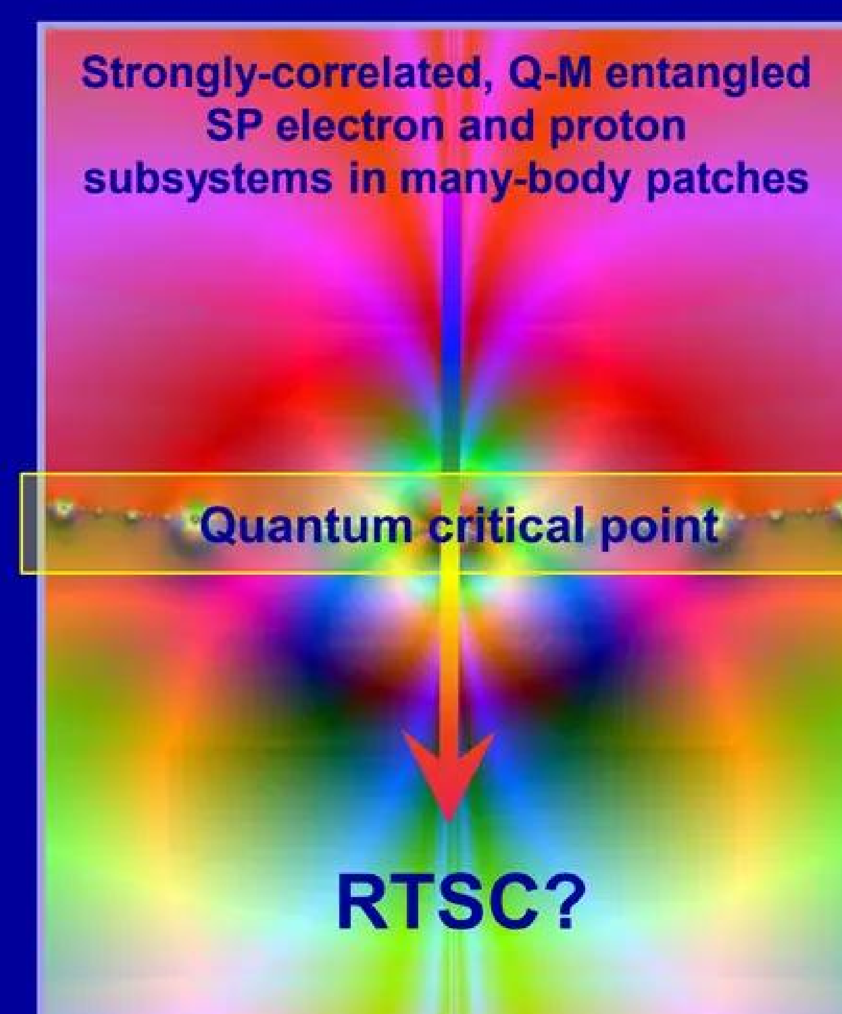
"I have learned to use the word 'impossible' with the greatest caution."

Wernher von Braun



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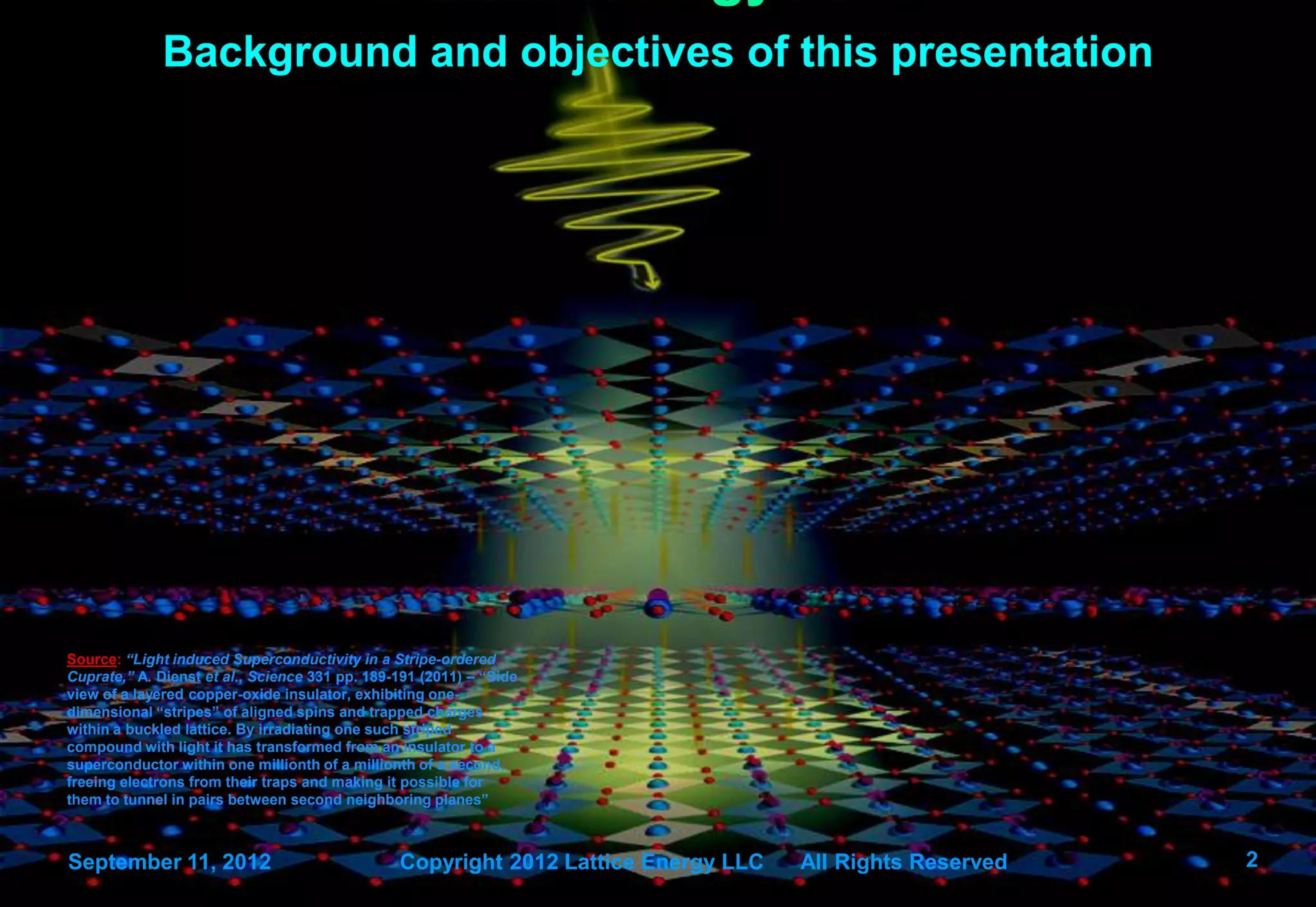
Background and objectives of this presentation



Source: *"Light induced Superconductivity in a Stripe-ordered Cuprate,"* A. Dienst *et al.*, *Science* 331 pp. 189-191 (2011) – "Side view of a layered copper-oxide insulator, exhibiting one-dimensional "stripes" of aligned spins and trapped charges within a buckled lattice. By irradiating one such striped compound with light it has transformed from an insulator to a superconductor within one millionth of a millionth of a second, freeing electrons from their traps and making it possible for them to tunnel in pairs between second neighboring planes"

Background and objectives of this presentation

Shukla & Eliasson's new mechanism provides an attractive force

Main Lattice reference to examine is a 92-slide August 23, 2012, PowerPoint presentation:

"*Speculation: evanescent 'exotic' superconductivity (some form of HTSC) in heavy-electron 'patches'?*"

http://www.slideshare.net/lewisglarsen/lattice-energy-llc-hightemperature-superconductivity-in-patchesaug-23-2012

- ✓ **For all the specific details, please see discussion on Slides #49 - 90 in above document**
- ✓ **Briefly summarizing from that document: conceptually, once local nuclear strength E-fields form in a given μ-scale patch, we have two many-body, ~2-D disk-shaped, Q-M entangled, strongly-correlated subsystems of oppositely charged particles that are mutually coupled to each other via E-M fields and to 'underlying' substrate subsystem; if Cooper pairs of electrons and protons were to form, these two particle subsystems could be viewed as 'mirror' quantum condensates (see Slide #14 herein and Slide #81 in Aug. 23 document)**
- ✓ **Attractive force between positively-charged ions would help facilitate formation of proton Cooper pairs: while it is not terribly difficult to imagine creation of Cooper pairs of entangled electrons in an SP electron patch subsystem, the issue of comparable pairing for protons is somewhat unfamiliar - more problematic. Like electrons, the problem with Coulomb repulsion between protons is obvious. That being the case, viewing the proton patch subsystem as a quantum plasma, is there an attractive force between protons (p^+) that might plausibly facilitate the formation of bosonic Cooper pairs in a W-L patch? It turns-out that there may well be such a force; please see:**
- ✓ **Cited on Slide #17 herein and on Slide #84 in August 23 document:**

"*Novel attractive force between ions in quantum plasmas*"
P. Shukla and B. Eliasson
***Physical Review Letters* 108 pp. 165007 - 165012 (2012)**
http://arxiv.org/pdf/1112.5556v7.pdf

Background and objectives of this presentation

Shukla & Eliasson's conclusions support idea of p^+ Cooper pairs

Please see preprint of their latest paper concerning the very novel "SE force" ion attraction mechanism:

- ✓ "*Clustering of ions at atomic dimensions in quantum plasmas*"
  P. Shukla and B. Eliasson
  September 5, 2012 (version #2 --- revised preprint published on Sept. 7, 2012)
  http://arxiv.org/pdf/1209.0914v2

- ✓ Directly quoting their abstract: "By means of particle simulations of the equations of motion for ions interacting with the newly discovered Shukla-Eliasson (SE) force in a dense quantum plasma, we demonstrate that the SE force is powerful to bring ions closer at atomic dimensions. Specifically, we present simulation results on the dynamics of an ensemble of ions in the presence of the SE force without and with confining external potentials and collisions between the ions and degenerate electrons. Our particle simulations reveal that under the SE force, ions attract each other, come closer and form ionic clusters in the bath of degenerate electrons that shield the ions. Furthermore, an external confining potential produces robust ion clusters that can have cigar-like and ball-like shapes. The binding between the ions on account of the SE force may provide possibility of non-Coulombic explosions of ionic clusters for inertial confined fusion (ICF) schemes when high-energy density plasmas (density exceeding 10^{23} per cubic centimeters) are produced by intense laser and relativistic electron beams. At such high plasma densities, the electrons will be degenerate and quantum forces due to the electron recoil effect caused by the overlapping of electron wave functions and electron tunneling through the Bohm potential, electron-exchange and electron correlations associated with electron-1/2 spin effect, and the quantum statistical pressure due to the Fermionic nature of degenerate electrons play a decisive role in producing the novel phenomena we describe in this paper."

- ✓ Quoting directly from their conclusions: "Specifically, we stress that the Cooper pairing of ions at atomic dimensions shall provide possibility of novel superconducting plasma based nanotechnology, since the electron transport in nanostructures would be rapid due to shortened distances between ions in the presence of the novel SE attractive force."

- ✓ Lattice comment thereon: while further investigation and calculations must certainly be undertaken, it appears that the newly discovered SE force between ions embedded in quantum plasmas may provide a mechanism that could potentially help facilitate the formation of Cooper pairs of protons in certain types of condensed matter systems as well as Widom-Larsen heavy electron patches as conjectured by this author

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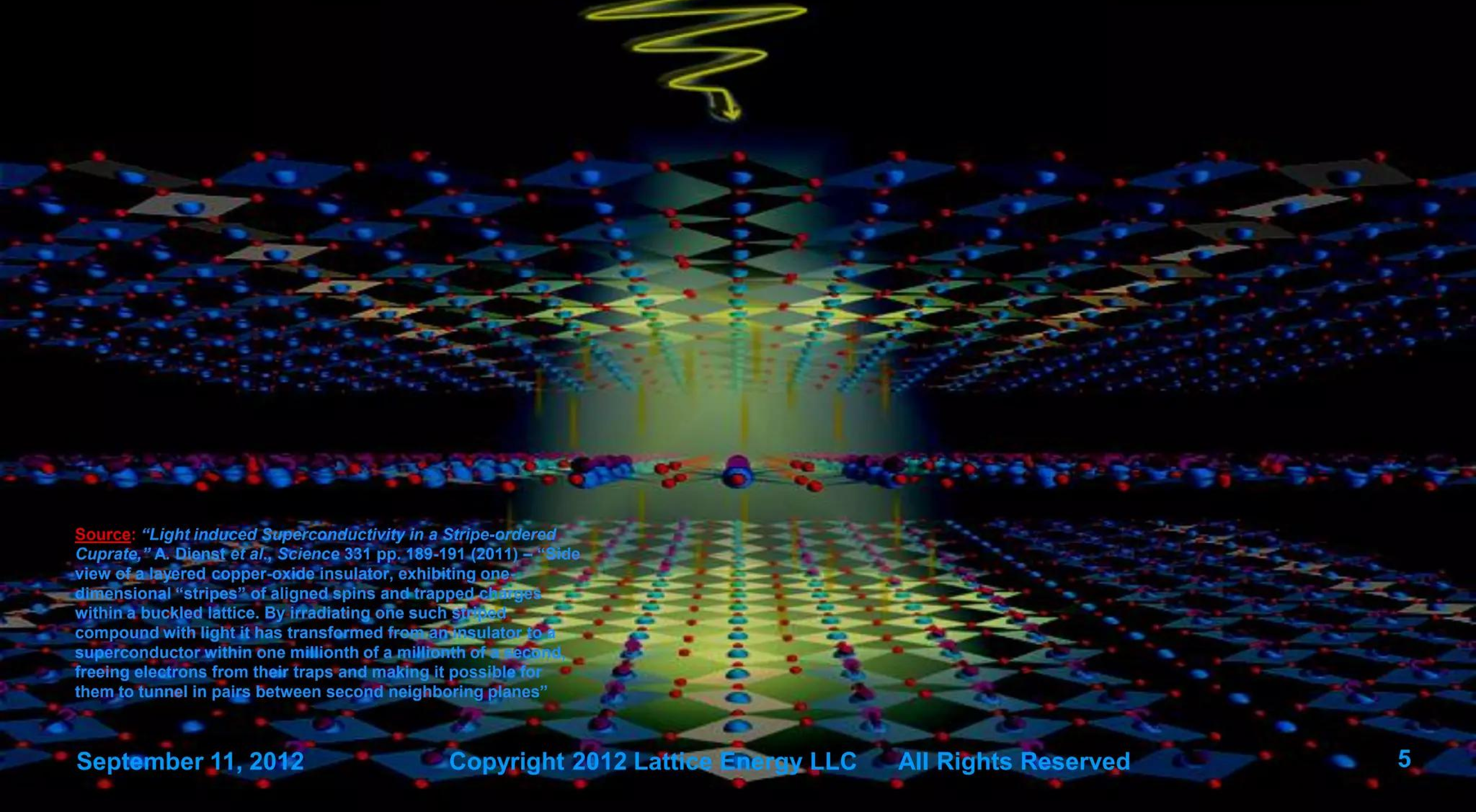
Following was extracted from August 23, 2012 PowerPoint

This information has been included to provide sufficient context so that readers are not compelled to immediately refer to the earlier document



<u>Source</u>: *"Light induced Superconductivity in a Stripe-ordered Cuprate,"* A. Dienst *et al.*, *Science* 331 pp. 189-191 (2011) – "Side view of a layered copper-oxide insulator, exhibiting one-dimensional "stripes" of aligned spins and trapped charges within a buckled lattice. By irradiating one such striped compound with light it has transformed from an insulator to a superconductor within one millionth of a millionth of a second, freeing electrons from their traps and making it possible for them to tunnel in pairs between second neighboring planes"

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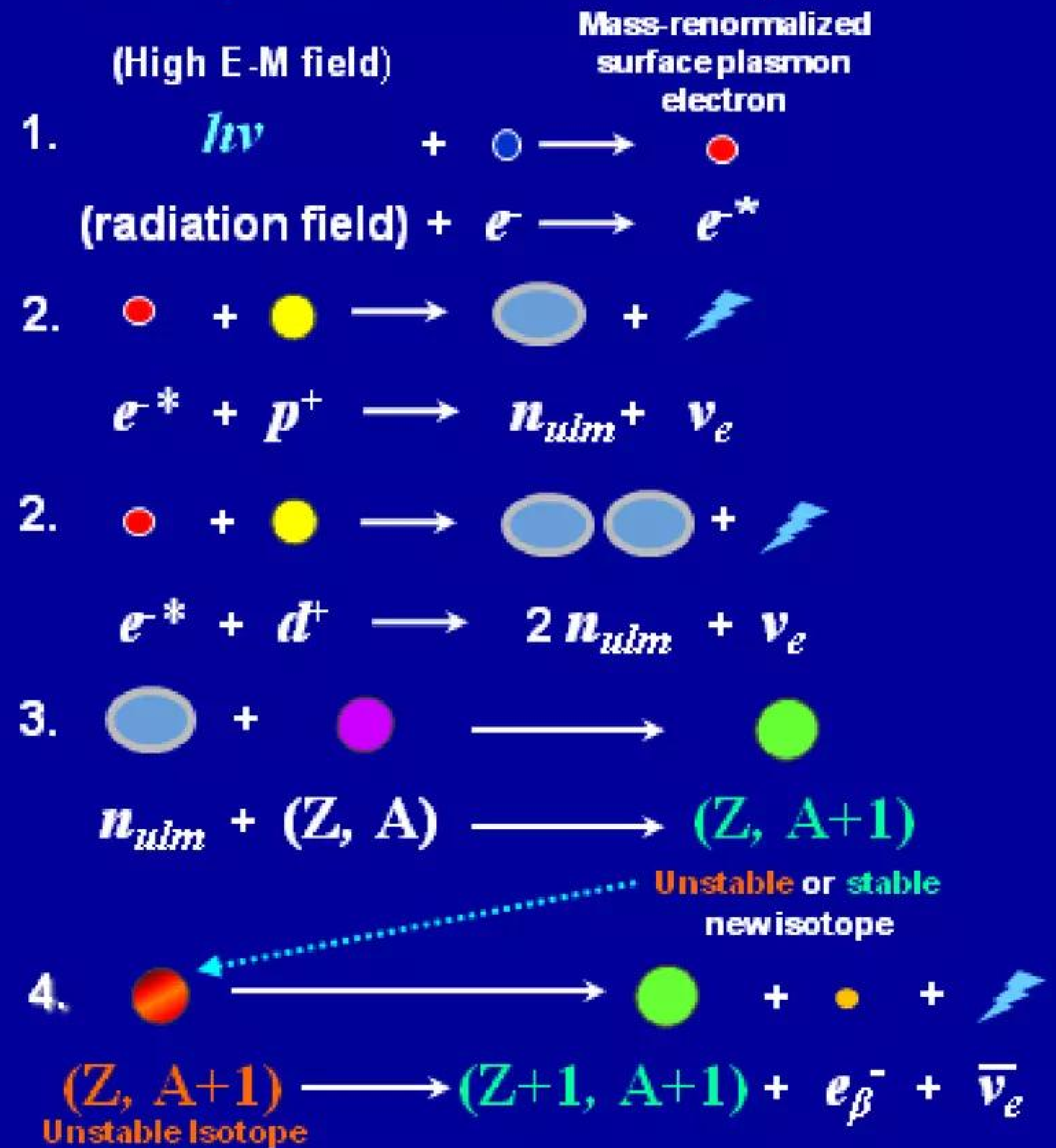
Overview of W-L theory in condensed matter systems

Weak interaction is crucially important in neutron-catalyzed LENRs

1. E-M radiation on metallic hydride surface increases mass of surface plasmon electrons
2. Heavy-mass surface plasmon electrons react directly with surface protons (p^+) or deuterons (d^+) to produce ultra low momentum (ULM) neutrons (n_{ulm} or 2 n_{ulm}, respectively) and an electron neutrino (ν_e)
3. Ultra low momentum neutrons (n_{ulm}) are captured by nearby atomic nuclei (Z, A) representing some element with charge (Z) and atomic mass (A). ULM neutron absorption produces a heavier-mass isotope (Z, A+1) via transmutation. This new isotope (Z, A+1) may itself be a stable or unstable, which will perforce eventually decay
4. Many unstable isotopes β^- decay, producing: transmuted element with increased charge (Z+1), ~ same mass (A+1) as 'parent' nucleus; β^- particle (e_β^-); and an antineutrino $\overline{\nu}_e$

<u>Note</u>: colored shapes associated with diagram on next Slide

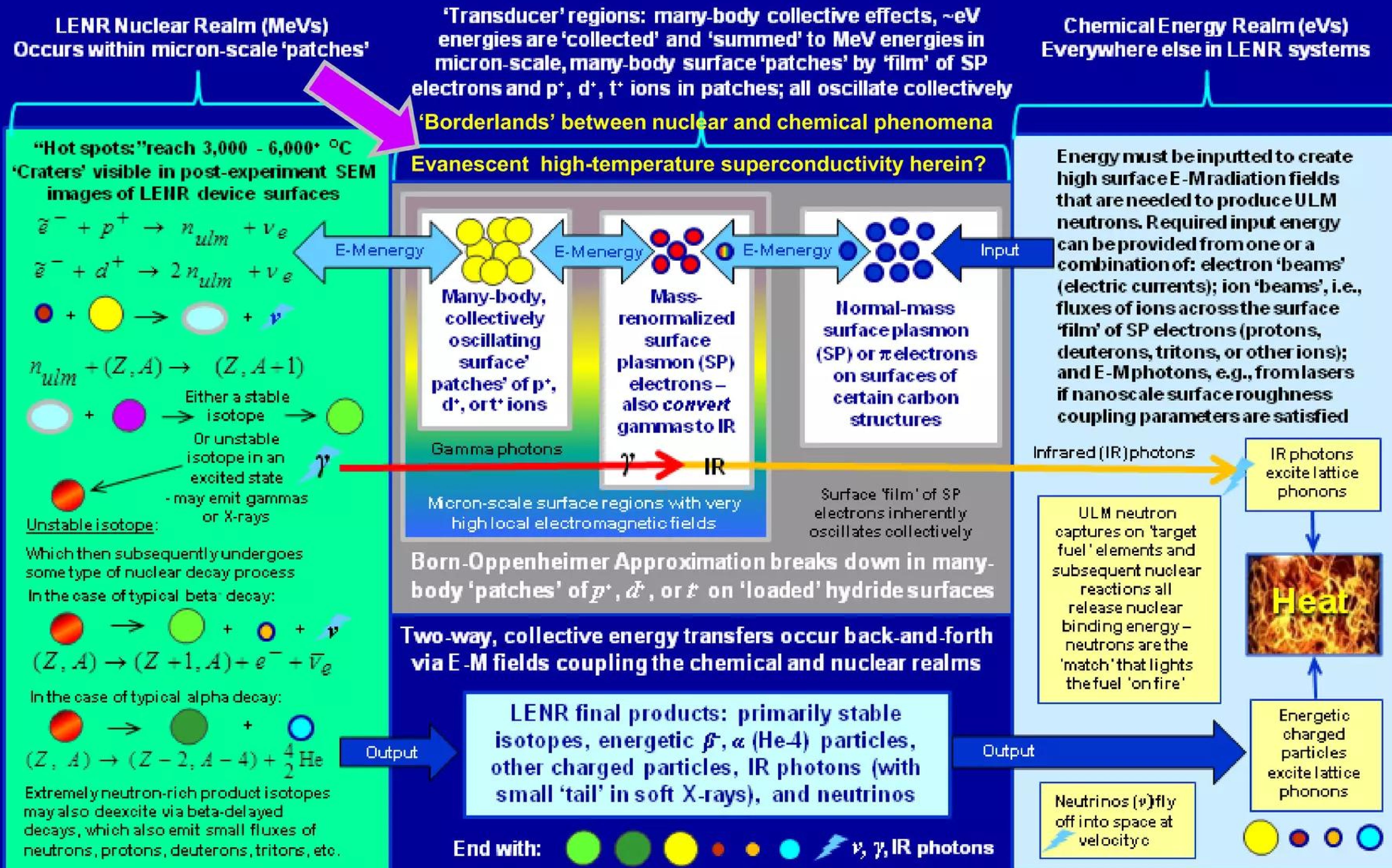
No strong interaction fusion or heavy element fission occurring below; weak interaction $e + p$ or $e + d$



Weak interaction β^- decays (shown just above), direct gamma conversion to infrared photons (not shown), and α decays (not shown) produce most of the excess heat calorimetrically observed in LENR systems

Chemical and nuclear realms interconnect at nm-μ scales

HTSC may be occurring at dynamic 'borderlands' between the two realms



$$\tilde{e}^- + p^+ \rightarrow n_{ulm} + \nu_e$$
$$\tilde{e}^- + d^+ \rightarrow 2n_{ulm} + \nu_e$$
$$n_{ulm} + (Z,A) \rightarrow (Z,A+1)$$
$$(Z,A) \rightarrow (Z+1,A) + e^- + \bar{\nu}_e$$
$$(Z,A) \rightarrow (Z-2,A-4) + {}^4_2He$$

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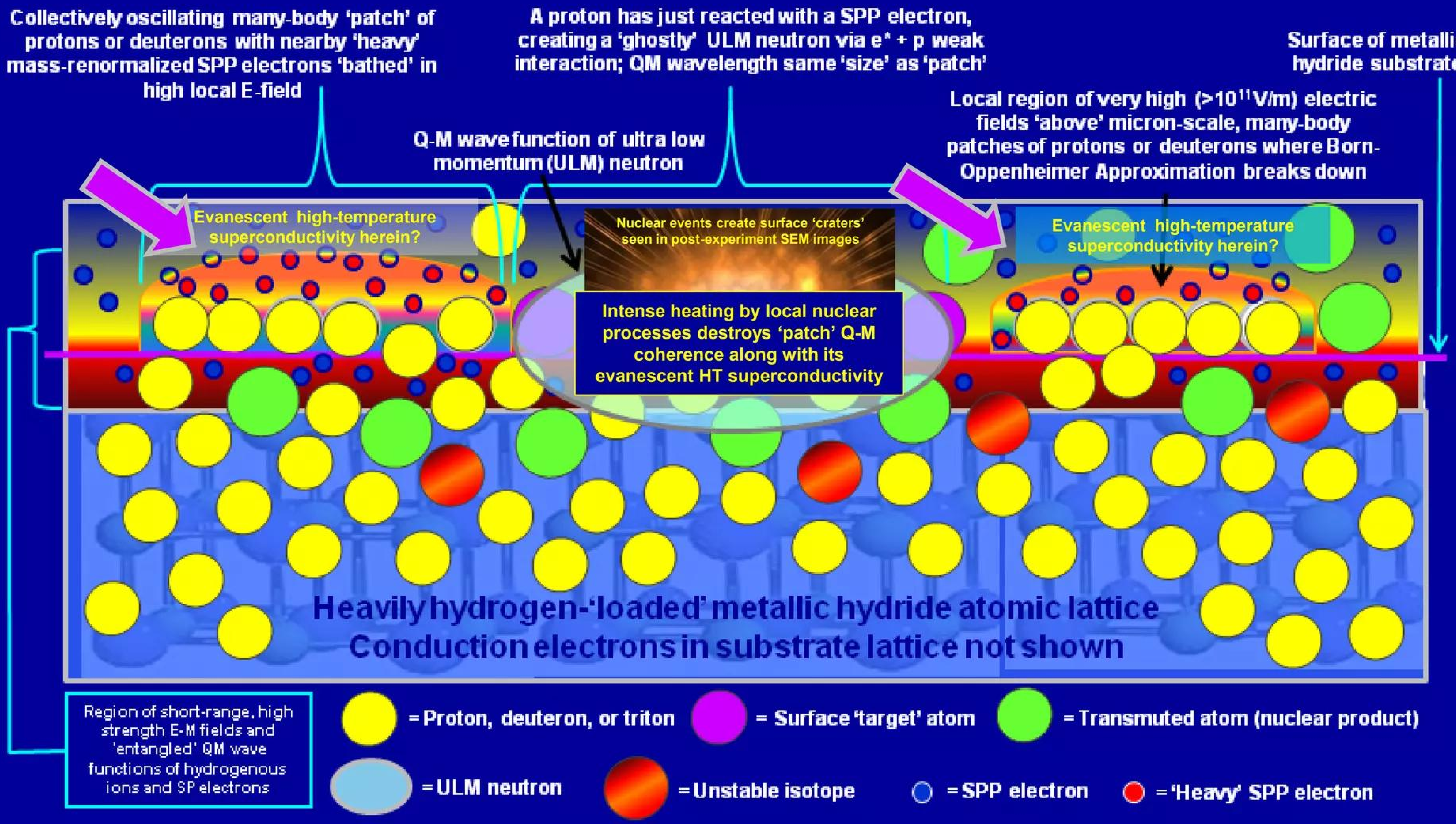
Collective many-body Q-M effects important in 'patches'

Just before 'going nuclear, does 'patch' become an evanescent HTSC?



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Many-body collective effects key to Widom-Larsen theory

How might we now conceptualize quantum systems found in ‘patches’?

- ✓ Herein we have described how the Widom-Larsen theory of LENRs operates in nm- to μ-scale collectively oscillating many-body, ~homogenous ‘patches’ of Q-M entangled protons, deuterons, or tritons (i.e., p^+, d^+, or t^+) found on condensed matter surfaces (see Slides # 8 – 48). For the purpose of discussion, let us conceptually idealize such: (1) hydrogenous ‘patches’ as being ~contiguous 2-D proton monolayers in an ~circular shape, i.e. a thin disk of strongly-correlated positive charges; and (2) surface plasmon electrons as being an essentially ‘flat’ ~2-D layer of collectively oscillating, many-body Q-M entangled particles that intrinsically cover an entire substrate surface, i.e. a ‘thin film’ of strongly-correlated negative charges
- ✓ Thanks to local breakdown of Born-Oppenheimer approximation in such ‘patches,’ we have approximately circular surface regions with diameters ranging from several nm to ~100 microns in which electromagnetic coupling is established between ~2-D disks of hydrogenous ions and ‘film’ of surface plasmon electrons ‘covering’ a substrate. Once B-O breakdown and local proton-electron E-M coupling occur: (1) proton-coupled SP electrons situated in patches can be conceptualized as thin, ~2-D circular disks; and (2) nuclear-strength local electric fields that are created and established within spatial dimensions of disk-like patches will in turn create local populations of ‘heavy’ mass-renormalized SP electrons that are also located within such patches
- ✓ In case of hydride-forming metallic substrates (e.g., certain metals such as Pd, Ni, Ti, etc.), it is known that ~2-D, island-like surface structures comprised of hydrogenous ions can form spontaneously once interior, material-specific interstitial sites in bulk lattice have become fully saturated or ‘loaded’ with ionized hydrogen isotopes. Conceptually, once local nuclear strength E-fields form in a given patch, we have two many-body, ~2-D disk-shaped, Q-M entangled, strongly-correlated subsystems of oppositely charged particles that are mutually coupled to each other via E-M fields and to ‘underlying’ substrate subsystem
- ✓ We will begin exploring some possible consequences of such conceptualization in the Slides to follow

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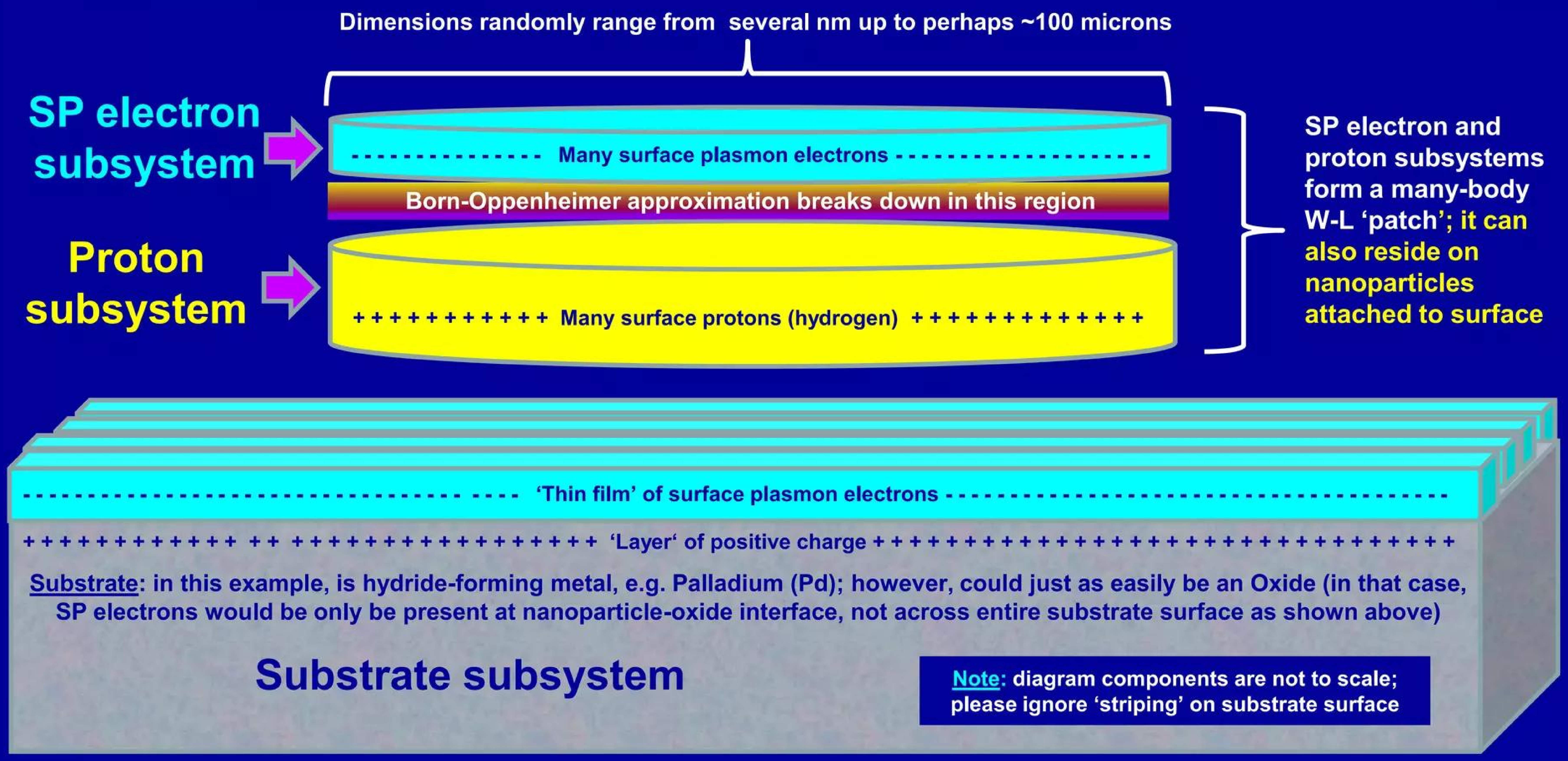
Idealized conceptual elements of a Widom-Larsen 'patch'

Patch comprises two many-body subsystems of interacting particles:

(1) Surface plasmon electrons and (2) surface protons, i.e. hydrogenous ions *p^+*, *d^+*, or *t^+*

Particles in subsystems oscillate collectively and are entangled so Q-M wave functions are delocalized



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Conceptual elements of a W-L 'patch' situated on substrate

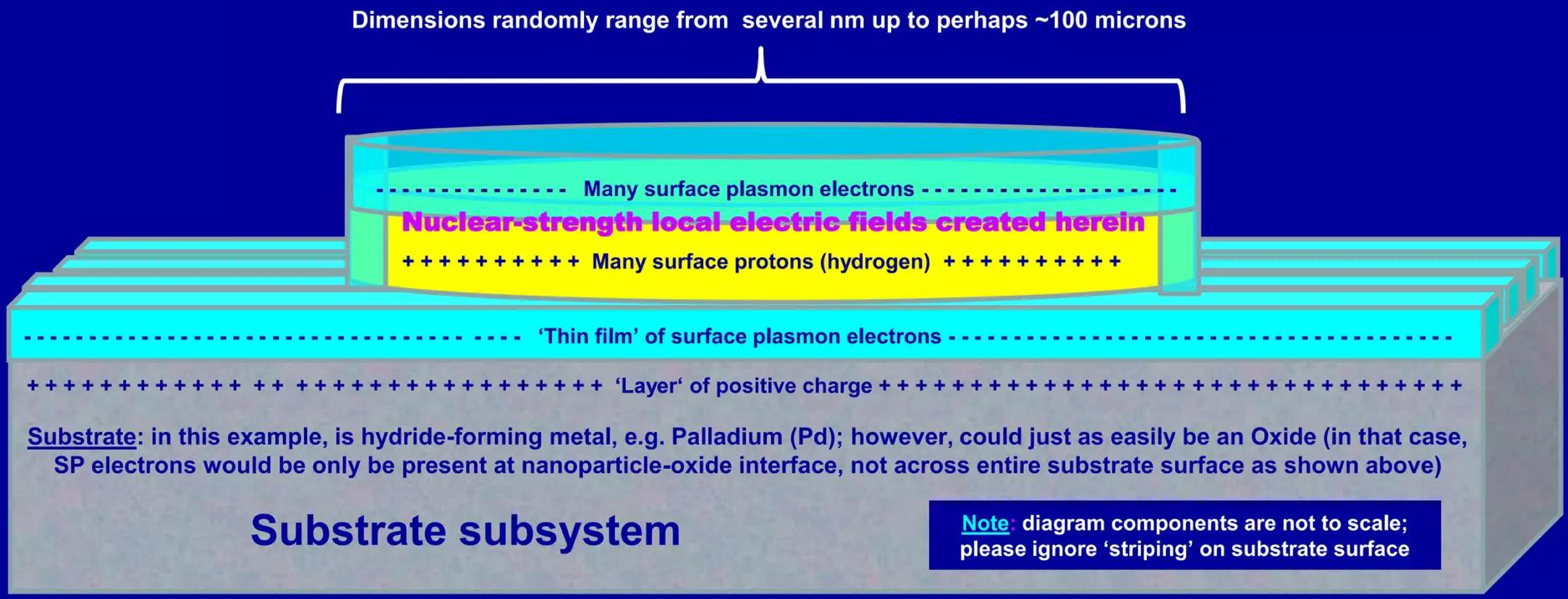
Patch is 'ready to go' but needs input energy to create heavy electrons

E-M fields couple surface plasmons to protons in patch and to SPs on substrate surface

'Substrate' can be planar surface of bulk material or complex geometric surface of 'host' nanoparticle

'Host' nanoparticles can be fabricated and affixed on substrate surfaces to optimize and manage E-fields and/or LENR products

Sufficient input energy will create local nuclear-strength E-fields > 10^{11} V/m within the patch



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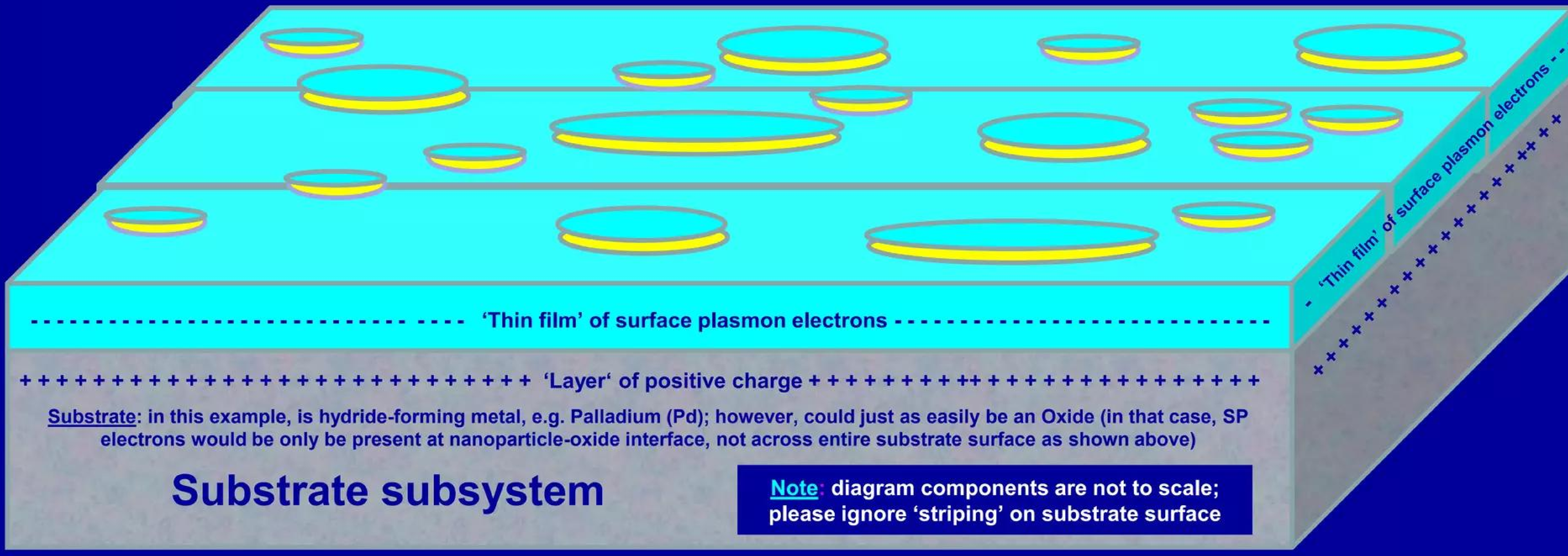
Collection of W-L 'patches' situated on a substrate surface

Dimensions and locations vary randomly across substrate surface

Patches are very dynamic evanescent structures that are 'born' and eventually 'die'

Unless local E-field strengths tightly controlled, maximum patch 'lifetime' may only be ~300 nanoseconds

Once a given W-L patch 'goes nuclear' it can create a 'crater'



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Summary of key Widom-Larsen patch characteristics

Patch comprised of coupled SP electron and surface proton subsystems

Some type of evanescent in-plane 2-D HTSC could potentially be occurring therein

	Type of particle in subsystem	Are particles in subsystem charged?	Dimensionality	Do particles collectively oscillate?	Are particles entangled?	Comments
Widom-Larsen surface patch Sizes vary randomly - diameters can range from several nm to perhaps up to ~100 microns	Surface plasmon electrons (fermions) decidedly many-body	Yes, -	~2-D reduced	Yes	Yes Q-M wave functions are very delocalized within a patch	Under proper conditions might form a quantum condensate comprised of Cooper pairs quantum confinement in patch *a la* quantum dots
	Surface protons (hydrogen) (fermions) decidedly many-body	Yes, +	~2-D reduced	Yes	Yes Q-M wave functions are very delocalized within a patch	Under proper conditions might form a quantum condensate comprised of Cooper pairs quantum confinement in patch *a la* quantum dots
Substrate material	Mostly neutral atoms except for interstitial absorbed hydrogenous ions that occupy material-specific sites in substrate bulk lattice	No charge-neutral for the most part	Essentially 3-D i.e., bulk material	No	No	Very high nuclear-strength electric fields > 10^{11} V/m present within an energized patch can potentially induce proximity E-M effects in substrate in close contact with that patch

Further Lattice comments: if some type of evanescent HTSC superconductivity truly occurs during the brief lifetime of W-L patches prior to their 'going nuclear,' since such patches are dimensionally ~2-D one can speculate that it would probably be in-plane, somewhat akin to Type-II layered superconductors such as Cuprates. Very high local E-fields within patches also suggest possibility that some sort of proximity effects might be induced locally in substrate material located beneath

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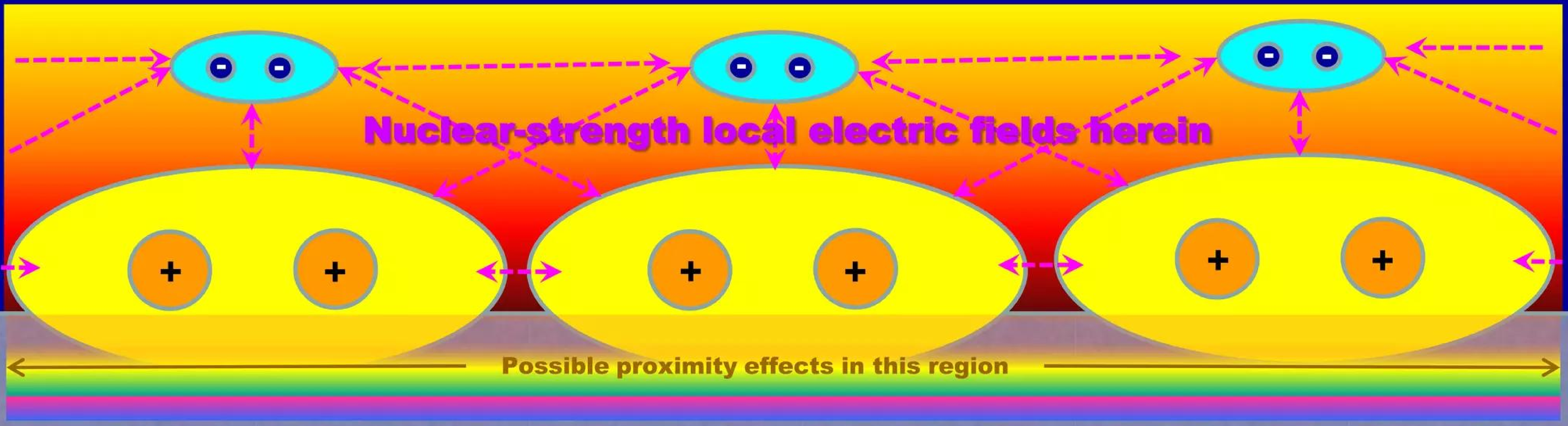
Speculate: create Cooper pairs of protons and SP electrons?

Do electromagnetically interacting 2-D ‘mirror’ quantum condensates form in surface heavy-electron ‘patches’ prior to their ‘going nuclear’ ?

Conceptual overview of condensates within a given many-body patch

What might be facilitating the formation of Cooper pairs in patch quantum condensates?



Substrate: in this example, it is a hydride-forming metal, e.g. Palladium (Pd); however, it could just as easily be an Oxide (in that case, SP electrons would be present at interface between patches and substrate, not across the entire substrate surface as would be the case if the underlying substrate was a metal)

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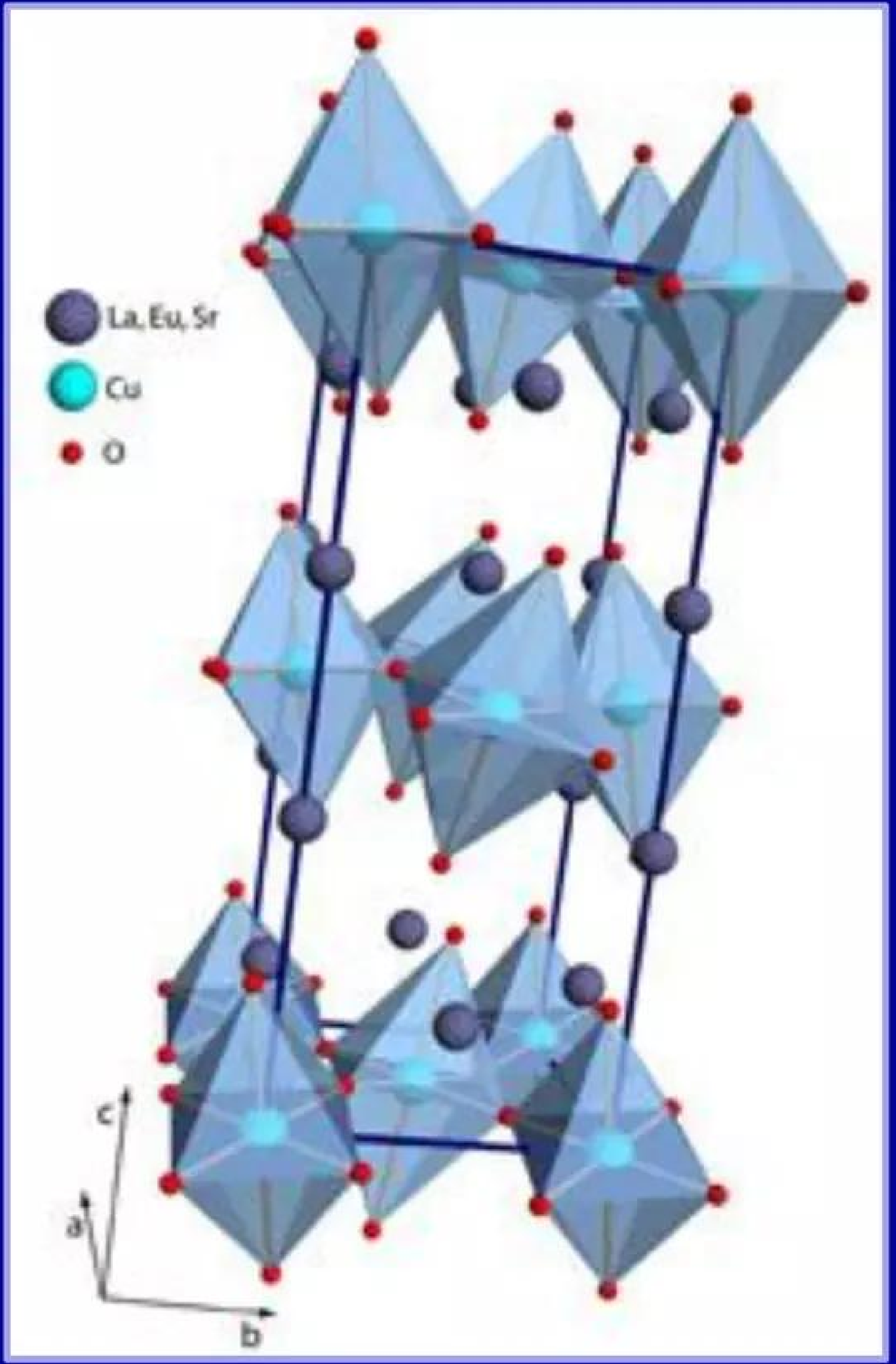
Quantum condensates and HTSC in W-L patches

Speculative discussion of theoretical ideas

- ✓ If a type of evanescent HTSC truly occurs in PdHx W-L patches, it may be helpful to first discuss what it is not likely to be:
  - Type-I 'classic' BCS - substrate lattice phonons would not appear to be involved in electron-pairing quantum condensate formation process that would necessarily have to occur in the SP electron subsystem, since those electrons are coupled more strongly to the dynamics of the intervening, locally dominant proton subsystem (thanks to breakdown of Born-Oppenheimer approximation in patches)
- ✓ If not Type-I, the next potential alternative is that we could perhaps be dealing with some new variant of known Type-II superconductors. Well, there are both pluses and minuses with that particular conceptualization as follows:
  - Pluses - patch HT superconductivity, if present, would likely be an in-plane ~2-D phenomenon which would be broad-brush conceptually consistent with known Type-II behavior; if Tripodi et *al.'s* experimental measurements are ultimately shown to be correct, there would be little doubt that RTSC is physically possible, at least in some types of systems; Lipson's *ca.* 2005 experimental observations are broadly consistent with low temperature Type-II behavior in PdHx; both Tripodi and Lipson *et al.* experimentally observed the Meissner effect
  - Minuses - a widely accepted, detailed theory of Type-II superconductivity is not yet available; except for Tripodi's work and that of a handful of other researchers, there still isn't any widely accepted experimental evidence for superconductivity occurring at anywhere close to room temperature (RTSC), let alone well above it; protons have not previously been known to participate in superconductivity (except in theoretical work involving cores of neutron stars); lastly, except for a hint in Lipson's work, oxides do not appear to play much of a role in W-L patches, which is decidedly unlike the vast majority of known oxide-based HTSCs



Source: *"Light induced Superconductivity in a Stripe-ordered Cuprate,"* A. Dienst *et al.*, *Science* 331 pp. 189-191 (2011) - "Structure of a $LaEuSrCuO_4$ crystal (positions of La, Eu, Sr are not distinguishable). CuO_4 builds connected tilted octahedral structures."

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Quantum condensates and HTSC in W-L patches

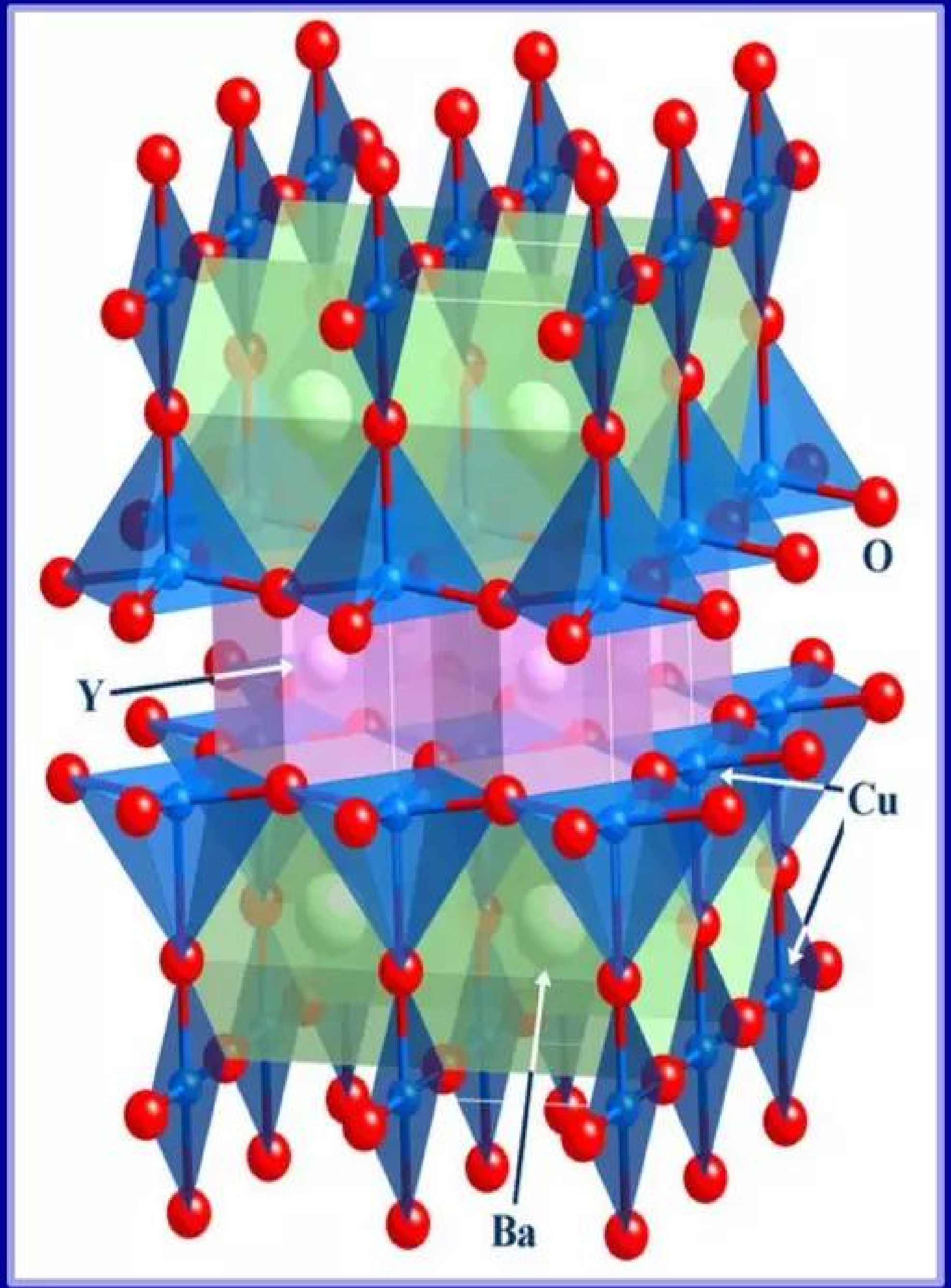
Speculative discussion of theoretical ideas

- ✓ Protons are interesting entities - in the context of W-L patches, they can be viewed as simply being entangled hydrogen atoms or as entangled nucleons (*p*+). That being the case, there may be some utility in conceptualizing such patches as being akin to exotic, very large, pancake-shaped, short-lived 'atoms' that, instead of being a many-body collection of nucleons confined and held together mainly by the strong force, are confined and held together mainly by a complex combination of chemical bonds, local electromagnetic fields, and collective quantum effects; i.e., like a quantum dot on steroids. That said, it is unclear exactly what such a radical concept might really mean

- ✓ Analogy exists between W-L patches and quantum dots - in patches, heavy-mass SP electrons can directly convert locally produced gamma radiation into infrared photons (with a poorly understood, variable emission 'tail' in soft X-rays) at high efficiencies. This process is explained in a 2005 arXiv preprint, "*Absorption of nuclear gamma radiation by heavy electrons on metallic hydride surfaces,*" and fundamental US patent issued to Lattice in 2011, US 7,893,414 B2. Interestingly, it turns-out that there is a close analogue for this type of photon energy down-conversion that also occurs in quantum dots and is called, "*luminescent downshifting*"; please see:

  - *"Performance of Hydrogenated a-Si:H solar cells with downshifting coating"*
    B. Nemeth *et al.* (preprint) Conference Paper NREL/CP-5200-51824 (May 2011)
    http://www.nrel.gov/docs/fy11osti/51824.pdf

- ✓ Micron-scale delocalization of electron, proton, and neutron Q-M wave functions – apart from the seminal experimental work of Chatzidimitriou-Dreismann *et al.,* the experimentally verified fact (Cirillo *et al.* 2012) that ultra low momentum (ultra-long Q-M wavelength) delocalized band-state neutrons are produced via collective electroweak reactions in W-L patches implies that the same degree of delocalization must be true for protons present in a patch and likely also for SP electrons. This argues in favor of idea that evanescent HTSC might be occurring in such patches



Source: Wikipedia - $YBa_2Cu_3O_7$: A 'hybrid' ball and stick/polyhedral representation of the $YBa_2Cu_3O_7$ structure http://commons.wikimedia.org/wiki/File:YBa2Cu3O7.png

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Quantum condensates and HTSC in W-L patches

Speculative discussion of theoretical ideas

- ✓ Formation of Cooper pairs in quantum condensates – while it is not terribly difficult to imagine creation of Cooper pairs of entangled electrons in an SP electron patch subsystem, the issue of comparable pairing for protons is somewhat unfamiliar - more problematic. Like electrons, the problem with Coulomb repulsion between protons is obvious. That being the case, viewing the proton patch subsystem as a quantum plasma, is there an attractive force *between protons* that might plausibly facilitate the formation of bosonic Cooper pairs in a W-L patch? It turns-out that there may well be such a force; please see:
  - "*Novel attractive force between ions in quantum plasmas*"
    P. Shukla and B. Eliasson
    Physical Review Letters 108 pp. 165007 - 165012 (2012)
    http://arxiv.org/pdf/1112.5556v7.pdf

- ✓ Alternatively, could electron and/or proton spin density waves perhaps also help create quantum condensates in patches? – in a recent presentation, "*Quantum phases of matter*" (2012), Subir Sachdev (Harvard) described a theoretical mechanism for recently discovered group of Iron-based superconductors, e.g., $BaFe_2(As_{1-x}P_x)_2$, in which the attractive force between electrons (which enables formation of Cooper pairs) is presently thought to arise not from their interactions with lattice phonons, but rather from a so-called "*spin density wave*" (SDW) that spatially organizes up/down electron spin configurations at lattice sites. Interestingly, when the net antiferromagnetic moment (*m*) measured across the entire lattice vanishes as $x = x_c$ (i.e., at the quantum critical point), the electrons involved are all effectively entangled and must be treated as a many-body quantum subsystem

Let us imagine a W-L patch proton subsystem as a dynamically organized 'lattice' of sorts, perhaps something akin to so-called "*Coulomb crystals*" that arise and are experimentally well-known in dusty, non-ideal plasmas. If that were the case, and since both electrons and protons assuredly possess spin, by analogy perhaps something like a SDW could also help enable the formation of electron and/or proton Cooper pairs in a W-L patch?

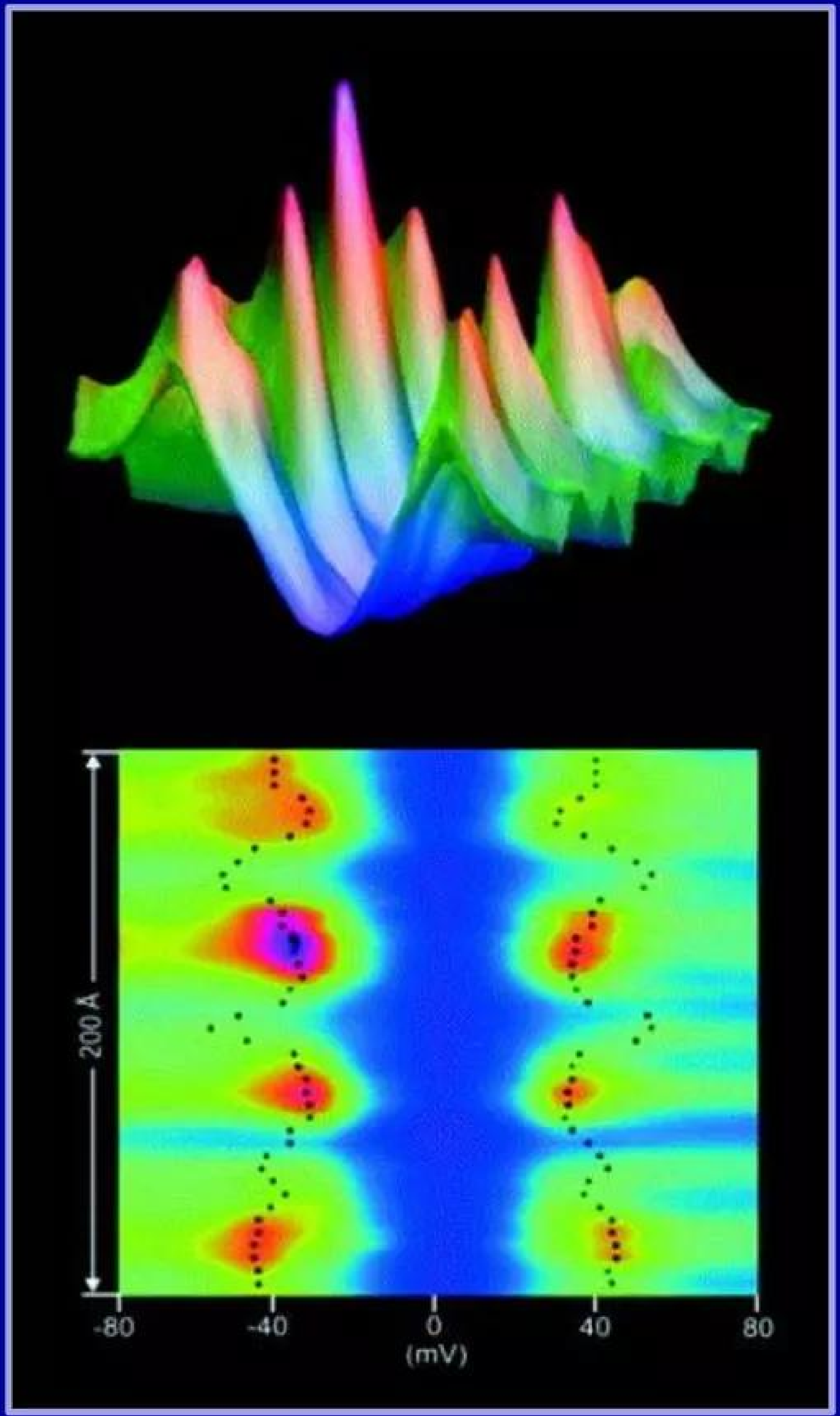

Fig. 18. 2D (bottom) and 3D (top) plots of the spatial dependence of the differential conductance showing the microscopic inhomogeneity in magnitude of *superconducting gap in* $Bi_2Sr_2CaCu_2O_{8-x}$ *in* E. Plummer *et al.* *Surface Science* 500 pp. 1-27 (2002)

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Quantum condensates and HTSC in W-L patches

Speculative discussion of theoretical ideas

- For this discussion, please see the following references:
  - *"Absorption of nuclear gamma radiation by heavy electrons on metallic hydride surfaces"*
    A. Widom and L. Larsen (2005) [see Slide #2 for full reference and hyperlink]
  - "*Room Temperature Superconductivity*"
    A. Mourachkine [author placed copy of entire 310-page book on arXiv]
    Cambridge International Science Publishing (2004)
    http://arxiv.org/ftp/cond-mat/papers/0606/0606187.pdf
- In evanescent W-L patches, both the proton and SP electron subsystems are characterized by strongly correlated, entangled particles and long-range Q-M coherence up to the physical dimensions of a given patch, which can range from several nm up to perhaps as large as ~100 microns
- Apart from having nuclear-strength local electric fields, what is extremely unusual about W-L patches are the energy-scales present therein. In 'typical' condensed matter environments and superconductors at chemical energies, meVs and eVs are the norm. By contrast, in energized patches, intrinsic energy scales of particles therein can range from eVs to keVs --- up to MeVs, i.e., they can and do enter the nuclear energy realm, unlike 'everyday' lattice environments
- Quoting excerpts from our 2005 arXiv preprint: "In order to achieve heavy electron pair energies of several MeV … The energy differences between electron states in the heavy electron conduction states is sufficient to pick up the 'particle-hole' energies of the order of MeV. Such particle-hole pair production in conduction states of metals is in conventional condensed matter physics described by electrical conductivity … energy spread of heavy electron-hole pair excitations implies that a high conductivity near the surface can persist well into the MeV photon energy range, strongly absorbing prompt gamma radiation … energy spread of the excited particle hole pair will have a cutoff of about 10 MeV based on mass renormalization of … the electron"
- While no direct experimental measurements of energy spreads in W-L patches have ever been made, one could speculate that they might well be much larger than those of presently well-known Types 1-2 superconductors. If 'mirror' Cooper pairs of SP electrons and protons can form in a coherent W-L patch, perhaps it is not unreasonable to expect that pairing energies therein might exceed value of 150 meV Mourachkine (2004) calculated for a RTSC at 580 K

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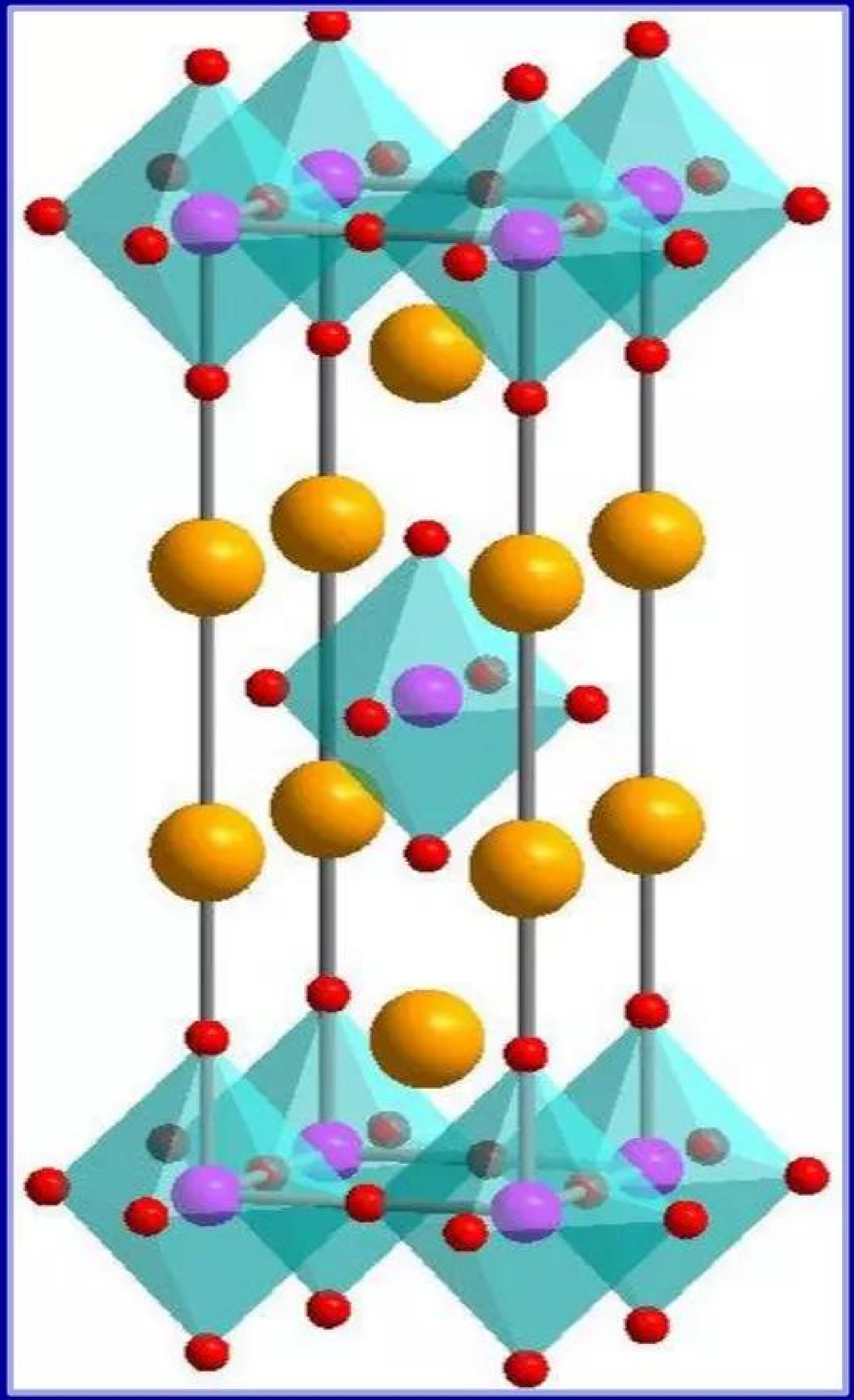
Quantum condensates and HTSC in W-L patches

Speculative discussion of theoretical ideas

Summary:

- ✓ Certain experimental data suggests that some form of HTSC may be occurring in W-L many-body patches found in LENR systems
- ✓ While not widely known or accepted, controversial experimental data collected and published by Tripodi *et al.,* if correct, suggests that >RTSC might be possible, at least in PdHx superconducting systems
- ✓ If HTSC or RTSC truly does occur in W-L heavy-electron patches, although it shares some common characteristics with Type-2 superconductors, it differs in many key ways
- ✓ For example, 'normal' lattice electron-phonon interactions seem unlikely to be involved in facilitating formation of Cooper pairing in a W-L patch's SP electron subsystem. Instead, it seems like, during brief attoseconds of collective proton coherence, the many-body collective proton subsystem somehow functions as a local 'lattice' (*a la* a dynamic Coulomb crystal???). Viewed in that manner, a many-body proton subsystem's electromagnetic and Q-M interactions with a patch's many-body SP electron subsystem might then be able to provide a local environment conducive to electron pairing therein. Perhaps a patch's two subsystems form dynamic, mutually reinforcing 'mirror quantum condensates' as conceptualized on Slide #81 herein
- ✓ Hopefully, subject matter experts will study these new theoretical ideas to see whether they might lead to additional fruitful insights



Credit: Y. Liu (Penn State Univ.)
p-wave superconductor
Sr_2RuO_4

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How does heavy-electron patch HTSC relate to literature?

While somewhat like Type-2, heavy-electron HTSC differs in key aspects

- ✓ Apart from reading a large number of published papers, some of which are cited herein, two must-read references shown to the right were particularly helpful to the author, who is not an expert on HTSC
- ✓ As noted earlier, if some form of HTSC or maybe even RTSC is truly occurring in W-L heavy SP electron patches, it may be providing us with some new and interesting theoretical 'twists' on HT superconductivity along with daunting experimental challenges that must be surmounted to fully understand what might be happening in these nanoscale many-body quantum systems
- ✓ As promised, this presentation raises many more questions than it answers. Hopefully, it will help provide impetus for additional theoretical and experimental work by other researchers

→ "*Strange and stringy*"
S. Sachdev, Harvard University
Scientific American (October 2012)
http://qpt.physics.harvard.edu/c63.pdf

Abstract (quoted from an earlier preprint):

"In many modern materials, 10^{23} electrons quantum-entangle with each other, and produce new phases of matter, such as high temperature superconductors. The challenge of describing the entanglement of such a large number of electrons may be met by ideas drawn from string theory."

→ "*Room Temperature Superconductivity*"
A. Mourachkine
Cambridge International Science Publishing (2004)
http://arxiv.org/ftp/cond-mat/papers/0606/0606187.pdf

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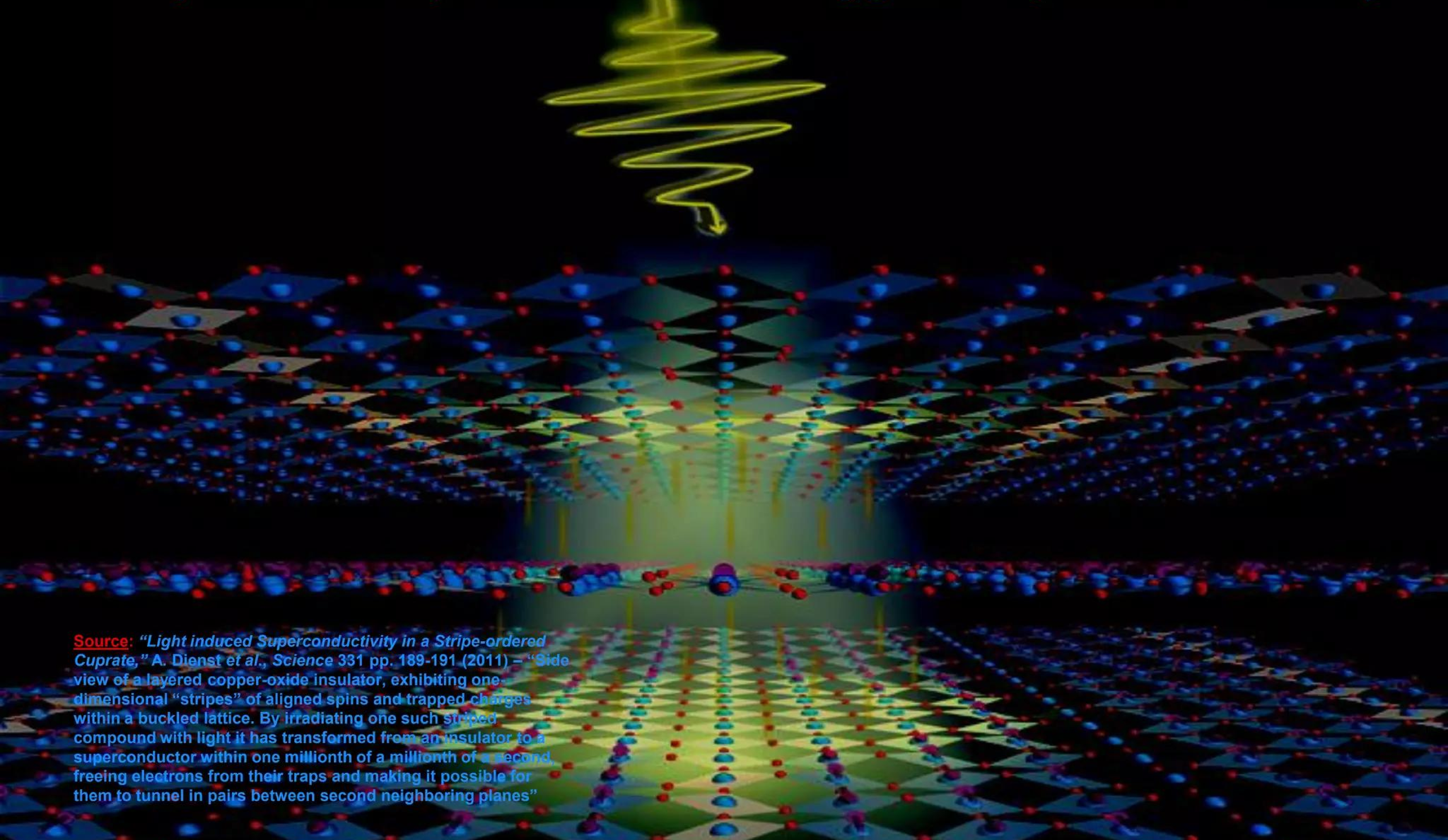
Recap: LENR experiments that suggest superconductivity



Source: *"Light induced Superconductivity in a Stripe-ordered Cuprate,"* A. Dienst *et al.*, *Science* 331 pp. 189-191 (2011) – "Side view of a layered copper-oxide insulator, exhibiting one-dimensional "stripes" of aligned spins and trapped charges within a buckled lattice. By irradiating one such striped compound with light it has transformed from an insulator to a superconductor within one millionth of a millionth of a second, freeing electrons from their traps and making it possible for them to tunnel in pairs between second neighboring planes"

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Recap: possible experimental evidence for SC in LENRs

Effects appear in PdH_x, PdD_x and PdH_x/PdO from cryo to above 273^OK

For more details please see Lattice's August 23, 2012, PowerPoint presentation

Slide #s in Aug. 23 document	Type of experiment	Researcher(s) and year reported	Material(s) range of temperatures(s) when effects are measured	Material/isotope in which effects are observed	Anomalous experimental effect(s)	Comments
5 and 50 - 52	Ultrathin 50 μm metal wire in current-driven electrolytic cell with D_2O (10^{-5} M $CaSO_4$)	Selvaggi: 2000 ICONE conference report	Room temp or above (> 273 K)	Pure Pd: PdDx	Large, rapid resistivity fluctuations	Correlated with calorimetric macro excess heat burst
6 and 53 - 61	Two alternative preferred system embodiments: metal cathode was loaded w. hydrogen isotope in electrolytic cell with H_2O (10^{-5} M Hg_2SO_4); or, metal thin-film 'target' hit with accelerated hydrogenous ions in pressure chamber	Tripodi *et al.*: two papers published in *Physica C* in 2003 and 2004; US Patent issued in 2006	Removed from electrolytic cell; then measurements were made at low cryogenic temps up to room temp (*Tc* > 273 K) or above, e.g. 400K	Pure Pd: PdHx Claimed alternative embodiments include PdDx	Multiple measurements were consistent with SC including Meissner effect; please see 2006 US patent and associated papers for details	Some measurements indicate possible RTSC observed; claimed some effects were supposedly observed for as long as 24 hours after removal from loading cell
62 - 65	12.5 μm thick metal foil; thermally grown oxide; loaded w. hydrogen isotope in electrolytic cell with H_2O (1M Li_2SO_4)	Lipson *et al.*: 2005 ICCF-12 conference report	Removed from electrolytic cell; then measurements made at low cryogenic temps up to T < ~67 K	Pure Pd: PdHx and PdHx:PdO heterostructres	Multiple measurements were consistent with SC; see full presentation	Conjectured Type II filamentary superconductor; observed Meissner effect
66	Macroscopic metal cathode in electrolytic cell with D_2O (1M LiOD with 200 ppm Al)	McKubre: 2009 ICCF-15 conference report	Room temp or above (> 273 K)	Pure Pd: PdDx	Large, rapid resistivity fluctuations measured across cathode surface	Correlated with large up/down macro fluctuations in calorimetric excess heat

Summary comments: altogether, viewed through the conceptual 'lens' of the Widom-Larsen theory of LENRs, these varied experimental observations suggest to the author that some form of evanescent high temperature superconductivity cold potentially be associated with heavy-SP electron 'patches' that form on surfaces that can, under proper conditions, become LENR-active sites

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Recap: possible experimental evidence for SC in LENRs

Effects appear in PdH_x, PdD_x and PdH_x /PdO from cryo to above 273^{O}K

Special commentary on work of Tripodi: amazing measurements have not been refuted

Renewed interest in Tripodi's earlier work became apparent in 2011 - 2012

APS March Meeting 2012, Volume 57, Number 1, Monday - Friday, February 27 - March 2 2012; Boston, MA.

Please take special note: new work below is for case of PdHx where 0 ≤ x ≤ 1; Tripodi and Lipson both conjectured that superconductivity effects should become progressively stronger as x increases further and further above x = 1, i.e., local values of hydrogen 'loading' >> 1

Session Q21: Novel Superconductivity in New and Low Dimensional Materials, 12:15 AM - 12:27 PM, Wednesday, February 29, 2012 Room: 254A Authors: P. Buczek *et al.*

"Elementary excitations and elusive superconductivity in palladium hydride --- *ab initio* perspective. I. Paramagnons "

"Motivated by a experimental reports on possible high temperature superconductivity in palladium hydride [Tripodi *et al., Physica C* 388-389, 571 (2003)], we present a first principle study of spin fluctuations, electron-phonon coupling and critical temperature in PdHx, 0 ≤ x ≤ 1. A prerequisite for any qualitative study of exchange-enhanced materials is the knowledge of spin flip fluctuation spectrum. It is generally believed [Berk & Schrieffer, *Phys. Rev. Lett.,* 17, 433 (1966)] that the ferromagnetic-like paramagnons of Pd are destructive for the conventional, i.e. *s*-wave, superconductivity. We describe them using linear response time dependent density functional theory, recently implemented to study complex metals [Buczek *et al., Phys. Rev. Lett.* 105, 097205 (2010)]. We find that hydrogenation suppresses the intense spin fluctuations of pure Pd, driving it away from a magnetic critical point. Under the assumption of *s*-wave pairing, this could lead to the formation of the superconducting state. The *ab initio* estimated electron-phonon coupling is strong enough to support superconductivity. Please look for the complementary contribution of Christophe Bersier."

Session Q21: Novel Superconductivity in New and Low Dimensional Materials, 12:27 AM - 12:39 PM, Wednesday, February 29, 2012 Room: 254A Authors: C. Bersier *et al.*

"Elementary excitations and elusive superconductivity in palladium hydride --- *ab initio* perspective. II. Phonons"

"Motivated by a experimental reports on possible high temperature superconductivity in palladium hydride [Tripodi *et al., Physica C* 388-389, 571 (2003)], we present a first principle study of spin fluctuations, electron-phonon coupling and critical temperature (Tc) in PdHx , 0 ≤ x ≤ 1. Our results described in terms of (i) electronic structure, (ii) phonon density of states and (iii) Eliashberg function show that the hydrogenation of Pd clearly enhance the electron-phonon coupling in this material. Assuming phonons to be the driving force for superconductivity, *fcc* Pd features a vanishingly small Tc, while for the stoichiometric *x* = 1 PdH the resulting Tc is around 10 K in agreement with experiment. It is generally believed [Berk & Schrieffer, *Phys. Rev. Lett*. 17, 433 (1966)] that intense spin-&flip fluctuations of Pd are destructive for the conventional, i.e. *s*-wave, superconductivity. However, the H doping leads to a drastic reduction of spin-flip scattering. Please look for complementary presentation of Pawel Buczek."

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Physics of LENRs is now understood and published

Hint about superconductivity possibility in Sept 2005 preprint

"***Ultra low momentum neutron catalyzed nuclear reactions on metallic hydride surfaces***"
Eur. Phys. J. C **46**, pp. 107 (March 2006) Widom and Larsen – initially placed on arXiv in May 2005 at http://arxiv.org/PS_cache/cond-mat/pdf/0505/0505026v1.pdf; a copy of the final *EPJC* article can be found at: http://www.newenergytimes.com/v2/library/2006/2006Widom-UltraLowMomentumNeutronCatalyzed.pdf

pp. 2 → "***Absorption of nuclear gamma radiation by heavy electrons on metallic hydride surfaces***"
http://arxiv.org/PS_cache/cond-mat/pdf/0509/0509269v1.pdf (Sept 2005) Widom and Larsen

"***Nuclear abundances in metallic hydride electrodes of electrolytic chemical cells***"
http://arxiv.org/PS_cache/cond-mat/pdf/0602/0602472v1.pdf (Feb 2006) Widom and Larsen

"***Theoretical Standard Model rates of proton to neutron conversions near metallic hydride surfaces***"
http://arxiv.org/PS_cache/nucl-th/pdf/0608/0608059v2.pdf (v2. Sep 2007) Widom and Larsen

"***Energetic electrons and nuclear transmutations in exploding wires***"
http://arxiv.org/PS_cache/arxiv/pdf/0709/0709.1222v1.pdf (Sept 2007) Widom, Srivastava, and Larsen

"***Errors in the quantum electrodynamic mass analysis of Hagelstein and Chaudhary***"
http://arxiv.org/PS_cache/arxiv/pdf/0802/0802.0466v2.pdf (Feb 2008) Widom, Srivastava, and Larsen

"***High energy particles in the solar corona***"
http://arxiv.org/PS_cache/arxiv/pdf/0804/0804.2647v1.pdf (April 2008) Widom, Srivastava, and Larsen

"***A primer for electro-weak induced low energy nuclear reactions***" Srivastava, Widom, and Larsen
Pramana – Journal of Physics **75** pp. 617 (October 2010) http://www.ias.ac.in/pramana/v75/p617/fulltext.pdf

"A scientist is supposed to have a complete and thorough knowledge, at first hand, of some subjects and, therefore, is usually expected not to write on any topic of which he is not a master. This is regarded as a matter of noblesse oblige. For the present purpose I beg to renounce the noblesse, if any, and to be freed of the ensuing obligation. My excuse is as follows: we have inherited from our forefathers the keen longing for unified, all-embracing knowledge. The very name given to the highest institutions of learning reminds us, that from antiquity and throughout many centuries the universal aspect has been the only one to be given full credit. But the spread, both in width and depth, of the multifarious branches of knowledge during the last hundred odd years has confronted us with a queer dilemma. We feel clearly that we are only now beginning to acquire reliable material for welding together the sum-total of all that is known into a whole; but, on the other hand, it has become next to impossible for a single mind fully to command more than a small specialized portion of it. I can see no other escape from this dilemma (lest our true aim be lost forever) than that some of us should venture to embark on a synthesis of facts and theories, albeit with second-hand and incomplete knowledge of some of them --- and at the risk of making fools of ourselves."

SPASER device's electric fields (2009): surface plasmon amplification by stimulated emission of radiation http://opfocus.org/content/v7/s5/opfocus_v7_s5.pdf

Erwin Schrödinger, "What is life?" (1944)

