Condensed Plasmoids (CPs)

The Nuclear-Active Environment of LENR

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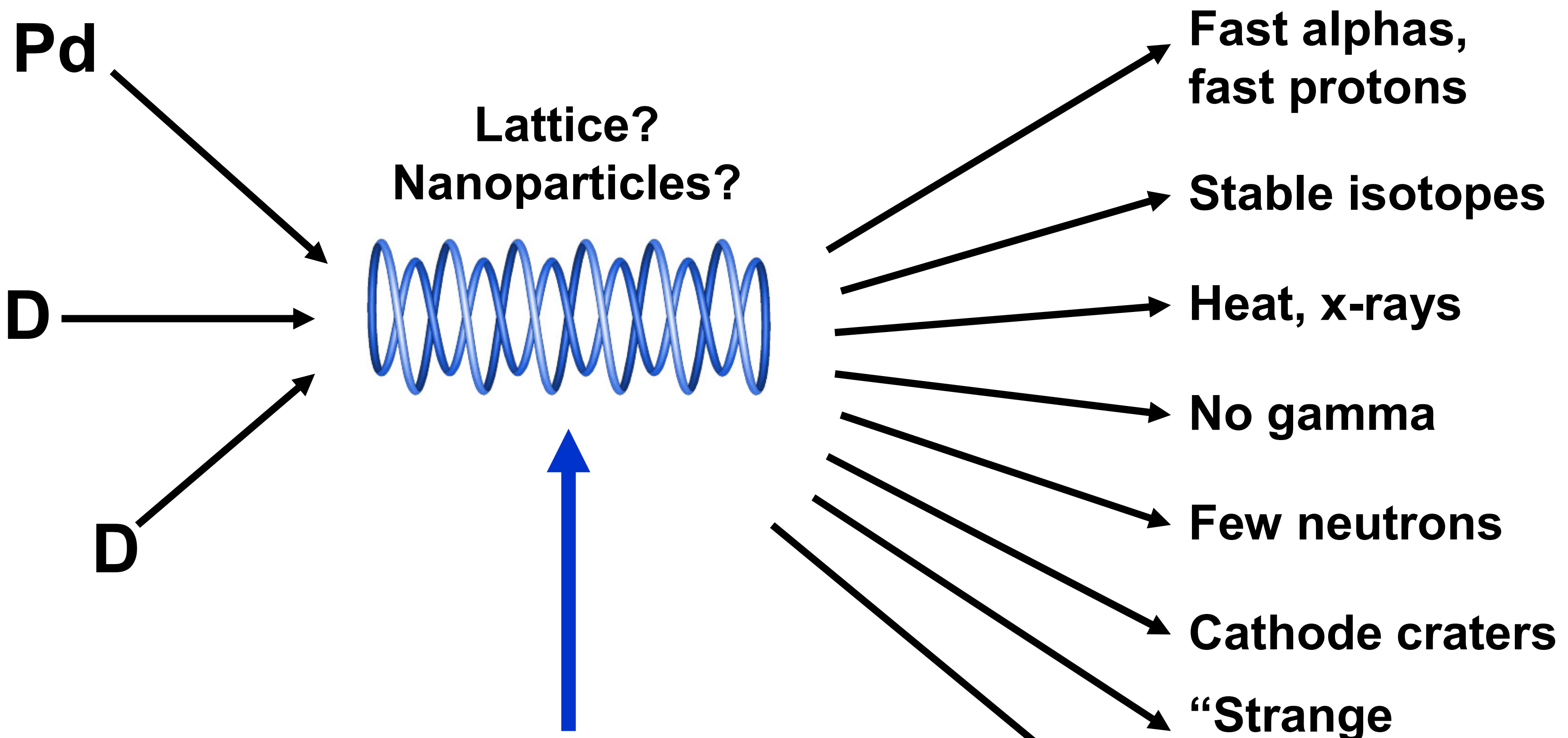
The NAE – Solving the Bizarre FP Puzzle



Condensed Plasmoids (CPs) are the nuclear active environment of LENR

“Strange Radiation” = CPs

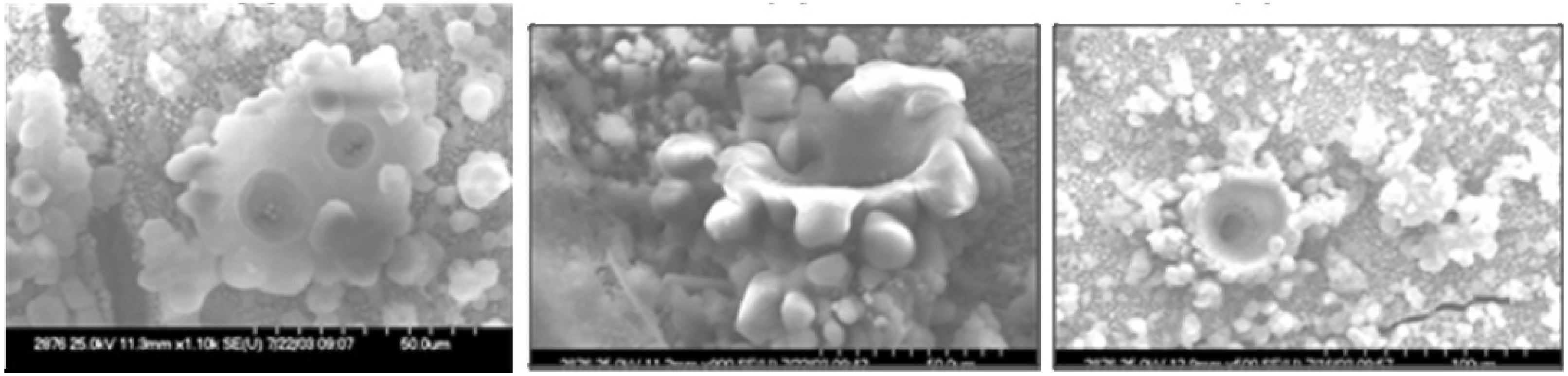
The pioneers in the observation of CPs:

- **Winston Bostick**
- **Ken Shoulders**
- **Takaaki Matsumoto**
- **Irina Savvatimova, B. Rodinov**
- **Leonid Urutskoev et. al.**
- **Claude Daviau et. al.**
- **Others**

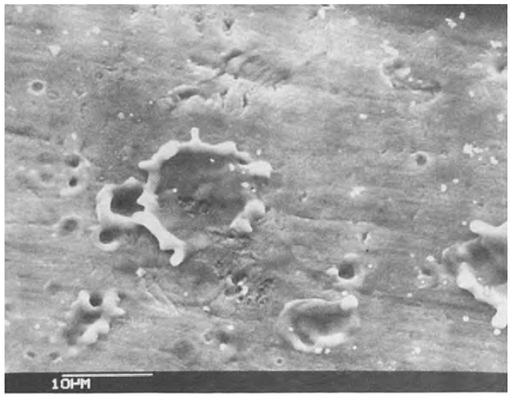
CPs have been also named: EVs, EVOs, high-density charge clusters, vortex filaments, ring clusters, micro ball lightnings, etc.

CPs Can Make Craters

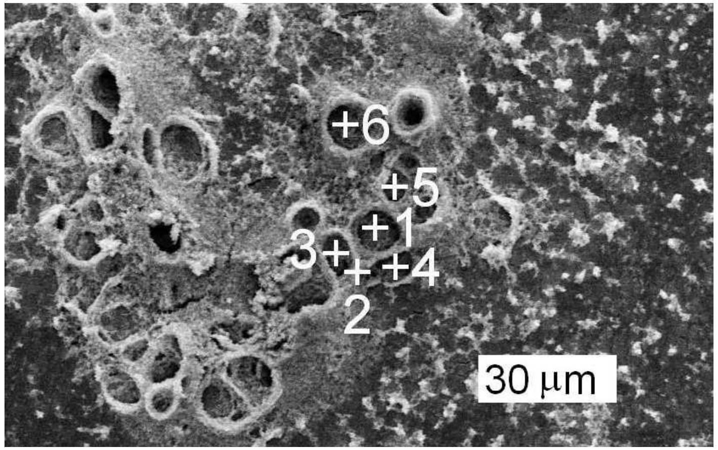
P.A. Mosier-Boss *et al.* at SPAWAR:



Ken Shoulders:

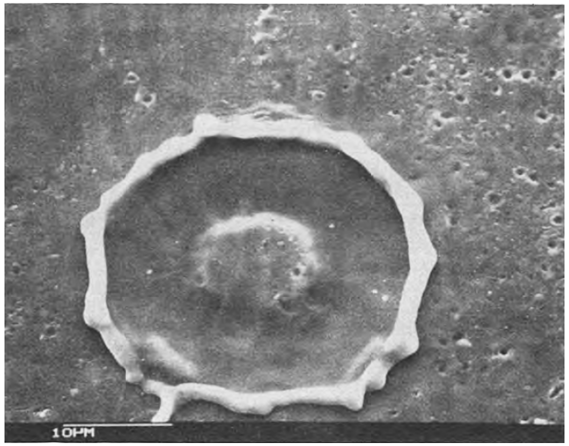


Zhang and Dash:

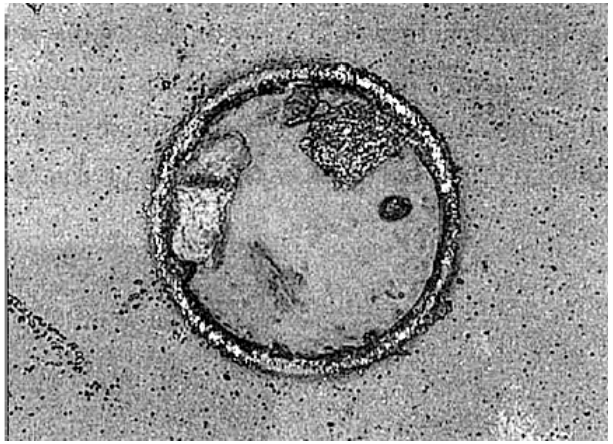


CPs Can Form Rings

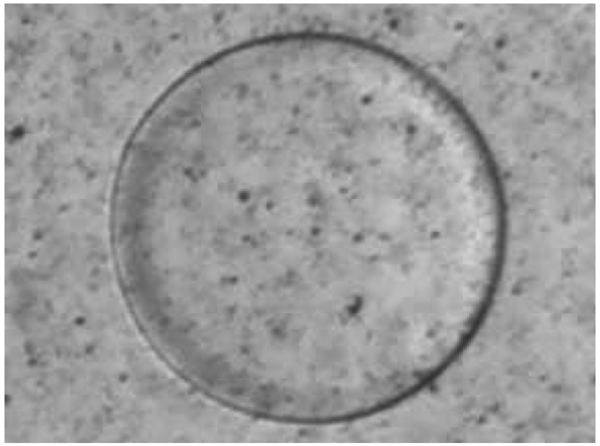
Ken Shoulders:



Takaaki Matsumoto:



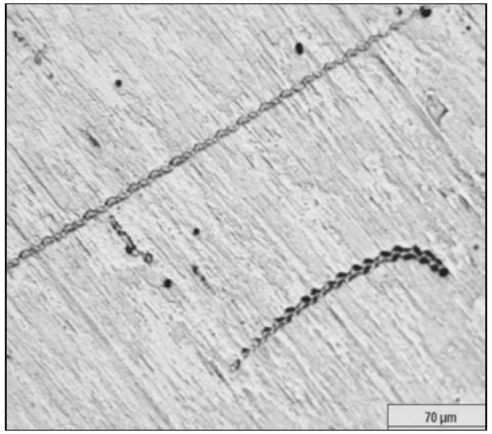
Claude Daviau:

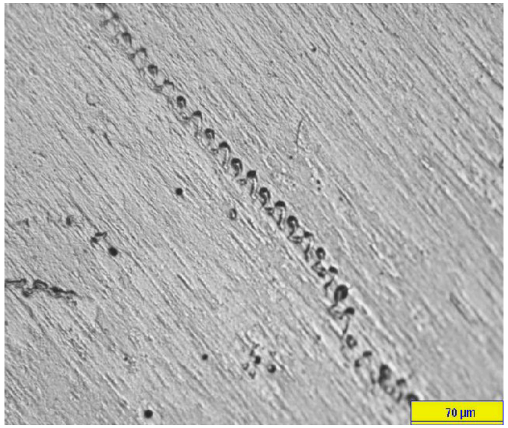


Rodinov/Savvatimova:

CPs Can Form Quasi-Periodic Structures

Rodinov/Savvatimova:





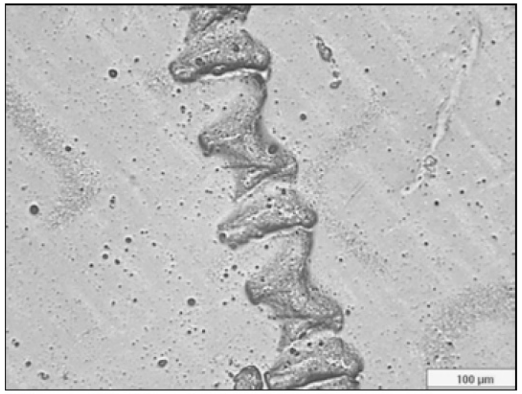
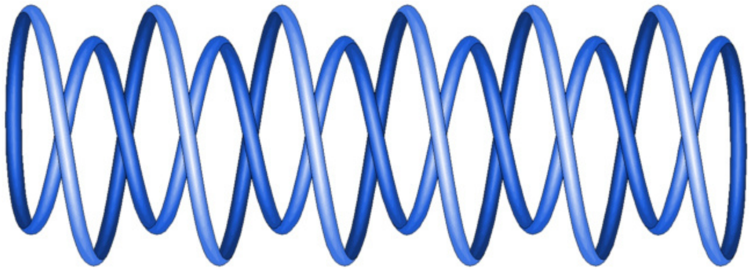
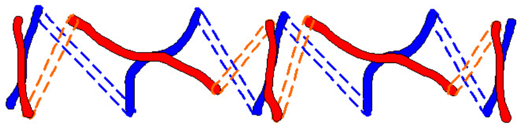


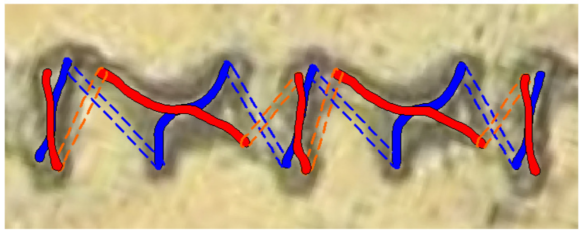
Figure 15. Residual trail mark on emulsion.

Basic structure (drawing):





Mapping to images:



Will Matter Collapse in a z-Pinch?

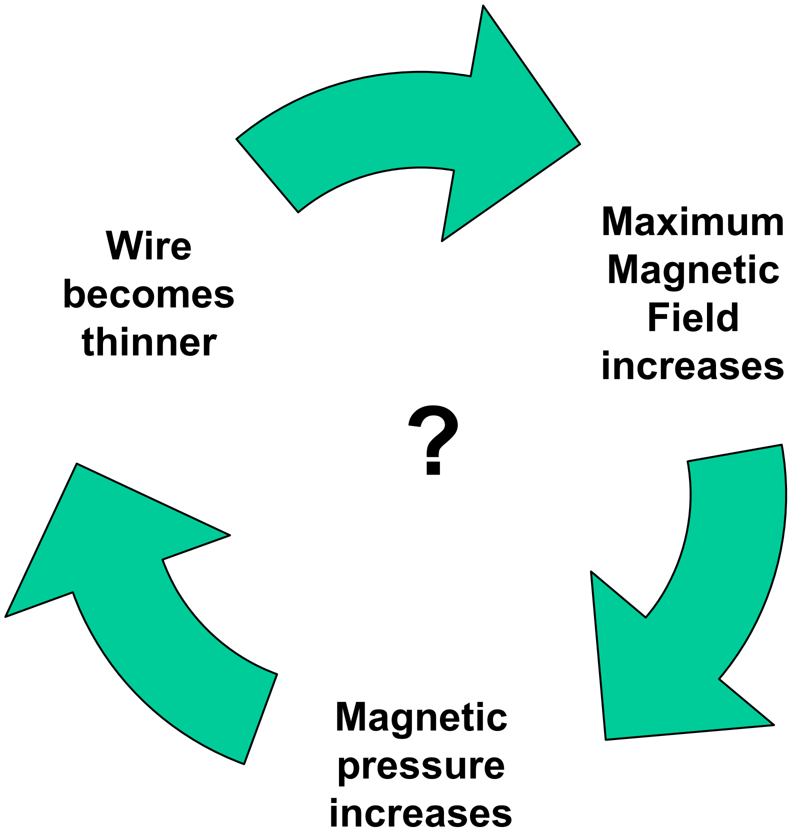
Maximum magnetic field of a plasma "wire":

$$\left|B\right|_{\max} = \frac{\mu_0}{2\pi}\frac{I}{r_0}$$

Singularity if wire radius r_0 approaches zero!

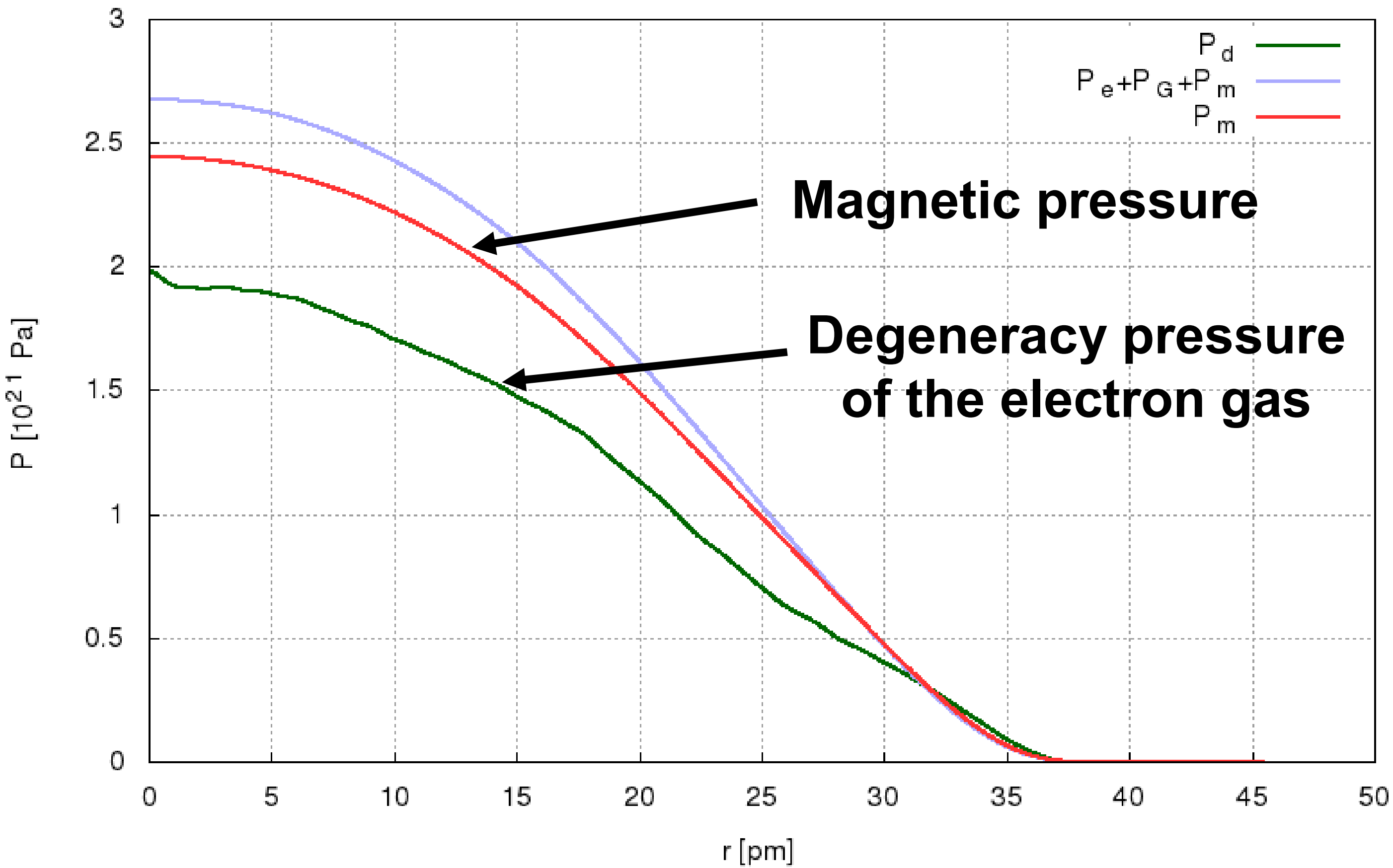
Assuming temperature is low, what will stop the collapse?

Answer: The degeneracy pressure of the electron gas



Degeneracy Pressure vs. Magnetic Pressure

- **The magnetic pressure in CPs can exceed 2 x 10^{21} Pa**
  - 5 orders of magnitude higher than in the solar core!
- **At r_0 = 35 pm, I = 9.2 kA**



Which Physics Applies to CPs?

A Plasmoid is a current-carrying plasma in a self-consistent state. It is condensed, if it is near the quantum-mechanical ground state.

Plasma physics at low temperatures and high densities?

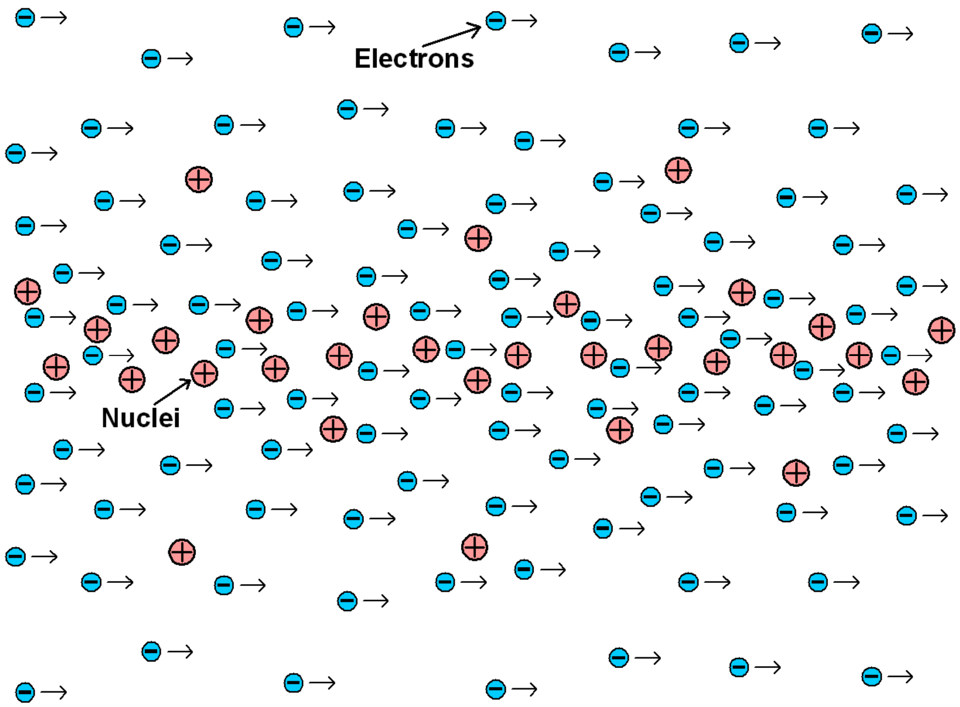
- **Would predict that the plasmoids dissolve into atoms and molecules**
- **<u>Not</u> aligned with the observed lifetimes of CPs (up to > 1 hour)**

Quantum mechanics at low temperatures and high densities:

- **Predicts that CPs remain in a plasma state due to the delocalization of the electrons**
- **Aligned with the observed lifetimes of CPs**

Basic Assumptions of the CP Modeling

- CPs contain atomic nuclei densely packed in a long and very narrow plasma channel
- The distances between the nuclei are so small, that all electrons bound to these nuclei are delocalized along the channel
- The electrons are moving with high velocity against the nuclei



The Relativistic Hamiltonian of a CP

Electron velocities can be up 80% of light speed, therefore relativistic quantum mechanics was used.

Total energy: $\hat{H} = c\sqrt{\left(\vec{P} - q\vec{A}\right)^2 + m_e{}^2 c^2} + q\Phi$

Canonical momentum: $\vec{P} = \gamma m_e \vec{v} + q\vec{A}$

Magnetic potential: $\vec{A}$

Electric potential Φ

Electron Mass m_e

Charge q

Light speed c

Klein-Gordon Equation of a CP

Quantizing the relativistic Hamiltonian is leading to the stationary Klein-Gordon Equation in cylindrical coordinates:

$$\left\{\frac{-\hbar^2}{2m_e}\left[\frac{1}{\rho}\frac{\partial}{\partial\rho}\left(\rho\frac{\partial}{\partial\rho}\right)+\frac{1}{\rho^2}\frac{\partial^2}{\partial\varphi^2}+\frac{\partial^2}{\partial z^2}+2\frac{e\overline{A}_z}{\hbar}i\frac{\partial}{\partial z}-\frac{e^2\overline{A}_z^{\,2}}{\hbar^2}\right]\right.$$

$$\left.-\frac{m_e c^2}{2}\left(\frac{\overline{E}+e\Phi}{m_e c^2}+1\right)^2+\frac{m_e c^2}{2}\right\}\Psi=0$$

Eigenvalues: $\overline{E}\equiv\hat{H}-m_e c^2$

This equation is for a single electron in the mean potential of a CP's all other electrons and the nuclei (Kohn-Sham)

Not interested in electron spin and positronic states, thus the Dirac equation would be unnecessarily complicated.

Electromagnetic Potential of a CP

Electric potential, depending on the charge density:

$$\Phi(\rho) = \frac{1}{4\pi\varepsilon_0}\int_0^\infty \overline{\sigma}(\rho')G(\rho,\rho')\rho' d\rho'$$

Magnetic vector potential, depending on the current density:

$$\overline{A}_z(\rho) = \frac{\mu_0}{4\pi}\int_0^\infty \overline{J}_z(\rho')G(\rho,\rho')\rho' d\rho'$$

Geometry integral:

$$G(\rho,\rho') = \begin{cases} 4\pi\left[\ln\left(\overline{L}/2 + \sqrt{\overline{L}^2/4 + \rho'^2}\right) - \ln\rho'\right] & \text{for } \rho \le \rho' \\ 4\pi\left[\ln\left(\overline{L}/2 + \sqrt{\overline{L}^2/4 + \rho^2}\right) - \ln\rho\right] & \text{for } \rho > \rho' \end{cases}$$

Product Ansatz

Total wave function: $\Psi = \Psi_\rho \Psi_\varphi \Psi_z$

Axial wave function: $\Psi_z = \sqrt{\frac{1}{L}} e^{ikz}$

Azimuthal wave function: $\Psi_\varphi = \sqrt{\frac{1}{2\pi}} e^{im\varphi}$

Klein-Gordon equation for the radial wave function:

$$\left\{ \frac{\hbar^2}{2m_e}\left[-\frac{1}{\rho}\frac{d}{d\rho}\left(\rho\frac{d}{d\rho}\right) + \frac{m^2}{\rho^2}\right] + \frac{\overline{p}_z^{\,2}}{2m_e} - \frac{m_e c^2}{2}\left(\frac{\overline{E} + e\Phi}{m_e c^2} + 1\right)^2 + \frac{m_e c^2}{2} \right\}\Psi_\rho = 0$$

Kinetic momentum: $\overline{p}_z = \overline{P}_z + e\overline{A}_z = \hbar k + e\overline{A}_z$

Solution of the Radial Klein-Gordon Equation

Radial wave function approximated by a polynomial:

$$\sqrt{\frac{a_0 e\overline{L}}{Q}}\Psi_\rho \equiv R(r) \approx \sum_{j=0}^{J} c_j r^{|m|+j} \cdot \exp(-\zeta r)$$

The energy terms of the Klein-Gordon equation depending on the potential are also approximated by a polynomial:

$$\sum_{p=0}^{P} b_p r^p$$

With these approximations an <u>analytical solution</u> for the radial Klein-Gordon equation has been found, which iteratively computes the coefficients:

$$c_j = \frac{1}{\left(2|m|j + j^2\right)}\left\{\zeta\left(2|m| + 2j - 1\right)c_{j-1} + \frac{2}{\lambda_n}\sum_{p=0}^{P} b_p c_{j-p-2}\right\}$$

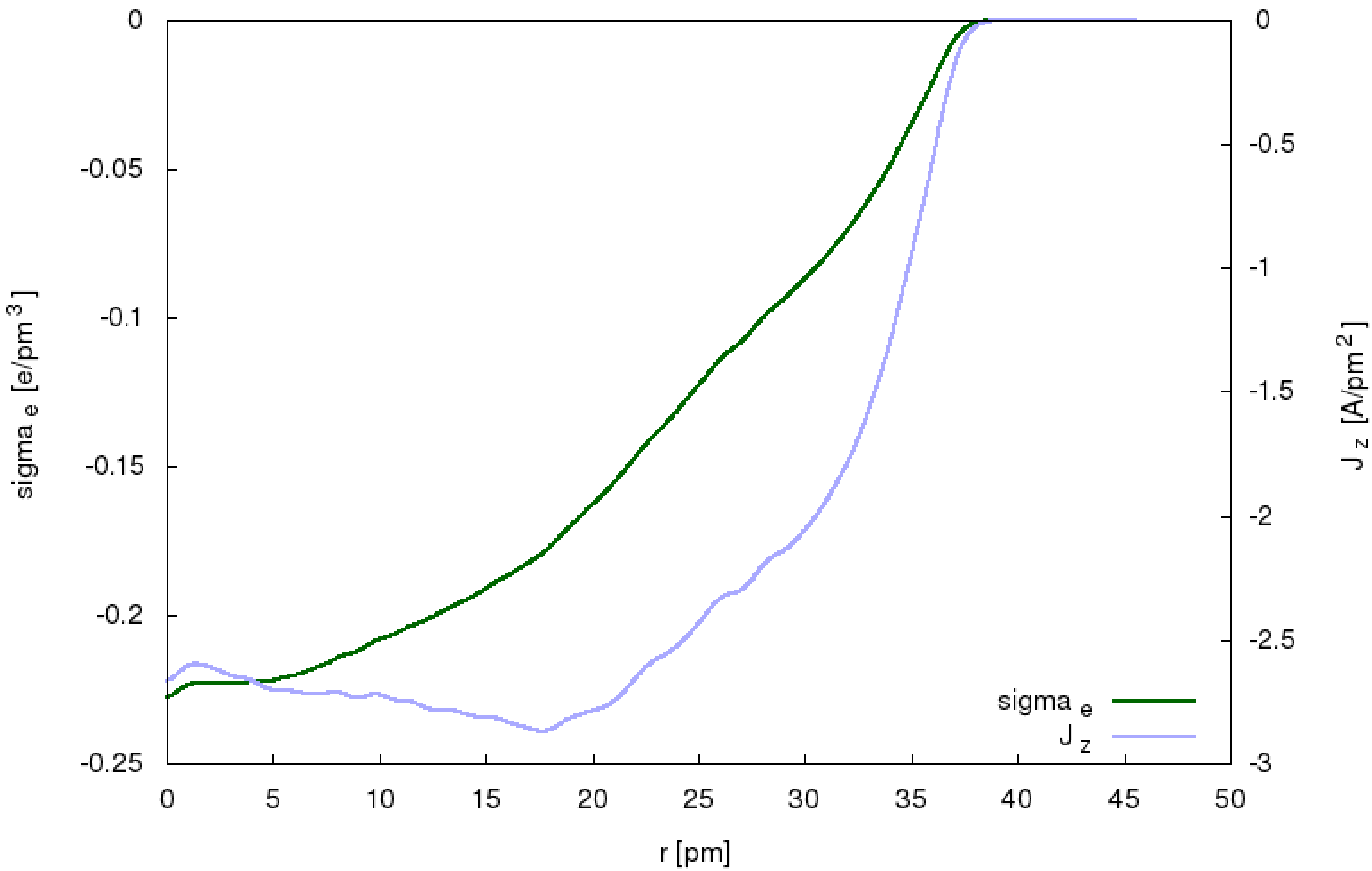
Main Properties of a CP

CPs can exist in many different configurations, influenced by experimental conditions.

- **Length > 10 micrometer, no upper limit**
- **Radius of the plasma wire: 35 – 130 pm**
- **Matter density: up to 100,000 times denser than ordinary matter**
- **Intrinsic current: 0.8 – 12 kA**
- **Mean electron velocity: 16 – 40 % of light speed**
- **Minimum electric potential: -7 to -60 kV**
- **Binding energy: 10 – 120 keV per electron (endothermic, preliminary)**

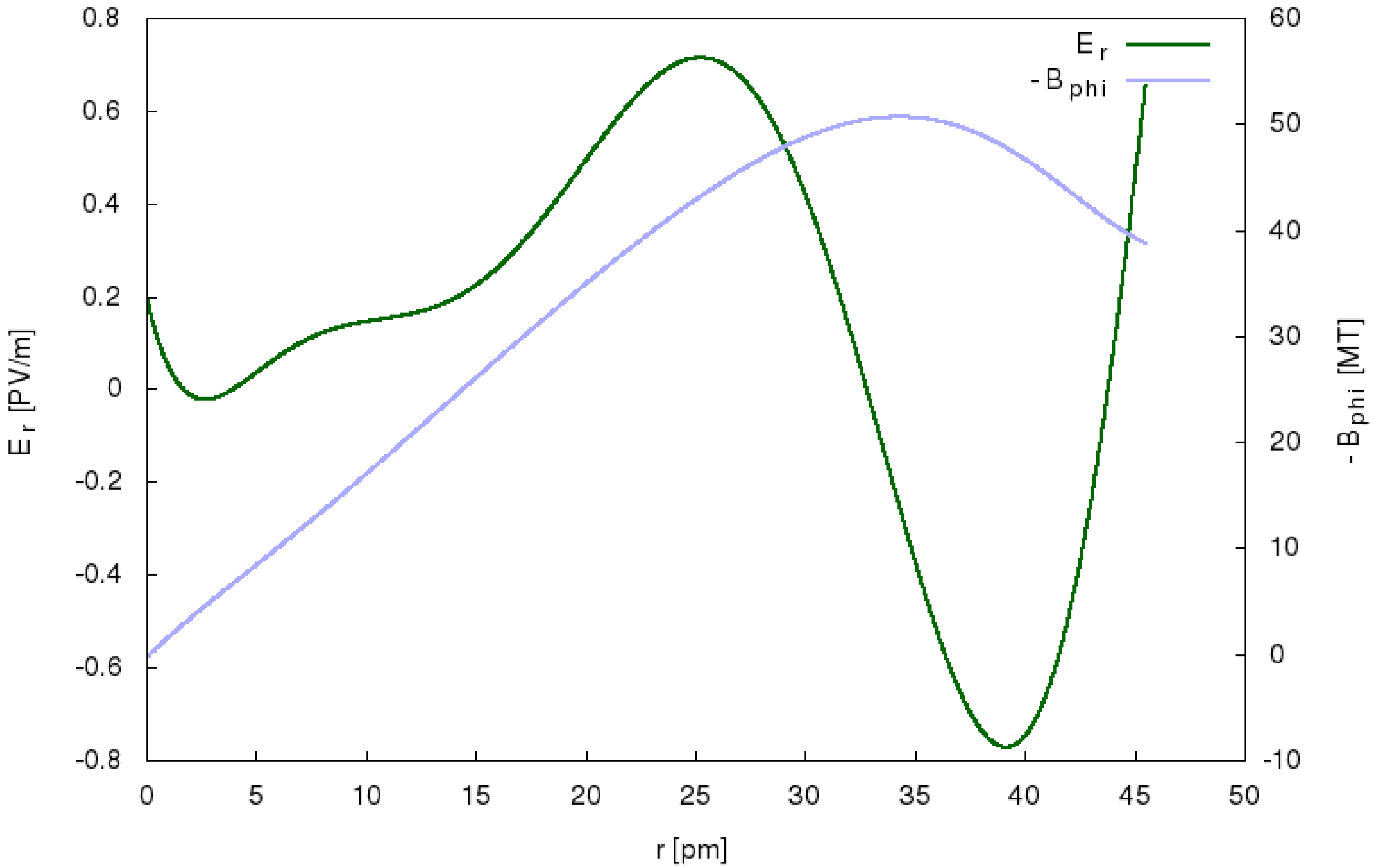
Electron Density, Current Density at 9.2 kA

- **Electron charge density: up to -0.22 e/pm^{-3}**
- **Current density: up to 2.8 A / pm^2**



Electric and Magnetic Fields at 9.2 kA

- **Electric field: Up to ±700 V/pm**
- **Magnetic field: Up to 50 MT**



Coulomb Tunneling Hypothesis

Minimum nuclear distance at 9.2 kA:

- **~2 pm (hydrogen), ~4pm (oxygen), ~8 pm (gadolinium)**

Coulomb tunneling (fusion) is probable with all sorts of elements

- **Not merely d-d fusion**

Really cold fusion:

- **No kinetic energy required for passing the Coulomb barrier**

Examples:

$$2\times{}^{16}O \rightarrow {}^{32}S + 16.54\,MeV$$

$${}^{2}H + {}^{105}Pd \rightarrow {}^{107}Ag + 13.12\,MeV$$

$${}^{1}H + {}^{39}K \rightarrow {}^{40}Ca + 8.33\,MeV$$

Spallation Hypothesis

Spallation = fusion-fission reaction

- **Emission of nucleons or nuclei from an excited nucleus**

Some excitation energy converted to kinetic energy of fragments

- **Fast: In the order of 0.1 femtosecond**

Examples:

$$^{2}H+^{105}Pd\rightarrow^{107}Ag^{*}(13.12\,MeV)\rightarrow^{1}H+^{106}Pd+7.34\,MeV$$

$$^{2}H+^{105}Pd\rightarrow^{107}Ag^{*}(13.12\,MeV)\rightarrow^{4}He+^{103}Rh+10.32\,MeV$$

$$^{2}H+^{104}Pd\rightarrow^{106}Ag^{*}(10.68\,MeV)\rightarrow^{48}Ca+^{58}Fe+30.10\,MeV$$

Near-field Interaction Hypothesis

The fusion energy is "cooled" away be the electrons of the CPs:

- **Excited nuclei have oscillating electric and magnetic moments**
- **The dense and fast electrons of CPs interact with the near-field of the oscillating moments**
- **An electron on average will be accelerated a bit, if it is passing an excited nucleus at a distance smaller than the electromagnetic wave length of the oscillation**
- **This is a non-resonant transfer of energy, because the electron "behaves" like a free electron to the frequency of the nucleus**
- **The big energy quantum of the excited nucleus is <u>down-converted</u> to millions of small amounts of kinetic energy**

Altered Weak-Interaction Hypothesis

Beta-plus decay is suppressed in favor of electron caption

- **Because of the extreme electron densities in CPs**
- **Explains, why the 511 keV annihilation radiation is not seen**

Speculation: Also beta-minus decay is accelerated

- **Could explain low output of radioactive isotopes and neutrons**

Example:

$$^{1}H + {}^{58}Ni \rightarrow {}^{59}Cu + 3.42\,MeV$$

$$^{59}Cu + e^{-} \rightarrow {}^{59}Ni + \nu_e + 4.80\,MeV$$

$$^{59}Ni + e^{-} \rightarrow {}^{59}Co + \nu_e + 1.07\,MeV$$

Self-Sustained Growth Hypothesis

The nuclear energy produced in a CP is providing a mechanism of growth:

- **The energy of excited nuclei is accelerating the electrons in the CP**
- **Vacates some electron orbitals corresponding to low axial velocities**
- **Vacated orbitals can be backfilled by electrons from the environment, if the electrons have enough axial momentum**
- **Thereby the electric potential is getting lower, which will attract cations from the environment to enter the CP**

Consequences:

- **Increased longevity of the CPs**
- **High temperatures increase the reaction rate**
- **Glow discharge can "nurture" CPs with fast electrons**
- **Sparks can have a negative resistance, i.e. they can produce energy**
- **Experiments with unlimited fuel supply are dangerous!**

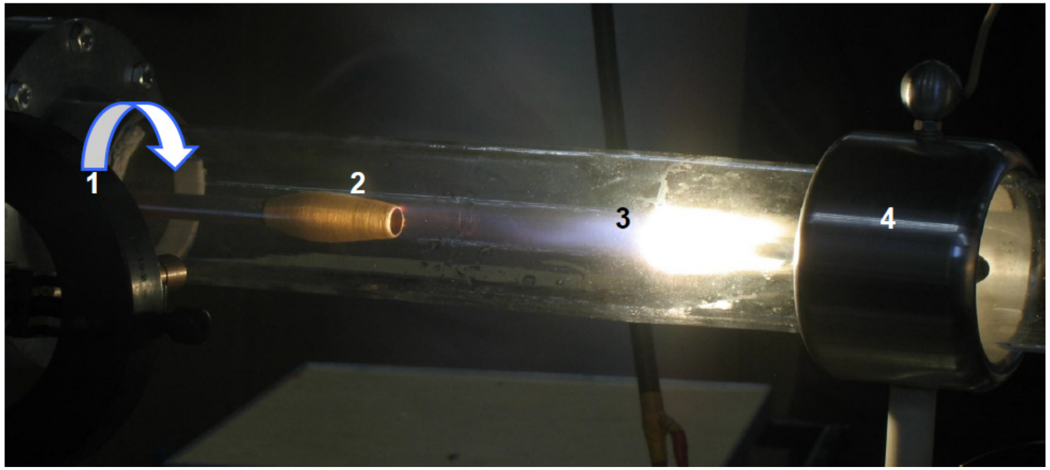
Be Careful!

- **CPs can damage biologic tissue and pose a health risk**
- **CPs can pass through the walls of a LENR apparatus**
- **CPs can emit intense soft x-ray and UV light**
- **CPs can destruct electronic components**
- **CPs can ionize all matter, which often looks like melting**

Proper shielding (iron) is required!

When You See the CPs Shining…

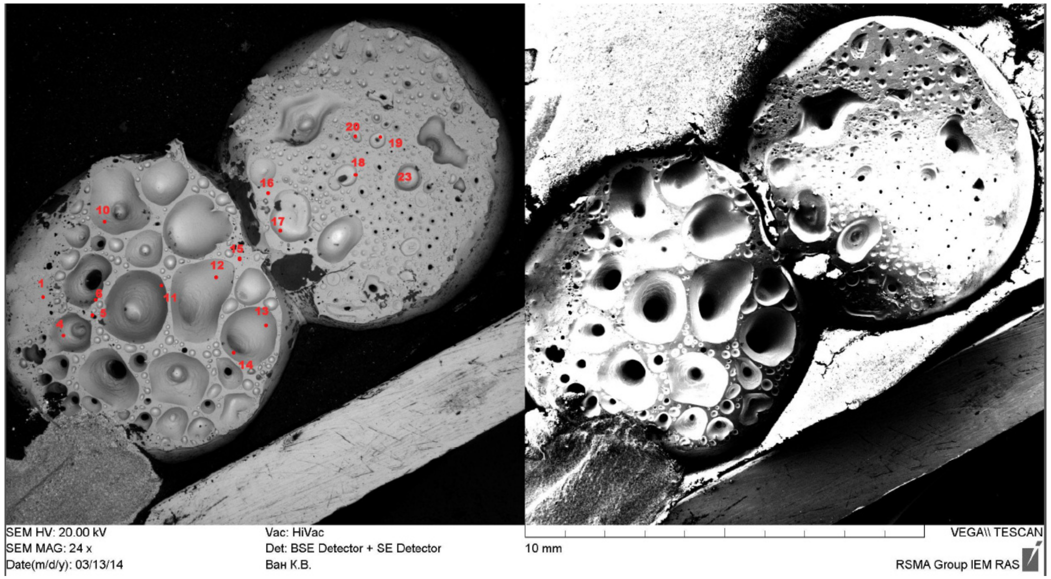
at the cathode…



Plasma vortex reactor of Anatoly Klimov et al.

and the craters…

you know there are kilowatts of excess heat!



Questions?

Condensed Plasmoids

Thank you for your interest!

www.condensed-plasmoids.com
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Backup Slides

Predictions

- All sorts of isotopes can transmute in LENR
- Most sorts of stable isotopes can be produced by LENR
- CPs will emit fast electrons, but almost no ions
- Time-correlated pulses of sound, radio frequencies, light and x-rays will be emitted, when a CP “dies”
- Cathodes will be eroded by the emission o CPs, some of the eroded material will be deposited on the anodes as little droplets
- No nuclear reactions will occur in the crystal lattice, because CPs will destroy all materials at the reaction spot

Predictions (continued)

- **Due to the intrinsic current of CPs, they will exhibit pseudo-ferromagnetism even at high temperatures**
- **CPs will emit a broad-band photon spectrum**
- **LENR is never spontaneous, because CP formation requires energy**
- **CPs are preferring to electrostatically attach to surfaces**
- **Sparks can have a negative resistance and can produce electric energy**
- **CPs can grow in some environments**

Miley’s Ni-H_2O experiment

Reaction product yield vs. atomic number