Polyneutron Theory

John C. Fisher
jcfisher@fisherstone.com

ICCF13, Sochi, Russia, 25 June 2007

Assumptions of polyneutron theory

Assumptions of polyneutron theory

Clusters of six or more neutrons are bound: Polyneutrons.

Assumptions of polyneutron theory

Clusters of six or more neutrons are bound: Polyneutrons.

Polyneutrons beta decay one neutron at a time: $\mathrm{n} \longrightarrow \mathrm{p} + \mathrm{e}^{-}$.

Assumptions of polyneutron theory

Clusters of six or more neutrons are bound: Polyneutrons.

Polyneutrons beta decay one neutron at a time: $\mathrm{n} \longrightarrow \mathrm{p} + \mathrm{e}^{-}$.

Polyneutrons and decay products obey the laws of nuclear physics.

Notation

Notation

^{A}n is a cluster of A neutrons (a polyneutron).

Notation

^{A}n is a cluster of A neutrons (a polyneutron).

^{A}H$_p$ is a cluster of A$-$1 neutrons and 1 proton.

Notation

^{A}n is a cluster of A neutrons (a polyneutron).

^{A}H$_p$ is a cluster of A$-$1 neutrons and 1 proton.

^{A}He$_p$ is a cluster of A$-$2 neutrons and 2 protons, etc.

Notation

^{A}n is a cluster of A neutrons (a polyneutron).

$^{A}\mathrm{H}_{p}$ is a cluster of A$-$1 neutrons and 1 proton.

$^{A}\mathrm{He}_{p}$ is a cluster of A$-$2 neutrons and 2 protons, etc.

$\Delta(^{A}\mathrm{n})$, $\Delta(^{A}\mathrm{H}_{p})$, $\Delta(^{A}\mathrm{He}_{p})$, ... are their mass excesses in MeV.

Challenge to theory

Challenge to theory

Determine mass excesses that can account for LENR reactions:

Challenge to theory

Determine mass excesses that can account for LENR reactions:

Energy, ^{4}He, ^{3}H, energetic particles, transmutation, particle showers, etc.

Present state of theory

Present state of theory

$$\Delta(^{\mathsf{A}}\mathsf{n}) = 104.7\mathsf{A}^{-1} + 1.088\mathsf{A} + 0.698\mathsf{A}^{2/3} \qquad (+4.2 \text{ if A is odd});$$

Present state of theory

$\Delta(^{\mathsf{A}}\mathsf{n}) = 104.7\mathsf{A}^{-1} + 1.088\mathsf{A} + 0.698\mathsf{A}^{2/3}$ $\quad$ (+4.2 if A is odd);

For $\Delta(^{\mathsf{A}}\mathsf{H}_p)$, $\Delta(^{\mathsf{A}}\mathsf{He}_p)$, ... add $-0.782Z + 0.57Z(Z-1)\mathsf{A}^{-1/3}$.

Tritium

Tritium

$$^{601}\mathsf{n} + {}^{2}\mathsf{H} \rightarrow {}^{600}\mathsf{n} + {}^{3}\mathsf{H} + 3.529 \text{ MeV}$$

Tritium

$$^{601}\mathsf{n} + {}^{2}\mathsf{H} \rightarrow {}^{600}\mathsf{n} + {}^{3}\mathsf{H} + 3.529 \text{ MeV}$$

$$^{101}\mathsf{n} + {}^{2}\mathsf{H} \rightarrow {}^{100}\mathsf{n} + {}^{3}\mathsf{H} + 3.564 \text{ MeV}$$

Transmutation to new element

Transmutation to new element

$$^{601}\mathsf{n} + {}^{137}\mathbf{Ba} \rightarrow {}^{598}\mathsf{n} + {}^{136}\mathbf{Xe} + {}^{4}\mathsf{He} + 3.908\ \mathrm{MeV}$$

Transmutation to new element

$$^{601}\mathsf{n} + {}^{137}\mathbf{Ba} \rightarrow {}^{598}\mathsf{n} + {}^{136}\mathbf{Xe} + {}^{4}\mathsf{He} + 3.908 \text{ MeV}$$

Probably seen.

Transmutation to new isotope

Transmutation to new isotope

$$^{601}\mathsf{n} + {}^{137}\mathbf{Ba} \rightarrow {}^{600}\mathsf{n} + {}^{138}\mathbf{Ba} + 5.884 \text{ MeV}$$

Transmutation to new isotope

$^{601}\mathsf{n} + {}^{137}\mathbf{Ba} \rightarrow {}^{600}\mathsf{n} + {}^{138}\mathbf{Ba} + 5.884$ MeV

Seen.

Energy and helium

Energy and helium

$$^{A}\mathrm{n} + {}^{2}\mathrm{H} \rightarrow {}^{A+1}\mathrm{n} + {}^{1}\mathrm{H}$$

$$^{A+1}\mathrm{n} + {}^{2}\mathrm{H} \rightarrow {}^{A+2}\mathrm{n} + {}^{1}\mathrm{H}$$

$$^{A+2}\mathrm{n} + {}^{2}\mathrm{H} \rightarrow {}^{A+3}\mathrm{n} + {}^{1}\mathrm{H}$$

$$^{A+3}\mathrm{n} + {}^{2}\mathrm{H} \rightarrow {}^{A+4}\mathrm{n} + {}^{1}\mathrm{H}$$

Energy and helium

$$^{A}\mathrm{n} + {}^{2}\mathrm{H} \rightarrow {}^{A+1}\mathrm{n} + {}^{1}\mathrm{H}$$

$$^{A+1}\mathrm{n} + {}^{2}\mathrm{H} \rightarrow {}^{A+2}\mathrm{n} + {}^{1}\mathrm{H}$$

$$^{A+2}\mathrm{n} + {}^{2}\mathrm{H} \rightarrow {}^{A+3}\mathrm{n} + {}^{1}\mathrm{H}$$

$$^{A+3}\mathrm{n} + {}^{2}\mathrm{H} \rightarrow {}^{A+4}\mathrm{n} + {}^{1}\mathrm{H}$$

$$^{A+4}\mathrm{n} \xrightarrow{\beta\beta} {}^{A+4}\mathrm{He}_{p} \xrightarrow{\alpha} {}^{A}\mathrm{n} + {}^{4}\mathrm{He}$$

Energy and helium

$$^{A}\mathrm{n} + {}^{2}\mathrm{H} \rightarrow {}^{A+1}\mathrm{n} + {}^{1}\mathrm{H}$$

$$^{A+1}\mathrm{n} + {}^{2}\mathrm{H} \rightarrow {}^{A+2}\mathrm{n} + {}^{1}\mathrm{H}$$

$$^{A+2}\mathrm{n} + {}^{2}\mathrm{H} \rightarrow {}^{A+3}\mathrm{n} + {}^{1}\mathrm{H}$$

$$^{A+3}\mathrm{n} + {}^{2}\mathrm{H} \rightarrow {}^{A+4}\mathrm{n} + {}^{1}\mathrm{H}$$

$$^{A+4}\mathrm{n} \xrightarrow{\beta\beta} {}^{A+4}\mathrm{He}_{p} \xrightarrow{\alpha} {}^{A}\mathrm{n} + {}^{4}\mathrm{He}$$

$$4({}^{2}\mathrm{H}) \rightarrow 4({}^{1}\mathrm{H}) + {}^{4}\mathrm{He} + 21\ \mathrm{MeV}$$

Energy and helium

$$^{A}\mathrm{n} + {}^{2}\mathrm{H} \rightarrow {}^{A+1}\mathrm{n} + {}^{1}\mathrm{H}$$

$$^{A+1}\mathrm{n} + {}^{2}\mathrm{H} \rightarrow {}^{A+2}\mathrm{n} + {}^{1}\mathrm{H}$$

$$^{A+2}\mathrm{n} + {}^{2}\mathrm{H} \rightarrow {}^{A+3}\mathrm{n} + {}^{1}\mathrm{H}$$

$$^{A+3}\mathrm{n} + {}^{2}\mathrm{H} \rightarrow {}^{A+4}\mathrm{n} + {}^{1}\mathrm{H}$$

$$^{A+4}\mathrm{n} \xrightarrow{\beta\beta} {}^{A+4}\mathrm{He}_{p} \xrightarrow{\alpha} {}^{A}\mathrm{n} + {}^{4}\mathrm{He}$$

$$4({}^{2}\mathrm{H}) \rightarrow 4({}^{1}\mathrm{H}) + {}^{4}\mathrm{He} + 21\ \mathrm{MeV}$$

Agrees with experimental ≈ 24 MeV per ^{4}He.

Composites

Composites

$^{1}\mathrm{H}^{\mathrm{A}}\mathrm{n}$, $^{16}\mathrm{O}\,^{\mathrm{A}}\mathrm{n}$, $^{96}\mathrm{Zr}^{\mathrm{A}}\mathrm{n}$, $^{141}\mathrm{Pr}^{\mathrm{A}}\mathrm{n}$ ....

Composites

$^{1}\mathrm{H}^{\mathrm{A}}\mathrm{n}$, $^{16}\mathrm{O}^{\mathrm{A}}\mathrm{n}$, $^{96}\mathrm{Zr}^{\mathrm{A}}\mathrm{n}$, $^{141}\mathrm{Pr}^{\mathrm{A}}\mathrm{n}$ ....

Stable against internal neutron transfer.

Composites

$^{1}\mathrm{H}^{A}\mathrm{n}$, $^{16}\mathrm{O}\,^{A}\mathrm{n}$, $^{96}\mathrm{Zr}^{A}\mathrm{n}$, $^{141}\mathrm{Pr}^{A}\mathrm{n}$ ....

Stable against internal neutron transfer.

Important roles in transmutations and chain reactions.

Transmutation sequences

Transmutation sequences

$$^{88}\mathbf{Sr} \xrightarrow{2\beta} {}^{96}\mathbf{Zr} \xrightarrow{2\beta} {}^{100}\mathbf{Mo} \xrightarrow{12\beta} {}^{136}\mathrm{Xe} \rightarrow \ \ldots$$

Transmutation sequences

$$^{88}\mathbf{Sr} \xrightarrow{2\beta} {}^{96}\mathbf{Zr} \xrightarrow{2\beta} {}^{100}\mathbf{Mo} \xrightarrow{12\beta} {}^{136}\mathrm{Xe} \rightarrow \ldots$$

$$^{133}\mathbf{Cs} \xrightarrow{\beta} {}^{137}\mathrm{Ba} \xrightarrow{\beta} {}^{139}\mathrm{La} \xrightarrow{2\beta} {}^{141}\mathbf{Pr} \xrightarrow{\beta} {}^{143}\mathrm{Nd} \xrightarrow{6\beta} {}^{163}\mathrm{Dy} \rightarrow \ldots$$

Transmutation sequences

$$^{88}\mathbf{Sr} \xrightarrow{2\beta} {}^{96}\mathbf{Zr} \xrightarrow{2\beta} {}^{100}\mathbf{Mo} \xrightarrow{12\beta} {}^{136}\mathrm{Xe} \rightarrow \ldots$$

$$^{133}\mathbf{Cs} \xrightarrow{\beta} {}^{137}\mathrm{Ba} \xrightarrow{\beta} {}^{139}\mathrm{La} \xrightarrow{2\beta} {}^{141}\mathbf{Pr} \xrightarrow{\beta} {}^{143}\mathrm{Nd} \xrightarrow{6\beta} {}^{163}\mathrm{Dy} \rightarrow \ldots$$

$$^{138}\mathbf{Ba} \xrightarrow{2\beta} {}^{140}\mathrm{Ce} \xrightarrow{2\beta} {}^{144}\mathbf{Nd} \xrightarrow{2\beta} {}^{150}\mathbf{Sm} \xrightarrow{\beta} {}^{156}\mathrm{Eu} \rightarrow \ldots\ .$$

Transmutation sequences

$$\mathbf{^{88}Sr} \xrightarrow{2\beta} \mathbf{^{96}Zr} \xrightarrow{2\beta} \mathbf{^{100}Mo} \xrightarrow{12\beta} {}^{136}\mathrm{Xe} \rightarrow \ldots$$

$$\mathbf{^{133}Cs} \xrightarrow{\beta} {}^{137}\mathrm{Ba} \xrightarrow{\beta} {}^{139}\mathrm{La} \xrightarrow{2\beta} \mathbf{^{141}Pr} \xrightarrow{\beta} {}^{143}\mathrm{Nd} \xrightarrow{6\beta} {}^{163}\mathrm{Dy} \rightarrow \ldots$$

$$\mathbf{^{138}Ba} \xrightarrow{2\beta} {}^{140}\mathrm{Ce} \xrightarrow{2\beta} \mathbf{^{144}Nd} \xrightarrow{2\beta} \mathbf{^{150}Sm} \xrightarrow{\beta} {}^{156}\mathrm{Eu} \rightarrow \ldots .$$

All potential transmutations are shown.

Transmutation sequences

$$\mathbf{^{88}Sr} \xrightarrow{2\beta} \mathbf{^{96}Zr} \xrightarrow{2\beta} \mathbf{^{100}Mo} \xrightarrow{12\beta} {}^{136}\mathrm{Xe} \rightarrow \ldots$$

$$\mathbf{^{133}Cs} \xrightarrow{\beta} {}^{137}\mathrm{Ba} \xrightarrow{\beta} {}^{139}\mathrm{La} \xrightarrow{2\beta} \mathbf{^{141}Pr} \xrightarrow{\beta} {}^{143}\mathrm{Nd} \xrightarrow{6\beta} {}^{163}\mathrm{Dy} \rightarrow \ldots$$

$$\mathbf{^{138}Ba} \xrightarrow{2\beta} {}^{140}\mathrm{Ce} \xrightarrow{2\beta} \mathbf{^{144}Nd} \xrightarrow{2\beta} \mathbf{^{150}Sm} \xrightarrow{\beta} {}^{156}\mathrm{Eu} \rightarrow \ldots .$$

All potential transmutations are shown.

Bold-faced transmutations have been seen.

Transmutation sequences

$\mathbf{^{88}Sr} \xrightarrow{2\beta} \mathbf{^{96}Zr} \xrightarrow{2\beta} \mathbf{^{100}Mo} \xrightarrow{12\beta} {}^{136}\mathrm{Xe} \rightarrow \ldots$

$\mathbf{^{133}Cs} \xrightarrow{\beta} {}^{137}\mathrm{Ba} \xrightarrow{\beta} {}^{139}\mathrm{La} \xrightarrow{2\beta} \mathbf{^{141}Pr} \xrightarrow{\beta} {}^{143}\mathrm{Nd} \xrightarrow{6\beta} {}^{163}\mathrm{Dy} \rightarrow \ldots$

$\mathbf{^{138}Ba} \xrightarrow{2\beta} {}^{140}\mathrm{Ce} \xrightarrow{2\beta} \mathbf{^{144}Nd} \xrightarrow{2\beta} \mathbf{^{150}Sm} \xrightarrow{\beta} {}^{156}\mathrm{Eu} \rightarrow \ldots$.

All potential transmutations are shown.

Bold-faced transmutations have been seen.

($\mathbf{^{133}Cs} \xrightarrow{\beta} {}^{137}\mathrm{Ba} \xrightarrow{\beta} {}^{139}\mathrm{La}$ possibly seen.)

Chain reaction

Chain reaction

Growth: $^{\mathbf{A}}\mathbf{n} + {}^{2}\mathrm{H} \rightarrow {}^{\mathbf{A+1}}\mathbf{n} + {}^{1}\mathrm{H} + (11.190/0.504)$ (odd A/even A).

Chain reaction

Growth: $^{\mathbf{A}}\mathbf{n} + {}^{2}\mathrm{H} \rightarrow {}^{\mathbf{A+1}}\mathbf{n} + {}^{1}\mathrm{H} + (11.190/0.504)$ (odd A/even A).

Fission: $^{\mathbf{A}}\mathbf{n} + {}^{2}\mathrm{H} \rightarrow {}^{\mathbf{A-33}}\mathbf{n} + {}^{\mathbf{34}}\mathbf{n} + {}^{1}\mathrm{H} + 0.383$ (odd A).

Chain reaction

Growth: $^{\mathbf{A}}\mathbf{n} + {}^{2}\mathrm{H} \rightarrow {}^{\mathbf{A+1}}\mathbf{n} + {}^{1}\mathrm{H} + (11.190/0.504)$ (odd A/even A).

Fission: $^{\mathbf{A}}\mathbf{n} + {}^{2}\mathrm{H} \rightarrow {}^{\mathbf{A-33}}\mathbf{n} + {}^{\mathbf{34}}\mathbf{n} + {}^{1}\mathrm{H} + 0.383$ (odd A).

Role of composites ($^{1}\mathrm{H}^{\mathrm{A}}\mathrm{n}$, $^{16}\mathrm{O}^{\mathrm{A}}\mathrm{n}$)

Chain reaction

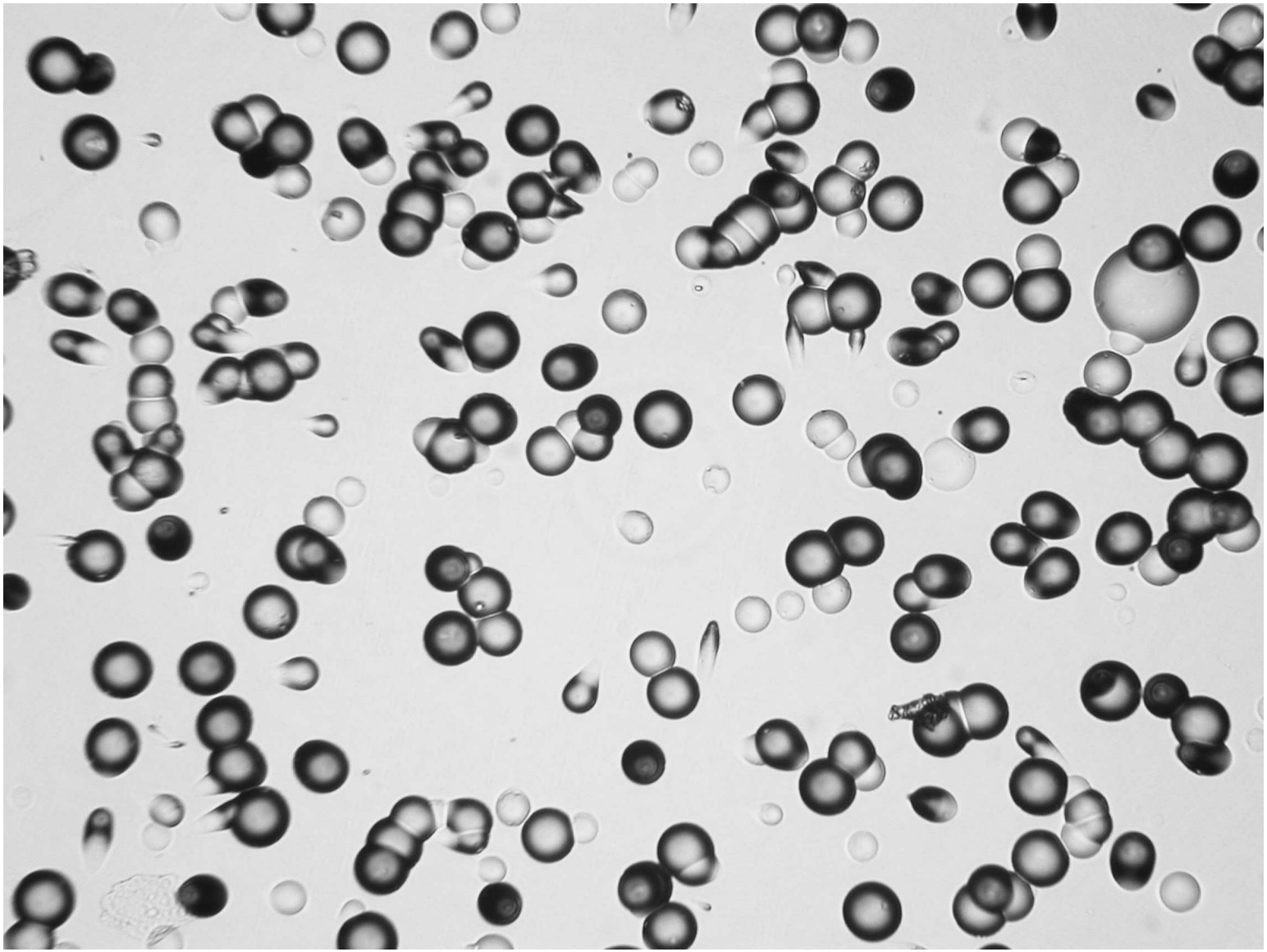
Growth: $^{\mathbf{A}}\mathbf{n} + {}^{2}\mathrm{H} \rightarrow {}^{\mathbf{A+1}}\mathbf{n} + {}^{1}\mathrm{H} + (11.190/0.504)$ (odd A/even A).

Fission: $^{\mathbf{A}}\mathbf{n} + {}^{2}\mathrm{H} \rightarrow {}^{\mathbf{A-33}}\mathbf{n} + {}^{\mathbf{34}}\mathbf{n} + {}^{1}\mathrm{H} + 0.383$ (odd A).

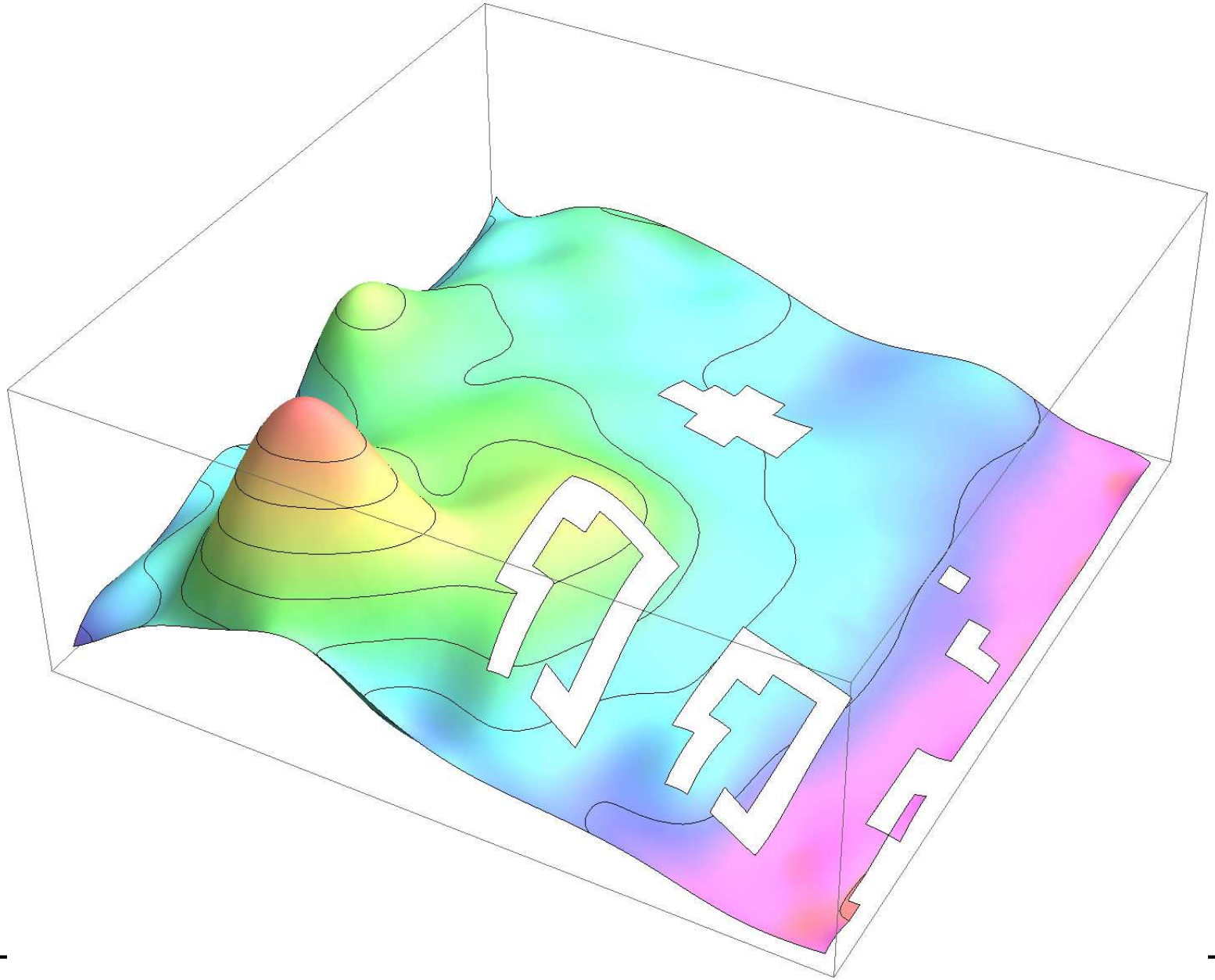
Role of composites ($^{1}\mathrm{H}^{\mathrm{A}}\mathrm{n}$, $^{16}\mathrm{O}^{\mathrm{A}}\mathrm{n}$)

Role of electrolysis.

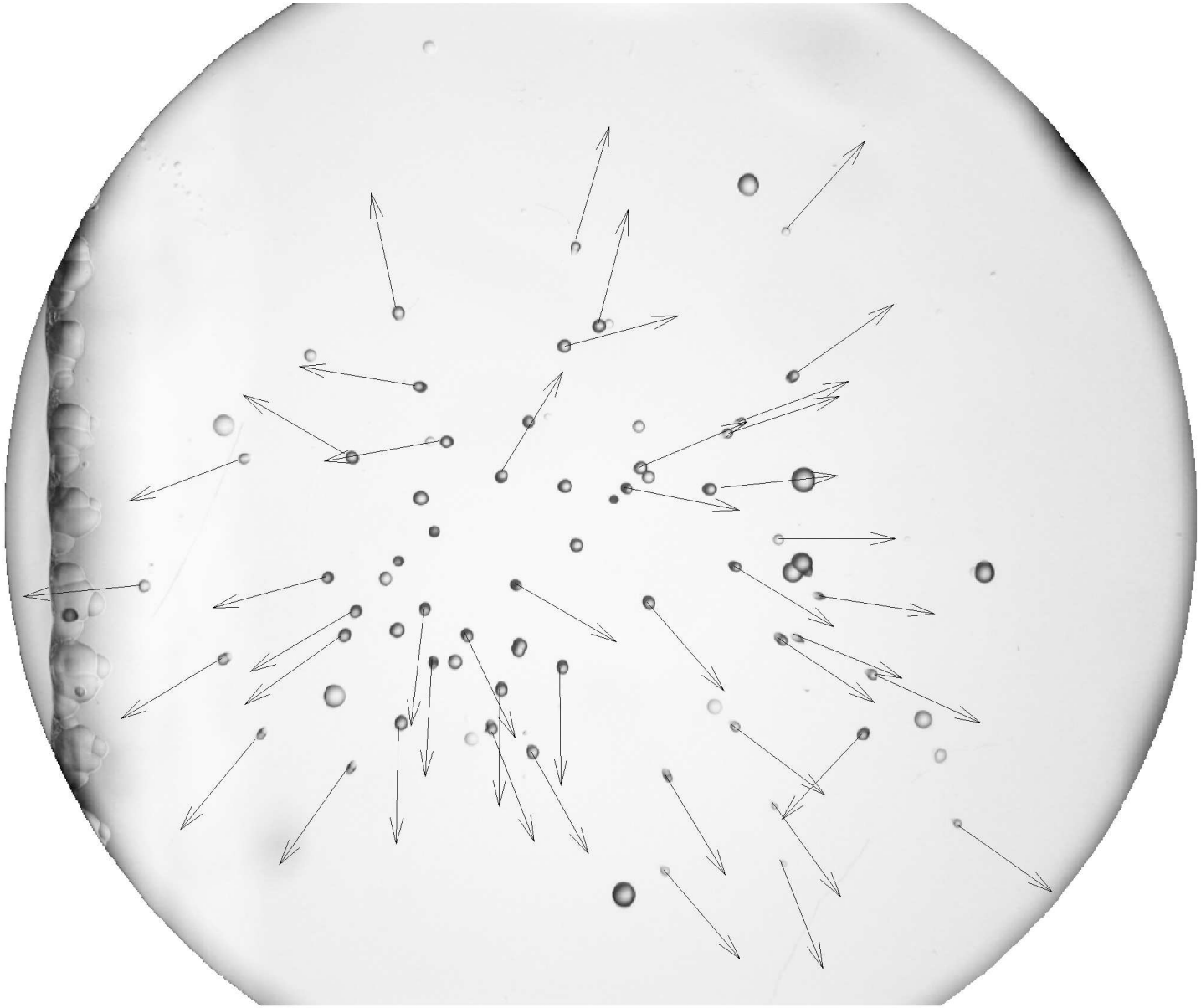
Particle shower etch pits



Etch pit density map (30,000 pits)



Small particle shower



Overall

Overall

Quantitative explanations for many LENR phenomena:

Overall

Quantitative explanations for many LENR phenomena:

Energy,

Overall

Quantitative explanations for many LENR phenomena:

Energy, Helium,

Overall

Quantitative explanations for many LENR phenomena:

Energy, Helium, Tritium,

Overall

Quantitative explanations for many LENR phenomena:

Energy, Helium, Tritium, Energetic Particles,

Overall

Quantitative explanations for many LENR phenomena:

Energy, Helium, Tritium, Energetic Particles, Transmutations,

Overall

Quantitative explanations for many LENR phenomena:

Energy, Helium, Tritium, Energetic Particles, Transmutations, Particle Showers,

Overall

Quantitative explanations for many LENR phenomena:

Energy, Helium, Tritium, Energetic Particles, Transmutations, Particle Showers, "Life after Death",

Overall

Quantitative explanations for many LENR phenomena:

Energy, Helium, Tritium, Energetic Particles, Transmutations, Particle Showers, "Life after Death", X-rays,

Overall

Quantitative explanations for many LENR phenomena:

Energy, Helium, Tritium, Energetic Particles, Transmutations, Particle Showers, "Life after Death", X-rays, Initial Polyneutron,

Overall

Quantitative explanations for many LENR phenomena:

Energy, Helium, Tritium, Energetic Particles, Transmutations, Particle Showers, "Life after Death", X-rays, Initial Polyneutron, Start-up Problems,

Overall

Quantitative explanations for many LENR phenomena:

Energy, Helium, Tritium, Energetic Particles, Transmutations, Particle Showers, "Life after Death", X-rays, Initial Polyneutron, Start-up Problems, Absence of Bremsstrahlung,

Overall

Quantitative explanations for many LENR phenomena:

Energy, Helium, Tritium, Energetic Particles, Transmutations,
Particle Showers, "Life after Death", X-rays, Initial Polyneutron,
Start-up Problems, Absence of Bremsstrahlung,
Role of Electrolysis,

Overall

Quantitative explanations for many LENR phenomena:

Energy, Helium, Tritium, Energetic Particles, Transmutations,
Particle Showers, "Life after Death", X-rays, Initial Polyneutron,
Start-up Problems, Absence of Bremsstrahlung,
Role of Electrolysis, Role of Calcium