Neutron Production from *Smart* materials: Pyro and Piezo electrics

LENT: Low Energy Nuclear Transmutations
From specially prepared materials

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Allan Widom, John Swain, YS

Our Basic Result:

All fundamental interactions
Gravitational, Strong, Electromagnetic &Weak
Lead to LENT both in Nature and in the laboratory.

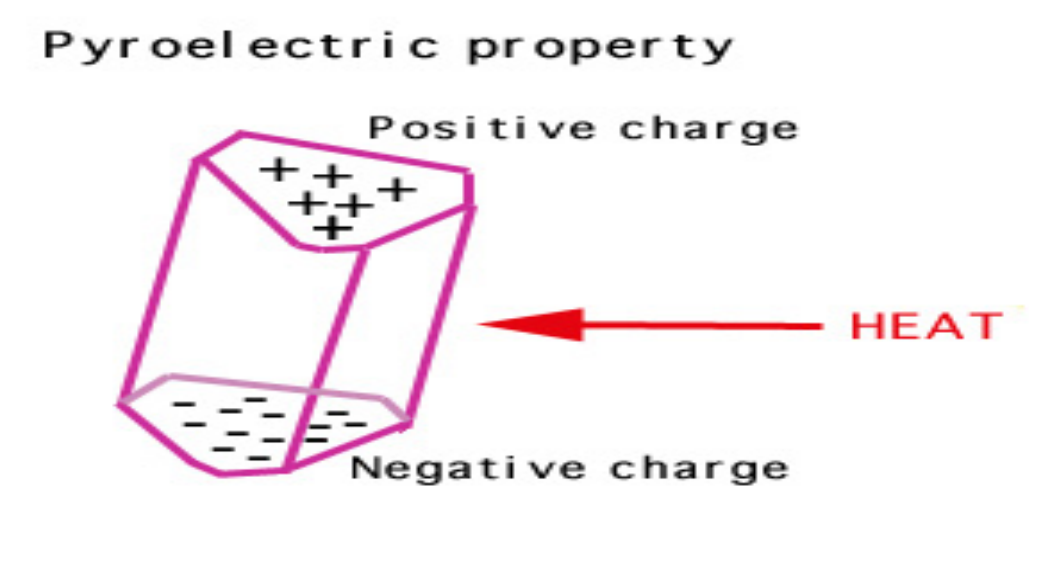
The debate should no longer be about their veracity.

The challenge now is to use modern technology to find new practical applications of the Standard Model of Particle Physics.

This is the goal of the Preparata Project at Perugia

Contents of the Talk: I

1. Pyroelectric crystals:
when heated or cooled
Produce electric fields

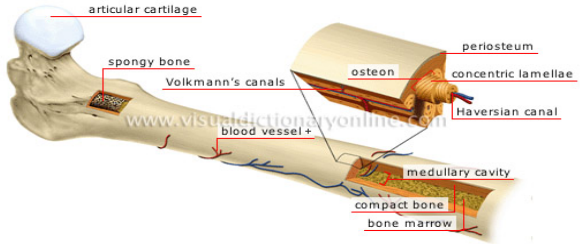


2. Piezoelectric crystals
when crushed produce
electric fields

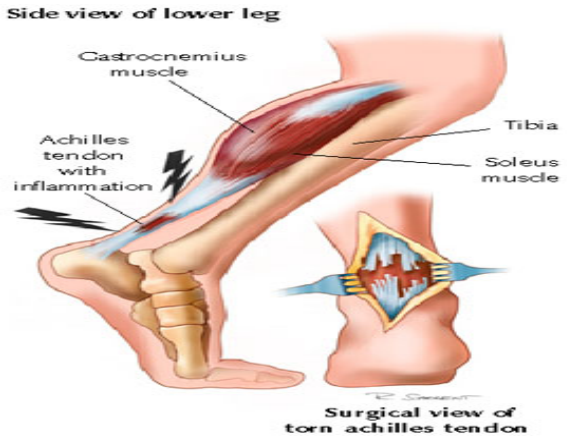
LENT in Smart Materials I: Pyroelectrics

A pyroelectric crystal develops an electric field due to (adiabatic) changes in its temperature and its opposite: an applied electric field causing an adiabatic heating or cooling of the system is called the electrocaloric effect.

Examples of natural pyroelectric crystal are: tourmaline, bone, tendon.



It was experimentally shown that pyroelectric crystals when heated or cooled produced nuclear dd fusion evidenced by the signal of 2.5 MeV neutrons. The system was used to ionize the gas and accelerate the ions up to 200 KeV sufficient to cause dd fusion. The measured yields agree with the calculated yields.



Pyroelectrics II

- In a single domain of a pyro-electric crystal, the mean electric induction is not zero:

$$< \mathbf{D} > \neq \ 0$$

- When such a crystal is heated or cooled, it gets spontaneously polarized: produces an electric field
- The effective electric field (E_{eff}) generated in the crystal is assumed proportional to the change in the temperature (ΔT): $E_{eff} = \phi \, \Delta T$
- Lithium Tantalate [$LiTaO_3$] has a large

$$\phi = 17 \text{ KV/cm K}$$

Pyroelectrics III

- The energy given to an ion of charge e may be written as $eV = 4\pi et\,\phi(\Delta T)/\varepsilon$ [t is the thickness; ε is the dielectric constant]
- For a two Lithium tantalate crystal set up, each 1 cm thick, $\varepsilon = 46$, $\Delta T = 100$ C, the energy should be

  2 eV = 933 KeV
- Instead the measured value is 200 KeV [In the core of the Sun it is only about 1.5 KeV]
- This energy is much more than sufficient for say two accelerated deuterons to overcome the Coulomb repulsion and cause fusion.
- Pyro fusion has been observed in several laboratories around the world.

Pyroelectrics IV

$$d + d \rightarrow {}^{3}\mathrm{He} + n$$

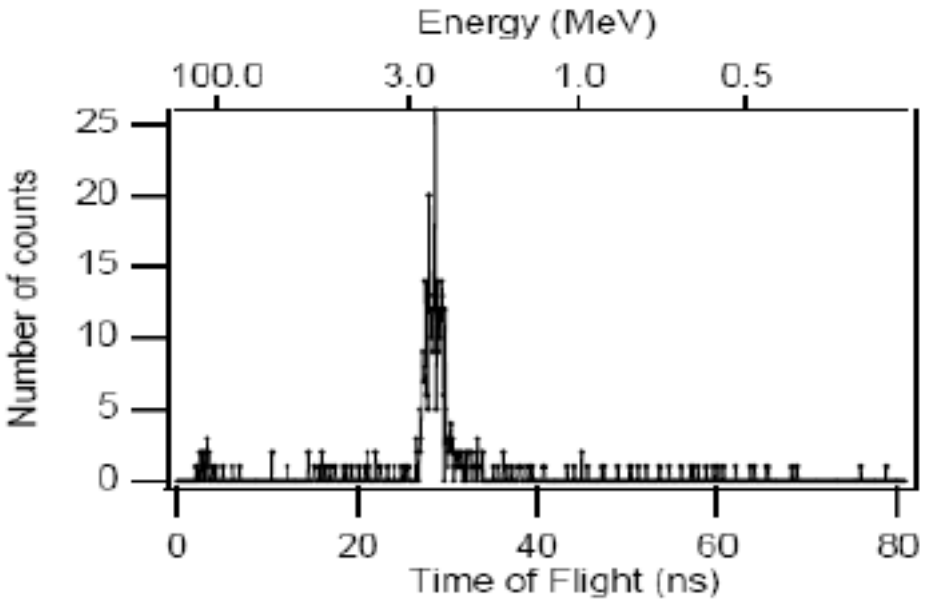


FIG. 1. Neutron time-of-flight spectrum. Neutrons were detected 62 cm from the target using a 7 mm thick plastic scintillator. The peak occurs at 2.45 ± 0.2 MeV, characteristic of DD fusion.

Neutron production from fracturing rocks [WSS]: II

Examples of piezoelectrics: Bone, hair, quartz

$\mathcal{E}$ Electric field

w Strain tensor

β Piezoelectric constant

$$\mathcal{H}_{int} = -\int \beta_{ijk} E_i w_{jk} d^3\mathbf{r}$$

Neutron Production from the Fracture of Piezoelectric Rocks

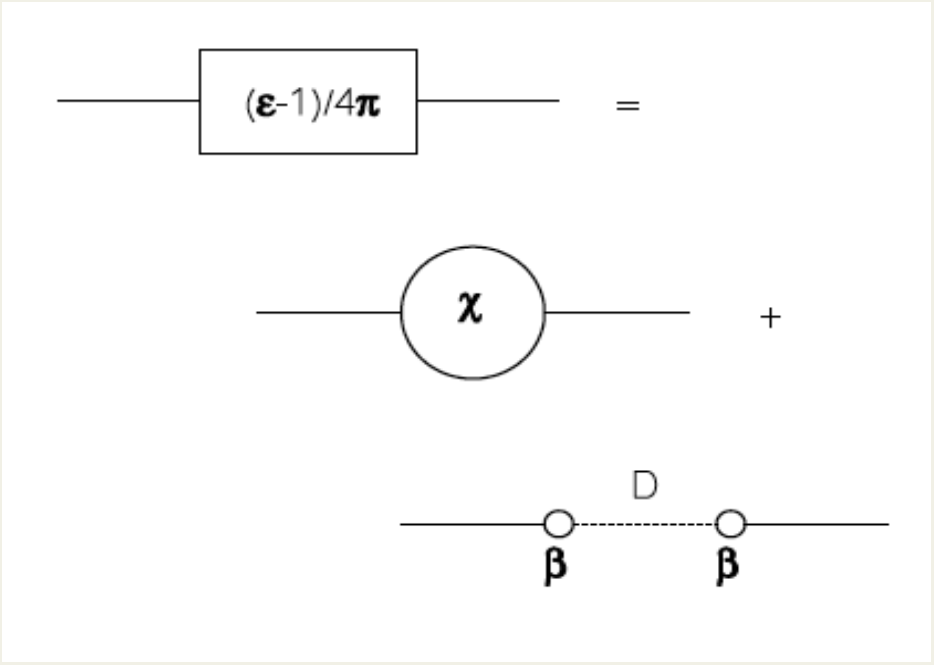
[Accepted for publication]

Neutron production from fracturing rocks [WSS]: III

$$\mathbf{D} = \mathbf{E} + 4\pi\mathbf{P},$$

$$\epsilon_{ij}(\zeta) = \delta_{ij} + 4\pi\tilde{\chi}_{ij}(\zeta),$$

$$\tilde{\chi}_{ij}(\zeta) = \chi_{ij}(\zeta) + \beta_{i,jk} D_{lknm}(\zeta)\beta_{j,nm}$$



- D_{ijkl} is the phonon propagator
- ε_{ij} is the dielectric response tensor; it appears in the polarization part of the photon propagator
- The Feynman diagram shows how the photon propagator is affected by β_{ijk}
- The above makes us understand why mechanical acoustic frequencies occur in the electrical response of piezoelectric materials

Neutron production from fracturing rocks [WSS]: IV

Numerical Estimates:

(i) v_s velocity of sound vs. c is ~ 10^{-5} hence

($\omega_{phonon}/\omega_{photon}$) ~ 10^{-5} for similar sized cavities

(ii) The mean electric field E ~ 10^5 Gauss

(iii) The frequency of a sound wave is in the microwave range $\Omega \sim 3 \times 10^{10}$/sec.

(iv) The mean electron energy on the surface of a micro-crack under stress σ_F is about W ~ 15 MeV

(v) The production rate of neutrons for the above is

$$\Gamma(e^- + p^+ \to n + \nu_e) \sim 0.6 \text{ Hz}$$

$$\varpi_2 \sim 10^{15} \frac{\text{Hz}}{\text{cm}^2} .$$

Conclusions:

Overwhelming experimental evidence and sound theoretical arguments now exist that all four fundamental interactions lead to LENT both in Nature and in the laboratory.

If before you were only convinced, now you can feel certain.

Hence, it is time to assemble and use modern technology to achieve further sorely needed applications of the Standard Model of Particle Physics.

We must in the words of T. S. Eliot – a consumate academician himself- stop indulging in

“a tedious argument of insidious intent”

Thank you
for your attention
and
your patience