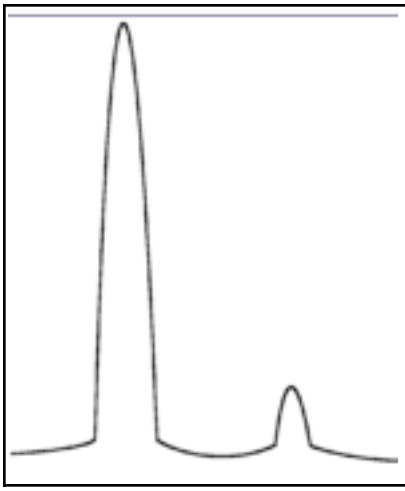
# *Pilot Project Design:* Predicted Temperature Changes Over Time by Field Capture of 233 Thorium

**Capture of a Radioisotope by Field Suppression of Beta Decay:**
***Suppression Produces a Nuclear Fermi Resonance***

Historically, Fermi resonance applies to the vibrations of the molecular bonds of chemical compounds. When molecules are energized by external radiation the bonds vibrate returning a characteristic infrared which identifies the compound. This return infrared is given in bursts suggestive of quantum-like timed-discharge of an electrical capacitor. These bursts are known as Fermi resonance.

**A Harmonic Version of Fermi Resonance**[1]



Since the normal vibrational modes of a molecule are generally of disparate energies, they do not mix. Thus, Fermi resonance most often occurs between normal and overtone modes, which are often nearly coincidental in energy.

Fermi resonance leads to several effects. In the one illustrated, the high energy mode shifts to higher energy and the low energy mode shifts to still lower energy.

The two transitions are describable as a linear combination of the parent vibrational state. Fermi resonance does not really lead to additional radiation bands in the spectrum.

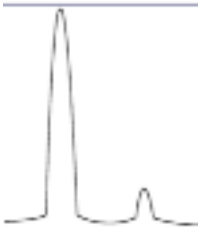
Our data demonstrates that the vibrational modes of the nuclei of radioactive elements can also link to provide a Fermi resonant discharge. However, this discharge is not the infrared of molecular Fermi resonance. Since it was detected by a Geiger-Mueller counter, the return discharge must be x-ray, not infrared. Only x-ray can ionize the gases in the Geiger-Mueller counter[2] which detected the Fermi resonance pattern.

**Random Discharges of Gamma Radiation Measured Over Time for a U-235 Sample Using a Geiger-Mueller Counter**


[1] Wikipedia: Fermi resonance

[2] *The use of the Geiger-Müller counter X-ray spectrometer in an X-ray laboratory, with special reference to automatic recording;* C Wainwright 1951 Br. J. Appl. Phys. 2 157

**These Random Gamma Discharges Became Fermi Resonate, Timed-Discharged X-Ray Under a Strong Negative Voltage Field**[3]



**Typical Fermi resonance peaks. Note similarity with above.**

The only way these data can be explained is that the Gamma emissions were suppressed by the strong negative voltage field and the energy returned to the nucleus, increasing the nuclear vibrational state. This increased nuclear vibrational energy established a Fermi resonance with x-ray being the characteristic return radiation measuring the increased vibrational energy. Unlike molecular Fermi resonance which returns infrared, suppressed nuclear radioactive Fermi resonance returns x-ray.

These results were predicted by the quantum geometric model of the atom which has demonstrated that increasing the electron's radius requires multiplication of the electron's charge by nuclear capacitance[4]. It is assumed gamma emissions accompany Beta-decay which is supported by data showing that gamma emissions are approximately 50% of both Beta and gamma emissions. The strong negative field opposes the negative charges of Beta electrons by enough to prevent ejection by nuclear charge multiplication. This returns Beta-gamma energy to the nucleus. The suppressed Beta-gamma energy is returned to the nucleus as an increased nuclear vibrational state at Fermi resonance.

**Beta-Gamma Suppression and Thorium 233 Capture**

The common radioisotope 'Thorium 232 ($^{232}$Th; 90 protons) produces the transitional radioisotope Thorium 233 ($^{233}$ Th; 90 protons) by the absorption of a slow neutron. $^{233}$ Th has a 1/2 life of 22 minutes, transitioning into $^{233}$ Pa (Protactinium-233; 91 protons):

> *"Neutron absorption by Th-232 produces Th-233, which has a half-life of about 22 minutes. This undergoes beta decay to form Pa-233 (half-life 27 days), most of which forms U-233 by further beta decay"*[5]

---

[3] *A Strong Voltage Field on U-235 Suppresses Beta Emissions, Regulates Gamma Emissions ;* Dawson, Lawrence and Morton, Lowell Ph.D; The Snake River N-Radiation Lab Archives.

[4] *The Quantum Dimension;* Chapt. 1; Dawson, Lawrence; Paradigm Publishing; ISBN:0-941995-24-0

[5] The World Nuclear Association web site.

**Beta Decay**
Beta decay is the transition of a neutron into a proton by the ejection of a beta-electron. While there is general agreement in the process underlying Beta decay between conventional physics and the quantum geometric model of the neutron, the quantum model is much more detailed in its description of that process. By the quantum model, the neutron is actually a "neutralized proton" the charge-bond of which has been rotated at 90° to the attached charge-bond of an electron and that proton charge-bond now resides outside the geometric volume of the proton[6] . This renders the charge no longer available to the proton, but still associated with the proton *cum* neutron by an "anchoring" via the attached electron. If the electron is stripped from the neutron, the charge returns to the nuclear particle and it becomes a proton again. Beta decay consists of this stripping of the electron from the neutralized proton, converting it back to a charged proton.

**Thorium-233 Capture**

With respect to the Thorium cycle, the absorption of a slow neutron by $^{232}$Th (producing $^{233}$ Th) places enough energy in the nucleus to cause a Beta decay of the neutron in an average of 1904.36 seconds[7]. If this Beta decay is suppressed by a strong negative voltage field, as our data has proven is possible, the $^{233}$ Th will be captured by the prevention of its decay to the transitional element $^{233}$ Pa.

**HYPOTHESIS: The suppression of Beta decay and capture of $^{233}$ Th by a strong negative voltage field will result in a predictable increase in nuclear vibrational heat energy due to an induced Fermi resonance of the nucleus.**

**Description of Test Device:**
The "proof of concept" initial thorium semi-reactor will be smaller than commercialized examples to follow. Thorium foil will cover the surface of a sphere with a two microgram Californium pellet in the center as the neutron source. The Californium pellet will be suspended in paraffin which will act as the neutron moderator. The inner side of the thorium skin will be bombarded with neutrons, converting thorium 232 to radioactive thorium 233 by neutron absorption. The $^{233}$Th will be captured and prevented from Beta-decaying to $^{233}$Pa by a strong negative voltage field. This suppression of Beta-gamma decay by such a field has been shown to produce a Fermi resonance in the x-ray spectrum[8] . Suppressed gamma emissions cause the nucleus to vibrate, outputting x-ray in a characteristically patterned Fermi resonance. The radius of the sphere will be 1.4104747205 cm which provides a diameter of 1.1106106159 inches (2.8209509644 cm) and a spherical thorium surface area of 25 cm$^2$ with a surface-to-mass ratio of 0.682758620. At .125 mm foil thickness, this calculates to 3.67 grams of Thorium.

The target sphere will be suspended in an aluminum or stainless-steel vacuum hot cell which will double as a Faraday cage[9] to contain the strong negative voltage field projected within the chamber via an interior antenna.

---

[6] *The Four-Dimensional Model of the Neutron;* The Snake River N-Radiation Lab Archives

[7] From the standard formula for the decay constant.

[8] *A Strong Voltage Field on U-235 Suppresses Beta Emissions, Regulates Gamma Emissions ;* Dawson, L and Morton, L; The Snake River N-Radiation Lab Archives

[9] Acrylics cannot be used because surface-resistivity figures show that Acrylic plastics would build up a static charge from the voltage field which would never dissipate. See *"Design Guidelines for Shielding Effectiveness....of Composite Materials"* : NASA , MSFC; Aug. 1997; p. 6

**Paraffin as a Neutron Thermalizing Agent:**

It is generally recognized in nuclear physics that high energy emitted neutrons must be "slowed" to approximate the thermal energy states of some radioactive targets before being absorbed to initiate nuclear processes. Thermalized neutrons are required for most U-235 fission reactors and thermalized neutrons are required to convert $^{232}$Th to $^{233}$ Th.

The thermalization of neutrons requires that energy states be moderated by passing through a medium which forces velocities to the thermal energy of the medium. However, the thermal energy of the moderating medium will also be influenced by the slowing of the neutron. By conventional thermodynamics, the energy released by the slowing of the neutron must be absorbed as thermal energy by the moderating medium. The rate of expected temperature gain by the paraffin chosen as a moderator is calculated below:

The gram formula weight for paraffin (C36H74) is 506 g/mol.

Paraffin density is given as 0.9 g/cm$^3$ in a physics lab project. I will use this as density.

x=molar volume

506/x=0.9 g/cm$^3$

x=(506/0.9)cm$^3$

molar volume=562.22 cm$^3$

*Molar volume is calculated at 562.22 cm$^3$ using 0.9 g/cm$^3$ as the density for paraffin.*

The experimental design=11.753968698 cm$^3$ of paraffin for total of 10.5785718282 grams of paraffin. This equals 0.0209062684 of a mole for a total of 1.259004064e22 molecules of paraffin. The total number of paraffin molecules in the experiment is determined using Avogadro's Constant as the total number of molecules in a mole.

1.0 micrograms of $^{252}$Cf has flux of 2.314 x 10$^6$ n/second.[10] The number of neutrons per second released by $^{252}$Cf represent 1.8379607073e-16 of the total number of paraffin molecules. Since paraffin is a hydrocarbon, the hydrogen bond can modify the neutron to thermal energy in one step[11] . The average neutron energy is about 2.1 MeV[12]. The average energy exchanged per moderation will be the following:

Energy=eV(*e* )=2,100,000(1.60217733e-19)=3.364572393e-13 joules

E=239 (g)($\Delta$℃) *Joule formula for change in temperature per gram of mass.*

3.364572393e-13 Joules=239(10.57857 g)($\Delta$℃)

$\Delta$℃=(3.364572393e-13)/239(10.57857 g)=1.3307761595e-16 $\Delta$℃ per thermal neutron

Total change in temperature per second=( 2.314 x 10$^6$)(1.3307761595e-16)

=3.079416033e-10 $\Delta$℃/sec.

It will take 3,247,368,946.828 seconds to change 1° in paraffin temperature from

[10] *Production, Distribution, and Applications of Californium-252 Neutron Sources;* R. C. Martin, J. B. Knauer, and P. A. Balo; Chemical Technology Division Oak Ridge National Laboratory*

[11] Wikipedia; *Neutron Moderator*; The energy exchange per second would decrease if there where more than a one stage moderation involved. The assumed one stage is the most efficient possible.

[12] Health Physics Society web site: http://hps.org

thermalization of the $^{252}Cf$ neutrons. This represents 3696.91 days (10 years+44 days). The heat from thermalization will be insignificant.

**Safety Concerns:**
The Oak Ridge National Labs (ORNL) have a research "loan" program for Californium to be used under qualifying safety conditions.

> *ORNL has an ongoing loan program to supply sealed $^{252}Cf$ sources to qualified organizations at a significantly discounted cost. With the recent establishment of the CUF, individuals and organizations involved in developmental neutron R&D can perform experiments within uncontaminated hot cells using a wide range of available 252Cf source sizes without the regulatory, radiological, and infra structural concerns of source possession*[13]

In addition to neutrons, the $^{252}Cf$ is also a gamma emitter. *"The total prompt gamma energy emitted per fission of 252 Cf is about 6.95 MeV; considering this with the average gamma energy of 0.87 MeV implies an average number of gamma rays of almost 8 per fission*[14]*."* Since Californium produces 3.76 neutrons per fission[15], this would produce 4.923 x $10^6$ gamma emissions per second at 4.283 x $10^6$ MeV per second (6.8622 $10^{-13}$ joules per second). This may be a significant enough potential dosage that the experimental hot cell may have to be further gamma protected by shielding available from nuclear medicine. An example is given below.

**Possible Table Top Shield for Gamma Radiation**

The dose equivalent rate from 1 $\mu g$ (microgram) of $^{252}Cf$ at 1 meter in air is 0.022 1 mSv/ h (2.2 1 mrem) from fast neutrons plus 0.00 19 mSv/h (milliSieverts per hour or 0.19 millirems per hour) from gamma rays[16] . To put this in perspective, the average American receives 80 millirems a year from environmental sources. It would take 421 hours or 17.5 days of continuous exposure to the gamma radiation of 1 microgram of Californium *in air* to equal a year's worth of natural exposure. The gamma radiation exposure from the experimental device, however, would be partially shielded first by the paraffin moderator and then by the thorium skin and finally by the vacuum hot cell. The actual exposure would be much less than 0.19 mrems/ hr.

---

[13] *Production, Distribution, and Applications of Californium-252 Neutron Sources;* op. cit.
[14] Health Physics Society; http://hfs.org . Answer to question about Californium emissions.
[15] ibid.
[16] *Production, Distribution, and Applications of Californium-252 Neutron Sources;* op. cit.

As to the environmental radiation release from the $^{252}Cf$ neutrons, the effect should be negligible. First, the neutrons are thermalized by the paraffin medium and then absorbed by the Thorium skin. Very few thermalized neutrons should be released from the experimental hot cell.

**252 Californium Gamma Factor:**

The $^{252}Cf$ gamma radiation provides an unknown factor. What effect, in any, might the strong negative voltage field have upon Californium gamma emissions. Those gamma emissions do not have the characteristic energy signature of $^{233}$ Th $\gamma$ (311.9 KeV[17] ). Rather, $^{252}Cf$ gamma-emission energies are a hyperbolic distribution[18].

These emissions originate not only from $^{252}Cf$ decay but from daughter elements as well. *"You must also be aware that as a $^{252}Cf$ source ages, the inventory of fission products increases; many of these fission products emit gamma radiation, and this contributes to the total gamma emission rate from the source."*[19] . Because of these ambiguities, the effects of the field upon $^{252}Cf$ gamma must be experimentally determined.

## Prediction of Energy Gain per Neutron Absorption by $^{233}$ Th Capture and Nuclear Fermi Resonance Induction

**Conversion of Calories to Joules:**

Joule=change in 0.239° C per kilogram
=239.° C per gram

*NOTE: HYPER PHYSICS USES 0.2388458966° C per kilogram .*

**Foil Size and Mass:**

Foil is 50 mm X 50 mm X 0.125 mm; 1.968503937 in X 1.968503937 in X 0.00492126"

Foil has 0.3125 $cm^3$

Thorium mass= 11.7171717172 grams per $cm^3$ = 11717171.717172 grams per $m^3$

Foil mass=(0.3125)(11.7171717172)=3.6616161616 grams

**Temperature Change per Joule for Foil:**

1 joule= $\Delta$65.272° C for 3.66+ grams of thorium foil *(239°/3.66+=65.272°)*

1 joule= $\Delta$117.489° F for 3.66+ grams of thorium foil *[ (65.272° C)(1.8) =117.489° F ]*

$\Delta$1° F=0.00851 joules for 3.66+ grams of thorium foil *($\Delta$1° F=1/ 117.489 joules=0.00851)*

$\Delta$10° F=0.0851 joules for 3.66+ grams of thorium foil *[ (10)(0.00851)=0.0851 joules ]*

**TARGET TEMPERATURE CHANGE OVER TIME:**

*Target Measurement: is change of 10° F in 10 minutes as per project engineer*

$\Delta$10 F in ten minutes time=( $\Delta$0.0166666667° F/ sec.)(600 seconds)

[17] *Measurement of the Effective Resonance Integral of Thorium Metal*; L. N. Yurova, A. A. Polyakov, V. P. Rukhlo, and Yu. E. Titarenko UDC 621.039.512.26 Translated from *Atomnaya Energiya*, Vol. 41, No. 4, pp. 279-280, October, 1976.

[18] *EVALUATION OF PROMPT FISSION GAMMA RAYS FOR USE IN SIMULATING NUCLEAR SAFEGUARD MEASUREMENTS*; Timothy E. Valentine; Oak Ridge National Laboratory *;* Oct. 1999.

[19] *Answer to Question #6333 Submitted to "Ask the Experts"* : Health Physics Society. http://hfs.org

$\Delta$0.0166666667° F/ sec.=1.4185712726e-4 joules/ sec. (for 3.66+ grams of thorium foil)
*Joules/ sec=($\Delta$0.0166666667° F/ sec.)(0.00851 joules)=1.4185712726e-4 joules/ sec.*

**Neutron Induction rate for foil sample[20] :**

$I_{eff}$ = effective induction of neutrons

linear law = $I_{eff} = a + c\sqrt{\frac{S}{M}}$ $\sqrt{S / M = 0.6827586207}$ =0.82629

*NOTE; Thin foil gives a very high induction value because of high surface area to mass ratio*

**Target Neutron Induction Requirements:**
In ten minutes $\Delta$10 F takes 1.4185712726e-4 Joules/ sec. (watts) "311.9 KeV $\gamma$ radiation emitted by $^{233}$Pa."[21]
*Note: I believe that the characteristic 311.9 KeV gamma radiation emission which Yurova et. al. used as an indicator of thorium neutron absorption is the emission associated with the beta decay of $^{233}$Th to $^{233}$Pa. It will be the suppressed gamma release by $^{233}$Th capture*

Energy gain per gamma suppression =E = $(\gamma \text{ eV})(e)$= 4.9971910923e-14 joules

Emission frequency required=*f*
*f* (4.9971910923e-14 joules)=1.4185712726e-4 joules/ sec.
*f* =2838737295.40947;
*This is target Fermi resonant frequency from suppressed beta-gamma emissions (frequency is hypothesized as returned Fermi x-ray emissions per second).*

**Inefficiency Factor:**
Assume 2 $\mu$grams of Californium will induce at the rate of 1$\mu$gram of Californium *(50% efficiency)*.

1.0 micrograms of $^{252}$Cf has flux of 2.314 x $10^6$ n/second

**Decays per Second; 1/2 Life Thorium is 22 Minutes:**
$\tau_{1/2}$ = Thorium half-life in seconds
decay constant = $\lambda = \frac{\ln(2)}{\tau_{1/2}}$; for $^{233}$Th=5.2511150042e-4
mean lifetime = $\bar{\tau} = \frac{\tau_{1/2}}{\ln(2)}$ ; for $^{233}$Th=1904.3574539734 seconds
N=number of particles in sample *(number atoms converted* per *sec.)*
=2.314 x $10^6$
A=number of decays per second
A= $\lambda$(N)=1215.1080119719 decays per second for each second of induction
One second of induction will return 1215.108 natural emissions per second for life of pile (Beta-gamma decay suppressed).

[20] *Measurement of the Effective Resonance Integral of Thorium Metal* ; op. cit.
[21] Ibid.

**Increased Fermi Frequency over Natural Emission Frequency:**

Our study showed that suppressed Beta-Gamma resulted in a 9% gain in frequency[22] :

Fermi Frequency=(natural frequency)(1.09)=(1215.108)(1.09)=1319.84 Hz.

It is assumed that this empirically determined increase in Fermi resonant frequency over natural gamma-emission frequency is due to a power gain caused by Beta decay suppression. The nucleus acquires a power gain when prevented from stabilizing itself via Beta decay. This results in an increase in the frequency of emission attempts.

Every second of induction will return the Fermi frequency of 1319.84 Hz. Therefore, the total Fermi frequency for any time value of suppressed Beta-gamma can be found by multiplying the Fermi frequency gain per second times the total number of seconds:

$$\text{n} = \text{number of seconds of field suppression} = \text{time}$$

$$f = \text{Fermi frequency at time "n"} = \text{n}(1319.84)$$

Target Frequency:

$f$ =2838737295.40947 Hz.=n(1319.84)

n=(2838737295.40947 Hz)/(1319.84 Hz)

n=2150819.26 seconds=24.894 days

*Time required for target temperature change of 10° F/ 10 min. under experimental design.*

*NOTE: Device must be vacuum isolated in order to measure temperature change for the small mass of 3.66 grams of thorium foil.*

**Expected Temperature Rise During Experimental Period**

$$\frac{\text{Joules}}{\text{sec}} = (\text{Fermi frequency per second})(\text{Joules per emission}) = \textit{Watts}$$

$$\frac{\text{Joules}}{\text{sec}} = (1319.84)\left(4.9971910923\ 10^{-14}\ \textit{Joules}\right) = 6.5954926913\ 10^{-11}\ \text{Joules/sec.}$$

$$\frac{\text{joules}}{\text{sec.}}(117.489°\ \text{F}) = \frac{\Delta\text{Temperature}}{\text{sec.}}\ \textit{Change in temperature per second for foil}$$

$$\frac{\Delta\text{Temp}}{\text{sec.}} = \left(\frac{6.5954926913\ 10^{-11}\ \text{Joules}}{\text{sec}}\right)(117.489°\ \text{F}) = \frac{\Delta 7.748978408\ 10^{-9}\ \ °\text{F}}{\text{sec}}$$

n = *time* in seconds.

$$\textit{Rate of}\ \Delta\text{Temp/sec. at "n" seconds} = \frac{\Delta\ \textit{Temp}}{\text{sec}}n;$$

While the rate of temperature change *per* second is linear, the rate of temperature change for the whole time is accelerating. Each subsequent second adds to the total. Thus "1(rate) +2(rate) +3(rate)=6(rate)" which gives a new average rate over the three seconds of "6(rate)/ 3=2(rate)":

$$\text{n} = \text{total number of seconds}$$

$$\text{Total}\ \frac{\Delta\text{temp}}{\text{n}} = \frac{\sum_{n=1}^{n}\text{n}\left(\Delta 7.748978408\ \ 10^{-9}\ °\text{F}\right)}{\text{n}} = \frac{\left(\Delta 7.748978408\ \ 10^{-9}\ °\text{F}\right)\sum_{n=1}^{n}\text{n}}{\text{n}}$$

[22] *A Strong Voltage Field Lon U-235 Suppresses Beta Emissions, Regulates Gamma Emissions ;* op.cit

$$\text{Total } \Delta\text{temp} = \left(\Delta 7.748978408\ \ 10^{-9}\ \ °\text{F}\right)\sum_{n=1}^{n} \text{n}$$

Below is the summation series for "$10^{n'}$." X= change in temperature per second. Notice the pattern:

$$\sum_{n=1}^{100} n(x) = (10)(55)x + (45)\left(10^2\right)x = 5050\text{x}$$

$$\sum_{n=1}^{1000} n(x) = (10)(5050)x + (45)\left(100^2\right)x = 500500\text{x}$$

$$\sum_{n=1}^{10{,}000} n(x) = (10)(500500)x + (45)\left(1000^2\right)x = 50005000\text{x}$$

$$\sum_{n=1}^{100{,}000} n(x) = (10)(50005000)x + (45)\left(10000^2\right)x = 5000050000\text{x}$$

$$\sum_{n=1}^{1{,}000{,}000} \text{n} = 500000500000$$

The series resolves to the following equation:

**Equation for Summation:** $\sum_{1}^{n} \mathbf{n} = \frac{\mathbf{n^2 + n}}{\mathbf{2}}$[23]

$$\frac{\Delta\text{Temp}}{\text{sec}} = \left(\frac{\text{Joules}}{\text{sec}}\right)(117.489° \text{ F})$$

$$\text{Total } \Delta\text{Temp over "n"} = \frac{\Delta\, Temp}{\text{sec}}\sum_{1}^{n} n = \frac{\Delta\, Temp}{\text{sec}}\left(\frac{n^2 + n}{2}\right)$$

$$\text{Average rate of change over "n"} = \frac{\Delta\, Temp}{\text{sec}}\left(\frac{1}{n}\right)\left(\frac{n^2 + n}{2}\right) = \frac{\Delta\, Temp}{\text{sec}}\left(\frac{n+1}{2}\right)$$

**Calculating the Predicted Change in Temperature over Time of Experiment:**
From the above, we have determined that the target of a change in 10 degrees F in 10 minutes would require the below amount of time:

n=2150819. seconds

In this amount of time the total change in temperature would be the following:

$$\text{Total } \Delta\text{temp} = \left(\Delta 7.748978408\ \ 10^{-9}\ \ °\text{F}\right)\sum_{n=1}^{n} \text{n} = \left(\Delta 7.748978408\ \ 10^{-9}\ \ °\text{F}\right)\left(\frac{\text{n}^2 + \text{n}}{2}\right)$$

$$\text{n} = 2150819 \text{ seconds}$$

$$\text{Total } \Delta\text{temp} = \left(\Delta 7.748978408\ \ 10^{-9}\ \ °\text{F}\right)\left(\frac{2150819^2 + 2150819}{2}\right) = \Delta 17923.48\ °\text{F}$$

[23] Special case of the arithmetic series; Gradshteyn and Ryzhik *"Table of Integrals, Series and Products"*

$$\text{Average } \Delta\text{temp} / \text{sec for whole period} = (0.00833\ ^\circ\text{F}) / \text{sec}.$$

The importance of this predicted 18,000 degree gain in temperature over the course of the 25 day experiment is that it could provide additional data points to test the hypothesis. If temperature is allowed to accumulate in vacuum, measurements of gains over longer periods could track the predicted changes for captured Thorium 233. Obviously, the test device could not be allowed to accumulate the full 18,000 degrees, but temperatures could be moderated by periodically flooding the vacuum chamber with gas.

**Monitoring Equipment:**

The most important measurements will be temperature of the Thorium surface and gamma and x-ray emissions. Continuous computer monitoring of thermal probes of both the Thorium skin and the interior of the sphere will be made by existing equipment and software. Gamma and x-ray will be monitored by a sensitive Geiger-Mueller counter which is time-stamped by a computer program which can identify frequency and regularity of emissions.