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"Can destructive seismic energy be stored into useful electrical and acoustic energy?'

By
Umesh Prasad verma
Teacher, MJK gov. girls' Inter College
Motihari(Bihar)
Research scholar (Guide-Dr G.Kumar)
BIT Sindri Department of Geology
Up_mth@yahoo.com, Mob09473289401

Since the dawn of precursory revolution in the seismology by Electromagnetic radiation platform,:F.T. Freund2010)et.al,basing piezoelectric effect on the crustal geomaterials emanation of seismic pre signals have been noted frequently. Their effect in form of ULF and VHF are commonly detected (by Greece and American seismologists)in the upper ionosphere from surface of globe.TEC, OLR. MMC are the consequent instrumentation in acquiring data to these pre-earthquake signals. Our attempt is to detect the signals prior to earthquake due to impending stress in the area and store the spreading destructive energy in electrical voltage applying the mathematics of piezoelectric equations and algebra.

Key words: TEC, OLR, MMC, seismology, ULF, VHF.ELS, SES. UHF, VHF, **piezoelectricity**.

Introduction; Pre earthquake phenomena in form of signals of electromagnetic radiation [1][10,11,1like ULF[2] [10,11.,14,15,17] , VHF[3][14,17], ELS[4][10,11,14,17], and IR anomaly [5] [16,17,22,29a] ; Ozunov Deimetre(2003,2004) and F.T. Freidman (2003, 2004, 2011-12) have provided wide spread panorama for the investigative study over the unsolved enigmatic issue in the seismology. Vast amount of uncontrolled seismic energy conversion into useful electrical energy now no more seems impossible. Applying the Murata piezoelectric equations and algebra on piezoelectricity conversion is easy. On the Greece plat form pre-earthquake signals detection have been a now reliable basis [7]{14,18,27,28] that gives the TEC variation in the ionosphere from the crustal surface. As per our flashback information there are geomaterials sensitive to mechanical stress and respond into piezoelectric effect by converting them into electrical impulses .Ceramic material viz tourmaline lead titan ate, silicon carbide, etc behave positive character to the impending stress by converting into voltage or charge generation.[8][24,27,28]/Experimental studies of applied stress and shocks over the quartz have reported yield of php transfer(Positive hole pair)[9][10,11,14,15];F.T.Freidmann(2004,-2007,2011)TEC ,MMC and other electromagnetic radiation phenomena prior to earthquakes are the consequent effect of mechanical or seismic stress over the geomaterials that have been observed by the seismologists in Greece , USA and China[10][22,34].ELS [11][20, 22,34],UHF IR anomaly prior to Earthquakes are the most seen observations at China, Greece, And Russian plateform.[12][22,34] Mission of the paper choose best conservation technique for the generated charge or potential and to theorize a suitable conversion mathematical methodology by: murata equations. Study states 2.5×10^{15}j seismic energy is released during one event of 6-6.5

Mw magnitude[13] [10,11 ,13,]in the paper of F.T.Freidmann(2003)This energy is equivalent to1.5×10^{14}megawatt electrical energy Most of seismic shocks range the power of 3000TNT explosives. Thus this wasted naturally available seismic energy if being converted and conserve may meet the energy crisis faced by civilization.

Figure below attempts to display piezoelectricity generation by the ceramics like quartz, tourmaline, and silicon and lead titan ate

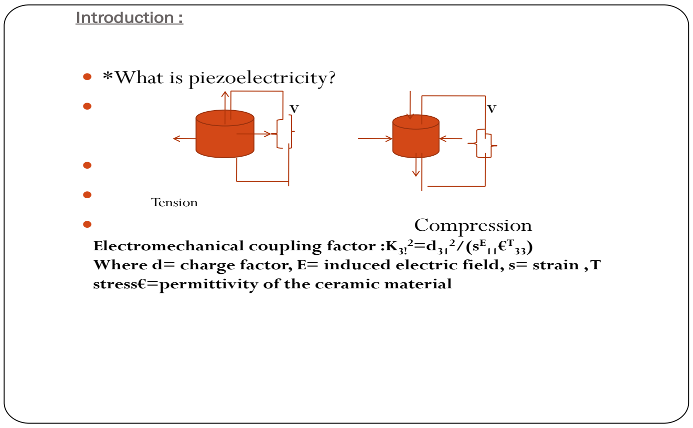

fig 1 attempts to state the possible generation of piezoelectric voltage in positive (for compression) and negative (for tension) due to impending stress in the stratum rocks.

Peroxy links in the crystal lattice of stratum rocks are point defects specially of fused silica(Ricci et al 2001) replacement of O_3X-O-YO_3 by O_3x- OO- YO_3 are common in the lattice structure of the crustal rocks where XY= Si^{4+} Al^{3+}etc.[14][14,16.]Supply of electronic charge to H^-ion in the mineral grains of cooling magma from 600to 400 ^{0}Ccondition makes O^-_2 in -1 from-2 state . Leaving oxygen 1-valency state. Two of O- ions then pair up forming peroxy link In most of Metamorphic, Igneous and detrital sediments there are o^-_2 ion in the structure. Presence of any O^- ion indicates defect electron. Such ions are called positive hole (Griscom et al.). Such pair of PHP are transient and for very short moment are self trapped and localized in the structure and are electrically inactive. But the bond between the pair of peroxy link is broken due to applied deviatoric stresses[15] [14, 16a,22] Freund etal2006) and cause mineral grains to deform plastically at grain to grain contact which serves the stress concentrators. Deformation in the grains are achieved by the movement of dislocations and each time the dislocation breaks the peroxy link. In due course O_2^- neighboring the peroxy link supplies electrons as in the equation;

$O3Si/^{OO}\backslash SiO_3+[Sio_4]^{4-}\rightarrow\{O_{3Si/\!/}{}^{O\bullet}{}_{\bullet O}{}^{/SiO}{}_3\}\rightarrow O_3Si/^{O\bullet}{}_{O/}{}^{SiO}{}_3+[SiO_4]^{3-}$-----------(1)[16][14, 17, 20,22]

Sub crustal stratum rocks are comprised of single and double crystal both as Mgo and quartz. Electrical conductivity by Mgo is favored by thermal activation of h▪carriers (Kathrein and Freund1983) but in case of double crystal like quartz electronic charge transmission is annihilated consequently At unstressed volume of stratum rock positive potential develops unlike negative to that of stressed sub volume. In this case three possibilities with the charges developed due to hole carriers are expected;

1Outflow of charges (+ve) from unstressed volume puts to an end in lack of circuit closure.[17] [14, 16,22]

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2At the depth of 10 -35 Km where temp is 500^0c and more stressed volume develops negative charges (where most of hypo central depth is located) again puts an end to the generated electronic charges.[18] [14,16,22]

3. On the ground to air contact positive charges due to unstressed volume if interacts with the atmospheric ionization fog or cloud (Daujeski and Pulinet2005) at the site may develop at the area at humid condition and TIR [19] [14, 22,16a29a] on the dry condition.

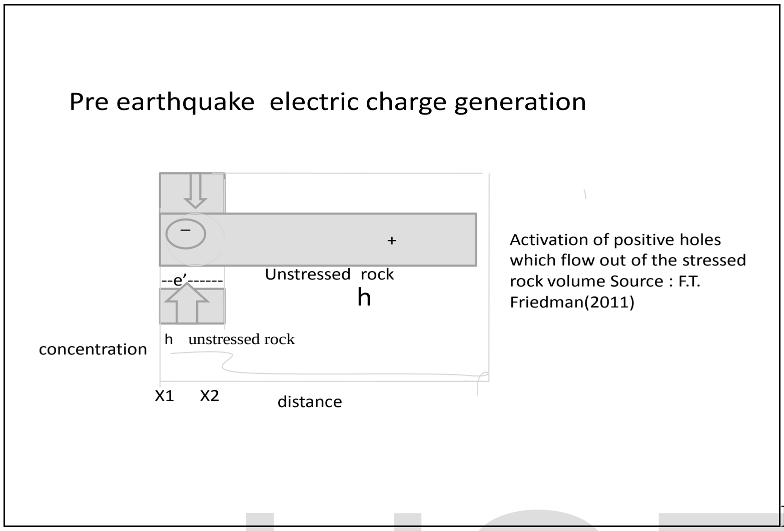

Fig2 attempts to show the electricity generation prior to pre-earthquake charge due to impending stress is the positive hole carriers and e' is the respective electronic charge as consequent to the hole drift.

Favorable facts

1 10-100A /km^{-2} has been associated with the SES and ULF reported.SES signals by Alum Rock EQ M=5.4mw (Belier et al 2009) was recognized with Cal MgNet sensor.20 [14,16a,22]

2Electric potential at the surface (crustal) is + 400mv relative to bulk where from charges come.[21] [16a,22]

3Electrostatic repulsive force in form of electric field rise is observed [22][16a 22] due to increase in charge carriers h▪[22][14,16a] at 100ppm up to from 400mv to 400,00 V/cm(a case of coronal discharge)

Considering the pros and cons of the electronic flow and outflow of h charge carriers due to stressed condition of the rock volume we are to find a suitable mechanism and principle that may govern the conversion of the mechanical stress into electrical energy (as in case of ELS[23] [22,]and coronal discharge [24] [16a, 17 ,22]phenomena often occurs) and storage thereof.

Principle and mechanism; 1. Impending stress at and within the sub crustal stratum rock volume responds as according to Rice and king (1990) equation below:

$\Delta j = \Delta\chi + NRM + NRP$ $--------$ (1) [25] [7,8] where, $\Delta j = applied field, \Delta\chi = change\ in\ susceptibility, NRM = remanant\ magnetism, and\ NRP\ acquired\ pressure.$

2Mineral crystall structure in the stratum rock interacts the applied stress in form of peizoelectricity and pieizomagnetsm[26][10,22,24,]. F.T. Friedmann et al(1984) ,Finkelstin et al (1973)Takeuchi et al/(2004),causing ELS and coranal discharge described as solid plasma state:St. Laurent(1991) .

3 Unstressed Subvulume rocks release and conduct positive hole ie site is positively charged comparitve to stressed volume. Stressed rocks are surrounding negative charge or inflow of electrons by the mechanism described by F.T.Friedmann(2011) his paper.[27][11,12,14,,16a,22.]

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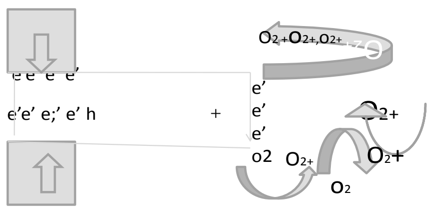
Principle and Mechanism



Corona discharge An extreme case of stress interaction over the rock sub volume specially at ground air interface: courtesy F.T.Freidmann2011

4Rocks at the depth of 30-35 km of hypo central location turn into n-type semiconductor from p type state.[28] [14,16a,22]
5 Non quartz ceramic sensors can show (single crystal like Mgo) semiconductor behavior due to thermal activation, mentioned on the pp387 fig1b F.T. Friedman in the paper.[29] [11,21,29a]
6Murata algebra of Piezoelectricity on various ceramic materials like Pb-titanate, tourmaline. Pb Zirconate have polarization effect and gets voltage and charge induced due to applied stress.[30] [25,27] which are laid in the equation below.

$E= (g_{ij}\, T)$ ----------2(a)31[27,28].where g= voltage constant and is $=\frac{d}{E}$ T and,

Q=(dij.F)---------------(2b)[32] [25,27,28] where dij=piezoelectric charge constant, E= electric field produced . F= force applied and Q= charge constant of the ceramic used, charge Q is charge constant of the ceramic is proportional to :
(a)*permittivity of the material (€) (b) Stress applied T© Stress direction X, Y,Z similar to polarization direction& crystallographic axes direction,(d) Dielectric constant& lastly electromechanical coupling factor Kt of the material (Piezoelectric) used as in the equation:

d= k.((SF F z)) ½ ---(2c)[33][25,27]

_where d=charge constant, K=dielectric constant s= strain produced in the material= electric field produced or applied, and T= stress applied. Similarly, in the equation

D_{31}=k3 (S_{11}€ET $_{33}$)1/2---------------------------------------(2d) [34][25,27]

Where, d_{31}= charge constant in the Z polarization direction, stress applied in the X direction,SE_{11}=strain in X direction parallel to the direction of polarization at constant electric field,E 33T= electric field produced or applied in the Z direction at constant Stress parallel in the polarization direction.

In the following equation for strain & stress relationship over the electric field induced for constant of charge d we can estimate imposed stress amount and direction 11**.**Which can be elaborated in the matrices form for a set of ceramic appliances of various shape& size used?

$\{S\} = \left[s^E\right]\{T\} + [d^t]\{E\}$--------------------------------- **(3)**)[35][4,5,25,27**]** where's=strain produced in the ceramic material due to applied stress T at constant electric field and d^t =charge constant at constant stress. In elaborated form for different set of sensors used in one mesh of network (circuit), we can apply the matrices to calculate the total charge generated is the function of electric field produced due to stresses and sum of charge constants multiplied by the field values.

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$$\begin{bmatrix} S_1 \\ S_2 \\ S_3 \\ S_4 \\ S_5 \\ S_6 \end{bmatrix} = \begin{bmatrix} s_{11}^E & s_{12}^E & s_{13}^E & 0 & 0 & 0 \\ s_{21}^E & s_{22}^E & s_{23}^E & 0 & 0 & 0 \\ s_{31}^E & s_{32}^E & s_{33}^E & 0 & 0 & 0 \\ 0 & 0 & 0 & s_{44}^E & 0 & 0 \\ 0 & 0 & 0 & 0 & s_{55}^E & 0 \\ 0 & 0 & 0 & 0 & 0 & s_{66}^E = 2\left(s_{11}^E - s_{12}^E\right) \end{bmatrix} \begin{bmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \\ T_6 \end{bmatrix} + \begin{bmatrix} 0 & 0 & d_{31} \\ 0 & 0 & d_{32} \\ 0 & 0 & d_{33} \\ 0 & d_{24} & 0 \\ d_{15} & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} E_1 \\ E_2 \\ E_3 \end{bmatrix}$$

--------------- (4)[36] [16, 25,27,28]And in the equation (4) value of charge constant of the materials relates with the produced electric field and strrain by the equation

$$d_{ij} = \left(\frac{\partial D_i}{\partial T_j}\right)^E = \left(\frac{\partial S_i}{\partial E_j}\right)^T$$

-------------------------(4b)[37][25,27,28]

From the observed value of electric displacement,D, calculated constant values of dij , & permittivity €of different material of peizeioelectric substance used for given stress total stressT in action shearing or normal can be estimated from the eqn below;

$$\{D\} = [d]\{T\} + \left[\varepsilon^T\right]\{E\}$$

--------------------------(4c)[38][25,27,28] here, E= electric field produced due to stress insurged .Voltage constant of the material for given electric displacement is interdependant with stress amount & correspondingelectric field produced as in the eqn no(5)

$$g_{ij} = -\left(\frac{\partial E_i}{\partial T_j}\right)^D = \left(\frac{\partial S_i}{\partial D_j}\right)^T$$

..--------------------------------(5)[39] [16,27,28]-

As for example .$g_{31}=d_{31}/ET_{33}$ ----------------- -----------(5a)

has voltage constant in z direction and polarisation direction is along X direction.ET_{33}= electric field in the zdirection parallel to the direction of stress applied. With the calculated value of voltage constant & charge constant of given ceramic material for given dimension ie shape & size electric field value in the direction assignedn can becalculatedvalue of D is depending on ratio of electric field due to stress applied on the selective thicness of ceramic material hij from the eqn no (5b) below;

$$h_{ij} = -\left(\frac{\partial E_i}{\partial S_j}\right)^D = -\left(\frac{\partial T_i}{\partial D_j}\right)^S$$

------------------------------------(5b).here,S=strain, T= stress,D= electric displacement,E= electric field produced due to applied stress..

Further,from the circuit diagram proposed to apply the available or desigined sensors of specific dimension sensitive to the stress magnitude and direction are set at the site as in the fig4.In the fig sensor at one point of application responds to the applied stresseither through R1 or R2 resistor choosing the polarisation direction cosequent to the direction (effective) of stress.Magnituide ofstress appied is stored in form of voltage in propotionate manner.

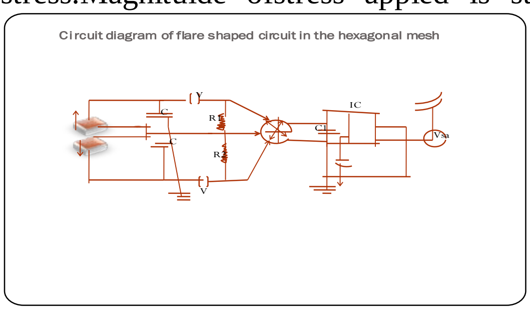


fig 4attempts to dislay the setting of fare shapedsensors connected to capacitorsand earth and finally voltmetre Va and transmission point.Coutsey:Piezoelectric wekepedia for piezoelectric sensors and Murta piezoelectric appliances. . Piezoelectric Wikipedia (2010-11).

Similar arrangements are set for the general circuit in mesh for advanced and elaborated stage in the instrumentation and methodology sec.

Methodology and Instrumentation: (i)Mesh arrangement at each point of peripherial octahedron a pair of flexture, plate,disc/ ring , rod shaped piezoelectric appliance(sensor) rated or 1khz to 10 Mhz respectively min to max frequency and oppositely polarised inX,Y direction are set ; fig6circuit diagram.

(ii) Values of dij,hij.Eij, andgij are determined for allthe shape of ceramic trimed & bent * Values of electromechanical coupling factorKt for flexture , disc., plate & rod shaped of appliances are determined or recorded.

(iii)Accordingly in the circuit diagram in fig -6piezoelectric individual chips or appliances are connected with the voltmetres V1,V2,capacitors C1,C2so as to give the final stored voltage VsA through their commutator& capacitor Cs ResistanceRs Their 's dij gij and kt values are rated &recorded.

(iv) All the average values of Vsb, Vsc,Vsd,VseVsf,Vsg,&Vsh are recorded and summed up to averag in grand for single periphery of Octahedron mesh shown below.

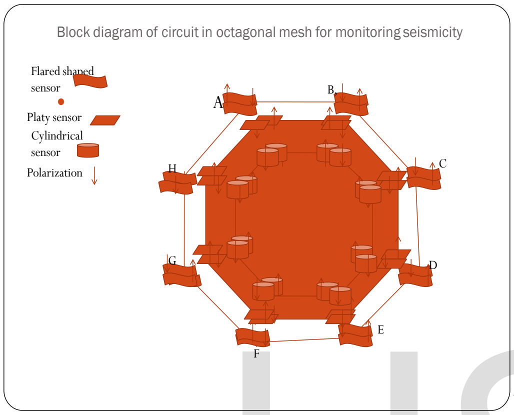


Fig 5 attempts to show the possible arrangement of sensors in the block diagram to harness the mechanical stress into voltage generation.

(v) Similar recording of observations are made for 2nd& 3rd peripherial octahedrons.For a given span of time prior to any event .Average value of all the averages of individual points give the voltage or charge generation in the given time moment releaesd by the stress of either kind. Which is & must be similar or same for the rest of peripheral octahedron confirming the accuracy of result & recorded observations

.(vi)Sum of all the voltagesrecorded at the vertices of the peripphery of the concentric octahedrons correspond to the total chrge generation due to stress of shear or normal kind applied on the site under investigation to this purpose at each vertex point of octahedrons galvanometre or voltmetre wih capacitance(of suitable value)& resistances (appropriate amount) are connected in parallel& series respectively.

(vii) At least two points on each perphery the direction and amount of voltage/charge shows similar result, confirming the amount &direction of stress applied which is highest of all the values recorded at other points.and sum of averagrs of all the points are similar to the max value which is exact recording of voltage due to stress.(viii) Placing the recorded values of charges / voltages at various points of the 1st octaheral periphery after converting them into reqired amount ofvoltage const gijand dij values we calculate the Eij and Sij valuesfrom eqn no (ia),(ib), (ic).

(Ix)These readings are placed into the matrics equation(v) that gives sum of average stress after placing the calculated values of Es we can average the stress produced for the given site specimen for given span of time.(x)Data obtained from the observations made on voltage readings, charge reading, are plotted for stress detrmination in amount and direction which are converted into equivalent Mw or moment magnitude from the energy releasd for the given event on given area . This released stress is determined with its direction and rate of rise in amount.

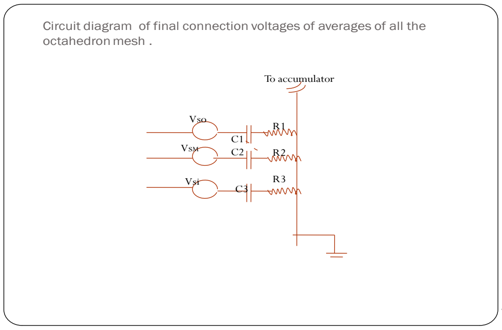


Fig 6attempts to show the three different shaped sensors parallel to each other are connected at one point to yield effective voltage and transmission of signal thereof.

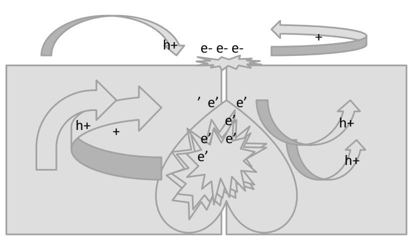
$$\begin{bmatrix} D_1 \\ D_2 \\ D_3 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 & d_{15} & 0 \\ 0 & 0 & 0 & d_{24} & 0 & 0 \\ d_{31} & d_{32} & d_{33} & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \\ T_5 \\ T_6 \end{bmatrix} + \begin{bmatrix} \varepsilon_{11} & 0 & 0 \\ 0 & \varepsilon_{22} & 0 \\ 0 & 0 & \varepsilon_{33} \end{bmatrix} \begin{bmatrix} E_1 \\ E_2 \\ E_3 \end{bmatrix}$$

-------- (6)[40][25,27]equation helps in the deduction of summed value of voltage generated due to sensors of different shaped set to applied stress.

Discussion and conclusion: On the instrumentation technique based on principle and can be possible. Conversion technique discussed in the paper opens the scope for widely wasted and dreaded devastating energy into an useful energy. Commercial scale basis needs application of sensors of high efficiency.2 Necessary testing and site selection..3Proper selection of ceramic material suiting to the ground nature and climatic gradients.4repeated and continuous monitoring over the site of instrumented area.

Fig bellow shows sudden rise in voltage due to coronal discharge of h positive carriers to the electrons accumulated at the stressed subvlume rocks prior to seismicity an extreme case of stress drop. This should be taken in account while constructing the instrument at the site and over protection cementing and insulation is to be favored.

Coronal discharge prior to seismicity



closure of rock battery circuit due to enhanced air conductivity above the hypo central region and reversal of surface potential: courtesy F. T.Friedmann(2011)

fig7attempts to show the air conductivity interacting the stressed condition of surface above the hypo central region prior seismicity; F.T. Friedman(2011)

After comprehensive discussion we conclude the following facts regarding the conversion of seismic energy into useful as

1 Though rigorous but not impossible is the conversion.

2Alert and tactful handling with the instruments and block diagram proposed for the circuit closure in the nature to harness the seismic energy is keeping pace with the mechanism detailed by F.T. Freidman and et al (2004,207,2011) and Greece seismologists Vrotsos, (1987,2005) are another scope of the paper.
3 SES and ELS (Lee Feng2012) Pullinets,S. (2009),:St Laurent ,F. et al(2006) phenomena are the natural panoramic view in support of seismic energy conversion into electrical energy .
4 Careful instrumentation and tactful handling of the data acquired from pre-seismic stress accumulation in form of charge and thus voltage generation can fruit into immensely useful electrical energy supported by works of Sorokin,V.M. et al(2006) and St- LaurenF.etal on preseimic earthquake light and electro atmospheric discharge.
5 On the platform of Chinese,(Lee Feng.2012, Zhao quian et al2009) Greece Vrotsos P.A.(2005) and ,Russian , and American(DeimitreOzunov2007,2011) much works on the preseismic phenomena related with the electrical energy signals are still upcoming and basing the ground of EM radiation .

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