TASSOS, STAVROS, Institute of Geodynamics, National Observatory of Athens, Athens, Greece.

THE SOLID, QUANTIFIED, GROWING AND RADIATING EARTH

Z ∞ Space

Z∞ Space re-examines cosmology, astronomy, relativity, quantum mechanics and particle physics upon the fundamental principle that infinity is the ultimate material actuality. In that context zero, vacuum, or empty space are nonexistent as physical entities. Space is the infinite source of all mass, accounts for the repelling 'dark-energy' and the contracting 'dark-matter', and becomes measurable as 'energy'–traveling, actually unpaired standing waves, and 'matter'–paired standing waves, i.e., waving space itself at the scale invariant constant of 299792458 m/s. A zero mass state cannot physically exist, because waves and energy without inertia-mass cannot exist. The 'massless' state is the scalar equilibrium state between the inertial and the elasticity forces in a waving material continuum. Due to its infinity the inertial resistance of Z∞ space is constantly balanced by its extension and oscillates constantly at light speed, c. All other media included in, and made of Z∞ space wave for as long as the force that counteracts their mass-inertia acts on them, and at speeds <c.
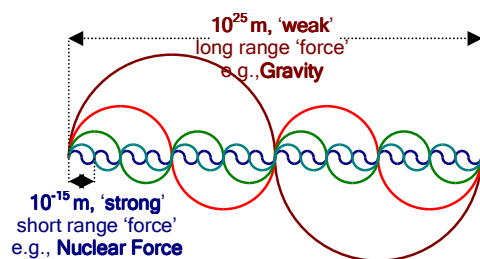

Figure 1. A simple sinusoidal wave of cosmic dimensions, e.g., 10^{25} m, gravity, and a simple sinusoidal wave of nuclear dimensions, e.g., 10^{-15} m, nuclear force, have exactly the same quantum of matter and energy, i.e., carry the same information. Gravity is tension and its inverse quantity is 'mass'-space density, i.e., in the same absolute space there are proportionally to the frequency increase more waves. In that context a 10^{25} m wave can be analyzed into 10^{40} waves of 10^{-15} m wavelength and appear to be 10^{40} times further away, or to travel 10^{40} times faster.

Energy and matter are sine waveforms of local anisotropy in the elastic, large-scale isotropic continuum, which is lossless and has infinite elasticity to any energy input up to any velocity lower than light speed, c, and infinite rigidity at velocities equal or greater than c. Gravity is tension and its inverse quantity is 'mass'-space density. All wave-particles contain a constant quantum of tensional elastic potential (information), irrespective of wavelength, as per E=hf (Fig. 1). The implication is that a frequency increase due to tension will result, proportionally to the frequency increase, to more waves in the same absolute space; thus greater mass and energy density. In that context a 10^{25} m wave can be analyzed into 10^{40} waves of 10^{-15} m wavelength and appear to be 10^{40} times further away, or to travel 10^{40} times faster.

Thus in material infinity the circular motion is the synthesis, a scalar quantity that represents the unity of linear motion, in opposite directions and at right angles, of the vector quantities of extension and compaction. It is produced when a standing wave/quantum of matter is reflected without loss between two absolutely rigid surfaces of a layer, the thickness of which gets smaller with time, but it is always greater than zero (Fig. 2). This is a self-sustained process because the cyclic (extension-compaction) component is coupled with a unidirectional extension component, which results to higher frequency over time, and it means that the 1 is divided into smaller parts the size of which is inversely proportional to the number of parts in which is divided, i.e., the two variables are related in a linear manner, so that there is a constant ratio between the two quantities (proportionality).

A traveling, or, unpaired standing wave (Fig. 2A), refers to the vector quantities of extension and compaction, i.e., linear motion and momentum, as per $p = mc = @f = {\sim}5.34{\times}10^{-28}$ kg.m.s^{-1}, where $f = {\sim}2.418{\times}10^{14}$ and $@ = {\sim}2.21{\times}10^{-42}$ kg.m, a new matter constant introduced by David Ford. It can be represented by two semi-circles displaced by one diameter, or two orthogonal isosceles triangles. The two orthogonal sides interchangeably represent extension and compaction, whereas motion-maximum

velocity is represented by the hypotenuse, always equal to 2R (R is the radius of the circle, the amplitude, and $\lambda/4$). The moving object actually is an oscillating quantum of matter-standing wave in an absolutely elastic continuum that accelerates from 'zero' to its maximum speed. In a traveling wave the 'zero' velocity is at 90^0 and 270^0, and occurs at the point the moving matter quantum is reflected without loss on the two absolutely rigid surfaces and changes direction of motion by 90^0. The v_{max} is at 0^0, 180^0 and 360^0, actually the hypotenuse line. In other words for all angles from 0 to 360^0 the sum of the squares of the orthogonal sides is equal to the square of the constant hypotenuse, as per $a^2 + b^2 = c^2$, or $\sin\theta^2 + \cos\theta^2 = 1$, where 1 is the constant speed of light, c.
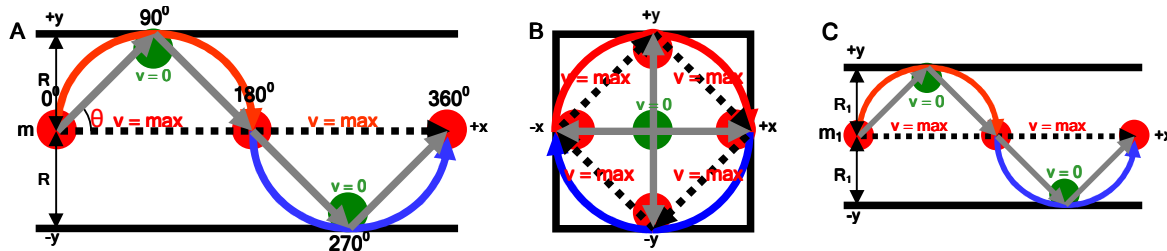

Figure 2. The ad infinitum extension constantly accelerates, as per v=a*t, the matter quantum (red and green full circles). But, due to the inability of space to wave faster than c, lossless reflection occurs and an unpaired standing or traveling wave (A), is formed. The red semi-circle represents extension and the blue compaction. The doted line represents the direction of motion. In a traveling wave the motion appears to be linear, and in a standing wave is circular, thus the spin of apparently discrete particles. A 'particle' actually is a standing wave, an oscillating matter quantum, in an absolutely elastic continuum. Any excess energy input results to the permanent formation of a pair of standing waves-matter (B), and to the release of an unpaired standing or traveling wave-energy (C), both with higher by $2^{0.5}$ frequencies, whereas v=max is always the c constant.

On the other hand a paired standing wave (Fig. 2B), can be considered as a traveling wave that is confined by four absolutely rigid boundaries, while it is absolutely elastic within its confinement, and upon lossless reflection the change in the direction of motion is 180^0. In other words, in an unpaired standing-traveling wave the duplication is transient, but it is permanent in a paired standing wave. A standing wave refers to rest position, circular motion, and potential energy, mv^2. In that context the famous Einstein's and Planck's equations $E = mc^2 = hf = {\sim}1.6{\times}10^{-19}$ J, where h = ${\sim}6.626{\times}10^{-34}$ Js is Planck's constant, refer to standing waves. In a standing wave the two orthogonal sides of the traveling wave have become the hypotenuse, but of two smaller isosceles orthogonal triangles. The maximum velocity is always represented by the hypotenuse, which now is $(2^{0.5})R$, instead of the 2R of a traveling wave. In a standing wave the zero speed point is the center of the circle, which actually is the maximum tension equilibrium, zero velocity rest point, a Lagrangian point. The location of the maximum and constant velocity, c, is the circumference of the circle, and without violating the conservation principle we have a duplication process at a higher, by $2^{0.5}$, frequency/energy. As a result the amplitude of the released traveling wave, i.e., the radius R_1 of the corresponding circle, will also be smaller and equal to $R/2^{0.5}$, and if R=1, then $R_1 = {\sim}0.707$ (Fig. 2C).
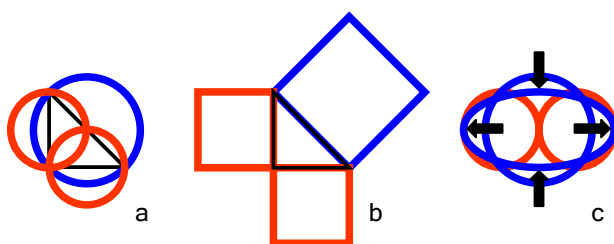

Figure 3. In perfect elasticity the areas of the big blue shapes are equal to the sum of the areas of the two smaller red shapes. Under extension or compression, as in (c), the R=1 circle becomes an ellipse with $2^{0.5}$ long semi-axis and $1/2^{0.5} = 2^{0.5}/2$ short semi-axis, the area of which is equal to the area of the R=1 circle, and the sum of the areas of the two $R_1=2^{0.5}/2$ circles. The equilibrium state is at 45^0, where $\sin45^0 = \cos45^0 = 1/2^{0.5} = 2^{0.5}/2 = {\sim}0.707$.

In absolute elasticity the equilibrium, as in Figure (3), is the maximum tension state, whereby the dimensionless scalar quantity of 1 is transiently 'split', without rupture of space continuity, into two equal quantities/areas that are aligned and move in opposite directions. If space is extended and its mass density is reduced proportionally, e.g., by $2^{0.5}$, in the direction normal to its extension space is compacted and its mass density is increased proportionally, by $2^{0.5}$. Thus the R=1 circle, which also represents a traveling-unpaired standing wave, becomes a $2^{0.5}$ long semi-axis and $1/2^{0.5} = 2^{0.5}/2$ short

semi-axis ellipse. The area of this 2:1 ellipse is equal to the area of the R=1 circle, and the sum of the areas of the two $2^{0.5}/2$ radius circles. The two equal masses/areas, or paired standing waves, attract each other with a force (inertial acceleration) which is exactly equal to the force (gravitational acceleration) the infinite space/mass is attracting each one forcing them to repel. As the binding energy per nucleon curve shows, if and when the excess energy to extend space to a higher frequency/energy quantum level is provided the duplication is permanent and irreversible.

In a wave absolute elasticity and absolute rigidity, rarefaction and compaction co-exist as one, the same way as in Z∞ space the no-change and change states co-exist as one. Steady-state means absolute proportionality, i.e., no change with time of the ratio of two equal and opposite quantities in their equilibrium position that represent rarefaction and compaction of space, e.g., energy and matter. Evolution is change of size-scale with time, i.e., frequency increase, and the constant transformation of the 'invisible' energy-unpaired standing waves, with apparent linear motion, into the 'visible' matter-paired standing waves, with actual circular motion, thus and the magnetic moment or spin that can take either the value +1 or -1. Both steady-state and evolution are manifestations of waving material infinity. Our cosmos remains unchanged, due to constant ratios, and changes and appears to grow, by becoming smaller and more energetic and massive with time. A quantum of matter-standing wave is connected with other quanta that comprise the space continuum, the continuity of which is never broken. Motion is imparted from one particle-standing wave (circular motion and rest position) to another, and a wave that appears to travel linearly is released. The amplitude of a wave is a measure of its mass. Thus the amplitude of a wave with infinite mass will be infinite. In turn infinite mass also implies infinite rigidity, i.e., flatness. Reversely infinite energy requires infinite frequency which implies a state that tends to be, but never becomes, zero amplitude, i.e., zero mass. Of the two opposite states the infinite mass is an actuality whereas the infinite energy/zero mass a potentiality, which acts as the perpetual 'force' that drives the process of continual linear extension of Z∞ space. So, due to its infinity the space continuum is under constant linear extension, and the total tensional elastic energy (E)-potentiality of the cosmos raises proportionally counteracting entropic dissipation, whilst local space density (m)-actuality, proportionally increases, as one, due to the frequency increase, implying proportionally more waves in the same absolute space. Thus the square root of energy over mass (1), or rigidity over density (2), or tension-gravity over space density (3) is a constant.

$$c = \sqrt{\frac{Energy(E)}{Mass(m)}} = \sqrt{\frac{hf}{m}} = \sqrt{\frac{Force \times Distance}{Mass}} = \sqrt{\frac{M \times LT^{-2} \times L}{M}} = \sqrt{\frac{MLT^{-2}}{ML^{-1}}} = \sqrt{\frac{L^2}{T^2}} = \frac{L}{T} \qquad (1)$$

$$v = \sqrt{\frac{Rigidity(\mu)}{Density(\rho)}} = \sqrt{\frac{Force/Area}{Mass/Volume}} = \sqrt{\frac{M \times LT^{-2} \times L^{-2}}{M \times L^{-3}}} = \sqrt{\frac{MLT^{-2}}{ML^{-1}}} = \sqrt{\frac{L^2}{T^2}} = \frac{L}{T} \qquad (2)$$

$$v = \sqrt{\frac{Tension - Gravity}{SpaceDensity}} = \sqrt{\frac{Force}{Mass/Distance}} = \sqrt{\frac{M \times LT^{-2}}{M \times L^{-1}}} = \sqrt{\frac{L^2}{T^2}} = \frac{L}{T} \qquad (3)$$

The maximum extension a wave/matter quantum can suffer is $\pi/2$, or ~1.57, to become a straight line, and within 90^0 or $\lambda/4$ from rest to reach v_{max}. In other words the wavelength, λ, of an R=1 circle is 4, and upon extension to become a straight line and to reach v_{max} it becomes ~6.28, i.e., $4 \times (\pi/2)$. Beyond this length increase there can be no wave, thus no photon emitted, no information reaching an observer. Any further extension will result to a wave but of higher frequency. Thus the total volume of the potentially observable cosmos is limited by the constant speed of light and extension rate, conventionally in the range of 10^{-18} s^{-1}. This observable volume is the 'Optical Bubble'. Doppler redshifts within Z∞ space never exceed z = ~0.57, and all higher components, e.g., the conventional 6.56, are non-Doppler, attributed to continuous linear rise in frequency of emission of photons, from standing waves–'matter'. Thus the actual extension rate is ~11.5 times slower, of the order of 10^{-19} s^{-1}. Non-Doppler components can be instrumentally measured and differentiated from Doppler components, via amplitude/wavelength ratios (A/W) of all photons. Extension is perfectly linear, and actuality, the waving material infinity, is perfectly Euclidean, as per $a^2 + b^2 = c^2$.

Excess Mass Stress Tectonics – EMST

In the context of Excess Mass Stress Tectonics – EMST, Earth is a quantified solid black body, the size of which appears to increase with time at an exponential rate. About 200 million years ago Earth's diameter was about 60% its present size, and its whole surface was covered with granitic Fe-poor continental crust with narrow and shallow epicontinental seas. The Fe-rich mafic mantle, the oceanic crust, and the deep and wide oceans formed during the last 200 m.y. or so (Fig. 4).
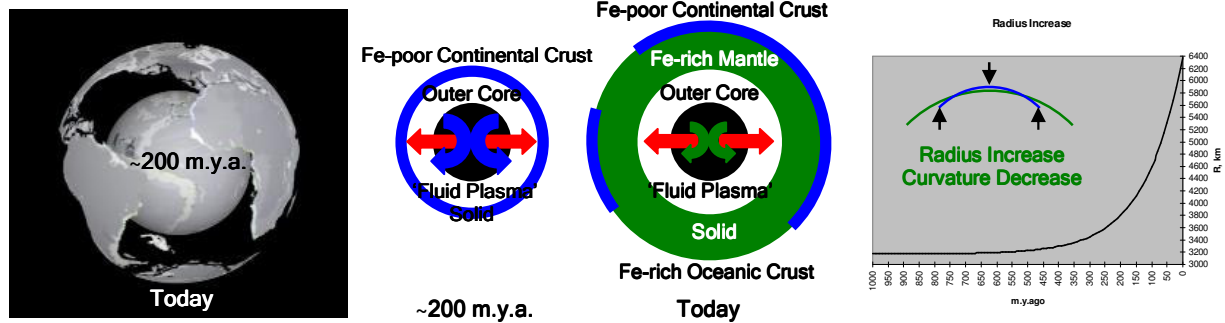

Figure 4. Earth's growth from 4.6 b.y to present. The blue represents the pre-200 m.y.a. felsic crust, and the green the meta-200 m.y.a. mafic mantle. For present radius R_{t0} = 6370 km, and a ~$0.5R_{t0}$ 4.6 b.y.a., the cumulative radius increase is given by $R_t = R_1 + R_2 e^{-rt}$, where R_1=3170 km, R_2=3200 km, t = time in m.y. ago, and r = 0.0081 (m.y.)$^{-1}$. The rate of radius increase is $dR/dt = rR_2 e^{rt}$, i.e., ~2.59 cm/year present rate, and is associated with a proportional curvature decrease that renders the vertical component undetectable from satellite interferometry. The rate of 'Excess Mass' - E.M. addition is $d(E.M.)/dt = m M_m e^{mt}$, where m = 0.0158 (m.y.)$^{-1}$, where M_m the 4.08×10^{24} kg of mantle, i.e., the present rate of E.M. addition is 6.45×10^{16} kg/year. So, the inferred extension rate is $(R_{t0}-R_1)/R_{t0}\times t$ = (3200 km)/$6370\times4.6\times10^9\times31.536\times10^6$ sec = 3.46×10^{-18} s^{-1}.

Earth's inner core is considered as a Lagrangian point, i.e., an equilibrium high-tension/high-frequency location, wherein energy–unpaired standing waves transform into matter–paired standing waves, so that the conservation principle is not violated, and form new elements, i.e., Excess Mass. Earth's outer core, being looser than the inner core space, in correspondence to the electron cloud of an atom, has the characteristics of a 'fluid' plasma state where newly formed atoms in the inner core accelerate from rest/equilibrium to v_{max}. But, whatever high temperature might develop is confined there, due to the very high rigidity, actually infinite rigidity at light speed, of the overlying mantle and the underlying inner core. The order which elements form depends on their nuclear binding energy. H^1, with only one proton and thus 0 MeV nuclear binding energy is the first element to form, and Fe^{56}, with the highest nuclear binding energy of ~8.8 MeV, the last and most stable (Fig. 5). Thus, the absence of Fe-rich rocks and true oceanic crust older than ~200 m.y. finds its physical explanation, and so do the Archean greenstone belts: Fe was emplaced during the last 200 m.y. in the crystalline structure of existing Fe-poor rocks.
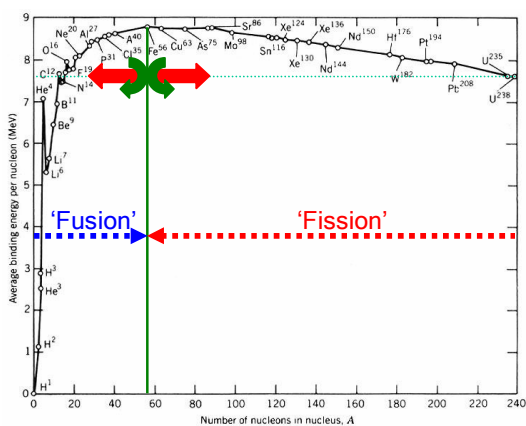

FIGURE 5. Through the apparent 'fusion' process to the left of the Fe peak of ~8.8 MeV per nucleon, smaller nuclei join together to form a larger and more stable nucleus, i.e., with higher nuclear binding energy. To the right of the Fe peak, the 'fission' process involves again a nucleus with lower binding energy per nucleon decaying to form a more stable, but smaller one. In both cases the new nuclei produced have a higher binding energy per nucleon, as per E=hf, and energy-travelling waves is given out. Thus all spontaneously occurring processes are on the overall non-entropic. They involve a cyclic (extension and compaction) and a linear extension component that increases frequency. As a result a pair of standing waves (green semi-circles) is formed, the wavelength of which gets smaller and smaller with time, due to the constant action of linear extension (red arrows).

The binding energies of atomic electrons are in the range of eV, whereas of nucleons in the range of MeV, i.e., ~10^6 times greater. Thus the proton-neutron pair of the nucleus of an atom represents the maximum possible tension of space, the equilibrium state, and the electron cloud represents the looser 'plasma' state of space where electrons accelerate from rest to light speed. On the 'fusion' side to the left of the Fe peak of ~8.8 MeV per nucleon, smaller nuclei appear to join together to form a larger and more

stable ones, i.e., with higher nuclear binding energy than the original nuclei. To the right of the Fe peak, processes such as radioactive decay and 'fission' again of a less stable nucleus, form a smaller but more stable nucleus with higher binding energy per nucleon. Actually, what appears as 'fusion', or 'fission' is more waves in the same absolute space. Thus, all spontaneously occurring processes are on the overall non-entropic, i.e., the products of both 'fusion' and 'fission' have higher frequency/energy as per E=hf. They involve a cyclic and a linear extension component that increases frequency with time, and any 'excess' energy input forms a pair of standing waves-matter to stay permanently. So, three phases in the Earth's growth are recognized:

1. The first pre-Fe (pre-U) phase when H^1 (0 MeV), H^2 (~1.1 MeV), He^3 (~2.5 MeV), H^3 (~2.9 MeV), Li^6 (~5.3 MeV), Li^7 (~5.7 MeV), Be^9 (~6.5 MeV), B^{11} (~6.9 MeV), He^4 (~7.1 MeV), and N^{14} (~7.5 MeV) were formed. Here the big jump is from the 0 of H^1 to the ~1.1 MeV of H^2.
2. The second pre-Fe, or meta-U, phase starts and sets the radioactive decay clock with the ~7.6 MeV of U^{238} on the 'fission' side, and the ~7.7 MeV of C^{12} (the ~7.6 MeV correspond to ~13 atomic mass) on the 'fusion' side. The two lines converge to the Fe^{56} peak of ~8.8 MeV, and involve a ~4.25 decrease in 'fission', and an equivalent increase in 'fusion' of the atomic mass, i.e., more than two halving or duplication periods. Considering the from 0 to ~7.6 MeV of the pre-U phase, the actual age of the Earth is much higher than the 4.5 billion years half life of U^{238}.
3. The meta-Fe phase started ~200 m.y.a. with the formation of Fe^{56}, and still goes on today.

All elements form in the Earth's core; then are emplaced atom-by-atom around it and depending on structural constraints can escape, or form compounds, crystals, minerals and rocks. The first rocks to form on the Earth's surface were the Li, Be, B rich proto-pegmatites. Later almost concurrently with U^{238}, C^{12} started to form and to enter into the crystalline structure of proto-pegmatites, thus forming the proto-kerogen, the source rock of the nearly H-free anthracite. Carbon upon its association with H gave CH_4, the parent molecule of hydrocarbons. At this early stage most of methane was released in the atmosphere, the same way as it is released from Titan's surface today. As the constant extension of space and the consequent frequency increase provided the higher binding energies per nucleon, elements like O, Na, Mg, Al, Si, S, K, and Ca, through 'fusion', and Th and Cs through 'fission' formed and entered into the crystalline structure of proto-pegmatites. As a result the feldspar $[(Na,K)AlSi_3O_8/CaAl_2Si_2O_8]$ and quartz (SiO_2) minerals were formed, and the proto-pegmatites gradually transformed into pegmatites and finally into granites, and the proto-kerogen into kerogen. At the end of the pre-Fe phase an all encompassing pegmatitic/granitic crust covered the surface of a smaller, ~0.6 its present radius, Earth. Finally, during the last 200 m.y. of the Earth's history, with the initiation of production of Fe and its emplacement into the crystalline structure of the preexisting felsic minerals, micas and the more mafic olivine and pyroxene minerals were formed, and of them rocks like gabbro and basalt, and the Earth grew to its present size. In that context rocks like shale and limestone originate from the primordial pegmatites. They were formed during the last 200 m.y. when the emplacement of Fe and the associated increased heat flow 'baked' and transformed in-situ the looser kaolinite and chalk into shale and limestone/marble, respectively.

Since ~200 m.y.a., Fe, the last element to form, rises as high pressure, actually high tension/high frequency/high energy reduced Fe^{2-}, in which the s- and d-orbital electronic states coincide. Upon decompression-oxidation releases its 4-5 'excess' electrons to become $Fe^{2,3+}$. The maximum depth decompression-oxidation of Fe can occur is the ~700 km, i.e., the maximum depth earthquakes can occur. 'Excess' electrons travel as free electrons, and thereby cause microcracks to form when the electron concentration exceeds the threshold of $>10^{18}$ electrons/m^2 that balances gravitational attraction. As the concentration of the self-repulsive electrons increases, microcracks enlarge, their cumulative internal pressure builds up, and a great mass of rock is uplifted over time. Microcracks serve as resonant cavities for 'old' electrons from $Fe^{2,3+}$ and electrons from the decay of U, Th, K and 'new' or 'excess' electrons from Fe^{2-}, radiating at the 10^{14} Hz thermal frequencies.

If and when the concentration of electrons in the microcavity surpasses the electrical impedance to electron flow a dielectric breakdown occurs, i.e., the transient discharging of electrons very rapidly

empties the network of cavities, causing their implosive collapse. As a result of this electron flooding we should have a sudden conductivity increase, a phenomenon that has been observed many times to concur with earthquakes; the Tangshan earthquake of 28 July 1976 being the most characteristic case. This high energy implosion coerces the otherwise plastic underlying rock block to respond instantaneously elastically, and an earthquake is thus generated. The magnitude of an earthquake depends on the size of the active volume of almost concomitantly discharging microcavities. Hence, we are referring to an electromagnetic self-organized criticality, a direct implication of which is the inherent deterministic non-predictability of an earthquake's origin time, magnitude and location. If this transient dynamic stress that caused the earthquake exceeds the rock's strength can also produce a fault rupture, a secondary non-elastic effect.
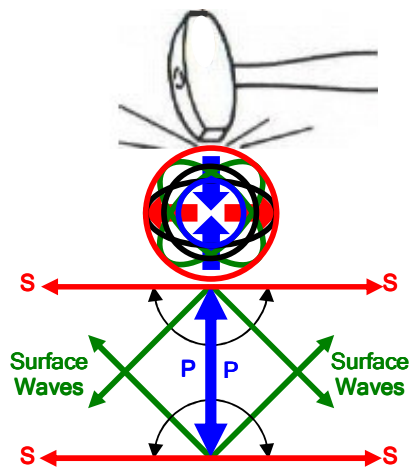

Figure 6. A hammer strike, i.e., a dynamic compressive stress acting as an elastic force on a black circle will cause its polarized compression (blue arrows), lossless reflection between two absolutely rigid surfaces in a direction parallel to the direction of strike, and its extension (red arrows) in the direction normal to the direction of strike. The black circle becomes a 2:1 black ellipse. Its short axis corresponds to compression and a pair of standing waves, the longitudinal (P) waves propagating parallel, and its long axis to proportional extension and two unpaired standing-traveling waves, the transverse (S) waves, propagating normal to the direction of strike. The result of the interplay of P and S waves, and at the 45^0 equilibrium position is the surface Rayleigh waves (green line ellipses). In isotropic and perpetual extension the R=1 black circle will extend to the $R_1=2^{0.5}$ red circle, 2 times the area and ½ the space density of the black circle, pass through the 45^0 R=1 equilibrium and stable black circle, and at 90^0 contract to the $R_2=1/2^{0.5}$ blue circle with ½ the area and 2 times the space density of the black circle; and so on endlessly.

A hammer strike, i.e., a dynamic stress acting as the elastic force, will cause compression and a pair of standing waves oscillating parallel to the direction of strike, as a result of lossless reflection between two absolutely rigid surfaces, and extension and two unpaired standing-traveling waves in opposite directions normal to the direction of strike, which coincides with the absolutely rigid surface that after 90^0 acts as absolutely elastic. The circle will transiently become a 2:1 ellipse and longitudinal (P), parallel to the direction of strike, and transverse (S), normal to the direction of strike, body waves will be generated, as a result of the interaction between inertia and elasticity forces. If there is no damping, i.e., the elasticity forces act infinitely long, as in the isotropic Z∞ space, the vibrations can be maintained also infinitely long. In the case of a non-recurrent force only the first cycle will be lossless. In rocks it can only occur with the action of a vertical dynamic load, because the horizontal static stress is too weak to overcome the inertial resistance of a rock block.

In an earthquake, as in a tsunami, the 'source' P waves are a pair of standing waves oscillating parallel to the direction of stress that produced them, and the diverging from the 'source' S waves are unpaired standing or traveling waves propagating normal to the direction of stress. The Love surface waves, like the light waves, have no vertical component, appear as horizontally polarized transverse waves, SH, and manifest the periodic dynamic absolute rigidity and elasticity of the x-y surface. The elliptical orbits of the Rayleigh surface waves, as the sea waves, represent the interplay of P and S body waves, and manifest the dynamic absolute elasticity and rigidity of the x-z and y-z planes. In actuality seismic waves, as any wave, is the interchangeable compaction and rarefaction in perpendicular directions, seen from different angles. The P waves from 0°, the S waves from 90°, whereas the surface waves from 45° relative to the direction of the stress that produced them. In a homogeneous and isotropic layer there is no change with depth, but in an inhomogeneous medium, the rigidity of which increases with depth, as inside the Earth, the amplitude of both body and surface waves decreases proportionally to the rigidity/frequency/space density increase with depth.