Research Article

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A simple earthquake theory based on tunnelling through the potential well

Abstract

Many theories have been put forward to explain earthquakes, which are natural events. Some of these theories have been accepted, and some have not been accepted at all. All these earthquake models are based on the seismic wave propagation theory. Seismic waves occur because of ruptures, fragmentations, dispersions and sliding of some layers on each other in the earth and the classical spread of these waves. All calculations are based on classical physics laws. It is based specifically on elasticity and wave propagation theories. In this article, the theory that we have given is proposed according to the laws of Quantum Mechanics. The Earth is considered as a radioactive atomic nucleus that emits energy (quantum of energy). Energy radiation (such as alpha, beta, gamma, neutrino, and similar radiations) is considered as a particle. It is based on the wave passing through the potential barrier by tunnelling. Therefore, the calculation of earthquake parameters does not depend on any statistical model. In this proposed new earthquake model, magnitude of the earthquake, its energy that may be released when the earthquake will occur, the depth of the earthquake from the earth surface, and in which regions it may occur on earth can be predicted in advance. In addition, the half-lives of earthquakes can be easily calculated. This will enable people to take precautions in advance. It appears that quantum mechanics can also be applied to macroscopic physical phenomena.

Keywords: earthquake theory, underground faults, vibrations underground, earthquake intensity, earthquake time, earthquake depth, earthquake parameters

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Introduction

Since the formation of the world, it is known that earthquakes occur sequentially in regions that are seismically active, and millions of people and shelters have been destroyed as a result. Earthquake is the phenomenon where the vibrations that occur suddenly due to the breaks in the earth's crust, thus they spread in waves and shake the surface and the environment they pass through. Earthquake is a natural event that shows the soil that people regarded as immobile and safely stepped on would also move, and that all the structures on it could be destroyed in a way that their lives could be damaged and even be lost. The branch of science that examines how the earthquake occurred, how earthquake waves spread across the earth, measuring instruments and methods, evaluation of records, and other issues related to earthquakes is called seismology. In earthquake science, many earthquake models have been proposed according to the statistics of many data collected according to the structure of the earth, the regions of the earth that produce the most earthquakes, etc.; Some of these have been partially accepted, some have not been accepted at all. Finally, the description of the occurrence of earthquakes in this way and under the name of "Elastic Back Tab Theory" was made by American Reid in 1911 and it has been proved by tested in laboratories. According to this theory, at any point, when the energy that is gradually formed by the elastic deformation accumulation, reaches a critical value, it overcomes the frictional force along the fault plane and creates relative movements of rock blocks on both sides of the fault line. This event is a sudden displacement movement. These sudden displacements, on the other hand, occur when the unit deformation energy accumulated at one point is released, discharged, in other words, it turns into mechanical energy and as a result, the breaking and tearing motion of the ground layers.

In fact, it is impossible for rocks to break without prior accumulation of a unit. This unit creates the movement of displacement, convection currents formed in the upper crust in the earth crust seen, rocks can resist until a certain deformation and then break. As a result of these breaks earthquakes occur. After this event, some or all the stresses and energy accumulated from the rocks for a long time have been removed. In the faults mostly formed during this earthquake event, elastic back tabs (beats) are formed on both sides of the fault and in the opposite direction. Faults are often named according to their direction of movement. Faults that are mostly formed because of horizontal movement are called "strike slip fault." It can also be mentioned that the two separate blocks formed by the fault move left or right relative to each other, which are examples of right or left directional pulsed faults. Faults occurring with vertical movements are called "slope slip fault." Most of the faults can have both horizontal and vertical movements.

Earthquakes can be of different types according to their causes. Although most of the earthquakes in the world occur in the form described above, there are also minor types of earthquakes that occur due to other natural causes. The earthquakes resulting from the movement of the plates described above are generally described as "tectonic" earthquakes and these earthquakes mostly occur at the boundaries of the plates. 90% of the earthquakes in the world fall into this group. The second type of earthquakes are "volcanic" earthquakes. These are formed because of eruption of volcanoes. In the depths of the earth, it is known that these types of earthquakes have become known due to the explosions of the gases formed because of physical and chemical events during the emergence of the molten substance. Since they are related to volcanoes, they are local and do not cause significant damage. Another type of earthquakes is collapsing earthquakes. These are formed by the collapse of the ceiling block of cavities underground (cave), galleries in coal mines, melting in salt and gypsum areas. The sensing areas are local, and their energy is low, and they do not cause much harm. Large landslides and meteorites falling from the sky are also known to cause small jolts. After the

Deep-Sea Earthquakes, whose focus is at the bottom of the sea, waves are formed in the seas leading up to the shores and sometimes causing great damage to the shores, which are called Tsunami. In earthquake theories, some parameters known as earthquake parameters are defined to better explain the earthquake. Some of these are given below.

Earthquake parameters

Focus point (inner centre**:** The focus is on the earth where the earthquake's energy emerges. This point is also called the focal point or the inner centre. Energy is not a point where it appears, but it is an area, but it is considered a point in practical applications.

External centre (outer centre, epicentre: It is the point on the place closest to the focal point. It is also the point where the earthquake suffered most or felt strongest. In fact, this is an area rather than a point. The outer centre area of the earthquake can be of various sizes depending on the severity of the earthquake. Sometimes the dimensions of the focal point of a large earthquake can also be determined by hundreds of kilometres, so it will be more accurate to define it as "epicentre area."

Focus depth: The shortest distance from the earth's point where the energy is released in the earthquake is called the focal depth of the earthquake. Earthquakes can be classified according to their depth of focus. This classification is valid for tectonic earthquakes. Earthquakes with a depth of 0-60 km of the ground are considered as shallow earthquakes. Earthquakes with a depth of 70-300 km of the ground are medium-depth earthquakes. Deep earthquakes are more than 300 km of the earth. Deep earthquakes are felt in very large areas, and their damage is minimal. Shallow earthquakes are felt in a narrow area and can cause great damage in this area.

Equal intensity curves: They are the points that connect the points that are shaken by the same intensity. According to the generally accepted situation, the area formed by the curves, that is, the area between the two curves, is limited in terms of severity being affected by earthquakes. For this reason, the intensity of the earthquake is written in the field, not on the intensity curves.

Earthquake intensity: It is defined as the measure of the impact of the earthquake of any depth at a point where it is felt on earth. In other words, the severity of the earthquake is a measure of its effects on structures, nature, and people. This effect, the magnitude of the earthquake, the depth of focus and the distance of the structures against the earthquake can be different. Although intensity does not provide accurate information about the magnitude of the earthquake, it reflects the damage caused by the earthquake depending on the factors mentioned above. The intensity of the earthquake is evaluated according to the intensity charts prepared because of the observed effects of the earthquakes and based on the experience of many years. In other words, earthquake intensity tables evaluate the response of everything living and inanimate to the earthquake. These previously prepared rulers determine the effects of earthquakes in every degree of violence on people, structures, and land.

When an earthquake occurs, the effects occurring in that area are observed to determine the severity of this earthquake at any point. The intensity of the earthquake is the degree of severity, if these impressions fit the definition of the severity scale in the Intensity Chart. For example, if the effects caused by the earthquake include the findings defined in the violence scale of VIII intensity, that earthquake is defined as an earthquake with the intensity of VIII. In the Earthquake Intensity Charts, the intensities are shown in roman numerals. The main intensity rulers used today are the modified Mercalli Ruler (MM) and Medvedev-Sponheur-Karnik (MSK) intensity ruler. XII intensities are covered in both scales. According to these rulers, earthquakes with an intensity of V and less generally do not cause damage to the structures and are evaluated according to the way people feel the earthquake. The intensities between VI-XII are evaluated based on the damage caused by earthquakes in the structures and the findings are such as fracture, splitting, landslide caused by the land.

Magnitude: It is defined as a measure of the energy released during the earthquake. Since there is no possibility to measure energy directly, Magnitude, an instrumental measure of earthquakes, was identified by a method found in the 1930s by Prof. C. Richter in United States. The magnitude of the earthquake is determined according to the ruler prepared by Richter. Since the formation of the world, it is known that earthquakes occur sequentially in regions that are seismically active, and millions of people and shelters have been destroyed as a result. A logarithm of the maximum amplitude measured in micron (1-micron 1/1000 mm) of ground motion recorded with a special seismograph (2800 magnification, with a special period of 0.8 seconds and 80% damping) placed on a hard ground at a distance. He described it as the magnitude of the earthquake. When the earthquakes up to date are analysed statistically, it is seen that the largest recorded magnitudes are 8.9. The magnitude of this earthquake reported by the observatories does not give an idea about the earthquake energy, because the earthquake can be shallow or deeply focused. Of the two earthquakes with the same magnitude, the shallower will do more damage, while the deeper will do less damage, so there will be a difference. However, the Richter scale (magnitude) is a very important factor in determining the properties of earthquakes.[1,2]

The introduction was written a bit long to reveal that the earthquake, which is a natural phenomenon, is very complex to understand and very difficult to solve. In short, it is not possible to predict when the earthquake will happen and how much energy will be generated in the earthquake theory already known. However, in the simple theory that we will give here, it may be possible to predict the time of the earthquake and the energy that will emerge. Thus, the damage to humanity will be reduced. This article is an updated version of the article with the same title (with additions and deletions, it is a modified and improved version), and published in the reference.[6]

New earthquake theory

We tried to give information about how earthquakes occurred in the introduction. It is impossible to know all the reasons why earthquakes occur. Due to many physical and chemical reasons, some of which we have given above, cracks and fractures occur in the earth. These cracks and fractures are called faults for short. The masses of these faults, and therefore their energies change. Apart from these faults, lakes of water, oil, etc. may form underground. Earthquakes can occur from the changing movements of all these volumes and masses. We briefly consider all these formations that create earthquakes as faults and think of these faults as a particle whose mass can change. The earth globe makes a periodic movement of rotation. Since the faults rotate with the earth globe, they also make periodic motions. During their movement, their energies change, and because the energy changes are quantized, they sometimes throw their energy out in waves. This event is known as an earthquake. In that case, information about the earthquake can be obtained by examining the movement of the faults. We consider all these reasons because of the movement of masses m . This mass represents not only faults, but all formations other than faults that caused the earthquake to occur. But to be short, we will accept the masses of these formations (all

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formations that cause earthquakes) as a fault. We briefly call these underground masses faults. Therefore, we consider movements of the faults that exist underground or that will occur with different forces. We assume that these faults do harmonic motion, their energy increases during their movements, and they occasionally release some of this energy as waves to the earth surface. We call this event an earthquake. We consider that, when the faults make harmonic motion, gain energy because of this movement, and some of the energy they give from time to time, as waves to the earth surface, and this event is called earthquake. Energy gain of faults occurs when their volume changes. When the volume of the fault changes, its mass changes. So, examining the motion of the fault means examining the earthquake, that is, understanding the earthquake. Until today, the earthquake was investigated according to elasticity theory of continuous environments and statistics models. In this study, we propose an earthquake model that is not based on these classical models and is dependent on the motion of the earth and quantum mechanics. Now, we explain this model below.

According to classical mechanics

We assume the earth to be an ellipsoid. However, as seen in Figure 1, the sphere is practically accepted. There should be N spaces called faults inside this ellipsoid. Let the masses of these voids be $m = -m_1$, (I=1,2,...N) and the total mass of the ellipsoid M as shown in Figure 1. The centre of mass of this ellipsoid is the Q point and the axis of rotation of the ellipsoid is the QZ axis. The ellipsoid rotates about the QZ axis with angular velocity $\vec{\omega} = \omega_0 \vec{K}$. We assume the effect of the earth's rotation around the sun is negligible. So, the $QXYZ$ coordinate system can be taken as an inertial system. As seen in Figure 1, consider the $QXYZ$ coordinate system (relative system) that rotates around the fixed $QXYZ$ system. This system is also an inertial system. Let the angle between the QZ axis and the Qz axis be α. Angular velocity in QZ axis is $\vec{\omega} = \omega_0 \vec{K}$. Since the angular velocities will be equal in the two coordinate systems, so the angular velocity in Oz axis,

$$\vec{\omega} = \omega_0 \vec{K} = \omega_0\left[-\sin(\alpha)\vec{1} + \cos(\alpha)\vec{k}\right] = \omega_0\left[-\cos(\beta)\vec{1} + \sin(\beta)\vec{k}\right].$$

So,

$$\omega = \sqrt{\vec{\omega}.\vec{\omega}} = \omega_0\sqrt{\sin(\alpha)^2 + \cos(\alpha)^2} = \sqrt{\sin(\beta)^2 + \cos(\beta)^2} = \omega_0.$$

Therefore, the coordinate system at O rotates with the same angular velocity as the coordinate system at Q. The angle α is the colatitude and $\beta = \pi/2 - \alpha$ is the latitude of the Opoint. Since the earth makes a complete rotation around the QZ axis per day, ω_0 = (2 π rad)/(86164 s=) 7.29212×10^{-5} is obtained. Thus, the angular velocity of the coordinate system at point O can be written as follows:

$$\begin{aligned}\vec{\omega} = \vec{\omega}(\beta) &= \omega_0\left[= -\cos(\beta)\vec{1} + \sin(\beta)\vec{k}\right]\\ \omega(\beta) &= \omega_0\, w(\beta)\\ w(\beta) &= \sqrt{\cos^2(\beta) + \sin^2(\beta)} = 1\end{aligned} \quad (1)$$

Although $w(\beta) = 1$ everywhere, the will often be used in ω to avoid some confusion. We call the earthquake to feel the motion of the faults in the ellipsoid on the earth. So, to understand the earthquake, it is necessary to examine the motion of these faults. Suppose that $\vec{R}$ is the position vector of origin Oof relative system to origin Q of the QXYZsystem (Figure 1). Denote $\dot{\vec{R}}$ and $\ddot{\vec{R}}$ the velocity and acceleration of Orelative to Q, respectively. Consider the motion of the mass m (fault) located at the point V_0 focus of fault with the position (rayon) vector $\overrightarrow{Fd}$ on the axis of Oxyz.

Finding the rayon vector of a particle of mass M located at point Fd. (V0 point in Figure 1)

Let us consider the Qxyz, $[X = r \sin(\theta)\cos(\phi),\ y = r\sin(\phi),\ z = r\cos(\theta)]$, system of spherical coordinates located at point O, as seen in Figure 1. The rayon vector of the earthquake's focal point Fd can find as follows: In Oxyz system of spherical coordinates, the rayon vector of a point is generally written as follows:

$$\vec{r} = r\left[\sin(\theta)\cos(\phi)\vec{1} + \sin(\theta)\sin(\phi)\vec{J} + \cos(\theta)\vec{k}\right]$$

If the angle between the unit vector $\vec{K}$ in the QXYZ coordinate system and the unit vectors $\vec{k}$ in the Oxyz coordinate system is α, K and $\vec{r}$ vectors are written as follows:

$$\vec{K} = -\sin(\alpha)\vec{1} + \cos(\alpha)\vec{k}$$

$$\vec{r} = r\left[\sin(\theta)\cos(\phi)\left(\vec{1}.\vec{K}\right)\vec{1} + \sin(\theta)\sin(\phi)\left(\vec{J}.\vec{K}\right)\vec{J} + \cos(\theta)\left(\vec{k}.\vec{k}\right)\vec{k}\right]$$

$$\vec{r} = r\left[-\sin(\alpha)\sin(\theta)\cos(\phi)\vec{1} + \cos(\alpha)\cos(\phi)\vec{k}\right]$$

For $\theta = \pi$, the rayon vector of point $(-V_0)$ becomes:

$$\overrightarrow{Fd} = \vec{r} = -r\cos(\alpha)\vec{k} = -\sin(\beta)\vec{k}$$

Here, α and $\beta = (\pi/2 - \alpha)$ are the collatitude and latitude of the point O, respectively. Then, the rayon vector of a particle located at point Fd depends on the latitude. The rayon vector of point O relative to point Q can be written as follows:

$$\vec{R} = R_0\vec{K} = R_0\left(\vec{k}.\vec{K}\right)\vec{k} = R_0\cos(\alpha)\vec{k} = R_0\sin(\beta)\vec{k};\ R_0$$ is polar radius of the earth.

When the beginning of the relative coordinate system is taken in the centre of mass, the reduced mass is taken instead of mass. Here, the Oxyz relative system is not in the center of mass. For this reason, the mass m can be taken directly instead of the reduced mass. If the total force affecting the mass m in the relative system is $\vec{F}$, according to Newton's second law, the motion equation of this mass is as follows:

$$m\frac{d^2\vec{r}}{dt^2} = \vec{F} - 2m\left(\vec{\omega}\times\vec{v}\right) - m\left[\vec{\omega}\times\left(\vec{\omega}\times\vec{r}\right)\right] - m\ddot{\vec{R}};\ \left[t \text{ time}, \vec{r} = \right]\overrightarrow{Fd} \quad (2)$$

In (2), $\vec{v}$ is the linear velocity and we are using the following terminology:

$2m\,(\vec{\omega}\times\vec{v})$ =Coriolis force, m $[\vec{\omega}\times(\vec{\omega}\times\vec{r})]$ =centripetal force, –m $[\vec{\omega}\times(\vec{\omega}\times\vec{r})]$ =centrifugal force. $\vec{F}$ is the resultant of all forces acting on the fault. $\ddot{\vec{R}} = \vec{\omega}\times\left(\vec{\omega}\times\vec{R}\right)$ and $\vec{\omega} = \omega_0\vec{K} = -\omega_0\sin(\alpha)\vec{l} + \omega_0\cos(\alpha)\vec{k} = -\omega_0\cos(\beta)\vec{1} + \omega_0\sin(\beta)\vec{k}$.

As can be seen from the formula $\omega(\beta) = \omega_0 w(\beta)$, the rotational angular velocity of point O is not clearly dependent on the geographical coordinate longitude. However, earthquakes are measured and

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evaluated according to geographic coordinates. For this reason, it is more convenient to connect the angular velocity with longitudinal. For this, the equation,

$$\mathrm{w}(\alpha,\beta)=\cos^2(\alpha)+\sin^2(\alpha)\cos^2(\phi)+\sin^2(\alpha)\sin^2(\phi)=1$$

between colatitude and longitude can be used. Here, ϕ is the longitude of point O. But, it is not necessary, for simplicity, it is sufficient to take the formula given by (1). Equation (2) represents both the translational and rotational motion of the mass m (fault). If the $\vec{F}$ force acting on the mass m and if the change of m over time is known, its motion can be examined by solving the differential equation (2) which the second order differential equation is according on time. And comments can be made; desired physical sizes can be calculated. But the solution to this equation is very difficult. Because it is very difficult to find the mass m and the force $\vec{F}$ acting on it, it is almost impossible. This problem can solve easier quantum mechanically. Therefore, we will consider and solve this problem as a quantum mechanics problem.

According to quantum mechanics

In nuclear physics, an atomic nucleus that emits alpha, beta, gamma, neutrino, and similar particles is called a radioactive nucleus. We consider the earth as a radioactive atomic nucleus in the form of an ellipsoid. We consider the faults in this core, which are formed due to various physical and chemical reasons and whose masses can vary, as radioactive particles. We accept that these faults can behave like gamma and neutrinos, which have zero mass and great energy. We consider faults as negative mass particles. We examine the motion of these masses according to the laws of quantum mechanics. This is the basis of the new earthquake theory.

Motion of a mass μ ; in classical mechanics, by solving the differential equation obtained by force $\vec{F}$ according to Newton's second law; in quantum mechanics, the Schrödinger equation obtained with the $U(r)$ potential is determined by solving it. There is $\vec{\mathrm{F}}=-\operatorname{grad}U(r)$ equation between $U(r)$ potential and $\vec{F}$ force. So, to examine the motion or state of mass μ at point $-V_0$ it is necessary to find the potential $U(r)$ in which this mass μ is located. We assume the earth to be an ellipsoid with centre of mass at Q rotating about the QZ axis with angular velocity $\vec{\omega}=\omega_0\vec{K}$ (Figure 1). We also use the fact that the effect of the earth's rotation around the sun is negligible, so that the QXYZ system can be taken as an inertial system. ω is the same on both systems, and if the angular velocity of the earth's sphere around its axis is ω . If the origin of the coordinate is taken in the mass centre system according to the two-body problem, it is necessary to take a reduced mass instead of the mass μ . Here, as mentioned above, mass can be taken remaining mass of the earth sphere $(\mathrm{M}-\mathrm{m}_0)$. According to the general gravitation law, the potential directly instead of reduced mass. If the mass of a fault in the earth sphere is taken a $\mu_f=-\mathrm{m}_0$, the gravitational potential of mass μ would be as follows:

$$\mathrm{V}_m(r)=-G_0\frac{(-m_0)(\mathrm{M}-\mathrm{m}_0)}{r}=G_0\frac{m_0(\mathrm{M}-\mathrm{m}_0)}{r}=\frac{c}{1};\ [G_0m_0(\mathrm{M}-\mathrm{m}_0)] \quad (3)$$

G_0 general gravitational constant, and M is the total mass of the earth sphere. This $V_m(r)$ potential is repulsive, that is, an obstacle potential and prevents the movement of mass $\mu_f=-\mathrm{m}_0$. Here, we accept that the fault makes harmonic motion with the earth's rotation. So, the potential we get should be the harmonic oscillator potential. As shown in Figure 1, the position vector of the fault relative to point O is $\vec{\mathrm{Fd}}$. Suppose an observer at point O follows the motion of the $\vec{\mathrm{Fd}}$ position vector. An observer at point O examines the motion of vector $\vec{\mathrm{Fd}}$ is equivalent to that an observer at point Q examines the movement of the observer at point O, that is, the movement of point O relative to point Q. Therefore, as shown in Figure 1, consider the position vector $\vec{\mathrm{R}}$ of the point O relative to point Q. α and $\beta=\pi/2-\alpha$ are the colatitude and latitude of the point O, respectively. The $\vec{\mathrm{Fd}}$ vector moves perpendicular to the Oxy plane.

Obtaining an ellipsoid from a sphere

So far, it has been accepted that the earth is shaped like a sphere. The earth globe is in the form of an ellipsoid symmetrical and flattened with respect to the QZ axis. So, first we must find the shape of this ellipsoid, mathematically. A spherical surface becomes an ellipsoid surface with small deformations. This state is called deformation of sphere. For small deformations of sphere, the surface of the deformed surface is an ellipsoid, arbitrarily oriented in space. A point on the ellipsoid is represented by two parameters ε and γ. The parameter ε defines the total deformation of the sphere. The parameter γ characterizes the deviation of the shape of the sphere from an axially symmetric shape. The principal semi-axes of the ellipsoid can be expressed in terms of ε and γ in the following way:

$$\mathrm{R}_k=\left[1+\sqrt{\frac{5}{4\pi}}\,\varepsilon\cos\left(\gamma-\frac{2\pi}{3}\right)k\right]\mathrm{R}_0;$$

(k=1,2,3=X, Y, Z)

If $\varepsilon>0$ and $\gamma=0$, the earth globe is a prolate ellipsoid of revolution:

$$\mathrm{R}_1=\mathrm{R}_2=\left(1-\frac{1}{2}\sqrt{\frac{5}{4\pi}}\,\varepsilon\right)\mathrm{R}_0;$$

$$\mathrm{R}_3=\left(1+\frac{1}{2}\sqrt{\frac{5}{4\pi}}\,\varepsilon\right)\mathrm{R}_0$$

If $\varepsilon>0$ and $\gamma=\pi$, the earth globe is an oblate ellipsoid of revolution:

$$\mathrm{R}_1=\mathrm{R}_2=\left(1+\frac{1}{2}\sqrt{\frac{5}{4\pi}}\,\varepsilon\right)\mathrm{R}_0;$$

$$\mathrm{R}_3=\left(1-\frac{1}{2}\sqrt{\frac{5}{4\pi}}\,\varepsilon\right)\mathrm{R}_0$$

Here, R_0 is the radius of the earth when it is a full sphere. For $\varepsilon>0$, $\gamma=0^0$ situation corresponds to the axially symmetric prolate ellipsoid; $\varepsilon>0$, $\gamma=60^0$ corresponds to the oblate ellipsoid. When $\gamma\neq0^0$ and $\gamma\neq60^0$, the ellipsoid has no axial symmetry. The earth globe ellipsoid conforms to the oblate state according to R_3-axis, $(\varepsilon>0$ and $\gamma=\pi)$. If ε and R_0 are solved from these last equations, the following values are found:

$$\varepsilon=\sqrt{\frac{\pi}{5}}\frac{4(R_1-R_3)}{2R_1+R_3};\ R_0=\frac{1}{3}(2R_1+R_3)$$

If the equatorial radius of earth R_1=6387 km and the polar radius of earth as R_3=6365 km are taken as the spherical radius and deformation parameter are found as $R_0\cong 6380$ km and $\varepsilon=0.00364463\cong 0.004$. On the other hand, if the deformation parameter ε is calculated according to the $\varepsilon=\frac{R_1-R_3}{R_1}=0.0034445$ is found. These two values are almost equal within the error limits.

Effective deformed potential energy

The earth globe is assumed to have a spherical shape, the faults move in a spherically symmetric potential. In deformed states, it is used the three-dimensional anisotropic harmonic oscillator potential which is given as follows:

$$V_0(x,y,z)=\frac{1}{2}\mu\left(\omega_x^2x^2+\omega_y^2y^2+\omega_z^2z^2\right),(\omega_x\neq\omega_y\neq\omega_z) \tag{4}$$

Here, μ is mass or reduced mass. In the case of deformed potential, it is generally restricted to axially symmetric potential, and it taken the z-axis as symmetry axis. So, it is accepted $\omega_x=\omega_y=\omega_\perp\neq\omega_z$ in the anisotropic harmonic oscillator potential. The motion of a particle (fault) in an axially symmetric potential, with additional symmetry plane, perpendicular to symmetry axis was described. The no-spherical potential has the shape of an ellipsoid of revolution. It is, however, possible that some faults have shapes of a three-axial ellipsoid. It is also possible that the shapes of excited states differ from the ground state shapes and that some exited states have three axial ellipsoidal forms. In the three axial cases, $\omega_x\neq\omega_y\neq\omega_z$. The no-axial shape is characterized by two deformation parameters ε and γ . For $\varepsilon>0,\ \gamma=0^0$ situation corresponds to the axially symmetric prolate ellipsoid, $\varepsilon>0,\ \gamma=60^0$ corresponds to the oblate ellipsoid. When $\gamma\neq 0^0$ *and* $\gamma\neq 60^0$, the ellipsoid has no axial symmetry. We accept that the angular frequencies $\omega_x,\omega_y,\omega_z$ relate to the deformation parameters ε *and* γ as like R_k by the following expressions:

$$\omega_k=\left[1+\sqrt{\frac{5}{4\pi}}\varepsilon\cos\left(\gamma-\frac{2\pi}{3}k\right)\right]\omega_0;$$

(k = x, y, z)

If $\varepsilon>0$ *and* $\gamma=\pi$, the earth globe is an oblate ellipsoid of revolution:

$$\omega_x=\omega_y=\left(1+\frac{1}{2}\sqrt{\frac{5}{4\pi}}\varepsilon\right)\omega_0\ ;\ \omega_z=\left(1-\sqrt{\frac{5}{4\pi}}\varepsilon\right)\omega_0 \tag{5}$$

Where, ω_0 is the angular frequency in the isotropic state. If $\varepsilon=0$, isotropic state is obtained. Let us express the potential given in Equation (4) the following spherical coordinates:

$$x=r\sin(\theta)\cos(\phi),y=r\sin(\theta)\sin(\phi),\ z=r\cos(\theta) \tag{6}$$

If the potential given in Equation (4) is calculated by considering Equations (5, 6), the following function is obtained:

$$V_0=\frac{1}{2}\mu r^2\omega_0^2w^2(\theta,\varepsilon);\ w(\theta,\varepsilon)=\sqrt{\frac{32\pi+\varepsilon\left(25\varepsilon-8\sqrt{5\pi}\right)+3\varepsilon\left(5\varepsilon-8\sqrt{5\pi}\right)\cos(2\theta)}{32\pi}}$$

$$w(\beta,\varepsilon)=\sqrt{\frac{32\pi+\varepsilon\left(25\varepsilon-8\sqrt{5\pi}\right)+3\varepsilon\left(5\varepsilon-8\sqrt{5\pi}\right)\left[\sin^2(\beta)-\cos^2(\beta)\right]}{32\pi}} \tag{7}$$

(β *is latitude*); $w(\beta,\varepsilon)=1$ *for* $\varepsilon=0$. If we take the deformation parameter of the earth $\varepsilon=0.004$, $w(\beta,\varepsilon)$ is obtained as follows:

$$w(\beta)=\sqrt{\frac{100.405+0.380239\left[\sin^2(\beta)-\cos^2(\beta)\right]}{32\pi}}=\sqrt{\frac{100.405+0.380239\left[\sin(\beta)-\cos(\beta)\right]\left[\sin(\beta)+\cos(\beta)\right]}{32\pi}}$$

Here, $\varepsilon=0.004$ was taken. Here, the deformation parameter of the fault is the deformation parameter of the earth, that is, the shape of the fault is assumed to be the same as the shape of the earth. There is no such obligation. In other words, the deformation of the fault may not be the same as the deformation of the earth. For this reason, any desired value between $\varepsilon=(0,1)$ can be taken for fault deformation. If another value is taken, the generality of the calculations will not be impaired. From now on, this deformation state will always be assumed. Generally, geographically a point on the globe is expressed by latitude and longitude. The formula (7) does not depend on longitude. Thus, the potential energy of a mass μ_f in harmonic motion at a point with latitude β is as follows:

$$V_0(r,\beta)=\frac{1}{2}\mu r^2\omega^2w^2(\beta)=\frac{1}{2}\mu r^2\omega^2(\beta);\ \left[\omega^2(\beta)=\omega_0^2w^2(\beta)\right] \tag{8}$$

Since the fault rotates together with the earth globe, it can be taken as: $\omega(\beta)=\omega_0w(\beta)=7.292121\times 0^{-5}w(\beta);\ \left[\omega_0=7.292121\times 0^{-5}\right]$ (9)

Thus, the deformed harmonic oscillator potential becomes as follows:

$$V_0(r,\beta)=\frac{1}{2}\mu\omega^2(\beta)r^2=\frac{1}{2}\mu\omega^2r^2=V_0(r),\quad \left[V_0(r)=V_0(r,\beta);\ \omega^2=\omega^2(\beta)\right] \tag{10}$$

With this potential, the effective potential U(r) of the fault is obtained as follows:

$$U(r)=V_0(r)+\frac{h^2}{2\mu_fr^2}j(j+1)=\frac{1}{2}\mu_f\omega^2r^2+\frac{h^2}{2\mu_fr^2}j(j+1) \tag{11}$$

Here, j total angular momentum quantum number. μ_f is reduced or single mass of fault. However, as will be seen later, there is no need to calculate these values explicitly, because they are not needed in the calculation of earthquake parameters.

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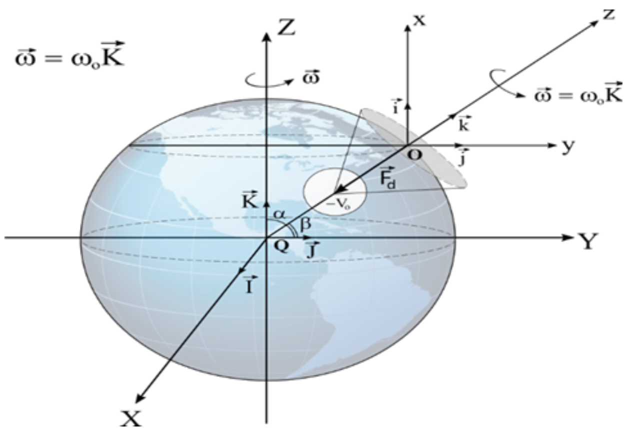

Figure 1 Depiction of the earthquake event on the earth globe.

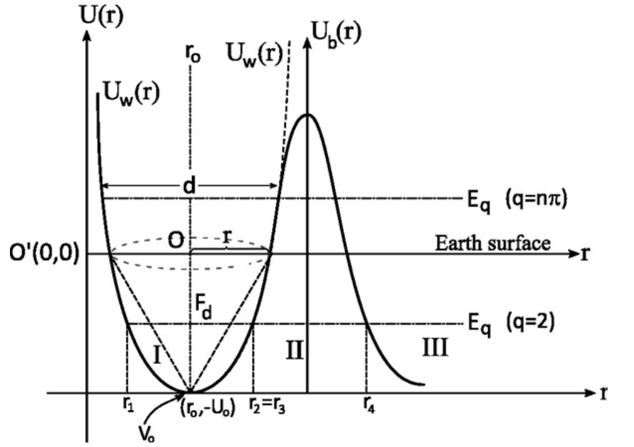

Figure 2 Graph of potential energy function at points O and $-V_0$. in Fig. 1.

Splitting the effective potential energy into two parts

Consider a particle of mass or reduced mass μ captured in quadratic potential well, as follows: $V(r) = -V_0 + a\ r^2$. The effective potential for this central potential is $U(r) = V(r) + b/r^2$. Here, the potential $a\ r^2$ is harmonic oscillator potential; the term b/r^2 is the centrifugal potential and comes from the rotation of the particle. If the potential is given as, $V(r)=V_0(r)-V_{00}$, ($V_0(r)>0$, $V_{00}>0$, the effective potential is $U(r) = V_0(r) - V_{00} + \frac{b}{r^2} < 0$ in the bound states. Here, $-V_{00}$ is the depth of the potential well (Fd point). Let us find the maximum and minimum values of this effective potential $U(r)$. Let the roots of equation $U'(r)=0$, r_{m1} and r_{m2} be. $r_0 = (r_{m1} + r_{m1})/2$ is the point where the potential receives the smallest values $U(r_{m1})$ and $U(r_{m2})$, and the largest value $U(r_0)$. Let $U_0 = U(r_0) - V_{00}$. Thus $U(r) = V_0(r) - U_0 + \frac{b}{r^2} < 0$ can be written. By solving this $U(r)$ potential directly, energy values and wave functions can be found. But if this potential is divided into two parts with an obstacle and a potential well, there may be some convenience. The obstacle in the potential well comes from rotational energy and the potential energy $(-V_{00})$. Apart from the rotational potential, for example the gravitational potential, it is necessary to add them to this potential. Therefore, the $U(r)$ effective potential can be written as the sum of two parts as follows:

$$U(r) = V_0(r) - U_0 + \frac{b}{r^2} + \frac{c}{r} = U_w(r) + U_b(r);\ [U_w(r) = -U_0 + V_0(r);\ U_b(r) = \frac{b}{r^2} + \frac{c}{r}] \tag{12}$$

Here, the $U_w(r)$ potential is the vibration part of the $U(r)$ potential, and the $U_b(r)$ potential is total of the rotational and the other obstacle potential parts of the potential $U(r)$. U_0 is the depth of the potential well. If the coordinate start is taken at the point $(r_0, -U_0)$, in this new coordinate system. Thus, the effective potential is written as follows:

$$U(r) = V_0(r) + \frac{b}{r^2} + \frac{c}{r} = U_w(r) + U_b(r);\ [U_w(r) = V_0(r)\ ;\ U_b(r) = \frac{b}{r^2} + \frac{c}{r}] \tag{13}$$

The graph of this potential is shown in Figure 2. Shape of the $U(r)$ function $(r_0, -U_0)$ in the coordinate system. Here, if the roots of the equation $U(r) = E$ are r_1 and r_2, $r_0 = (r_1 + r_2)/2$. The line r_0 is the Oz axis in the Oxyz coordinate system. In this way, three domains I, II, III are obtained. With this potential, the energy values and wave functions are obtained by solving the Schrödinger equation with the quantization condition.

Calculation of total energy (solution of the radial Schrodinger equation)

If the fault with mass μ_f is assumed to make three-dimensional harmonic motion, the potential of this motion is $U_w(r) = \frac{1}{2}\mu_f\,\omega^2 r^2 = a\ r^2$. Thus, the following values are obtained from (13):

$$U_w(r) = a\ r^2\ ;\ U_b(r) = \frac{b}{r^2} + \frac{c}{r}\ ;$$

$$U_0 = 2\sqrt{a\,b} - V_{00}\ ;\ a = \frac{1}{2}\mu_f\,\omega^2;\ b = \frac{\hbar^2 J^{(J+1)}}{2\ \mu_f} \tag{14}$$

The $U_b(r)$ potential is a barrier (obstacle) in the $U_w(r)$ potential well. The energy and wave functions are obtained by solving the equation $U_w(r) = E_q$, with the K d= q quantization condition.[3–6,9] From solution of equation $U_w(r) = E_q$, e have: $r_1 = -\sqrt{E_q/a}$, $r_2 = \sqrt{E_q/a}$, $d = r_2 - r_1 = 2\sqrt{E_q/a}$. From the quantization condition of energy, $K\,d = q$, [$K=\sqrt{2\mu_f E_q/\hbar^2}$], we have the following energy:

$$E_q = \pm\frac{q}{2}\sqrt{a\,m_h}\ ;\ [m_h = \frac{\hbar^2}{2\mu_f}] \tag{15}$$

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For the isotropic harmonic oscillator, $a=\frac{1}{2}\mu_f\omega^2$ his value is replaced in (15), the following energies are obtained:

$$E_{q1}=\frac{q}{4}\hbar\omega(\beta)\ ;\ E_{q2}=-\frac{q}{4}\hbar\omega(\beta).\Delta E_q=E_{q1}-E_{q2}=\frac{2q}{4}\hbar\omega(\beta);$$

$$E_q(q,\beta)=\frac{\Delta E_q}{2}=\frac{q}{4}\hbar\omega(\beta);$$

$$[q=2 \text{ and } n\pi,(n=1,2,3,...)] \tag{16}$$

We have for $q=2$ the minimum (ground) state energy occurs; for $q=n\pi,(n=1,2,3,...)$, for the exited state energies occur. We have symmetric states for odd integer values of n; antisymmetric states for even integer values of n. E_{q2} shows the energy of the particle that it is bound, and E_{q1} shows the energy of the state after out of getting of the bound state. An earthquake event occurs when the fault becomes excited states while vibrating with E_q constant energy at ground state. When it gets excited state, it gains kinetic energy. Since $\omega(\beta)$ is constant at point $O(\beta)$ the excitation of the fault occurs by changing its mass. It cannot remain steady while stimulated and tries to become at its ground state. This kinetic energy being in zone (I) passes through the zone (II) to zone (III) by tunnelling. Region (III) becomes the region where earthquake is felt on the earth. It appears that the energy given by (16) does not depend on the mass of μ_f. This mass is transformed to energy. This transformed energy is in q. So, whether the mass μ_f is big or small, it does not matter for us. Therefore, it is not necessary to calculate this mass precisely, i.e., to know it exactly. As can be seen from the formula (16), the energy depends on the variable (parameter) q. As this variable changes, the E_q energy will also change. Since the potential energy depends on the mass μ_f, the energy E_q also changes with the mass μ_f. Therefore, the variable q also changes with the mass μ_f.

The variation of the variable q depending on time can be found as follows: If the energy change of the fault is uniform and the energy change rate is $E_{qv}=dE_{qv}/dt$, q is found by solving the following differential equation $dq/dt=4E_{qv}/[\hbar\omega(\beta)]$ obtained from the formula (16). The solution to this equation is as follows:

$$q=q(t)=4E_{qv}t/[\hbar\omega(\beta)]+q_0 \tag{17}$$

Here, the integral constant q_0 is obtained with the initial conditions. q_0=0 or 2 can also be taken. $\omega(\beta)=\omega_0\,w(\beta)=7.292121\times 0^{-5}w(\beta)$, the rotational angular frequency of the earth can be taken. This value is the same and constant at every point of the earth as given above. If the change of energy of the fault is not uniform, that is chaotic, the value of q(t) cannot be calculated with this differential equation. In this case, it is necessary to calculate the q value in other ways. This q parameter can also be calculated by measuring the change of the seismic wave function (the seismic wave function will be given in the next paragraph). If the time dependent variable q(t) is known, it may be possible to calculate the probable time of the earthquake to occur. I would guess that geophysicists can measure or will try to measure the rate of energy change.

Finding wave functions

The radial normalized wave functions can be written as follows: [3-7]

$$Q(r)=m_1\int\sqrt{|U_w(r)|}\,dr=m_1\int\sqrt{a}\,r^2dr=m_1\frac{\sqrt{a}}{2}r^2\ ;\ [m_1\sqrt{\frac{2\mu_f}{\hbar^2}}=\frac{\sqrt{2\mu_f}}{\hbar}]$$

For the state of E_q, the independent of time and time-dependent radial normalized wave functions are as follows, respectively:

$$F^s(r)=Ac\cos[K r]e^{\pm iQ(r)};$$

$$F^s(r,t)=Ac\cos[K r]e^{\pm iQ(r)}e^{-\frac{i}{\hbar}E_q t}$$

$$F^a(r)=Bc\sin[K r]e^{\pm iQ(r)};$$

$$F^a(r,t)=Bc\sin[K r]e^{\pm iQ(r)}e^{-\frac{i}{\hbar}E_q t}$$

Here, (s: symmetric; a: antisymmetric), Ac and Bc are integral constants, they are found by normalizing these functions to 1 in the range $r=-\frac{d}{2}$ and $r=\frac{d}{2}$. Thus, the following values are obtained.

$$Ac=Ac(q,d)=\sqrt{\frac{ü}{d\,q+d\sin(q)}}=\sqrt{\frac{2}{d}}\sqrt{\frac{q}{q+\sin(q)}};\ Bc=Bc(q,d)=\sqrt{\frac{2q}{d\,q+d\sin(q)}}=\sqrt{\frac{2}{d}}\sqrt{\frac{q}{q-\sin(q)}}.$$

$$k\,d=q\ ;\ K=\sqrt{\frac{2\mu_f E_q}{\hbar^2}}=\frac{q}{d};d=\frac{q}{k}\ ;$$

(f is fault).

By solving the equation $K=\frac{q}{d}$, $\mu_f=\frac{2\hbar}{\omega}\frac{q}{d^2}$ is obtained. Let us find the value of d. The roots of $\frac{1}{2}\mu_f\omega^2r^2=E_q$ are

$$r_1=-\sqrt{\frac{2E_q}{\mu_f\omega^2}} \text{ and } r_2=\sqrt{\frac{2E_q}{\mu_f\omega^2}}.$$

From here, we obtain:

$$d=r_2-r_1=2\sqrt{\frac{2E_q}{\mu_f\omega^2}}=2\sqrt{\frac{2*\frac{q}{4}\hbar*\omega(\beta)}{\mu_f\omega^2}}=\sqrt{\frac{2q\hbar}{\mu_f\omega^2}} \text{ and } \mu_f=\frac{2q\hbar}{d^2\omega^2}.$$

The independent of time and time-dependent total normalized wave functions are as follows, respectively:

$$\psi^s(r,\theta,\phi)=R(r)\big|jm\!>=\frac{F^s(r)}{r}\big|jm>\ ;$$

$$\psi^a(r,\theta,\phi)=R(r)\big|jm\!>=\frac{F^s(r)}{r}\big|jm>$$

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$$\psi^s(r,\theta,\phi,t)=\frac{F^s(r)}{r}\Big| j\,\mathrm{m}> e-\frac{i}{\hbar}E_q\,\mathrm{t}\,;$$

$$\psi^a(r,\theta,\phi,t)=\frac{F^a(r)}{r}\Big| j\,\mathrm{m}> e\frac{i}{\hbar}E_q\,\mathrm{t}\,.$$

Here, $|jm>$ is the wave function due to angular momentum. In the earthquake theory here, this function will not be considered since it has no importance in the calculations. Therefore, the $|jm>$ function will not be considered from now on. Let us consider a general solution of the type of time-depending functions:

$$\Psi(r,t)=C\{\psi_s(r)e^{-iEst/\hbar}+\psi_a(r)e^{-iEst/\hbar}\}=$$

$$C\frac{1}{r}\{Ac\,\cos(K\,r)+Bc\,\sin(K\,r)\}\,e^{\pm i\,Q(r)}e^{-iE_qt/\hbar}$$

$$Ac\,\cos(K\,r)+Bc\,\sin(K\,r)=Ac\,[\cos(K\,r)+$$

$$\frac{Bc}{Ac}\sin(K\,r)]=Ac\,[\cos(K\,r)+\tan(\delta)\sin(K\,r)]$$

$$\tan(\delta)=\frac{Bc}{Ac}=\sqrt{\frac{q+\sin(q)}{q-\sin(q)}}\,;$$

$$\delta=\text{arc }\tan\left(\sqrt{\frac{q+\sin(q)}{q-\sin(q)}}\right).$$

Thus, we have:

$$\text{Ac}\,[\cos(K\,r)+\tan(\delta)\,\sin(K\,r)]=$$

$$\frac{Ac}{\cos(\delta)}\cos(K\,r-\delta)=\sqrt{Ac^2+Bc^2}\,\cos(K\,r-\delta).$$

Thus, we have:

$$\Psi(r,t)=A\frac{1}{r}\cos(K\,r-\delta)e^{\pm i\,Q(r)}e^{-iE_qt/\hbar};$$

$$[\text{A}=\text{C}\sqrt{Ac^2+Bc^2}\,]$$

By normalizing this last function to 1, the following value for constant A is obtained:

$$\text{A}=\text{C}\sqrt{Ac^2+Bc^2}=A(q,d,\delta)=$$

$$\sqrt{\frac{2\,\text{q}}{d\,[\text{q}+\sin(\text{q})\cos(2\,\delta)}}=\sqrt{\frac{2}{q}}\sqrt{\frac{\text{q}}{d\,[\text{q}+\sin(\text{q})\cos(2\,\delta)}}$$

Here, both states, ground and excited, are equally probable. The probability of the system being in state q is $|\Psi_q(r,t)|^2$ and is independent of time for a steady state. To comply with the radioactive decay law, the probability of our decaying system being in the q state is expected to decrease as $e^{-t/\tau}$ r time. That is $|\Psi_q(r,t)|^2=|\Psi_q(r,0)|^2e^{-t/\tau q}$. Where $\tau_q=1/\lambda_q$ is the average lifetime of the state with the decay constant λ_q. Thus, the time dependent wave function of state q can be written as follows:

$$\Psi_q(r,t)=A\frac{1}{r}\cos(K\,r-\delta)e^{\pm i\,Q(r)}e^{-iE_qt/\hbar}\;e^{-t/\tau q}$$

Adding the real part of exponential term to $\Psi_q(r,t)$ reduces the possibility of an exact determination of the state energy. The situation in question is no longer stable. According to the Heisenberg uncertainty principle, even if $\Delta\text{t}\to\infty$ is $\Delta\text{E}=0$, we can determine the energy of the state exactly. If a state has a lifetime of τ, we can determine its energy with an uncertainty of $\Delta\text{E}\sim\hbar/\tau$. But here we do not need to calculate the energy precisely for our theory. Therefore, there is no need to take the factor $e^{-t/2\tau q}$ in the wave function. So, the following function will be taken as the earthquake wave function from now on.

$$\Psi_q(r,t)=A\frac{1}{r}\cos\,(K\,r-\delta)e^{\pm i\,Q(r)}e^{-iE_qt/\hbar}=$$

$$A\frac{1}{r}\cos\,[K\,r-\delta]e^{\pm i\,Q(r)}e^{-i\,\omega\,t}\;\;;\left(\omega=E_q/\hbar\right).$$

The $e^{\pm i\,Q(r)}$ function may not be considered here because it does not work in calculations. In this last function, if the $e^{\pm i\,Q(r)}$ factor is neglected, this wave function can be written simply as follows:

$$\psi_q(r,t)=A\,\frac{1}{r}\cos[kr-\delta]e^{-i\,\omega t}=A(q,d,\delta)\frac{1}{r}\cos\left[\frac{q}{d}r-\delta\right]e^{-i\,\omega t}\quad(18)$$

The function (18) is a spherically propagating mechanical wave function and the seismic wave function of the fault. Function of harmonic waves are expressed in three main quantities. Speed of wave $v=\lambda/P=\lambda f$, wave number $K=2\pi/\lambda$ angular frequency, $\omega=2\pi/P=2\pi f$. Here, λ, P, f are wavelength, period, frequency, respectively. Let us calculate these sizes from the earthquake wave function (18) given above.

$$\text{K}=\sqrt{\frac{2\mu_f}{h^2}E_q}\;;\;Kd=q\;;\;K=\frac{q}{d}\,;$$

$$\lambda=\frac{2\pi}{K}=2\pi\frac{d}{q}\,;\omega=\frac{E_q}{h}=\frac{q}{4}\omega_0(\beta)$$

$$\omega(q,\beta)=\frac{q}{4}\omega_0(\beta)\qquad(19)$$

Here $\omega_0(\beta)$ is the angular frequency of the Earth and its value is equal to $\omega_0(\beta)=\omega_0\,w(\beta)=7.29212\times10^{-5}\,w(\beta)\;rad/s=7.29212\times10^{-5}\,w(\beta)rad/s$.

This function satisfies the following equations:

$$\phi_q(r,t)=A\,\cos\left[\frac{q}{d}r-\delta\right]e^{-i\,\omega\,t}\;;\;\frac{\partial^2\phi_q(r,t)}{\partial r^2}=\frac{1}{v^2}\frac{\partial^2\phi_q(r,t)}{\partial t^2}\qquad(20)$$

$$v=\frac{\omega}{k}=\omega\frac{d}{q}\,,\;(v\text{ speed of wave})\,.$$

Using this equation, the following expression for the speed of the wave is obtained as:

$$v=\frac{\lambda}{P}=\lambda f=\frac{\omega\lambda}{2\pi}=\frac{\omega d}{q}=\frac{d}{4}\omega_0(\beta)\,;\left\{\omega_0(\beta)=\omega_0\,w(\beta)=7.29212\times10^{-5}w(\beta)\right\}$$

From the quantization condition $K\,d=q,\,K=q/d$ is obtained. The potential created by the mass μ_f is $U(r)=\frac{1}{2}\mu_f\omega^2r^2$. Thus, $r_1=-\sqrt{\frac{2Eq}{\mu_f\omega^2}}$, $r_2=\sqrt{\frac{2Eq}{\mu_f\omega^2}}$ and $d=r_2-r_1=2\sqrt{\frac{2Eq}{\mu_f\omega^2}}$ are obtained from the solution of the equation $U(r)=E_q$. The energy value $E_q(q,\beta)=\frac{q}{4}\hbar\omega(\beta)$ is obtained from the solution of this equation. On the other hand, the energy of the harmonic wave is $E_q=\frac{1}{2}\mu_f\omega^2A^2$. When there is an earthquake,

$v=\frac{d}{4}\omega$, $Ke=\frac{1}{2}\mu_f v^2$ and $Ke=\frac{q-2}{4}\hbar\omega$ Thus, $\mu_f=\frac{8(q-2)\hbar}{d^2\omega}$ is found from the solution of the equation $\frac{1}{2}\mu_f v^2=\frac{q-2}{4}\hbar\omega(\beta)$.

From here, the following value are obtained for d, K and μ_f :

$$d=\frac{2q}{q+\sin(q)\cos(2\delta)};\ K=\sqrt{\frac{2\mu_f E_q}{h^2}}=\frac{q}{d};$$

$$\mu_f=\frac{8(q-2)\hbar}{d^2\omega};\ \lambda=\frac{2\pi}{k}=2\pi\frac{d}{q} \qquad (21)$$

λ , Wavelength of the earthquake wave.

Calculation of the focus depth (earthquake focus depth)

According to Figure 2, let there be an earthquake at point O (external focus) in the potential energy well. When there is an earthquake, the energy at point O is $E_q=\frac{q}{4}\hbar\omega(\beta)$. When an earthquake occurs, the energy passes from the I region to the III region by tunnelling from the II region. Let the widths of regions I and II be d_1 and d_2 , respectively. It is understood that $Kd_1=Kd_2=q$, hence $d_1=d_2$, due to the condition of quantization of energy. The distance between the points $-U_0$ and O is $Fd1=0-(-U_0)=U_0=\hbar\omega(\beta)$. This U_0 is energy dimension and q=1. The energy at this point is $E_1=\frac{1}{4}\hbar\omega(\beta)$. . However, in the ground state of the harmonic oscillator, q = 2. Since there is no earthquake in the ground state. Since no earthquake occurs in the ground state, so, an earthquake occurs, q >2. When q =2, the energy becomes $E_q=E_2=\frac{2}{4}\hbar\omega(\beta)$. The point where the energy is in this state becomes the inner focus of the earthquake. Thus, the rayon vector of the inner focus relative to the outer focus of the earthquake can be written as follows:

$$\vec{r}=r\left[-\sin(\alpha)\sin(\theta)\cos(\phi)\vec{i}+\cos(\alpha)\cos(\theta)\ \vec{k}\right]$$

For $\theta=\pi$, the rayon vector of point $(-V_0)$ becomes:

$$\overrightarrow{Fd}=\vec{r}=-r\cos(\alpha)\vec{k}=-r\sin(\beta)\vec{k}$$

$\overrightarrow{Fd}=-\frac{q-2}{4}\cos(\alpha)\vec{k}$ or $\widehat{Fd}=\frac{q-2}{4}\cos(\alpha)=\frac{q-2}{4}\sin(\beta)$; (rayon vector of inner focal)

The expected value (average value) of the rayon vector of the focal point of the earthquake is calculated as follows:

$$\Psi_q(r,t)=A\frac{1}{r}\cos[K\ r-\delta]e^{-i\omega t}=A\frac{1}{r}\cos\left[\frac{q}{d}r-\delta\right]e^{-i\omega t};$$

$$F_q(r,t)=A\cos[K\ r-\delta]\ e^{-i\omega t}.$$

The expected value of Fd is follows,

$$<\widehat{Fd}>=\overline{Fd}=\frac{(\Psi_q(r,t),\widehat{Fd}\Psi_q(r,t))}{(F_q(r,t),F_q(r,t))}=\frac{\int\Psi_q*(r,t),\widehat{Fd}\Psi_q(r,t)dV}{\int F_q*(r,t),F_q(r,t)dr}$$

$$\overline{Fd}=\frac{\iiint\frac{1}{r}\cos[\frac{q}{d}r-\delta]\frac{q-2}{4}\cos(\alpha)\frac{1}{r}\cos\left[\frac{q}{d}r-\delta\right]r^2dr\sin(\theta)d\theta d\phi}{\int\cos\left[\frac{q}{d}r-\delta\right]\cos\left[\frac{q}{d}r-\delta\right]dr}=$$

$$\frac{q-2}{4}\cos(\alpha)[-\sin(\alpha)\textstyle\int_{\pi}^{\pi/2}\sin(\theta)d\theta]\int_0^{2\pi}d\phi$$

$$\overline{Fd}=\frac{q-2}{4}\cos(\alpha)2\pi\sin(\alpha)=\frac{\pi(q-2)}{2}\sin(\beta)\cos(\beta).$$

α and $\beta=(\pi/2-\alpha)$ are the colatitude and latitude, respectively.

Thus, Fd is the inner focal of earthquake as,

$$Fd(\alpha,\beta)=\frac{\pi(q-2)}{2}\sin(\beta)\cos(\beta) \qquad (22)$$

All parameters in the Fd formula (22) is dimensionless. Whereas Fd is measured in the length dimension (as km). Since the radius of the earth is given in km, I believe that there is no harm in giving this dimensionless quantity as km. As can be seen from the (18-22) formulas, all parameters of the earthquake wave function depend on the q parameter, which is the quantization condition of the energy, $K\ d=q$. As seen from (21), $\mu f=0$ for $q=2$, that is, when $q\le 2$, an earthquake never occurs. Therefore, there is a possibility of an earthquake after q>2 As can be seen from formula (22), $\beta=0$ at the equator and $\beta=\pi/2$ at the poles, so Fd=0 at these points. Therefore, there will be no earthquakes at the equator and poles. Indeed, when earthquakes in the past are investigated, it is seen that there are no earthquakes. (I could not find any data at the equator and poles). This shows that the theory that we give here is correct. For $\beta=\pi/4$, Fd is the maximum value. This latitude is in the middle of the earthquake zone. As can be seen from formula (22), $Fd=0$ for $q=2$. This shows that there will be no earthquake on earth.

How and when can an earthquake occur?

Now, let us consider a general solution of the type of time-depending functions:

$\psi(r,t)=\frac{1}{\sqrt{2}}\left\{\psi_g(r)e^{-iE_gt/\hbar}+\psi_e(r)e^{-iE_et/\hbar}\right\}$; (g ground, e excited).

The probability of a particle being found at a point as follows:

$$\rho=\psi*(r,t)\psi(r,t)=|\psi(r,t)|^2=\frac{1}{2}\left\{\psi_g^2+\psi_e^2+2\psi_g\psi_e\cos\left[E_e-E_g\right]t/\hbar\right\} \qquad (23)$$

In (23), when the cosine is equal to +1, we have $\rho=\frac{1}{2}(\psi_g+\psi_e)^2$, and this corresponds to a state where the probability of finding the particle in domain I is maximum, and in domain III is minimum. When the cosine is equal to -1, we have $\rho=\frac{1}{2}(\psi_e-\psi_g)^2$ and this corresponds to a state where the probability of finding the particle in domain I is minimum and in domain III is maximum. The expression (18) must be interpreted by saying that it is a state where particle oscillates in domain I. In some cases, if it can tunnel from zone II to zone III, then the particle can pass into zone III, i.e., an earthquake may occur. The frequency of this oscillation is $f=E_e-E_g/h$. If $E_e=E_g$ then f = 0, and no vibration. To perform such an oscillation

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corresponding to the energy variation $E_e - E_g$, the particle must receive energy from somewhere. The particle (fault) gains this energy by changing the mass (so energy) of the oscillating fault. Here, the energy of the fault changes from the movements of the fault (with shrinkage, growth, and similar events of fault), that is, it gains kinetic energy. If the mass and rate of change of mass (or energy) of the fault at a certain time t_0 can be measured, it may be possible to calculate the probability of an earthquake occurring at any time t in that region. So, according to (23), when $\cos\left[\left(E_e - E_g\right)t/\hbar\right] = -1$, there is a probability of an earthquake. This probability depends on the transition coefficient T (tunnelling coefficient) from the II-region to the III-region. (This T coefficient will be calculated in the next paragraph). From here, the following equation can be written:

$$T(q)\left(E_e - E_g\right)t/\hbar = T(q)\frac{(q-2)t}{4\hbar}\hbar\omega(\beta) = \quad ; (n1 = 1, 2, 3, \ldots)$$

$$T(q)\frac{(q-2)t}{4}\omega(\beta) = (2n_1 - 1)\pi$$

From here, the following t-value is obtained:

$$t(n_1, q, \beta) = \frac{4\pi(2n-1)}{T(q)(q-2)\omega(\beta)}S \quad (q > 2, n1 = 1, 2, 3, \ldots) \quad (24)$$

Where, q is the value when there is an earthquake. As can be seen from (24), when q = 2 (ground state), $t = \infty$, that is, there will never be an earthquake. If the quantization condition $q = n_2\pi, (n_2 = 1, 2, 3, \ldots)$ for the excited states of energy is taken, the formula (24) can be also written as follows:

$$t(n_1 n_2, \beta) = \frac{4\pi(2n-1)}{T(n_2\pi)(n_2\pi - 2)\omega(\beta)}S$$

$(n_1, n_2 = 1, 2, 3, \ldots)$ (25)

To predict when an earthquake may occur in a region, it is necessary to calculate the value of q (or n2) in the formula (24, 25). For this, it is necessary to calculate the exchange function of the energy E_q. It is exceedingly difficult to calculate or to measure this value in advance, but it is possible. For example, if the rate of change of energy can be measured, the q value can be calculated according to the formula (17). But I think there is a need for more thought, study, and verification on this subject by making observations. More work needs to be done in this regard. Geophysicists have a lot of work to do.

Calculation of the transmission coefficient through the zone (II) To zone (III)

The particle is unbound state in the region (II). From the solution of the $[U_b(r) = E_q]$ equation, r_3 and r_4 values depending on E_q are obtained. The solution to this equation (at the point r_0) gives the following values $r_2 = r_3 = r_0 + d_1/2 and r_4 = r_0 + d_1/2 + d_2$ From here, the width of the obstacle d2 is found: $d_2 = r_4 - r_3$. The energy E_q is found by the equation (16). In the region II, $E_q < U_b(r)$ nbound state, thus the particle (here kinetic energy of the fault) cannot remain stable in zone II, it can pass from region I to region III by tunnelling from region II. Here the probability of passing coefficient is calculated. The tunnelling probability coefficient (or transmission coefficient) is given by the following formula.[3-7]

$$T = \frac{2}{\cosh[2Kd] + \cos(2P)}$$

Here, the width of the potential barrier d, $K = m_1\sqrt{|E|}, \left(m_1 = \sqrt{2m/\hbar^2}\right)$ E total energy, $Q_r = m_1\int\sqrt{|U(r)|}dr$ U(r) is barrier potential and $P = Q(r_4) - Q(r_3)$ m is the mass of the tunnelling particle. Here, according to our quantities, these quantities are as follows:

$$P = \sqrt{\frac{2m}{\hbar^2}}\int_{r_3}^{r_4}\sqrt{|U_b(r)|}dr = Q_b(r_4) - Q_b(r_3)$$

$$Q_b(r) = m_1\int\sqrt{|U_b(r)|}dr$$

$$d = d_2\,;\; K = m_1\sqrt{|E_q|}; m_1 = \sqrt{2\mu_f/\hbar^2}$$

IfQ_b(r)ispair,P=0IfQ_b(r)isnotpair, $P = \mathrm{Real}\left[Q_b(r_4) - Q_b(r_3)\right] = 0$, or approximately zero. So, it can take, P = 0 Thus, the following coefficient of transmission is obtained.

$$T = \frac{2}{1 + \cosh(2K(E)d_2(E))}, \text{ and If } d_2 = 0, \text{ the } T = 1 \quad (26)$$

In zone (I), the energy provides the quantization condition $K(E_q)d_1(E_q) = q$ Energy in the (II) region is not quantified, but since the energy in the (I) region will pass through the (II) region, so, $K(E_q)$ $d2(E_q)$ = q equation is also provided in the (II) region. Thus, the coefficient of transmission obtained in the region (II) from (26) as follows:

$$T(q) = \frac{2}{1 + \cosh(2q)}; \quad [q = 2 \text{ and } n\pi, (n = 1, 2, 3 \ldots)] \quad (27)$$

We have for q = 2 the minimum (ground) state energy occurs; for q = nπ, (n = 1, 2, 3 …) for the exited state energies occur. The quantity T is the coefficient of crossing the potential barrier. It is a probability function and function of q.

Calculation of the energy released in the earthquake

In the ground state q = 2. An earthquake occurs when the fault is excited states. q = nπ, (n = 1, 2, 3 …) The difference between the excited states and the ground state energy gives kinetic energy. So kinetic energy (K_e) is found as follows:

$$E_q = \frac{q}{4}\hbar\omega(\beta); E_2 = \frac{2}{4}\hbar\omega(\beta); K_e = E_q -$$

$$E_2 = \left(\frac{q}{4} - \frac{2}{4}\right)\hbar\omega(\beta) = \frac{(q-2)}{4}\hbar\omega(\beta)$$

$$K_e = E_k(q, \beta) = \frac{(q-2)}{4}\hbar\omega(\beta)$$

[q=2 and nπ, (n = 1, 2, 3 …)]

If q=2, Ek=0, If q=2, Ek= 0 then an earthquake does not occur in ground state. When q>2 an earthquake occurs at excited states. When an earthquake occurs, the energy released comes from the broken or destroyed μ_f mass. Then, $\mu_f c^2$ becomes the released energy. Well, from (21), the following released energy is obtained:

$$\mu_f c^2 = \frac{8(q-2)\hbar}{\omega(\beta)d^2}c^2$$

[c is the speed of light in vacuum] (28)

Calculation of earthquake intensity and magnitude

We define the earthquake intensity as follows: $\omega(\beta) = \omega_0 w(\beta)$

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$$Intensity = \frac{kineticenergy}{\hbar\omega_0} = \frac{E_k(q,\beta)}{\hbar\omega_0} =$$

$$\frac{\frac{q-2}{4}\hbar\omega(\beta)}{\hbar\omega_0} = \frac{q-2}{4}w(\beta) = Int(q,\beta)$$

So, intensity is as follows:

$$Inq(q,\beta) = \frac{(q-2)}{4}\mathrm{w}(\beta);\left[q = 2andn\pi,(n = 1,2,3...)\right] \quad (29)$$

For q = 2, $E_k = 0$ then an earthquake does not occur. Therefore, in (29), q should also be q>2 Today, the Richter scale or similar scale is used as intensity in the world. So, it is more convenient to use **Rm** (**R**ichter **m**agnitude) as below to compare it to this familiar scale. It can be taken according to the Richter scale [Int (q,β) = I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII]

Thus, earthquake intensity as **R**ichter **m**agnitude is obtained as follows:

$$Rm(q,\beta) = Int(q,\beta) = Inq(q)w(\beta)$$

$$Inq(q) = \frac{(q-2)}{4};\left[q = 2andn\pi,(n = 1,2,3...)\right] \quad (30)$$

If the seismic intensity found by seismographs is Rm(sis), the value of q is found by the solution of the equation, $Rm(q,\beta) = Rm(sis)$. So, q is obtained by solving the equation, $Inq(q) = \frac{(q-2)}{4} = \frac{Rm(sis)}{w(\beta)}$. Thus, $q = 2 + \frac{4Rm(sis)}{w(\beta)}$. It is the q value at the time of the earthquake. Accordingly, scaling Rm = (0, 1 ,2, …, 12) can be equated to scaling q = (2, 6, 10, 4, …, 50).

Calculation of the half-life and the average life of the earthquake

The earthquake event can compare to a radioactive atomic nucleus (a radioactive nucleus that emits gamma rays and neutrinos). If a nucleus is radioactive, the decay constant is $\lambda_c = fT(q)$. The half-life of the particle (here fault that is energy) coming out of the atomic nucleus given by the formula $t_{1/2} = \frac{0.693}{\lambda_c} = \frac{0.693}{fT(q)}$,.[9] Here f is the frequency of the particle emitted by the atomic nucleus to find itself in front of the potential barrier, and T is the probability of passing the barrier. Here, particle do not emit, that is, earthquake energy emits instead of particle. Therefore, the particle emission half-life can take as the earthquake half-life. Thus, the half-life of the earthquake would be as follows:

$$\omega = \omega(q,\beta) = \frac{E_k}{\hbar} = \frac{q-2}{4}\omega(\beta) ;$$

$$T(q) = \frac{2}{1+\cosh[2q]};$$

$$t_{1/2} = \frac{0.693}{fT(q)} = \frac{0.693}{\omega/(2\pi)T(q)} = \frac{0.693\times 2\pi}{\frac{q-2}{4}\omega_0(\beta)T(q)}S =$$

$$\frac{0.693\times 2\pi\times 4}{(q-2)\omega_0 w(\beta)T(q)}S = \frac{238847}{(q-2)w(\beta)T(q)}S$$

$$W(\beta) = \sqrt{\frac{100.405 + 0.380239\left[\sin^2(\beta) - \cos^2(\beta)\right]}{32\pi}} ;$$

$$t_{1/2}(q,\beta) = \frac{238847}{(q-2)w(\beta)T(q)}S,(q>2) \quad (31)$$

Here, T(q) is the transmission coefficient given by (27). In (31), $t_{1/2}=\infty$ for q=2. Thus, there will never be an earthquake at the ground state.

The decay constant is given as $\lambda_c = fT(q)$. Thus, the average life τ is found as follows:

$$\tau(q) = \frac{1}{\lambda_c} = \frac{1}{fT(q)} = \frac{2\pi}{\omega_0 T(q)w(\beta)} = \frac{86164}{T(q)w(\beta)}S \quad (32)$$

This quantity shows how long the earthquake will last. As seen from (32), the average life is second.

Estimation of the time of the earthquake

No earthquake occurs when the fault remains in the ground states. The half-life indicates when an earthquake will occur after an earthquake occurs somewhere. Earthquake occurs in excited energy states, that is, if there is greater kinetic energy than the ground state energy, an earthquake occurs. There is a possibility of an earthquake in all the excited states, but it cannot always pass the obstacle because energy is quantum. An earthquake occurs when the energy barrier passes. In other words, when an earthquake occurs, it passes the barrier. Currently, kinetic energy (28), earthquake intensity (29), Richter magnitude (30) and half-life (31) are given, respectively. All of them depend on the number q, and in all they must be the same number q. How to find q in Richter magnitude expression is given. Accordingly, the half-life should be as follows:

$$t_{1/2}(q) = \frac{238847}{(q-2)w(\beta)T(q)}S$$

[s second, q=2 and nπ, (n=1,2,3…)];

$$T(q) = \frac{2}{1+\cosh[2q]}$$

$$Rm(q,\beta) - Inq(q)w(\beta); Inq(q) = \frac{(q-2)}{4};[q = 2andn\pi, n = 1,2,3...]$$

If the seismic intensity founded by seismographs is Rm(sis), the value of q is found by the solution of the equation Rm(q,β) = Rm(sis). So, q is obtained by solving the equation $Inq(q) = \frac{Rm(sis)}{w(\alpha,\beta)}$. Thus, the probability of an earthquake with the same intensity somewhere is obtained as follows:

$$t_{1/2}(q,\beta) = \frac{238847}{(q-2)w(\beta)T(q)}S;$$

$$q = \frac{2\left[2Rm(sis) + w(\beta)\right]}{w(\alpha,\beta)} = 2 + \frac{4Rm(sis)}{w(\beta)} \quad (33)$$

Here Rm (sis) is the intensity to be measured by the seismograph.

If the expected intensity Rm (sis) is taken, the time and depth of the earthquake can be estimated when the earthquake occurs.

Is it possible to predict the probability of a sequential earthquake? that is, when will the same earthquake occur?

When an earthquake occurs somewhere on the globe, it is particularly important to predict when an earthquake of the same magnitude and location will occur. Because if the time of the earthquake is known, measures can be taken, and the damages can be minimized. The answer to this question can be given in two ways: (1) according to formula (24), (2) according to the radioactivity half-life.

According to formula (24)

When an earthquake occurs somewhere on earth, the parameters of this equation are known. Let us rewrite the formula (24):

$$t(n_1,q,\beta)=\frac{4\pi(2n_1-1)}{T(q)(q-2)\omega\beta}S \quad q>2, n_1=1,2,3\ldots .$$

If an earthquake occurs in a place whose latitude is β, then if it is taken to be zero, the same earthquake may occur after the time given below.

$$t(n_1,q,\beta)=\frac{4\pi(2n_1-1)}{T(q)(q-2)\omega\beta}S$$

The q value is calculated when an earthquake occurs. With that q value, it can be calculated when the same earthquake may occur.

According to the radioactivity half-life

We consider the earthquake event as the radioactive decay of atomic nuclei. The radioactive decay formula is given as follows.[9]

$$N=N(t)=N_0e^{-\lambda_c t} \tag{34}$$

Here, t time, λ_c decay constant N_0 is the number of particles that have not yet decayed at time t=0. Half-life $t_{1/2}$ gives the time required for half of the atomic nuclei to decay. If $N=N_0/2$ is taken in the Equation (34), it is found $t_{1/2}=Log(2)/\lambda_c\cong 0.693/\lambda_c$. Average life is $\tau=1/\lambda_c$. The average life of the atomic nucleus gives the time until the nucleus completely decays.

Consider an earthquake that occurred at a point on earth at time t=0. After this earthquake, let us show the time t_1 that the same earthquake will occur. If the number of earthquakes likely to occur at time t=0 is $N=N_0$, the number of earthquakes that will occur after that will be $N=N_0-1$, since an earthquake will occur at time t_1. If the average lifetime of this earthquake is τ, the time of the last earthquake will be N=1 Thus, the following two equations can be written:

$$N_0-1=N_0e^{-\lambda c t_1} and 1=N_0e^{-\lambda c\tau} \tag{35}$$

Since $\tau=1/\lambda_c$, , the following value is found from equations (35),

$$t_1=\frac{1}{\lambda_c}Log\left(\frac{e^{\lambda c\tau}}{e^{\lambda c\tau}-1}\right)=\frac{1}{\lambda_c}Log\left(\frac{e}{e-1}\right)=\frac{0.458675}{\lambda_c}S$$

The decay constant is given as $\lambda_c=fT(q)$. Thus, the time t_1 is found as follows:

$$t_1(q)=\frac{0.458675}{\lambda_c}=\frac{0.458975}{fT(q)}=\frac{0.458675\times 2\pi}{\omega(\beta)T(q)}= \frac{0.458675\times 2\pi}{\omega_0T(q)w(\beta)}=\frac{39607.5}{T(q)w(\beta)}S \tag{36}$$

On the other hand, kinetic energy K_e: $K_e=\frac{(q-2)}{4}\hbar\omega(\beta)=\frac{n\pi-2}{4}\hbar\omega(\beta)$ [n= 1,2,3,…]. According to the Heisenberg uncertainty principle, $\Delta E\times\Delta t\geq\hbar/2$ can be written. From here, $\Delta K_e\times\Delta t_1\geq\hbar/2\rightarrow\frac{\Delta n\pi}{4}\hbar\omega(\beta)\times\Delta t_1\geq\hbar/2 and \Delta n=1$.

From here, we find Δt_1 as follows:

$$\Delta t_1=\frac{2}{\pi\omega(\beta)}=\frac{2}{\pi\omega_0w(\beta)}=\frac{8730.24}{w(\beta)}S$$

Thus, we have t_1 as follows:

$$t_1(q)=\frac{39607.5}{T(q)w(\beta)}S\pm\frac{8730.24}{w(\beta)}S \tag{37}$$

Here, it was accepted that underground earthquakes occur homogeneously everywhere. However, due to the different structures of the interior of the place, these calculations may differ slightly according to the regions.

In general, time is measured even in minutes, hours, days, months, and years. When using, these seconds can be converted to desired units. This conversion is done as in Table 1.

Calculation of the Rm, Fd and t1/2 of some earthquake and comparison

Some earthquakes data calculated by formulas (22), (30) and (31) given by earthquake observation agencies are shown in Table 2.

Table 1 Half-Life Conversion Table

Times	$T_{1/2}$(years)	$T_{1/2}$(days)	$T_{1/2}$(hours)	$T_{1/2}$(minutes)	$T_{1/2}$(seconds)
Td	3.14723x10^7 s	86164 s	3600 s	60 s	1 s
$\frac{t1/2(q,\beta)}{Td}$	$\frac{0.00189728\ y}{T(q)w(\beta)}$	$\frac{0.693001\ d}{T(q)w(\beta)}$	$\frac{16.5866\ h}{T(q)w(\beta)}$	$\frac{995.195\ m}{T(q)w(\beta)}$	$\frac{59711.7\ s}{T(q)w(\beta)}$

Table 2 Some Earthquakes Data Calculated by Formulas and Given by Earthquake Observation[1,8]

Date year. mon. day.	Latitude (Degree)	Longitude (Degree)	Depth Calculed (measured)	Magnit. Calculed (measured)	q (rad)	Half-life (Year)	Country province
2024 01.25	38.175	38.4357	16.2 (4.2)	5.3 (5.3)	23.2228	1.3269×10^{16}	Turkey Sıncık
2023 07.25	37.5915	35.8967	17.03 (1.1)	5.6 (5.6)	24.4249	1.3902×10^{17}	Turkey Kozan
2023 02.27	38.2492	38.2912	16.82 (5.7)	5.5 (5.5)	24.0235	6.3429×10^{16}	Turkey Yeşilyurt

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Table 2 Continued...

Date year. mon. day.	Latitude (Degree)	Longitude (Degree)	Depth Calculed (measured)	Magnit. Calculed (measured)	q (rad)	Half-life (Year)	Country province
2023 02.20	36.0487	36.1132	19.16 (20.2)	6.4 (6.4)	27.631	7.4106×10^{19}	Turkey Dağdüzü
2023 02.16	36.1652	35.7968	14.98 (19.0)	5.0 (5.0)	22.0241	1.2792×10^{15}	Turkey Samanda.
2023 02.08	37.995	37.6223	16.78 (4.3)	5.5 (5.5)	24.0239	6.3474×10^{16}	Turkey Doğanşe.
2023 02.07	37.992	36.4482	15.26 (5.0)	5.0 (5.0)	22.0217	1.2733×10^{15}	Turkey Göksun
2023 2.07	37.8275	37.6303	17.06 (2.0)	5.6 (5.6)	24.4246	1.3893×10^{17}	Turkey Gölbaşı
2023 02.06	38.0752	37.052	15.57 (5.0)	5.1 (5.1)	22.4221	2.7800×10^{15}	Turkey Ekinözü
2023 02.06	38.2742	38.1295	16.82 (5.0)	5.5 (5.5)	24.0235	6.3424×10^{16}	Turkey Yeşilyurt
2023 02.06	38.4495	37.7962	15.93 (16.2)	5.2 (5.2)	22.822	6.0672×10^{15}	Turkey Akçadağ
2023 02.06	38.0243	36.5085	18.31 (5.0)	6.0 (6.0)	26.026	3.1903×10^{18}	Turkey Göksun
2023 2.06	38.0818	37.1773	23.21 (5.0)	7.6 (7.6)	32.4328	9.2485×10^{23}	Turkey Ekinözü
2023 02.06	37.2127	36.777	20.00 (5.0)	6.6 (6.6)	28.43	3.5523×10^{20}	Turkey Nurdağı
2023 02.06	37.1757	37.085	23.32 (5.5)	7.7 (7.7)	32.8351	2.0406×10^{24}	Turkey Ş. Kamil

As can be seen from Table 2, the data given by the agencies and our calculation do not exactly match. We think our accounts are more accurate. Because our calculations are calculated directly from the theory. The values given by the agencies are calculated with the formulas obtained with some statistical models. Considering the location of earthquakes, the data are expected to be close to each other. However, their data is quite different. It is seen that our accounts are more compatible. Calculating the depth exactly one way or another does not give us much information. Therefore, I think it is not very important to calculate it exactly.[3–9]

Conclusion

In previous publications, a simple procedure for the general solution of the radial Schrödinger equation has been found for spherical symmetric potentials without making any approximation. In this study, using this method, a new earthquake model was proposed. In this proposed new earthquake model, (1) the magnitude of the earthquake, (2) its energy that may be released, (3) the depth of the earthquake from the earth, (4) how long the probability of an earthquake when the earthquake will occur, (5) and in which regions earthquakes may occur on earth can be predicted in advance. (6) It is particularly important to know in advance the probability of an earthquake because they can take measures and precautions to minimize damage from this earthquake. This will enable people to take precautions in advance, (7) the half-life of an earthquake occurring on earth can be calculated. (8) Earthquake parameters used were calculated here. If other parameters are desired or required, they can be calculated in similar ways. All earthquake parameters depend on only one parameter (q). If the change of this parameter can be observed at any point on the earth, it will be possible to predict the time of the earthquake at that point in advance. Therefore, the change of this parameter (q) needs to be measured to find out beforehand that an earthquake will occur in a place. I think it is possible with today's technology. If this is successful, it will be of great benefit to humanity. Geophysicists will do this job. In addition, it seems that the laws of quantum mechanics, which are valid in the microscopic universe, may also be valid in the macroscopic universe. Isotropic harmonic potential is taken here. By taking the non-isotropic (deformed) potential, similar calculations can be made, and this model can be expanded as needed. I think that with the contributions of geophysical scientists, this earthquake theory can be further improved, so that it is possible to predict when an earthquake may occur before it happens.

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Conflicts of interest

The author declares there is no conflict of interest

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