Fluctuations of the planetary gravitational field and nonlinear interactions with matter – triggering earthquakes.

Dr. Michael Nitsche (✉ michael.nitsche@lettris.de)
privato

Research Article

Keywords: triggering earthquakes, correlation function, Nature hazard, planetary gravitational field, Gravity, complex systems

Posted Date: January 17th, 2022

DOI: <https://doi.org/10.21203/rs.3.rs-1261580/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.
[Read Full License](#)

Fluctuations of the planetary gravitational field and nonlinear interactions with matter – triggering earthquakes.

Michael Nitsche 2021-12-24

Abstract

The orbits of the big planets are very stable during millions of years. In addition to this, there is another important circumstance: the orbits of the planets lie almost on the same level. They represent natural oscillators on a big scale. Such a rhythm or such duration of vibration is determined by the time period from conjunction to conjunction of two planets. These are relatively stable frequencies. A non-linear correlation function forms a good way of describing these processes. It can be shown that this correlation function can also be interpreted as a non-linear interaction of the planetary fluctuations of the gravitational field with material structures. The vibrations of the planetary gravitational field lead to higher vibrations, to higher harmonics, in material structures. The problems of the correlation function are the coefficients a_k and the meaning of H_{ij} . In my researches I restricted myself to the polar qualities which are associated with the concepts of "stability" and "instability". The change from stable to unstable conditions and vice versa, can be observed in the evolution of many complex systems. Statistical researches will be presented and show this non-linear influence. *Translated from German into English by DeepL.*

Table of Contents

The model of nonlinear interactions

1 The model of nonlinear interactions

1.1 Fluctuations of the planetary gravitational field

1.2 Nonlinear interactions

1.3 The correlation function

2 Earthquakes

2.1 An initial study of 41 of the strongest earthquakes

2.2 A study of 588 earthquakes

3 Summary

4 Bibliography and References

1 The model of nonlinear interactions

1.1 Fluctuations of the planetary gravitational field

Galaxies in space, planetary systems, clouds, geological formations, plants and animals, human societies, our nervous system, quantum physical systems form simple and also complex structures on scales of different sizes. It is possible that the formation of such structures can be described from a model of more or less strongly coupled, oscillating subsystems.

One such oscillating subsystem is the planetary system. The sun and moon are weakly coupled with the system of oceans, causing them to oscillate even in the ebb and flow of the tide. "Big earthquakes, such as the ones that devastated Chile in 2010 and Japan in 2011, are more likely to occur during full and new moons — the two times each month when tidal stresses are highest." [1] Cause and effect are related in a relatively simple and proportional way. But are there also non-linear relationships in which cause and effect are not directly proportional?

The development of computer technology makes it increasingly possible to study complex systems with nonlinear dynamics in nature and society.

One hypothesis underlying such investigations is the assumption that nature, but also society, can be modeled by nonlinear coupled oscillators on many scales. Starting with quantum fluctuations and ending with the "great cosmic rhythms of our solar system" [1], the complex human organism is influenced in its evolution but also in its individual development. The mathematical model for the influence of fluctuations of the gravitational field on complex systems in nature (triggering of earthquakes) and the human organism has emerged more or less by chance from different, originally separate investigations.

The publication aims to draw attention to this oscillating subsystem (the solar system) and to stimulate further research. The computer program developed for this purpose is accessible for research projects.

There are a number of indications that the relatively weak fluctuations of the planetary gravitational field influence structure formation processes in a nonlinear way. [2] [4]

A correlation function that indicates stabilizing and destabilizing states with a certain probability is suitable for describing these processes. The underlying hypothesis is the oscillation between stable and unstable states throughout evolution. The pursuit of a stable state can only ever be a stage of evolution that maintains that state for more or less time.

The structure and development of physical systems is determined by the interaction of different parts of the system with each other and between systems and the environment. Four groups of interactions are distinguished: strong, electromagnetic, weak and gravitational. These interactions are not equally effective on the different scales of nature, but they are also not completely decoupled in their effect.

The aim of these investigations here is to develop a model based on gravitational interaction that is suitable for demonstrating an influence of cosmic rhythms of the planetary system on structures and processes of varying complexity in nature.

The planetary system of the sun is on the one hand an object of research in astronomy, but on the other hand also a factor of influence on the evolution of the earth and its inhabitants. Thus, the Earth's moon not only acts in the formation of romantic and mystical ideas in human consciousness, but also through its stabilizing effect on the Earth's axis. Thus it guarantees the relative stability of climatic conditions necessary in biological evolution.

Although Einstein's general relativistic theory of gravitation forms the basis for today's cosmology, Newton's theory of gravitation is sufficient for investigations on the scale of the solar system.

1.2 Nonlinear interactions

The fundamental Newtonian equation of motion of N mass points has the form:

$$\ddot{\mathbf{r}}_i = G \sum_{\substack{j=1 \\ j \neq i}}^N M_j \frac{\mathbf{r}_j - \mathbf{r}_i}{|\mathbf{r}_j - \mathbf{r}_i|^3} \quad (1)$$

$\mathbf{r}_i, \mathbf{r}_j$ = position vectors of planets i, j with masses M_i and M_j ;

G = gravitational constant

This equation is the starting point for the derivation of the "Cosmic Fluctuations", but it is not yet in the form favorable for the present problem of the fluctuations. For this purpose, it becomes necessary to take into account first ordering points of view, which result from the structure and dynamics of the planetary system.

They are:

A) The stability of the solar system.

The present solar system is about 4.5 billion years old and consequently must have manifested itself as a quasi-stable structure during this time.

Although Newton's equations of motion (1) are nonlinearly coupled, the structure of the planetary system is preserved over longer periods of time.

The Lyapunov constant t_L , which indicates the time at which the orbital shapes of the planets are entirely different, was determined by Laskar to be $t_L \sim 5$ million years. For the outer planets from Jupiter onwards, even larger Lyapunov periods were calculated. This gives fairly tight bounds on the orbital elements of the major planets over periods of time the size of the age of the solar system.

B) Cosmic rhythms are considered over very long periods of evolution.

Therefore, above all the cosmic rhythms (frequencies), which are stable over longer periods, will be able to exert an influence. So it is not so much the absolute forces of the major planets, but rather their periodic changes that come into consideration. A stable alternating part is filtered out.

C) The planets of the solar system all move around the sun on circular orbits that are almost in one plane.

They represent natural oscillators whose couplings produce the superposition frequencies of the cosmic fluctuations.

A cosmic cycle begins with the conjunction (seen from Earth) of two planets i, j and ends after the opposition with the next conjunction.

From the ordering points of view A, B and C a model of the cosmic fluctuation can be set up.

Heliocentrically considered, circular frequencies i, j can be given for the cosmic cycles, which are relatively stable and change only little with time.

$$\omega_{i,j} = \frac{2\pi}{T_{i,j}} \quad (2)$$

$T_{i,j}$ = time duration from conjunction to conjunction of planets i, j .

Without considering the direction of the resulting planetary forces (only direction-invariant processes are investigated), one can apply for the changes of the planetary forces (in a first approximation).

$$F_{i,j} \propto f_{i,j}(t) + k_{i,j}(t) \cdot \cos(\omega_{i,j} \cdot t) \quad (3)^*$$

t = Zeit

**Relation (3) follows from the vector addition of the forces F_i and F_j .*

$$\begin{aligned} \mathbf{F}_{i,j} &= \mathbf{F}_i + \mathbf{F}_j \\ \mathbf{F}_{i,j}^2 &= \mathbf{F}_i^2 + \mathbf{F}_j^2 + 2 \cdot |\mathbf{F}_i| |\mathbf{F}_j| \cos(\alpha) \end{aligned}$$

The quantities $f_{i,j}(t)$ and $k_{i,j}(t)$ contain the slowly and not very regularly changing components resulting from distance changes of the planets.

From a geocentric point of view, cosmic cycles are not quite so stable, so instead of $i,j(t)$ it is easier to substitute the angle i, j at which planets i, j appear from Earth into (3).

$$F_{i,j} \propto f_{i,j}(t) + k_{i,j}(t) \cdot \cos(\alpha_{i,j}) \quad (4)$$

For the further investigations only the faster and more "regular" changing cosine part in (4) is considered for the cosmic fluctuations. For a conjunction ($i,j = 0^\circ$) $F_{i,j}$ is maximal and for the opposition ($i,j = 180^\circ$) minimal.

The weak gravitational field changes, in particular their cosine component, can be considered as a kind of excitation field strength on matter.

$$F_{i,j} = f_{i,j}(t) + k_{i,j}(t) \cdot \cos(\alpha_{i,j}) \quad (5)$$

The quantities $f_{i,j}(t)$ and $k_{i,j}(t)$ are set approximately constant since they change weakly and less regularly with time.

$$F_{i,j} = f_0 + k_0 \cdot \cos(\alpha_{i,j}) \quad (6)$$

The interactions of these "waves" (6) with matter and its different structures will be non-linear. It must be noted that these are not the gravitational waves derived from a linearization of Einstein's General Relativity. In analogy to other nonlinear interactions with matter (e.g. nonlinear optics), with

$$\gamma_1 = \frac{k_1}{k_0}; \gamma_2 = \left(\frac{k_2}{k_0} \right)^2; \dots \quad (7)$$

a general correlation function $H_{i,j}$ for the influence of two planets i, j can be established.

$$H_{i,j}(\alpha) = \gamma_1 F_{i,j} + \gamma_2 F_{i,j}^2 + \gamma_3 F_{i,j}^3 + \dots \quad (8)$$

Better suited is the transformation of (8) into a Fourier series.

$$H_{i,j}(\alpha) = a_0 + a_1 \cos(\alpha) + a_2 \cos(2\alpha) + a_3 \cos(3\alpha) + \dots \quad (9)$$

with $\alpha = \alpha_{i,j}$

The form (9) of the correlation function shows the emergence of "higher harmonics" in the interaction of cosmic fluctuations with matter.

1.3 The correlation function

The problem of the correlation function is the determination of the coefficients a_k in (9) and the definition of the meaning of H .

It is not intended to measure a force or a "deflection" with H . This would certainly cause insurmountable difficulties experimentally.

This would certainly cause insurmountable difficulties experimentally, if one wanted to determine the influence of the fluctuations on test specimens with rotating lead balls (approximately according to Table 1). Moreover, evolution, which has extended over millions of years, is unlikely to be simulated experimentally.

Since the fluctuations of the planetary gravitational field are very weak in their effect, only the following areas come into question for correlations:

- a) spatial structure-forming processes that are not or only very slightly determined by other effects.
- b) Formation of not fully determined biological patterns.
- c) Critical states in high-dimensional dissipative systems.
- d) Highly complex systems, far from thermal equilibrium and on the edge of chaos.

The coefficients a_k will thus be determined from the study of interactions with regions a) to d).

It is obvious to construct a correlation function H interacting with stable (harmonic) and unstable (disharmonic) states in regions a) to d).

Determining the coefficients a_k from statistical studies of unstable or chaotic processes, where small perturbations can have an effect, is very costly. Therefore, it seems reasonable to first obtain an approximation for the coefficients a_k from theoretical considerations, which can then be adjusted by optimization procedures if necessary.

Since we are dealing with cosmic cycles from conjunction to conjunction, one can take structural considerations about these oscillations as a starting point. If one takes the circle division as a basis (Fig 1), then the following structural points can be found:

Fig 1. structures of the circle division. The starting point is the conjunction, followed by the opposition, and so on.

1 point: "starting point" (conjunction)

2 points: polar structure; opposites that need balancing. Due to their tension and, if necessary, the impossibility of balancing them, they can nevertheless form a unity over a longer period of time.

Score: strongly disharmonic

3 points: very stable structure; especially in engineering it is a prerequisite for stability in mechanical constructions.

Score: very harmonious

4 points: unstable, dynamic structure; in engineering, this structure is often the basis for lever gears.

Score: disharmonious

5 points: quasi-stable pentagram - structure; borderline between stability and instability.

Complicated patterns and structures can be formed that do not repeat.

Score: indifferent

6 points: Honeycomb - structure; close to the circle, relatively stable structure in the compound with good use of space.

Rating: harmonious

The addition of further points is possible, but the changes in the qualities become smaller as the structure becomes more similar to the circle. These qualitative statements are quantified step by step and plotted in a diagram (Fig. 2).

Fig. 2. quantification of the circular pitch subdivided according to structural aspects. A symmetrical oscillation and decay process is assumed. The image is the basis for a Fourier transform for the 1st approximation of the coefficients a_k .

Since this is a periodic cycle, a Fourier transform can be performed.

The coefficients obtained are the first Fibonacci numbers (alternately mirrored, see 11.). The correlation function takes the following form:

$$H_{i,j} = \sum_{s=1}^{N \cdot 12 - 1} a_k \cos(s \cdot \alpha); \text{ with } (k = s \bmod 12) \quad (10)$$

$$a_k = (0, 1, -2, 3, -5, 0, -5, 3, -2, 1) \quad (11)$$

(Calculation of the planetary positions according to J. Meeus [3])

The first-order correlation function is shown in Fig 1, which is a first approximation for the study of the influence of cosmic fluctuations on the stable and unstable states of complex systems.

Fig 1. 1st order correlation function $H_{i,j}$ according to equation (10) with $N=1$.

Consideration of higher orders may need to be made dependent on the problem under investigation. In general, it can be said that the higher orders will be more suitable for resonance and triggering.

Fig 2. 7th order correlation function $H_{i,j}$ according to equation (10) with $N=7$. The higher orders of the correlation function are suitable for resonance problems.

It must be said at this point that the hypothesis: "Stable and unstable processes of complex systems are reflected in the structures of the circle division" seems daring at first. Only practical investigations can bring confirmation that these assumptions are sufficient for a first approximation. For this purpose, it must be ensured that the correlation function (10) is not only suitable for describing one process, but also provides useful results for different processes and states. Expected values, at least in the tendency, must occur and no negative correlations may occur, in that, for example, the correlation function (10) indicates a higher probability for stability, but in reality there is a higher probability for an unstable state.

Complex nonlinear processes are widespread in nature and society. High-dimensional complex systems are the rule. Far from thermodynamic equilibrium, these processes exhibit diverse spatiotemporal behavior.

The fluctuations of the planetary gravitational field are, in absolute terms, certainly very weak. However, they act on a very large scale and on all material structures of the Earth. Crucial for the proof of the influence of these fluctuations is the emergence of the "higher harmonics" in the complex structures of matter.

It is to be expected that the lower frequencies (1st order of correlation) will have a triggering or structuring effect on large-scale structures, the higher frequencies on small-scale areas.

2 Earthquakes

2.1 An initial study of 41 of the strongest earthquakes

Are earthquakes triggered by the planetary gravitational field?

(For data see [2] The 41 strongest earthquakes)

This is particularly interesting because when strong earthquakes occur in densely populated areas of the earth, there is usually a lot of damage to buildings and, above all, many lives are lost.

Prior to an earthquake, stresses build up in the earth's crust, which then reach a critical state after a certain time. Generally starting with foreshocks, these tensions discharge in an earthquake, whereby a prediction of the strength of the earthquake is not possible.

The investigations on the influence of planetary fluctuations on the triggering of earthquakes are based on the hypothesis that the reaching of a critical state of the stresses in the earth's crust happens within a certain time window. For this extremely unstable state, large-scale excitation field strengths of certain frequencies of the planetary fluctuations can then lead to the triggering of the earthquake and thus the relaxation of the earth's crust.

According to this hypothesis, the following results are expected:

Only relatively stable excitation frequencies that are decoupled from the Sun will show correlations. Mercury and Venus always appear close to the Sun from Earth, they are not decoupled and are dominated by the Sun. Similarly, Mars' correlations are decoupled from the Sun, but because of the relatively large changes in distance from Earth, its excitation frequencies cannot be said to be stable. (Mars would first have to be removed from the statistical studies and examined separately).

The correlation function (10) will take a negative value (instability) in the coherent superposition of all relevant planets, which is significantly far from the general expected value.

Taking into account the foreshocks, the mean value of the first derivative will be positive. This means that the correlation function will be even more negative on average before the actual earthquake.

Only the frequencies of the fluctuations will show a correlation, which also gravitationally develop the largest forces. Pluto (and the planetoids) will therefore hardly show any correlation

Can these expectations be confirmed?

These are the "strongest earthquakes" of the last century and the quakes with the highest loss of life, a total of 41 events [2] being studied.

To evaluate the influence of planetary fluctuations on "earthquake" events, the following calculations were performed:

1.

- a) Superposition of the correlation function $H_{i,j}$ (harmonic function)
- b) Superposition of the absolute amounts / $H_{i,j}$ / ("energy" function)
- c) Superposition of the 1st derivative according to the correlation function $D_{i,j}$ (time dynamics)
- d) Superposition of the absolute values of the 1st derivative according to the correlation function / $D_{i,j}$ / (time dynamics absolute)
- a) to d) Superposition of all 41 earthquake events related to sun, moon and selected planets.

2.

100 000 events were correlated over the period from 1900 to the end of 2000. The events are equally distributed over the period. The superposition, normalized to a group strength (here the 41 earthquakes), gives the statistically expected mean values.

Fig 4. 1st order density function $H_{i,j}$ according to equation (10) with $N=1$. Sun, Moon, Jupiter, Uranus and Neptune were correlated. The significance is very high 0.03% (99.97 % of the 10 000 control groups are more harmonic).

The expected values of the correlation Uranus - Neptune are caused by the large oscillation period (approx. $T_1 = 172$ years in the fundamental frequency) of this correlation. According to equation (10), the following shorter periods still occur for this correlation : $T_2 = 86$ years, $T_3 = 57$ years, $T_4 = 43$ years, $T_6 = 29$ years, $T_8 = 22$ years, $T_9 = 19$ years, $T_{10} = 17$ years and $T_{11} = 16$ years (all values rounded). The two planets had an opposition in the last century in 1906/1908, a trine in 1935/1937, a square in 1949/1951, a sextile in 1963/1965 and a conjunction in 1992/1994. In the

last century the negative parts of the function $H_{8,9}$ predominate.

It was not the aim of this first investigation to derive concrete probabilities for the triggering of earthquakes. First of all, it is important to prove the effectiveness of planetary fluctuations of the gravitational field on highly complex processes on Earth, as represented by earthquake dynamics. This has been confirmed with the above investigations with an error probability of less than 1%. On the other hand, the correlation function derived from structural considerations of stability and instability is to be tested for its ability to describe the probability of stability and instability of complex processes and structure formation processes. It was therefore logical to apply this function also and perhaps primarily to a process which makes an influence of gravitational fluctuations on complex physical systems seem plausible from the outset.

Two investigations are still connected here.

1. Are the higher orders (harmonics) better at indicating triggering of earthquakes?
2. Is the period before and after the earthquake more meaningful?
3. Which frequencies could be relevant for triggering?

The following table shows the probabilities for orders 1 to 12 of the correlation function for Sun, Moon, Jupiter, Saturn, Uranus, Neptune.

Order/Probability	1	2	3	4	5	6	7	9	12
Correlation	99.15	77.29	85.26	95.82	94.59	87.11	45.78	34.87	36.59
Energy	45.32	98.06	85.80	98.40	95.03	98.84	96.99	96.99	98.14
Dynamic	90.49	23.32	64.51	43.03	51.67	62.31	88.69	53.53	32.19
Dynamic absolut	44.68	43.78	36.78	83.49	52.92	95.56	81.71	82.81	80.01

Table 1 probabilities in % for the correlation function and its 1st derivative. The significant values are drawn in blue. The correlation function shows relatively high values up to the 6th order. From the 2nd order on, the energy becomes significant (with the exception of the 3rd order).

Order 1 time-shift/ Probability	-5d	-3d	-2d	-1d	-6h	0	+6h	+1d	+2d	+3d	+5d
Correlation	74.90	96.95	87.26	97.84	99.18	99.15	99.32	93.35	91.22	95.66	63.02
Energy	67.46	87.18	86.37	56.45	46.27	45.32	50.21	59.80	64.61	30.93	23.89
Dynamic	30.35	73.59	31.18	76.54	90.42	90.49	93.60	65.70	49.11	94.54	64.58
Dynamic absolut	78.70	66.45	80.57	57.62	53.92	44.68	36.46	55.88	64.52	71.83	88.74

Table 2 time shift to 5 days before and after the event for the 1st order.

Fig 5 graphical representation to table 2 for the correlation. The compensation curve indicates the maximum significance for 8 hours before the event. However, this is not certain and would need further verification.

Order 7 time-shift/ Probability	-5d	-3d	-2d	-1d	-6h	0	+6h	+1d	+2d	+3d	+5d
Correlation	66.42	77.35	52.19	26.07	67.48	45.78	50.14	33.28	25.50	79.75	17.83
Energy	97.87	94.69	72.97	95.27	88.58	96.99	97.97	96.46	98.30	63.50	69.23
Dynamic	44.61	45.91	33.62	46.74	10.58	88.69	64.40	17.84	42.15	40.13	98.96
Dynamic absolut	90.39	87.67	74.76	54.04	81.56	81.71	78.54	92.18	62.45	45.11	21.25

Table 3. time shift to 5 days before and after the event for the 7th order.

The energy is relatively low for the entire period. A trend cannot be identified with certainty. While the 1st order correlates more strongly with the quality of time (stability-instability), the triggering effect of the higher frequencies of the 7th order is remarkable for the energy.

Generally, it is expected that the energy for triggering could be high. Moreover, the high frequencies of the Sun and Moon should be particularly suitable. The correlation function for the 12th order does not indicate this.

The low energy for the Order of the correlation **98.14%** (*of the 10 000 control groups have a higher energy*) at the time of the earthquake seems strange. It is reasonable to assume that before the time of the event the energy is higher.

An investigation can confirm this assumption for the sun and moon:

Order 12 time-shift/ Probability So-Mo	-24h	-11h	-10h	-9h	-8h	-7h	-6h	-5h	-3h	0	+3h	+6h	+9h	+12h	+18h	+24h
Correlation	17.18	95.33	97.84	95.08	81.22	61.59	63.91	70.05	27.52	89.45	66.08	59.67	69.49	99.09	35.91	83.90
Energy	57.78	15.71	13.17	18.17	4.51	0.95	3.10	30.73	73.21	60.87	67.15	96.44	36.68	11.08	68.76	66.61
Dynamic	85.55	85.62	44.46	11.44	11.90	37.09	62.17	45.59	23.15	86.90	25.11	17.90	98.92	8.47	41.71	88.09
Dynamic absolute	69.35	43.28	21.45	1.80	2.80	53.10	19.60	5.58	78.23	54.10	44.15	61.82	29.24	60.94	73.11	74.05

Table 4. time shift for correlation of sun and moon.

Accordingly, 10 hours before an earthquake, the correlation is very discordant, with simultaneous increases in energy first in the dynamics and then in the correlation function.

Are these random oscillations? Can this be generalized? Does this only apply to these very large earthquakes?

2.2 A study of 588 earthquakes

For data see [7]

The study of the strongest earthquakes of a century has shown that a correlation with the harmonics of the planetary gravitational field can be demonstrated. This could be proven with an error probability of less than one percent.

Nevertheless, it cannot be ruled out that it is an artifact. Therefore, further groups of earthquakes in smaller time periods were examined. The addition in magnitude of smaller earthquakes could cause a stronger noise, so that no significant correlations are detectable.

The following investigations refer to earthquakes in the years 1996 to 2002, in total earthquakes with a magnitude of $m = 6.5$ and greater or which caused severe damage.

The following questions were examined:

Which order of correlation best describes a possible triggering of the earthquakes.

Are there special frequencies that are suitable for triggering?

The results are shown in the following table:

Order /Probability 1996-2003 Periode	1	3	4	5	7	9	12	12 1900-2100 Periode
Correlation Harmonic ; all planets just sun and moon all planets with gravity*	31.47 78.63 73.47	79.43 27.33 30.53	85.8 28.87 12.77	65.1 35.33 15.03	62.13 74.90 34.10	58.87 61.33 44.97	60.40 63.80 41.23	62.37
Energy ; all planets just sun and moon all planets with gravity*	19.10 4.73 21.83	55.93 3.07 18.57	41.9 1.23 12.67	39.43 1.03 11.27	35.90 0.97 8.07	19.50 0.33 2.97	27.41 0.17 1.47	0.20
Dynamic ; all planets just sun and moon all planets with gravity*	93.27 99.27 92.07	38.7 79.67 40.27	34.23 69.73 24.57	46.37 77.73 83.30	16.6 23.13 75.37	37.0 53.13 57.37	12.52 62.53 97.80	61.99
Dynamic absolut ; all planets just sun and moon all planets with gravity*	30.7 72.10 59.47	21.13 27.47 63.33	56.7 27.53 64.07	51.0 24.03 61.90	54.97 15.60 62.17	82.47 21.73 69.27	31.40 2.00 38.69	1.97

Table 5. 588 Earthquakes unsorted; (*Earthquakes of magnitude 6.5 or greater or ones that caused fatalities, injuries or substantial damage. BRK--Berkeley. PAS--Pasadena.*) ; Time period 1996 to 2003. Significance is marked in red and blue.

* Weighting of the planets, oriented to the effect of gravity	sun	weight: 57.20
	moon	weight: 10.24
	mercury	weight: 0.31
	venus	weight: 0.77
	mars	weight: 0.30
	jupiter	weight: 1.87
	saturn	weight: 0.84
	uranus	weight: 0.28
	neptun	weight: 0.22
	pluto	weight: 0.01
	IC	weight: 57.20

For this list of earthquakes only the energy of sun and moon is significant and highly significant. This is also true for a larger time period (1900 to 2100) of the comparative calculations according to the Monte Carlo simulation.

The 4th order shows for the matrix of correlation (harmony and disharmony) the largest values for disharmony. With 85% the control groups are more harmonious than the earthquake group. A look at the matrix shows that strongly differentiated behavior of the individual correlations: strongly disharmonious are Sun-Venus, Moon-Mars, Venus-Saturn, Saturn-Uranus, Moon-Neptune, Venus-Pluto, Mars-Pluto, Venus-IC (Imum Coeli, represents the center of the Earth), Saturn-IC.

Looking at the row sums of the correlation matrix, Venus and the IC are significantly disharmonic. There does not seem to be an explanation for this based on the effect of gravity.

Statistics 4: Probability of events: correlation matrix H

Order of the correlation: 4 ; time shift d: 0 h: 0;

GROUP-MEMBERS: 588 ; NUMBER OF THE GROUPS: 3000

Julian-date-start: 2450083.458333 Julian-date-end: 2452640.458345

Accidental selection; TEST: Number of accidental selection >= correlation

CORRELATION-MATRIX H AS INPUT

	1	2	3	4	5	6	7	8	9	10	11
1	*	0.04	-0.10	-0.06	0.06	-0.08	0.01	0.07	-0.00	0.00	0.09
2	0.04	*	0.04	0.02	-0.13	-0.02	-0.04	0.02	-0.12	0.08	-0.02
3	-0.10	0.04	*	0.11	-0.05	-0.06	-0.05	0.05	0.10	0.15	-0.08
4	-0.06	0.02	0.11	*	0.06	-0.04	-0.09	0.02	-0.06	-0.08	-0.15
5	0.06	-0.13	-0.05	0.06	*	-0.09	-0.17	0.21	0.12	-0.05	-0.08
6	-0.08	-0.02	-0.06	-0.04	-0.09	*	0.03	0.05	-0.02	0.09	0.04
7	0.01	-0.04	-0.05	-0.09	-0.17	0.03	*	0.10	0.32	-0.15	-0.14
8	0.07	0.02	0.05	0.02	0.21	0.05	0.10	*	-0.00	0.56	0.02
9	-0.00	-0.12	0.10	-0.06	0.12	-0.02	0.32	-0.00	*	-0.18	-0.04
10	0.00	0.08	0.15	-0.08	-0.05	0.09	-0.15	0.56	-0.18	*	-0.08
11	0.09	-0.02	-0.08	-0.15	-0.08	0.04	-0.14	0.02	-0.04	-0.08	*

Matrix H of the probability of error:

	1	2	3	4	5	6	7	8	9	10	11
1	*	29.47	67.13	100.00	25.33	93.60	48.90	17.10	50.40	50.23	10.10 PR 39.53
2	29.47	*	32.37	41.20	96.83	57.60	68.43	36.63	95.10	13.40	61.10 PR 70.90
3	67.13	32.37	*	46.40	82.60	62.93	75.17	61.37	33.97	12.40	86.30 PR 64.80
4	100.00	41.20	46.40	*	50.03	88.90	94.67	42.63	62.50	98.40	97.97 PR 99.90
5	25.33	96.83	82.60	50.03	*	25.03	19.87	33.27	7.57	96.63	86.27 PR 60.70
6	93.60	57.60	62.93	88.90	25.03	*	93.27	17.10	13.70	6.83	29.73 PR 35.00
7	48.90	68.43	75.17	94.67	19.87	93.27	*	95.87	5.13	28.30	97.83 PR 81.03
8	17.10	36.63	61.37	42.63	33.27	17.10	95.87	*	90.63	47.80	44.87 PR 43.47
9	50.40	95.10	33.97	62.50	7.57	13.70	5.13	90.63	*	70.57	71.23 PR 21.47
10	50.23	13.40	12.40	98.40	96.63	6.83	28.30	47.80	70.57	*	84.97 PR 49.67
11	10.10	61.10	86.30	97.97	86.27	29.73	97.83	44.87	71.23	84.97	*

bigger are: 85.80 %

1=SUN; 2=MOON; 3=MERKUR; 4=VENUS; 5=MARS; 6=JUPITER; 7=SATURN; 8=URANUS; 9=NEPTUN; 10=PLUTO; 11=IC;

BEGIN: year: 1996 month: 1 day: 1 hour: 0 END: year: 2003 month: 1 day: 1 hour: 0

9 out of 55 elements of the matrix are significant at $\leq 5\%$ $p \leq 0.05$ Probability of error: 0.0015
2 of 11 elements are significant with $p \leq 2\%$ $p = 0.025$ Probability of error: 0.0296

It can be seen from Table 5 that the energy is significant over all orders for the Sun and Moon and even highly significant from order 7 on wards. The density function for the energy can be seen in Fig 6.

Fig 6. density function for the 12th order energy of the Sun and Moon for 588 earthquakes.

This result suggests that for this group of earthquakes the energy could be a trigger. 588 earthquakes distributed over 7 years corresponds to an average of 7 earthquakes per month. It is understandable that in such short periods the major planets show only small changes in their correlation function. The sun and moon are better for that.

To illustrate this, December 2000 is examined in more detail here. During this period 8 earthquakes took place.

Number in list	Magnitude	Länge	Breite	Datum	Zeit
495	7.0	54.48	39.34	06.12.2000	17:11:06
401	6.4	152.43	-4.13	06.12.2000	22:11:06
374	6.1	-82.41	6.90	12.12.2000	05:26:46
174	5.9	31.21	38.27	15.12.2000	16:44:48
532	6.5	-179.74	-21.11	18.12.2000	01:19:22
253	6.2	-74.40	-39.48	20.12.2000	11:23:54
105	6.5	154.21	-9.14	20.12.2000	16:49:43
424	6.4	151.73	-5.42	21.12.2000	01:01:28

Table 6. 8 earthquakes for the period 2000-12 from the list of 588 earthquakes.

The results are shown in Table 7:

Order	1	3	6	9	12
Probability in %					
Correlation	1.17	0.15	0.37	0.27	0.34
Energy	1.02	0.03	0.05	0.01	0.03
Dynamic	37.12	82.59	36.09	0.23	0.91
Dynamic absolute	76.63	31.20	2.24	1.86	0.17

Table 7. Correlation funktion according to the Monte-Carlo-Simulation (10000 control groups, each with 8 random selected events); 8 earthquakes for the period 2000-12 from the list of 588 earthquakes.

The high significances for the high orders are remarkable.

Fig 7. 9th-order energy curve of the Sun and Moon for 8 earthquakes during 2000-12.

Can these results be used for earthquake forecasting?

Fig 8 shows the correlation function and its first derivative. Assuming an energy level, 5 out of 8 earthquakes could be related to the correlation of the Sun and Moon. The expected value is 1.5 earthquakes out of 8 if there is no influence. Accordingly, about 3 earthquakes would be due to triggering by the Sun and Moon. However, it is only one month out of a period of 84 months (1996 -2002).

If the investigations are extended to the entire period, then 96 of 588 events are above the level. The expected value for this entire period is 83 events.

According to this, only 13 events would be due to a triggering of the sun and moon, which is 2.2%. This is too low for forecasting, but it clearly shows that there is also a certain increase in probability from the many other influences that can trigger an earthquake. This probability can be increased somewhat by adding other frequencies (those of Jupiter, Saturn and the IC) and the 1st derivative of the correlation function.

Fig 8. correlation function and 9th-order first derivative of the Sun and Moon for 8 earthquakes during 2000-12. the solid vertical black lines indicate the events.

The same research applied to the first study of 41 earthquakes gives similar results. Of the 41 earthquakes, 8 are above the level for energy, the expected value is 5.9 earthquakes. There could be 2 of the 41 earthquakes triggered by the sun and moon.

These initial investigations are only intended to show that further investigations appear to be useful. As can be seen in Fig. 8, in such a small period of time only high frequencies, as they are given by the sun and the moon, are suitable for a possible triggering of earthquakes. At the time of the full moon no earthquake took place. However about 24 hours later. Further investigations would have to show whether this is significant. Figure 9 shows the correlation function for the 1st order for comparison. It does not seem to be suitable for triggering.

Fig 9. correlation function (harmonic) for 1st order Sun and Moon for 8 earthquakes during 2000-12.

Do the 588 earthquakes show similar behavior to the group of 41?

Very many smaller earthquakes are certainly not to be compared with few, very large ones. There are also no groups formed according to depth or location!

Order 12 time-shift/ Probability So-Mo	-24h	-11h	-10h	-9h	-8h	-7h	-6h	-5h	-3h	0	+3h	+6h	+9h	+12h	+18h	+24h
Correlation	53.60	94.54	84.98	33.52	4.72	4.42	22.16	48.72	35.86	63.20	53.42	17.44	98.88	90.28	99.78	19.30
Energy	71.26	98.96	96.12	92.14	96.20	89.80	67.06	27.30	61.00	0.30	6.90	10.78	2.34	6.46	26.42	81.86
Dynamic	30.26	43.22	6.66	1.26	15.34	80.86	93.16	70.38	35.80	62.86	23.28	91.20	33.70	65.64	83.86	19.14
Dynamic absolute	79.70	65.24	90.64	98.06	85.74	67.26	58.32	77.82	25.20	2.38	0.30	1.50	0.24	0.20	0.36	53.88

Table 8. time shift for 588 earthquakes

In Table 8, we can at least see that at the time of the event, the energy in the correlation function was very high, as was the energy in the dynamics.

A low energy (-11h) is driven to a high energy by a high dynamic (1st derivative), likewise the energy of the dynamic increases until the event. Can this scenario also be stated for the much larger period from 1900 to 2100. The results are shown in Table 9.

Order 12 time-shift/ Probability So-Mo	-6h	-3h	-2h	-1h	0	+1h	+2h	+3h	+6h
Correlation	20.28	34.63	35.40	51.18	64.58	66.40	61.74	54.10	16.32
Energy	67.96	63.24	67.66	29.32	0.22	0.00	0.86	7.16	10.78
Dynamic	93.08	34.72	63.38	74.16	63.88	51.18	39.88	21.78	91.14
Dynamic absolute	58.10	25.08	15.32	1.78	1.96	32.78	0.06	0.30	1.86

Table 9. time displacement for 588 earthquakes during the period 1900 to 2100.

Despite the much larger time period, the characteristic remains. That is amazing.

If we add the Earth's rotation as another high frequency, we get the results in Table 10.

Order 10 time-shift/ Probability So-Mo-IC	-6h	-5h	-4h	-3h	-2h	-1h	0	+1h	+2h	+3h	+4h	+5h	+6h
Correlation	66.72	36.08	64.64	41.16	32.96	25.90	38.98	69.78	61.64	66.18	9.12	7.36	61.38
Energy	92.06	35.04	64.60	56.82	81.02	30.72	0.10	1.75	19.46	3.24	4.90	80.32	5.70
Dynamic	85.62	95.04	92.36	32.72	6.36	84.56	74.78	84.66	42.46	1.84	4.22	60.60	79.40
Dynamic absolute	65.26	41.40	63.12	48.20	6.98	1.92	60.54	27.70	2.38	17.02	2.92	66.82	4.46

Table 10. time offsets for 588 earthquakes in the period 1996 to 2002. they are the correlations of the Sun, Moon and IC (Earth's rotation).

The expected value for high energy is 203 earthquakes. 222 have a higher energy in the correlation function. According to this, 19 earthquakes could be triggered by the sun, moon, and IC, which is 3.23 percent. That's a 1% increase. The IC, as expected, brings an increase in the probability of triggering because the local energy maxima indicated by the IC with the Sun and Moon occur at different times than those of the Sun and Moon.

Certainly the major planets Jupiter and Saturn (lower frequencies) in interaction with the high frequency of the earth's rotation are also of influence.

This is shown in Table 11:

Order 10 time-shift/ Probability Ju-Sa-IC	-6h	-5h	-4h	-3h	-2h	-1h	0	+1h	+2h	+3h	+4h	+5h	+6h
Correlation	55.02	7.54	26.24	71.50	64.88	56.24	61.08	69.78	3.16	88.48	55.96	69.50	62.68
Energy	20.76	65.46	83.54	72.32	58.30	43.56	0.58	1.75	0.02	10.30	23.62	84.92	28.32
Dynamic	41.70	26.12	98.00	41.92	78.18	25.58	89.82	84.66	95.94	57.84	83.06	47.34	91.90
Dynamic absolute	36.00	75.98	84.02	72.58	26.74	14.56	14.58	27.70	1.38	19.46	34.08	63.14	14.44

Table 11. time offsets for 588 earthquakes in the period 1996 to 2002. they are the correlations of Jupiter, Saturn and IC (Earth rotation).

The energy peaks between the IC and the planets Jupiter and Saturn are at different points on the time axis than those from the IC with the Sun and Moon. The expected value is 159 earthquakes. 176 earthquakes show higher energy, which is 2.9% above the expected value.

3 Summary

According to the calculations, it seems possible that about 6% of the 588 earthquakes are triggered by the Sun, Moon, IC, Jupiter and Saturn. This figure of 6% can certainly be increased if the energy level is optimized and other elements of the correlation function are added. For further investigation, it can be hypothesized that a trigger or threshold energy exists that is constantly decreasing. Before this threshold energy becomes zero, small external disturbances (e.g., weather events) may be triggering. But this can also be the fluctuations of the planetary gravitational field in the higher frequencies. Earthquakes occur at all times. When the threshold energy drops, they can also be triggered by harmonics of the gravitational field. This seems to be a characteristic of highly complex, nonlinear systems, that small external energies can trigger large changes.

Fig 10. model of the triggering of earthquakes.

Our planetary system is highly complex. The nonlinear dynamics of this system also has an influence on the triggering of earthquakes. This now seems to be a fact and opens the door for further investigations. *From [6]*

4. bibliography and references

[1] *NATURE* | NEWS - Alexandra Witze; 12 September 2016

Moon's pull can trigger big earthquakes - Geologic strain of tides during full and new moons could increase magnitude of tremors.

[2] Keilis-Borok, V., Soloviev, A.: Nonlinear Dynamics of the Lithosphere and Earthquake Prediction, Springer Verlag, Berlin, 2003. ISBN: 978-3-662-05298-3

[3] Jean Meeus "Astronomische Algorithmen; publisher Johann Ambrosius Barth; 1992-01-01; ISBN-13 978-3335003182

[4]

NAME,C,200	ORT,C,200	LAENGE,BREITE,ZEIT,DATUM,C,20	ZEIT,C,20	SOMMERZEIT,C,20
China Tangshan	Peking	116.25 39.55 8	28.7.1976	03:42:00 0
Japan Yokohama	Yokohama	141.15 41.4 10	1.9.1923	11:58:00 0
China Gansu	Peking	116.25 39.55 8	16.12.1920	20:06:53 0
Peru Norden	Lima	-77.3 -12.3 -5	31.5.1970	11:23:00 0
Iran Nordwesten	Teheran	51.26 35.4 3	21.6.1990	00:30:00 0
Tuerkei Osten	Ankara	32.52 39.56 2	27.12.1939	01:57:00 0
Chile Chillan	Santiago	-70.4 -33.27 -5	24.1.1939	23:32:00 0
Iran Nordosten	Teheran	56.55 33.35 3	16.9.1978	19:38:00 0
Armenien Nordwesten	Jerewan	44.30 40.11 4	7.12.1988	11:41:00 0
Guatemala Guatemala	Guatemala City	90.77 14.6 -6	4.2.1976	03:02:00 0
Indien SW	Bombay	72.5 18.58 5	30.9.1993	03:56:00 0
Chile Valparaiso	Santiago	-70.4 -33.27 -5	16.8.1906	19:55:00 0
Mexico Mexico	Mexiko City	-99.9 19.24 -6	19.9.1985	07:18:00 0
Japan Kobe	Tokyo	139.46 35.42 9	17.1.1995	05:46:00 0
Afghanistan NO	Kabul	70.0 35.0 4	4.2.1998	10:33:00 0
Tuerkei XY	Ankara	32.52 39.56 2	17.8.1999	03:02:00 0
L1-1 Nordjapan	Nordjapan	148.50 44.30 9	6.11.1958	22:58:00 0
L1-2 Kurilen	Kurilen	161.0 53.0 10	3.2.1923	16:01:00 0
L1-3 Mitteljapan	Mitteljapan	144.50 39.20 9	2.3.1933	17:30:00 0
L1-5 Mongolei	Mongolei	98.0 49.0 6	23.7.1905	2:46:00 0
L1-4 Mongolei	Mongolei	99.0 49.0 6	9.7.1905	9:40:00 0
L1-6 Molukken	Molukken	130.50 -5.20 9	1.2.1938	19:04:00 0
L1-7 Chile	Chile	-70.0 -28.50 -4	11.11.1920	4:32:00 0
L1-8 Kurilen	Kurilen	149.50 44.80 10	13.10.1963	5:17:00 0
L1-9 Nordindien	Nordindien	96.50 28.60 6	15.8.1950	14:09:00 0
L1-10 Aleuten	Aleuten	178.60 51.30 13	4.2.1965	5:01:00 0
L1-11 Kolumbien	Kolumbien	-81.50 1.0 -5	31.1.1906	15:36:00 0
L1-12 Nordkurilen	Nordkurilen	161.0 52.30 12	4.11.1952	16:58:00 0
L1-13 Aleuten	Aleuten	-175.80 51.30 -11	9.3.1957	14:22:00 0
L1-14 Alaska	Alaska	-147.60 61.10 -10	28.3.1964	3:36:00 0
L1-15 Chile	Chile	-74.50 -39.50 -4	22.5.1960	19:11:00 0
L2-1 China	China	77.0 40.0 8	22.8.1902	3:00:00 0
L2-2 Japan	Japan	143.0 42.50 9	4.3.1952	6:03:00 0
L2-3 Ecuador	Ecuador	-76.80 -8.0 -5	16.11.1907	10:10:00 0
L2-4 Marianen	Arianen	143.0 22.0 10	24.11.1914	11:53:00 0
L2-5 Samoa	Samoa	-173.0 -15.50 -10	26.6.1917	5:49:00 0
L2-6 Nicobaren	Nicobaren	92.50 12.50 5	26.6.1941	11:52:00 0
L2-7 S	S	131.0 28.0 10	15.6.1911	12:00:00 0
L2-8 S	S	-158.0 55.50 -10	10.11.1938	20:18:00 0
L2-9 Westchina	westchina	77.50 43.50 8	3.1.1911	23:25:00 0
L2-10 Nordneuseeland	Nordneuseeland	-176.40 -28.10 -12	20.10.1986	6:46:00 0

[5] Tidal Phenomena (Lecture Notes in Earth Sciences) (Lecture Notes in Earth Sciences, 66, Volume 66; Paperback – Illustrated; 25. Juni 1997 : Springer; 1. Edition (25. Juni 1997)

Helmut Wilhelm (editor), [Hans-Georg Wenzel](#) (editor) ISBN-13: 978-3540628330

[6] Nitsche, M. E., 2001: THE NON-LINEAR INTERACTION OF THE PLANETARY GRAVITATIONAL FIELD ON EARTHQUAKES; Lecture on the International Association for Mathematical Geology; IAMG 2003 Portsmouth, UK ; September 7-12, 2003.
<http://www.planetare-korrelation.eu/lectures.htm>

[7] "Earthquakes of magnitude 6.5 or greater or those that caused fatalities, injuries or substantial damage."

Compiled by Waverly J. Person

SGS National Earthquake Information Center

<http://www.usgs.gov/>

<http://neic.usgs.gov/neis/eqlists/significant.html>