Empirical support for the Expanding Earth Model and TGD view about classical gauge fields

November 22, 2021

Matti Pitkänen

Email: matpitka6@gmail.com.
http://tgdtheory.com/public_html/.
Recent postal address: Rinnekatu 2-4 A 8, 03620, Karkkila, Finland.

Abstract

In this article I will discuss some empirical facts providing further support for the Expanding Earth Model (EEM) and TGD view about classical fields.

The first strange finding is the large fluctuations of oxygen levels during the Cambrian Explosion. The general form of EEM applies to all astrophysical objects and could explain the strange lack of craters and volcanic activity in Venus suggesting a global resurfacing for 750 million years ago.

Contrary to expectations, the magnetic field of Venus vanishes. The TGD based view about gauge fields differs from the standard view in that it allows the notion of monopole flux. The monopole part field would be analogous to the external magnetic field H inducing magnetization M as the non-monopole part of B. Venus would be a perfect diamagnet and even a superconductor whereas Earth would be a paramagnet. In the TGD framework, superconductivity driven by the thermal energy feed from the interior of Venus would be possible. The interior of Venus could be a living system but in a very different sense than Earth.

Contents

1 Introduction

In this article I will discuss some empirical facts providing further support for the Expanding Earth Model (EEM) and TGD view about classical fields.

1.1 Findings supporting the Expanding Earth Model

There are two findings that provide further support for EEM and its generalization.

1. The Great Oxidation event that culminated during the Cambrian Explosion involved strong fluctuations of the oxidation level manifesting itself as extinctions and emergence of new species [I2]. The expansion of Earth would have involved breakages of the crust bringing oxygen rich water from the Earth interior containing multicellulars to the surface and the dilution of this oxygen rich water would have led to the extinction.

2. The fact that the surface of Venus involves very few craters and the volcanic activity is absent suggests that Venus has effectively turned itself inside out about 750 million years ago [E1, E2]. The general form of the EEM applies to all astrophysical objects: could Expanding Venus Hypothesis explain the strange absence of craters and volcanic activity in Venus?

1.2 Why does the magnetic field of Venus vanish?

The TGD based view about gauge fields differs from the standard view in that it allows the notion of monopole fluxes requiring non-trivial space-time topology. The monopole part field would be analogous to the external magnetic field H inducing magnetization M as the non-monopole part of B. Venus would be a perfect diamagnet and even a superconductor whereas Earth would be a paramagnet. In the TGD framework, superconductivity driven by the thermal energy feed from the interior of Venus would be possible.

It has been known for a long time that Venus has a very weak magnetic field although the dynamo model would suggest its presence. TGD based model for the maintenance of magnetic field assumes that the monopole part of field, which requires no currents to maintain it, is analogous to the external magnetic field H, which induces magnetization M ($B = H + M$) suggests that Venus is diamagnetic ($B = 0$) Earth would be paramagnetic.

Superconductors are ideal diamagnets: could Venus be a superconductor? This is possible in the TGD framework. The heat flow from the core of Venus would provide the "metabolic energy feed" making possible the large value of h_{eff} required by high Tc superconductivity above critical temperature [L5]. The magnetization created by supercurrents would cancel the external magnetic field: this would provide a TGD based view about the Meissner effect. The interior of Venus could be a living system but in a very different sense than Earth.

1.3 Could superionic phase of water give rise to planetary super-conductivity and Meissner effect?

A superionic ice-like phase of water at high temperature and pressure (20 GPa but much less than the expected pressure, which is higher than 50 GPa) has been discovered. Inside Earth, 20-25 GPa pressure exists in the transition zone between upper and lower mantle. The new phases, bcc and fcc cubic lattices emerge at T=2000 K. See the the popular article "*Scientists find strange black 'superionic ice' that could exist inside other planets*" (`https://www.eurekalert.org/news-releases/933099`) and the article "*Structure and properties of two superionic ice phases*" of Prakapenka et al [**?**] (`https://cutt.ly/7TPvYlL`).

The bonds between hydrogen atoms and oxygen ions are broken in this phase and ionized hydrogen atoms form a fluid, a kind of proton ocean in which the oxygen lattice floats.

In the TGD framework dark proton sequences with effective Planck constant $h_{eff} \geq h$ at monopole magnetic tubes play a key role in quantum biology. Dark DNA codons would be 3-proton triplets at monopole flux tubes parallel to DNA strands and would give rise to a fundamental realization of the genetic code.

One can wonder whether the protons of this superionic could be dark in the TGD sense and reside in monopole flux tubes. Could they form a superfluid-like or superconductor-like phase by a universal mechanism which I call Galois confinement, which requires that the total momenta of composites of dark protons with are algebraic integer valued momenta are ordinary integers in suitable units (periodic boundary conditions) [L6, L7].

It is conjectured that this kind phase could reside in the interiors of Neptune and Uranus perhaps even deep inside the Earth. Could superionic phases of water in the interior of planets like Mars and Venus give rise to the speculated super-conductivity implying the vanishing of large scale magnetic field via the TGD variant of the Meissner effect?

Could superionic ice appear in the interior of Earth? Could one consider the following scenario?

Primordial Earth had a vanishing magnetic field by the Meissner effect caused by superionic ice. Part of the superconducting superionic water melted and formed ordinary water at lower temperature and pressure and gave rise to underground oceans. Superconductivity was lost in the Earth scale but the monopole flux based magnetic field and the ordinary magnetic field induced by the currents that it generated remained but did not cancel each other anymore. In the transition increasing the radius of Earth by factor 2 during the Cambrian explosion the water in these oceans bursted to the surface of Earth.

1.3.1 Earthquakes that that should not occur

There is an interesting finding, which seems to relate to the superionic ice. It has been discovered that there are earthquakes much deeper in the interior of Earth than expected (`https://cutt.ly/VTSEe5j`). These earthquakes are in the transition zone between upper and lower mantle and (the depth range 410-620 km) even below it (750 km). The pressure range is 20-25 GPa. The temperature at the base of the transition zone is estimated to be about 1900 K (`https://cutt.ly/jTSWxbA`). This parameter range inspires the question whether superionic could emerge at the base of the transition zone and whether the appearance of hydrogen as liquid in pores could make possible the earthquakes below the transition zone just as the presence of ordinary liquid in pores is believed to make them possible above the transition zone.

In the crust above 20 km depth the rocks are cold and brittle and prone to breaking and most earthquakes occur in this region. At deeper the rocks deform under high pressures and no breaking occurs. Deeper in the crust the matter is hotter and pressure higher and breaking does not occur easily.

Around a depth of 400 km, just above the transition zone, the upper mantle of the rock consists of olivine, which is brittle. In the transition zone olivine is believed to transform to wadsleyite and at deeper depth ringwoodite. At 680 km, where the upper mantle ends, ringwoodite would transform to bridgmanite and periclase. The higher pressure phases are analogous to graphite, which deforms easily under pressure and does not break whereas olivine is analogous to diamond and is brittle.

One can understand the earthquakes down to 400 km near the upper boundary of the transition zone in terms of the model in which water in the proposed upper mantle is pushed away from the pores by pressure, which leads to breaking. Below this depth water is believed to be totally squeezed out from the pores so that mechanism does not work. The deepest reported earthquake occurs at a depth 750 km and looks mysterious. There are several proposals for its origin.

The area of Bonin island is a subduction zone and it has been proposed that the boundary between upper and lower mantle is at a larger depth than thought. The cold Earth crust could allow a lower temperature so that matter would remain brittle since the transition to high pressure forms of rock would not occur. Another proposal is that the region considered is not homogenous and different forms of rock are present. Even direct transition of olivine to ringwoodite is possible and it has been suggested that this could make the earthquakes possible.

1.3.2 Could superionic ice and earthquakes relate?

TGD allows us to consider the situation from a new perspective by bringing in the notions of magnetic flux tubes carrying dark matter. Also the zero energy ontology (ZEO) might be highly relevant. The following represents innocent and naive questions of a layman at the general level.

1. ZEO inspires the proposal that earthquakes correspond to "big" state function reductions (BSFRs) in which the arrow of time at the magnetic body of the system changes. This would explain the generation of ELF radiation before the earthquake although one would expect it after the earthquake [L4].

   The BSFRs would occur at quantum criticality and the question is what this quantum criticality corresponds to. Could the BSFR correspond to the occurrence of a phase transition in which the superionic ice becomes ordinary water? If this is the case, the transition zone, and also a region below it, would be near quantum criticality and prone to earthquakes.

2. The dark magnetic flux tubes are 1-D objects and possess Hagedorn temperature T_H as a limiting temperature. The heat capacity increases without limit as T_H is approached. Could a considerable part of thermal energy go to the flux tube degrees of freedom so that the temperature of the ordinary matter would remain lower than expected and the material could remain in a brittle olivine form.

3. Could the energy liberated in the earthquake correspond to the dark magnetic energy (for large enough value of h_{eff} assignable to gravitational magnetic flux tubes) assignable to the flux tubes rather than to the elastic energy of the rock material? Could the liberated energy be dark energy liberated as h_{eff} decreases and flux tubes suddenly shorten? Could this correspond to a phase transition in which superionic ice transforms to an ordinary phase of water?

One can also ask more concrete questions.

1. Suppose that water below the transition zone (P$\geq$ 20 GPa and T $\geq$ 1900 K) can exist in superionic ice containing hydrogen ions in liquid form. Could the high pressure force the superionic liquid out from the pores and induce the breaking?

2. In the range 350-655 km, the temperature varies in the range 1700-1900 K (`https://cutt.ly/jTSWxbA`). The temperature at the top of transition zones would be slightly above 1700 K. Could regions of superionic ice appear already at 1700 K, which is below T=2000 K?

3. Could the transition zone be at criticality against the phase transition to superionic water? This idea would conform with the proposal that the region in question is not homogenous.

2 Cambrian explosion, the Great Oxidation Event, and EEM

I encountered two interesting articles related to the Great Oxidation Event that started long before the Cambrian Explosion (CE) and reached its climax during CE (about 541 million years ago) leading to the oxygen based multicellular life in a very rapid time scale.

The standard view is that oceans before CE had very low oxygen content. The emergence of photosynthesizing cyanobacteria producing oxygen as a side product led to the oxygenation of the atmosphere and to mysteriously rapid evolution of life. How this is possible at all is not understood.

The first popular article (`https://cutt.ly/UQWZA31`) discusses the proposal [I2] that the slowing down of the spinning of Earth was somehow related to this. The idea is that the lengthening of the day made photosynthesis by cyanobacteria more effective since their reaction to the dawn of the day was slow. The second article in Quanta Magazine (`https://cutt.ly/PQWZDzD`) tells about the finding [I1] that during the Cambrian Explosion (`https://cutt.ly/1QWZF4E`) the oxygen content of the studied shallow ocean show fluctuations with with about 4-5 peaks. The reduction/increase of the oxygen content was even 40 per cent, which is a huge number. The reduction of oxygen content caused extinctions and its increase was accompanied by the emergence of new species. The mystery is how this could happen so fast and which caused the fluctuations.

2.1 Expanding Earth model very briefly

EEM is not originally TGD based but TGD provides its realization. The proposal is that the Cambrian Explosion was caused by a rapid increase of the radius of Earth by factor 2 [L3, L2, L9].

This hypothesis also solves one of the basic mysteries of cosmology. Astrophysical objects participate in cosmological expansion by comoving with it but do not expand themselves. Why? The prediction that the expansion of the astrophysical objects did not occur smoothly but as rapid phase transitions and the expansion was very slow in the intermediate states. Cambrian Explosion would correspond to one particular jerk of this kind in which the radius of Earth grew by a factor 2 (p-adic length scale hypothesis). The length of the day increased by factor 4 from conservation of angular momentum. This might relate to the conjecture of the first article.

The rapid expansion led to the breakage of the Earth crust and to the birth of plate tectonics. It also led to the burst of underground oceans to the surface of the Earth. The photosynthesizing multicellular life had developed in these oceans and emerged almost instantaneously and led to a rapid oxygenation of the atmosphere. One can say that life evolved in the womb of Mother Gaia shielded from meteorites and cosmic rays. No superfast evolution was needed. Already Charles Darwin realized that the sudden appearance of trilobites was a heavy objection against the theory of natural selection.

Possible scenarios for the phase transition are discussed in [L9]. The thickening of magnetic flux tubes for water blobs at the surface of Earth led to the increase of the volume of water blobs and induced the increase of h_{eff} a factor 2 for valence electrons but not for the inner electrons. Since valence electrons are responsible for chemistry, atoms became effectively dark and the water blobs could leak to the interior of Earth. By their darkness they could have much lower temperature and pressure than the matter around them and life could evolve.

2.2 How was photosynthesis possible underground?

What made photosynthesis possible in the underground oceans? One possible explanation is that the photons from the Sun propagated along flux tubes of the "endogenous" part of the Earth's magnetic field as dark photons with $h_{eff} = nh_0 > h$. Endogenous part would be the part of Earth's magnetic field with a strength about 2/5 of the Earth's magnetic field for which flux tubes carry monopole flux: this is possible in TGD but not in Maxwell's theory.

Since these photons behave like dark matter with respect to the ordinary matter, they were not absorbed considerably and reached the water blobs (or actually their magnetic bodies consisting of flux tubes) in underground oceans having a portion with the same value of $h_{eff} \geq h$. Of course, several values of h_{eff} were possible since this is the case in quantum critical system (large values of h_{eff} characterize the quantum scales of long range fluctuations). One can also consider other variants of the model. The ordinary matter in Earth's crust had $h_{eff} = h/2$ and photons with $h_{eff} = h$ propagated to the interior and reached the water blobs with $h_{eff} = h$.

2.3 The sudden emergence of multicellulars and oxygen fluctuations

Before the expansion period was much like the surface of Mars now and contained no oceans, perhaps some ponds allowing primitive monocellular lifeforms. As the ground of Earth broke here and there during the rapid expansion period, lakes and oceans were formed at the surface of Earth. The multicellulars bursted to these oceans and oxygenation of the atmosphere started locally.

Since the oxygen rich water was mixed with the water in the shallow oceans, the local oxygen content of the burst water was reduced and this led to an eventual extinction of many multicellulars in the burst. Burgess Shale fauna contained entire classes, which suffered extinction. In the average sense the oxygen concentration increased and led to the apparent very rapid evolution of multicellulars, which had actually already occurred underground. Of course, also evolution at the surface of Earth took place.

3 Has venus turned itself inside-out and why its magnetic field vanishes?

News about unexpected findings relating to the physics of astrophysical objects emerge on an almost daily basis. The most recent news (`https://cutt.ly/YQSZgpv`) told about the lack of craters and volcanic activity in Venus (`https://cutt.ly/wQSZzaS`). The findings are actually not new. The resurfacing history of Venus was summarized 1979 by Schaber et al [E1] . Turcotte and

Rome have proposed cyclic global catastrophic events as an analog of the plate tectonics allowing a heat transfer from the interior of Venus and effectively turning Venus inside out [E2].

The Venus does not have appreciable magnetic field although dynamo mechanism suggests magnetic field as in the case of Earth, has been also known.

3.1 Has Venus turned itself inside-out?

The surface of Venus was expected to have craters, just like the surface of Earth, Moon, and Mars but the number of craters is very small. The surface of Venus also has weird features and many volcanoes. Also trace signs of erosion and tectonic shifts were found. The impression is that the surface of Venus had been turned inside out in a catastrophic event that occurred about 750 million years ago.

Since Venus is our sister planet with almost the same mass and radius, it is interesting to notice that the biology of Earth experienced the Cambrian explosion 541 million years ago.

1. The TGD explanation for Cambrian Explosion relies on EEM [L3, **?**, L9]. The model assumes that there was a relatively fast increase of the Earth's radius by factor, which led to the burst of underground oceans to the surface of the Earth and led to the formation of oceans. Standard cosmology predicts a continuous smooth expansion of astrophysical objects. Contrary to this prediction, astrophysical objects do not seem to expand smoothly. In the TGD Universe, the smooth expansion is replaced by rapid jerks and the Cambrian Explosion would be associated with this kind of phase transitions.

2. In this expansion the multicellular photosynthesizing life burst to the surface. This explains the sudden emergence of highly evolved life forms during the Cambrian Explosion that Darwin realized to be a heavy objection against his theory.

3. There are many objections to be circumvented. For instance, how photosynthesis could evolve in the underground ocean. Here TGD views dark matter as $h_{eff} = nh_0$ phases of ordinary matter, which are relatively dark with respect to each other, come in rescue. Dark water blobs could leak into the interior of Earth and the solar light possessing a dark portion could do the same so that photosynthesis became possible [L9].

4. Did Venus experience a similar rapid expansion 200 million years earlier, about 750 million years ago (or maybe roughly at the same time). Venus does not have water at its surface. This can be understood in terms of heat from solar radiation forcing the evaporation of water and subsequent loss. This also prevented the leakage of the water to the interior of Venus. If there were no water reservoirs inside Venus, no oceans were formed. The cracks of the crust created expanding areas of magma, which were like the bottoms of the oceans at Earth. Also at Earth a fraction about 2/3 of the Earth's surface is sea bottom.

3.2 Why does Venus not possess a magnetic field?

Venus also offers a second puzzle. Venus does not have an appreciable magnetic field although it has been speculated that it has had it (`https://cutt.ly/VQSZt9m`). The solar dynamo mechanism would suggest its presence.

1. TGD predicts that there are two kinds of flux tubes carrying Earth's magnetic field B_E with a nominal value of .5 Gauss. This applies quite generally. The flux tubes have a closed cross section - this is possible only in TGD Universe, where the space-time is 4-surface in $M^4 \times CP_2$. The flux tubes can have a vanishing Kähler magnetic flux or non-vanishing quantized monopole flux: this has no counterpart in Maxwellian electrodynamics.

   For Earth, the monopole part would correspond to about .2 Gauss - 2/5 of the full strength of B_E.

2. Monopole part needs no currents to maintain it and this makes it possible to understand how the Earth's magnetic field has not disappeared a long time ago. This also explains the existence of magnetic fields in cosmological scales.

The orientation of the Earth's magnetic field is varying. In the TGD based model the monopole part plays the role of master. When the non-monopole part becomes too weak, the magnetic body defined by the monopole part changes its orientation. This induced currents refresh the non-monopole part [L1]. The standard dynamo model is part of this model.

3. There is an interesting (perhaps more than) analogy with the standard phenomenological description of magnetism in condensed matter. One has $B = H + M$. H field is analogous to the monopole part and the non-monopole part is analogous to the magnetization M induced by H. $B = H + M$ would represent the total field. If this description corresponds to the presence of two kinds of flux tubes, the TGD view about magnetic fields would have been part of electromagnetism from the beginning!

   Flux tubes can also carry electric fields and also for them this kind of decomposition makes sense. Could also the fields D, P, and E have a similar interpretation?

   In the linear model of magnetism, one has $M = \chi H$ and $B = \mu H = (1+\chi)H$. For diamagnets one has $\chi \leq 0$ and for paramagnets $\chi \geq 0$. Earth would be paramagnetic with $\chi \simeq 3/2$ if the linear model works. χ is a tensor in the general case so that B and H can have different directions.

4. All stars and planets, also Venus, correspond to flux tube tangles formed from monopole flux tubes. This leaves only one possibility. Venus behaves like a super-conductor and is an ideal diamagnet with $\chi = -1$ so that B vanishes. The monopole part would be present however.

   This could provide a totally new insight to the Meissner effect and loss of superconductivity. In TGD the based model [L5], monopole flux tubes carry supracurrent. The BCS model however requires the absence of a magnetic field. Could the induced non-monopole field cancelling the monopole part. Venus would indeed be a superconductor!

5. The TGD based model of superconductivity [L5] also predicts superconductivity driven by an external energy feed would be also above critical temperature. The energy feed would increase the value of h_{eff} and below the critical temperature it would be provided by the energy liberated in the formation of Cooper pairs, which need not actually be the current carriers since dark electrons can carry the current without dissipation. In TGD inspired biology and quite universally, the basic role of metabolic energy feed is to prevent the reductions of the values of h_{eff}.

   Superconductivity means in the TGD framework large h_{eff} and therefore complexity, intelligence, and long quantum coherence length [L10]. Could Venus be alive but in a very different sense than Earth?

6. Could the superconductivity be forced by the thermal energy feed from the interior of Venus? The tilt of the rotation axis relative to the plane of rotation around the Sun is very small for Venus, about 3 degrees and much smaller than for the Earth. This implies that the surface temperature of Venus is roughly constant. At Earth plate tectonics makes possible the heat transfer from the interior to the surface and its leakage to outer space. For Venus this is not possible. Could the energy flow from the interior of Venus force the superconductivity by increasing the values of h_{eff}. This would in turn force the vanishing of the magnetic field of Venus.

7. Sun has an enormous feed of metabolic energy from the core: could it be alive? Also in the case of Earth, the energy feed from the interior could have been crucial for the development of life in the interior of Earth and made possible even the development of photosynthesis.

   The possibility that life actually appears in cosmic scales and is associated with quantum coherent flux tube networks associated with the active galactic nuclei usually identified as supermassive blackholes containing stellar and planetary systems as tangles is suggested by the TGD based model of galactic jets [L8] explaining also ultrahigh energy cosmic rays. The model inspires the proposal that active galactic nuclei having typically sizes 1-2 AU (!) involve gravitationally quantum coherent regions of radius at most of the Schwartschild radius defining a minimal gravitational Compton length [L8].

8. Also Mars lacks the global magnetic field although it has auroras assigned with local fields. Could also Mars be alive in the same same sense as Venus? Note that the recent radius of Mars is about 1/2 of Earth's radius. If Venus expanded by factor 2, all these 3 planets would have had roughly the same radius for about 750 million years ago. Mars would be waiting for the moment of expansion.

3.3 Could superionic phase of water give rise to super-conductivity and planetary Meissner effect?

A superionic ice-like phase of water at high temperature and pressure (20 gigaPascals but much less than the expected pressure, which is higher than 50 gigaPascals) has been discovered. See the the popular article "*Scientists find strange black 'superionic ice' that could exist inside other planets*" (`https://www.eurekalert.org/news-releases/933099`) and the article "*Structure and properties of two superionic ice phases*" of Prakapenka et al [**?**] (`https://cutt.ly/7TPvYlL`).

The bonds between hydrogen atoms and oxygen ions are broken in this phase and ionized hydrogen atoms form a fluid, a kind of proton ocean in which the oxygen lattice floats.

In the TGD framework dark proton sequences with effective Planck constant $h_{eff} \geq h$ at monopole magnetic tubes play a key role in quantum biology. Dark DNA codons would be 3-proton triplets at monopole flux tubes parallel to DNA strands and would give rise to a fundamental realization of the genetic code.

One can wonder whether the protons of this superionic could be dark in the TGD sense and reside in monopole flux tubes. Could they form a superfluid-like or superconductor-like phase by a universal mechanism which I call Galois confinement, which requires that the total momenta of composites of dark protons with are algebraic integer valued momenta are ordinary integers in suitable units (periodic boundary conditions) [L6, L7].

It is conjectured that this kind phase could reside in the interiors of Neptune and Uranus perhaps even deep inside the Earth. Could superionic phases of water in the interior of planets like Mars and Venus give rise to the speculated super-conductivity implying the vanishing of large scale magnetic field via the TGD variant of the Meissner effect?

What about Earth? Could one consider the following scenario? Primordial Earth had a vanishing magnetic field by the Meissner effect caused by superionic ice. Part of the superconducting superionic water melted and formed ordinary water at lower temperature and pressure and gave rise to underground oceans. Superconductivity was lost in the Earth scale but the monopole flux based magnetic field and the ordinary magnetic field induced by the currents that it generated remained but did not cancel each other anymore. In the transition increasing the radius of Earth by factor 2 during the Cambrian explosion the water in these oceans bursted to the surface of Earth.

REFERENCES

Cosmology and Astro-Physics

[E1] Schaber R et al. The Resurfacing History of Venus, 1997. Available at: `https://www.researchgate.net/publication/234304451_The_Resurfacing_History_of_Venus`.

[E2] Romeo I and Turcotte DL. Resurfacing on Venus . *Planetary and Space Science*, 58(10):1374–1380, 2010. Available at: `https://doi.org/10.1016/j.pss.2010.05.022`.

Biology

[I1] He T et al. Possible links between extreme oxygen perturbations and the Cambrian radiation of animals. *Nature Geoscience*, 12:468–474, 2019. Available at: `https://www.nature.com/articles/s41561-019-0357-z`.

[I2] Klatt JM et al. Possible link between Earth's rotation rate and oxygenation. *Nature Geoscience*, 14:564–570, 2021. Available at: https://www.nature.com/articles/s41561-021-00784-3.

Articles about TGD

[L1] Pitkänen M. Maintenance problem for Earth's magnetic field. Available at: http://tgdtheory.fi/public_html/articles/Bmaintenance.pdf., 2015.

[L2] Pitkänen M. Expanding Earth hypothesis, Platonic solids, and plate tectonics as a symplectic flow. Available at: http://tgdtheory.fi/public_html/articles/platoplate.pdf., 2018.

[L3] Pitkänen M. Expanding Earth Model and Pre-Cambrian Evolution of Continents, Climate, and Life. Available at: http://tgdtheory.fi/public_html/articles/expearth.pdf., 2018.

[L4] Pitkänen M. Earhquakes and volcanic eruptions as macroscopic quantum jumps in zero energy ontology. Available at: http://tgdtheory.fi/public_html/articles/earthquakes.pdf., 2019.

[L5] Pitkänen M. Comparing the Berry phase model of super-conductivity with the TGD based model. https://tgdtheory.fi/public_html/articles/SCBerryTGD.pdf., 2021.

[L6] Pitkänen M. TGD and Condensed Matter. https://tgdtheory.fi/public_html/articles/TGDcondmatshort.pdf., 2021.

[L7] Pitkänen M. TGD as it is towards the end of 2021. https://tgdtheory.fi/public_html/articles/TGD2021.pdf., 2021.

[L8] Pitkänen M. TGD view of the engine powering jets from active galactic nuclei. https://tgdtheory.fi/public_html/articles/galjets.pdf., 2021.

[L9] Pitkänen M. Updated version of Expanding Earth model. https://tgdtheory.fi/public_html/articles/expearth2021.pdf., 2021.

[L10] Pitkänen M and Rastmanesh R. The based view about dark matter at the level of molecular biology. Available at: http://tgdtheory.fi/public_html/articles/darkchemi.pdf., 2020.