An "Earth-Planet" or "Earth-Star" Couplet as a Gravitational Wave Antenna, wherein the Indicators are Microseismic Peaks in the Earth

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An "Earth-planet" or "Earth-star" couplet can be considered as a gravitational wave antenna. There in such an antenna a gravitational wave should lead to a peak in the microseismic background spectrum on the Earth (one of the ends of the antenna). This paper presents numerous observational results on the Earth's microseismic background. The microseismic spectrum, being compared to the distribution of the relative location of the nearest stars, found a close peak-to-peak correspondence. Hence such peaks can be a manifestation of an oscillation in the couplet "Earth-star" caused by gravitational waves arriving from the cosmos.

1 Introduction

Use the following simplest model. Focus on two gravitationally-connected objects such as the couplets "Earth-Moon", "Earth-Jupiter", "Earth-Saturn", "Earth-Sun", or "Earth-star" (a near star is meant). Such a couplet can be considered as a gravitational wave antenna. A gravitational wave, falling down onto such an antenna, should produce an oscillation in the system that leads to a peak in the microseismic background spectrum of the Earth (one of the ends of the antenna).

Gravitational waves radiated on different frequencies may have an origin in gravitationally unstable objects in the Universe. For instance, a gravitationally unstable cosmic cloud wherein a stellar form may be such a source. A mechanism which generates gravitational waves on a wide spectrum can be shown in such an example. There is a theorem: "if a system is in the state of unstable equilibrium, such a system can oscillatorily bounce at low frequencies in the stable area of the states; the frequency decreases while the system approaches the state of equilibrium (threshold of instability) with a finite wavenumber at zero frequency" [1, 2]. This theorem is applicable exactly to the case of the gravitational instability of the cosmic clouds. Such a gravitational instability is known as Jeans's instability, and leads to the process of the formation of stars [3]. In this process intense gravitational radiation should be produced. Besides the spectrum of the waves should be continuously shifting on low frequency scales as such a cloud approaches to the threshold of instability. Hence, gravitational waves radiated on the wide spectrum of frequencies should be presented in the Universe always as stellar creation process.

Hence, the peaks of the microseismic background on the Earth (if any observed), if correlated to the parameters of the "Earth-space body"system (such as the distance L between them), should manifest the reaction in the "Earth-space body" couplet of the gravitational waves arriving from the cosmos. The target of this study is the search for such correlation peaks in the microseismic background of the Earth.

2 Observations

Our observations were processed at the Seismic Station of Simpheropol University (Sevastopol, Crimea Peninsula), using a laser interferometer [4]. Six peaks were registered at 2.3 Hz, 1 Hz, 0.9 Hz, 0.6 Hz, 0.4 Hz, 0.2 Hz (see Fig. 1a and Fig. 1b). The graphs were drawn directly on the basis of the records made by the spectrum analyzer SK4-72. The spectrum analyzer SK4-72 accumulates output signals from an interferometer, then enhances periodic components of the signal relative to the chaotic components. 1,024 segregate records, 40-second length each, were averaged.

Many massive gravitating objects are located near the solar system at the distance of 1.3, 2.7, 3.5, 5, 8, and 11 parsecs. All the distances L between the Earth and these objects correspond to all the observed peaks (see Fig. 1a and Fig. 1b). The calculated distribution of the gravitational potential of the nearest stars is shown in Fig. 1c. Comparing Fig. 1a and Fig. 1b to Fig. 1c, we reveal a close similarity between the corresponding curves: each peak of Fig. 1a and Fig. 1b corresponds to a peak in Fig. 1c, and vice versa. Besides there are small deviations, that should be pointed out for clarity. For distances $L > 4$ parsecs the data were taken only for the brightest star, and the curve of the gravitational potential corresponding to this distance is lower than that for the $L < 4$ shown in the theoretical Fig. 1c. Another deviation is the presence of a uniform growth for the low-frequency background component in the experimental Fig. 1a and Fig. 1b, which doesn't appear in Fig. 1c. Such a uniform component of the microseismic background is usually described by the law $A_\omega \sim 1/\omega^2$ [5, 6].

*Posthumous publication prepared by Prof. Simon E. Shnoll (Institute of Theoretical and Experimental Biophysics, Russian Academy of Sciences, Pushino, Moscow Region, 142290, Russia), who was close to the author. E-mail of the submitter: shnoll@iteb.ru; shnoll@mail.ru. See Afterword for the biography and bibliography of the author, Prof. Vladimir A. Dubrovskiy (1935–2006).

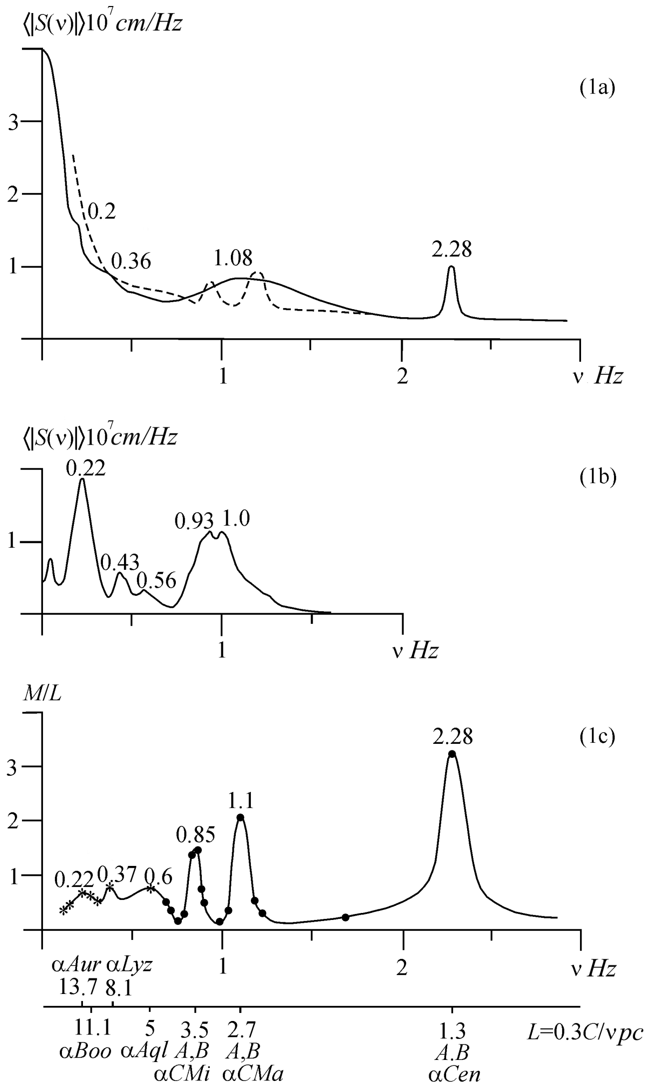

Fig. 1: The observed microseismic background (solid curve) after accumulation of the background signals from the interferometer output: Fig. 1a shows the range 0.1–5 Hz; Fig. 1b shows the range 0.1–2 Hz. The dotted curve of Fig. 1a shows the calculated distribution of the gravitational potential of the stars in common with the uniform part of the microseismic background. This dotted curve is normalized so that it is the same as that of the solid curve at 2.28 Hz. Fig. 1c shows the calculated distribution of the gravitational potential of the stars. The solid points correspond to all the nearest stars, a distance to which is $L < 4$ parsecs, and to all the brightest stars located at $L > 4$ parsecs. Masses M are expressed in the mass of the Sun. α Aur, α Lyz, etc. mean α stars of the constellations according to the astronomical notation [7, 8]. A, B sign for the components of the binaries. The numbers typed at the extrema are frequencies.

Moreover, the quantitative correlation between the frequency peaks and the distribution of the nearest stars is found. Namely, the sharpest peak at 2.28 Hz corresponds to the distance between the Earth and the nearest binary stars A and B, α Centaurus [7, 8]. The broader peak at 1 Hz (see Fig. 1a, and Fig. 1b) corresponds to the distances to the stars which are distributed over the range from 2.4 to 3.8 parsecs [7, 8]. The spectrum analyzer SK4-72 averages all the peaks in the range 2.4–3.8 parsecs into one broad peak near 1 Hz (Fig. 1a). At the same time the broad peak of Fig. 1a, being taken under detailed study, is shown to be split into two peaks (Fig. 1b) if the spectrum analyzer SK4-72 processes the frequency range from 0.1 to 2 Hz (the exaggeration of the frequency scale). This subdivision of the frequency range corresponds to the division of the group of stars located as far as in the range from 2.4 to 3.8 parsecs into two subgroups which are near 2.7 and 3.5 parsecs (Fig. 1c).

The distribution of the gravitational potential over the subgroups, in common with the uniform background spectrum, is shown by the dotted curve in Fig. 1a. We see therein both the quantitative and qualitative correlation between the frequent spectra of the microseismic background and the distribution of the gravitational potential in the subgroups.

The Sevastopol data correlation on the frequency spectra between the microseismic background and the distances between the Earth and the nearest stars are the same as the data registered in Arizona. The Sevastopol and Arizona data are well-overlapping with coincidence in three peaks [9].

It is possible to propose more decisive observations. Namely, it would be reasonable to look for peaks which could be corresponding to the Earth-Moon" ($\sim$240 MHz), "Earth-Sun" ($\sim$0.6 MHz), "Earth-Venus" ($\sim$0.3–2.2 MHz), "Earth-Jupiter" ($\sim$100–150 kHz), and "Earth-Saturn" ($\sim$58–72 kHz) antennae. Moreover, the peaks corresponding to Venus, Jupiter and Saturn should change their frequency in accordance with the change in the distance between the Earth and these planets during their orbital motion around the Sun. If such a correlation could be registered in an experiment, this would be experimentum crucis in support of the above presented results.

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Afterword by the Editor

In addition to the posthumous paper by Prof. Dubrovskiy, I should provide an explaination why we publish it in a form substantially trunscated to the originally version of the manuscript.

The originally Dubrovskiy manuscript, submitted by Prof. Simon E. Shnoll, was based on the preprint uloaded in 2001 into the Cornell arXiv.org, astro-ph/0106350. In that manuscript, aside for the experimental data presented in the current publication, Dubrovskiy tried to use the data as a verification to the Laplace speed of gravitation, which is many orders higher than the velocity of light. His belief in Laplace's theory unfortunately carried him into a few formally errors.

Laplace supposed such a speed as a result of his soltion of the gravitational two-body problem, which concerns the motion of two point particles that interact only with each other, due to gravity. In this problem a body A experiences that the force of gravitation which acts at that point where the body A is located in the moment. Because a body B (the source of the force) is distant from the body A and moves with respect to it with a velocity, there is incoincidence of two directions: the line connecting both bodies in the moment and the direction from the body A to that point where the body B was located, due to its motion, some time ago. What line is the location of the centre of gravity in such a system? If it is located in the first line, a force accelerating the body A should appear. If it is the second line, a non-compensated component of the momentum should appear in the body B, that is the breaking of the conservation law. As a result such a system becomes unstable anyway. This is a paradox of the two body problem of the 18th century. Using the mathematical methods accessed in the end of the 18th century, Laplace resolved this problem by introduction of the speed of gravitation, which should be, in the sample of the planets, at least ten orders higher than the velocity of light.

The contemporary Newtonian celestial mechanics resolves the two body problem with use of the methods of higher mathematics. This is a classical example, which shows that two bodies orbiting a common centre of gravity under specific conditions move along stable elliptic orbits so that they cannot leave the system or fall onto each other. This classical problem, known as the Kepler problem, is described in detail in §13 of *Short Course of Theoretical Physics. Mechanics. Electrodynamics* by Landau and Lifshitz (Nauka Publishers, Moscow, 1969).

The same situation takes a place in the General Theory of Relativity in a case where the physical conditions of the motion are close to the non-relativistic Newtonian mechanics. This problem is discussed in detail in §101 of *The Classical Theory of Fields* by Landau and Lifshitz (Butterworth-Heinemann, 1980). The mechanical energy and the moment of momentum of a two body system remain unchanged with only a small correction for the energy-momentum loss with gravitational radiation. In a system like the solar system the power of gravitational radiation, which is due to the orbiting planets, is nothing but only a few kilowatts. Therefore such a system is stable with the speed of gravitation equal to the velocity of light: the planets cannot leave the solar system or fall onto each other within a duration compared to the age of the Universe.

Due to the aforementioned reason, I substantially corrected the originally Dubrovskiy manuscript. I removed everything on the superluminal Laplace velocity of gravitation. I also corrected minor errors in the description of gravitational wave antennae.

I did it through the prior permission of Dr. Victor N. Sergeev (e-mail: svn@idg.chph.ras.ru), who was a close friend of Prof. Dubrovskiy and a co-author of many his works.

Dr. Sergeev is in contact with Prof. Shnoll. He read the corrected version of the manuscript, and agreed with the edition. Sergeev wrote, in a private letter of January 29, 2008: "... He [Dubrovskiy] considered the manuscript as a verification to his theory of gravitation where gravitational waves travel with a superluminal velocity. However the precense of a correlation of the microseismic spectra to the cosmic bodies, the result itself is important independent from interpretation given to it. Of course, it would be very good to publish this result. Besides, the edited version has nothing of those contradicting to the views of V. A. Dubrovskiy."

In general, an idea about a free-mass gravitational wave antenna whose basis is set up by an "Earth-planet" or "Earth-star" couplet is highly original. No such an idea met in the science before Dubrovskiy. Moreover, the correlation of the microseismic oscillations to the distances found by him gives good chances that such a couplet can be used as a huge free-mass gravitational wave detector in the future. The interstellar distances are extremely larger to 5 mln. km of the basis of LISA — the Laser Interferometer Space Antenna planned by the European Space Agency to launch on the next decade. So the displacement effect in the Dubrovskiy mass-detector due the a falling gravitatuonal wave should be large that could result a microseismic activity in the Earth.

With such a fine result, this paper will leave fond memories of Prof. Dubrovskiy. May his memory live for ever!

Dmitri Rabounski, Editor-in-Chief
Progress in Physics

Vladimir A. Dubrovskiy (1935–2006)

Vladimir Anatolievich Dubrovskiy was born on March 20, 1935, in the formerly-known Soviet Union. In 1953–1959 he was a student in the Physics Department of Moscow University. Then he worked on the research stuff of the Academy of Sciences of URSS (now the Russian Academy of Sciences, RAS) all his life. During the first period, from 1959 to 1962, he was employed as a research scientist at the Institute of Mathematics in the Siberian Branch of the Academy of Sciences, where he worked on the physics of elementary particles. During the second period, from 1962 to 1965, he completed postgraduate education at the Institute of Applied Mechanics: his theme was a "quasi-classical approximation of the equations of Quantum Mechanics". During two decades, from 1966 to 1998, he worked at the Laboratory of Seismology of the Institute of the Physics of the Earth, in Moscow, where he advanced from a junior scientist to the Chief of the Laboratory. His main research at the Institute concerned the internal constitution and evolution of the Earth.

From 1972 to 1992 Dubrovskiy was the Executive Secretary of the "Intergovernmental Commission URSS-USA on the Prediction for Earthquakes". In 1986–1991 he was the Executive Secretary of the "Commission on the Constitution, Composition, and Evaluation of the Earth's Interior" by the Academy of Science of URSS and the German Research Foundation (Deutsche Forschungsgemeinschaft). In 1997 he was elected a Professor in the Department of Mechanics and Mathematics of Moscow University.

In the end of 1996, Dubrovskiy and all the people working with him at his Laboratory of Seismology were ordered for discharge from the Institute of the Physics of the Earth due to a conflict between Dubrovskiy and the Director of the Institute. Then, in February of 1997, Dubrovskiy accused the Director with repression in science like those against genetics during the Stalin regime, and claimed hungry strike. A month later, in March, his health condition had become so poor, forcing him to be hospitalized. (Despite the urgent medical treatment, his health didn't come back to him; he was still remaining very ill, and died nine years later.) All the story met a resonance in the scientific community. As a result, Dubrovskiy, in common with two his co-workers, was invited by another Institute of the Academy of Sciences, the Institute of Geospheres Dynamics in Moscow, where he worked from 1998 till death. He died on November 12, 2006, in Moscow.

Dubrovskiy authored 102 research papers published in scientific journals and the proceedings of various scientific conferences. A brief list of his scientific publications attached.

Main scientific legacy of V. A. Dubrovskiy

A five dimensional approach to the quasiclassical approach of the equations of Quantum Mechanics:

- Dubrovskiy V. A. and Skuridin G. A. Asymptotic decomposition in wave mechanics. *Magazine of Computational Mathematics and Mathematical Physics*, 1964, v. 5, no. 4.

The hypothesis on the iron oxides contents of the Earth's core:

- Dubrovskiy V. A. and Pan'kov V. L. On the composition of the Earth's core. *Izvestiya of the Academy of Sciences of USSR, Earth Phys.*, 1972, no. 7, 48–54.

Now this hypothesis has been verified by many scientists in their experimental and theoretical studies. A new idea is that the d-electrons of the transition elements (mainly iron), being under high pressure, participate with high activity in the formation of the additional covalent bindings. As a result the substances become dense, so the iron oxide FeO can be seen as the main part of the contents formation of the core of the Earth.

The theory of eigenoscillation of the elastic inhomogeneities:

- Dubrovskiy V. A. Formation of coda waves. In: *The Soviet-American Exchange in Earthquake Prediction. U.S. Geological Survey. Open-File Report*, 81–1150, 1981, 437–456.
- Dubrovskiy V. A. and Morochnik V. S. Natural vibrations of a spherical inhomogeneity in an elastic medium. *Izvestiya of the Academy of Sciences of USSR, Physics of the Solid Earth*, 1981, v. 17, no. 7, 494–504.
- Dubrovskiy V. A. and Morochnik V. S. Nonstationary scattering of elastic waves by spherical inclusion. *Izvestiya of the Academy of Sciences of USSR, Physics of the Solid Earth*, 1989, v. 25, no. 8, 679–685.

This presents the analytic solution of the boundary problem. The frequent equation is derived for both radial, torsional and spheroidal vibrations. A new method of solution for the diffraction problem is developed for a spherical elastic inclusion into an infinite elastic medium. The obtained analytical solution is checked by numerical computation. Formulae are obtained for the coda waves envelop in two limiting cases: single scattering and diffusion scattering. A frequency dependence on the quality factor is manifest through the corresponding dependance on the scattering cross-section.

The mechanism of the tectonic movements:

- Artemjev M. E., Bune V. J., Dubrovskiy V. A., and Kambarov N. Sh. Seismicity and isostasy. *Phys. Earth Planet. Interiors*, 1972, v. 6, no. 4, 256–262.
- Dubrovskiy V. A. Mechanism of tectonic movements. *Izvestiya of the Academy of Sciences of USSR, Physics of the Solid Earth*, 1986, v. 22, no. 1, 18–27.
- Dubrovskiy V. A., Sergeev V. N., and Fuis G. S. Generalized condition of isostasy. *Doklady of the Russian Academy of Sciences*, 1995, v. 342, no. 1.
- Dubrovskiy V. A. and Sergeev V. N. Physics of tectonic waves. *Izvestiya of the Russian Academy of Sciences, Physics of the Solid Earth*, 1997, v. 33, no. 10, 865–866.

This mechanism is seen to be at work in a "lithosphere-astenosphere" system which has the density inversion between the lithosphere and astenosphere. The substance of the elastic lithosphere is denser than that of the liquid astenosphere. A solution for the model of the elastic layer above the incompressible fluid with the density inversion is found. It is found that there is a nontrivial, unstable equilibrium on nonzero displacement of the elastic layer. The bifurcation point is characterized by a critical wavelength of the periodic disturbance. This wavelength is that of the wave disturbance when the Archimedian force reaches the elastic force of disturbance.

Two-level convection in Earth's mantle:

- Dubrovskiy V. A. Two-level convection in the Earth's mantle. *Doklady of the Russian Academy of Sciences*, 1994, v. 334, no. 1.
- Dubrovskiy V. A. Convective instability motions in the Earth's interiors. *Izvestiya of the Russian Academy of Sciences, Physics of the Solid Earth*, 1995, no. 9.

The mantle convection is considered at two levels: a convection in the lower mantle is the chemical-density convection due to the core-mantle boundary differentiation into the different compositionally light and heavy components, while the other convection is the heat-density convection in the"elastic lithosphere — fluid astenosphere" system. The last one manifests itself in different tectonic phenomena such as the tectonic waves, the oceanic plate tectonic and continental tectonic as a result of the density inversion in the "lithosphere-astenosphere" system. The lower mantle chemical convection gives the heat energy flow to the upper mantle heat convection.

Generation for the magnetic, electric and vortex fields in magnetohydrodynamics, electrohydrodynamics and vortex hydrodynamics:

- Dubrovskiy V. A. and Skuridin G. A. The propagation of small disturbances in magnetohydrodynamics. *Geomagnetism and Aeronomy*, 1965, v. 5, no. 2, 234–250.
- Dubrovskiy V. A. The equations of electrohydrodynamics and electroelasticity. *Soviet Physics Doklady*, v. 29(12), December 1984 (transl. from *Doklady Akademii Nauk URSS*, 1984, v. 279, 857–860).
- Dubrovskiy V. A. Conditions for magnetic field Generation. *Doklady Akadmii Nauk URSS*, 1986, v. 286, no. 1, 74–77.
- Dubrovskiy V. A. and Rusakov N. N. Mechanism of generation of an elastic field. *Doklady Akadmii Nauk URSS*, 1989, v. 306, no. 6, 64–67.

- Dubrovskiy V. A. On a relation between strains and vortices in hydrodynamic flows. *Doklady Physics*, 2000, v. 45, no. 2, 52–54 (transl. from *Doklady Akademii Nauk URSS*, 2000, v. 370, no. 6, 754–756.

A nonlinear system of the equations is obtained, which manifests a mutual influence between the motion of a dielectric medium and an electric field. This theory well-describes the atmospheric electricity, including ball lighting. The theory proves: the motion of a magnetohydrodynamical, electrohydrodynamical or hydrodynamical incompressible fluid is locally unstable everywhere relative to the disturbances of a vortex, magnetic or electric field. A mutual, pendulumlike conversion energy of the fluid flow and energy of a magnetic, electric or vortex field is possible. Two-dimensional motions are stable in a case where they are large enough. The magnetic restrain of plasma is impossible in three-dimensional case.

The elastic model of the physical vacuum:

- Dubrovskiy V. A. Elastic model of the physical vacuum. *Soviet Physics Doklady*, v. 30(5), May 1985 (translated from *Doklady Akademii Nauk URSS*, 1985, v. 283, 83–85.
- Dubrovskiy V. A. Measurments of the gravity waves velocity. arXiv: astro-ph/0106350.
- Dubrovskiy V. A. Relation of the microseismic background with cosmic objects. *Vestnik MGU* (Transactions of the Moscow University), 2004, no. 4.
- Dubrovskiy V. A. and Smirnov N. N. Experimental evaluation of the gravity waves velocity. In: *Proc. of the 54nd International Astronautical Congress*, September 29 — October 3, 2003, Bremen, Germany.

New variables in the theory of elasticity are used (e.g. the velocity, vortex, and dilation set up instead the velocity and stress used in the standard theory). This gives a new system of the equations describing the wave motion of the velocity, vortex and dilation. In such a model, transversal waves and longitudinal waves are associated to electromagnetic and gravitational waves respectively. Such an approach realizes the field theory wherein elementary particles are the singularities in the elastic physical vacuum.

A universal precursor for the geomechanical catastrophes:

- Dubrovskiy V. A. Tectonic waves. *Izvestiya of the Academy of Sciences of URSS, Earth Physics*, 1985, v. 21, no. 1, 20–23.
- Dubrovskiy V. A. and Dieterich D. Wave propagation along faults and the onset of slip instability. *EOS*, 1990, v. 71, no. 17, 635–636.
- Dubrovskiy V. A., McEvilly T. V., Belyakov A. S., Kuznetzov V. Y., and Timonov M. V. Borehole seismoacoustical emission study at the Parkfield prognosis range. *Doklady of the Russian Academy of Sciences*, 1992, v. 325, no. 4.
- Dubrovskiy V. A. and Sergeev V. N. The necessary precursor for a catastrophe. In: *Tectonic of Neogey: General and Regional Aspects*, GEOS, Moscow, 2001, v. 1, 222–226.

Unstable phenomena such as earthquakes can occur in a geomechanical system, if there is an unstable state of equilibrium in a set of critical geophysical parameters. There are two fields of the geophysical parameters, which correspond to the stable and unstable states. According to Dubrovskiy (1985) and also Dubrovskiy and Sergeev (2001), in the stable field of the parameters the geosystem has vibratory eigenmotions, where the frequencies tend to zero if the system approaches unstable equilibrium (during an earthquake occurrence, for instance). However the critical wavelength of the vibrations remains finite at zero frequency, and characterizes the size of the instability. Change in the eigenfrequencies affects the spectrum of seismoacoustic emission in an area surrounding an impending earthquake. Such a change indicates the fact that the geomechanical system is close to an unstable threshold, and the critical wavelength determines the energy and space dimensions of the developing instability sorce. Such an approach to the study of a systems in the state of unstable equilibrium is applicable to all system, whose behavior is described by hyperbolic equations in partial derivatives, i.e. not only geomechanical systems.