КНИЖНОЕ ОБОЗРЕНИЕ

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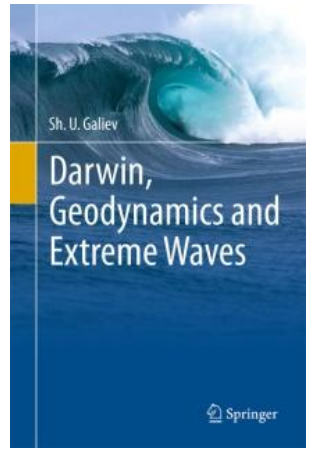
GALIEV SH.U. (2015) DARWIN, GEODYNAMICS AND EXTREME WAVES, 352 pp., Springer



Galiev attracts the reader's attention to some of Darwin's results which were not discussed earlier although a few of his geophysical observations have been mentioned in some previous publications (see, for example, [1–5]). At the same time, Galiev presents in his book the theory which qualitatively describes the Darwin's geophysical observations as well as some other highly nonlinear extreme events.

Charles Robert Darwin is the brilliant English naturalist whose theory of evolution lies at the basis of modern science. Darwin shocked religious Victorian society by suggesting that animals and humans shared a common ancestry.

In 2009 the world celebrated the 200th birth anniversary of Charles Darwin and 150-year anniversary of the publication of his book "On the Origin of Species". Probably, there are no such a person and a book in the history of science that had a similarly great impact on the development of human society. Darwin wrote some more books which made scientific revolutions in various areas of knowledge. However, the most read and the most available for readers is his book "Journal of Researches into the Geology and Natural History of the Various Countries Visited by H.M.S. Beagle, under the Command of Captain FitzRoy, R.N. from 1832 to 1836" commonly referred to as "The Voyage of the Beagle".

Darwin thought that travel on the Beagle was the most considerable event in his life. In particular, he was appalled by a huge earthquake in Chile, in 1835, and its consequences. He was the first researcher who observed and analysed local amplifications of seismic effects associated with topography of the Earth's surface and geological features. He described the earthquake-volcano interaction, seaquake, tsunami formation and destruction of the cities caused by this wave.

Darwin explained the extreme effects from the Chilean 1835 earthquake by the earthquake-induced vertical shock.

Darwin assumed that an earthquake is the result of *… the rending of strata, at a point not very deep below the surface of the earth …* It is well known that earthquakes trigger horizontal and vertical ground movements. Usually the vertical movement is smaller than the horizontal one. Therefore, earthquake-hazard assessment studies have usually been focussed on the horizontal shocks. However, the earthquake described by Darwin was primarily vertical. According to Darwin, the vertical acceleration of the Earth's surface exceeded the gravity acceleration *g* (*…small bodies should have been pitched a few inches from the ground…*). The effects of strong vertical shocks described by Darwin remained almost undiscussed up to that moment. The margins of safety against gravity-induced static vertical forces in buildings and structures usually provide adequate resistance to dynamic forces induced by the vertical acceleration during an earthquake. However, the earthquakes in Port-au-Prince (2010, Haiti; the depth of the epicentre – 13 km), Christchurch (2011, New

Zealand; the depth of the epicentre – 5 km) and Ludian County (2014, China; the depth of the epicentre – 10 km) are the examples of vertical seismic shocks resulted in the collapse of the cities. The earthquake magnitudes were not very large (around 7, 6.3 and 6.1, respectively). However, the consequences were catastrophic. The vertical acceleration measured during the 14 June 2008 Iwate-Miyagi earthquake in Japan was 3.8 *g* (the depth of the epicentre – 8 km, the earthquake magnitude - 6.9). It was 5.5 times larger than the horizontal acceleration. The peak vertical acceleration was 2.7 *g* during the 2011 Tōhoku (Japan) shallow earthquake. Thus, modern data completely confirm the Darwin's idea of the importance of great vertical movements in causing catastrophic consequences of some shallow earthquakes. He explained the synchronicity of volcano eruptions during the earthquake also by the vertical shocks. It is well known now that severe earthquakes generate extreme large-amplitude waves and shocks in the Earth and its crust.

Does modern science know about the generation of similar waves and shocks in the upper layers of the Earth, in the ocean and even in the Universe? Galiev thinks that some resonant solutions to highly nonlinear wave equations may explain the emergence and evolution of these disturbances. In particular, he conjectures that many objects in Nature may serve as natural resonators. These resonators may be formed by sedimentary layers, hills, volcanoes and sea shelfs. When such objects are excited with resonant frequencies, strong nonlinear effects can cause rapid evolution of small initial perturbations into extreme waves. Galiev proposes to describe this evolution using highly nonlinear wave equations. He also proposes to use similar equations to simulate the earthquake-induced dynamics on the Earth's surface and to model the creation of the Universe. He believes that the dynamics of dark matter and dark energy are highly nonlinear wave phenomena.

Darwin characterized his geophysical observations as shocks, waves and paroxysmal vertical movements. Although the description of the geophysical observations occupies only a small part of the Darwin's book [6], in [7] they are treated in more detail. Galiev demonstrates deep interest that Darwin had to various wave processes occurring deep in the ocean and on its surface. He describes a huge sea wave which almost sank the Beagle and emphasizes the influence of seabed morphology on the amplitude of tsunami waves. He describes the transient boiling of ocean water during the seaquake and explains the emergence of porous structures in volcanic bombs by thermal processes and an impact effect of the centrifugal force. No doubt, Darwin was the first naturalist who witnessed a catastrophic earthquake and published a detailed scientific portrayal of this disastrous phenomenon.

In the book "Darwin, Geodynamics and Extreme Waves" the author – Galiyev – re-opens the Darwin's pages devoted to the 1835 earthquake and related to catastrophic natural phenomena for today's thoughtful reader. He asks questions: how these data of Darwin and his ideas agree with the results of modern science? Is it possible to compare modern data of physical and mechanical experiments with the description of the catastrophic earthquake given by Darwin? And, at last, can results of catastrophic earthquakes be successfully modelled using mathematical methods?

Galiev emphasizes the priority of Darwin in the description of some catastrophic natural phenomena and in the formulation of the principles forming the basis of some geosciences.

He shows that modern seismology and volcanology have only recently started formulating the ideas similar to those generated by Darwin nearly 200 years ago.

He believes that the science about catastrophic earthquakes is at the stage of formation and Darwin's ideas can define its further development. Thus, the book discusses some geophysical results obtained by Darwin when the brilliant theory known as Darwinism had not yet been stated.

The book "Darwin, Geodynamics and Extreme Waves" begins with the Prologue where consideration is given to a wide spectrum of issues associated with the research of young Charles Darwin, modern geophysics and extreme seismic and ocean waves.

Chapter 1 is devoted to the behaviour of surface layers of the Earth, and volcanoes excited by vertical waves. Chapter 2 gives extracts from several Darwin's publications dealing with his observations and analysis of rapid change of the terrestrial surface as a result of seismic impact that confirmed his assumptions about variability existing in Nature. Chapter 3 describes ground vertical waves. It considers loosening, rupture and lifting of sedimentary layers, soils and magma resulted from rapid decompression after the seismic impact. A huge volume of results of current experimental and theoretical research studies are presented that support the Darwin's evidence.

Seaquake-induced ocean waves are considered in Chapter 4.

The evolution of a tsunami in coastal waters described by Darwin is simulated. Bubbles, cavitation and highly nonlinear waves emerge in ocean water, if seabed oscillations are greater than the gravity acceleration *g*. Extreme (rogue, freak or catastrophic) waves are considered in Chapter 5. Apparently, some extreme wave shook the Beagle near Cape Horn. The occurrence of extreme ocean waves is associated with the resonance of dispersive waves and the inhomogeneity of the ocean in thickness due to variable density, temperature and the concentration of marine organisms.

The theory of extreme waves excited in ocean, sedimentary layers, volcanoes and scalar fields is briefly described in Chapter 6. Results of a comparison of the theory and experiments are presented as well as different approximate solutions of the nonlinear Klein-Gordon equation (NKGE). According to resonant NKGE solutions, the Universe's evolution differs from predictions of the Big Bang model. Modern cosmology is fantastically successful, but its successes disclose new deep and complex mysteries. The author tries to cast light on some of them. Thus, a scheme of the origin of the Universe having initially finite dimensions is put forward, which fundamentally distinguishes it from the Big Bang model and the well-known theory of inflation. Of course, the presented model of the evolution of the Universe is vulnerable to criticism, as, apparently, all models devoted to such complex problems.

However, on the whole, it corresponds to the more and more popular ideas about the existence of a Pre-Universe and many (infinite!) Universes [8–13].

Chapter 7 considers the results of catastrophic earthquakes occurred in the recent years. The importance of Darwin's geophysical observations and his geodynamic ideas for modern science is emphasized.

Today, many scientists consider nonlinear science the most important frontier to gain a fundamental understanding of Nature. Close to their critical point, greatly different systems exhibit much the same nonlinear dynamics. Similar nonlinear waves can be generated in various fields ranging from fluids, plasmas and the Bose-Einstein condensate to solid-state, chemical, biological, astrophysical and geological systems.

After all, we can look on wave processes from the most general point of view. It is possible to say that waves are the most widespread elements in the world around us. Details of wave movements vary depending on an environment (the physical environment, the social environment or the information environment), but the laws of propagation, fluctuations and evolution of waves are universal. If we wish to understand the Universe and the human society, it is necessary to understand all details of the propagation of waves, their interactions, and the influences of the environment on the existence and evolution of waves. The origin of the extreme waves is associated with the resonant phenomena and the occurrence of singular terms in the governing equations and in their solutions. The well-known problem of "small" dividers defining the occurrence of resonances is considered as fundamental for the extreme waves.

Let me also mention that global trips of British naturalists (including Darwin) are a long-existing tradition in the history of the British fleet [14]. This tradition began with the voyage of Joseph Banks in 1768–1771. In many ways, Joseph Banks' story starts like that of Darwin. After Banks, several voyages followed: by Johann Reinhold Forster and Johann Georg Adam Forster in 1772–1775, by Robert Brown in 1801–1803, by Charles Darwin in 1831–1836, by Joseph Hooker in 1839–1843, by Tomas Huxley in 1846-1850 and by Henry Moseley in 1872–1876. Each of these trips was highly successful from a scientific standpoint. The Beagle voyage occurred to be especially successful and not only for the British fleet!

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Review by M.A. Ilgamov

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