Physical Factors of the Historical Process

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The influence of cosmic factors on the behaviour of organized human masses and on the course of the world-historical process, beginning from the 5th century B.C. and until the present time. This is a short presentation of my research and theory.

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Alexander L. Chizhevsky, NY, 1920s

Alexander L. Chizhevsky (1897–1964), also spelled as "Tchijevsky", was born into a noble Russian family having close relatives among the English, Italian, French and German aristocracy. He was born in Poland, where his father, a Major General of artillery, served in the Russian Royal Army. From his childhood, Chizhevsky was free in English, Italian, French and German (which were the native languages of his aristocratic relatives). Similarly to many young men of that time, he volunteered as a private for World War I, but months later he was demobilized after being wounded in Galicia and awarded the St. George Military Cross of the 4th degree.

Alexander Chizhevsky is known as the discoverer of the effect of solar flares and geomagnetic storms on the human organism, and also the founder of *heliobiology* — the science revealing solar-terrestrial connexions. The presented article is his groundbreaking work on this topic. This is his Doctor of Sciences dissertation, defended by him in 1918 at Moscow University (at the age of 21). This is his main scientific study, which he then expanded and updated with new scientific results throughout his subsequent life. Two decades later, in 1938, he published an extensive "update" of this research in the form of a monograph (3.5 times larger in volume than the first edition of 1924), written by him in French, which was the international language of communication among scientists in those years: *Les épidémies et les perturbations électromagnétiques du milieu extérieur* (Ed. Hippocrate, Paris, 1938, 238 pages).

Chizhevsky's research was inspired and then reinforced by the discoveries of business cycles linked to solar activity cycles, such as, for example, the 7–11-year investment cycle (Clément Juglar, 1862), the 40-month "inventory" business cycle (Joseph Kitchin, 1923), the 50–60-year cycle of economic booms and depressions (Nikolai Kondratiev, 1925) and 15–25 year waves of infrastructural investment and demographic activity (Simon Kuznets, 1930). Edward Dewey in his 1930–1940s works proved that the entire USA economy, including agriculture, industry, trade, banking, stock exchange, etc., is driven by the mentioned four business cycles (which are the result of the interference of solar activity cycles).

Based on extensive empirical data from the last thousand years, Chizhevsky proved that all types of social activity (culture, economy, military conflicts and even epidemics) are conditioned by a complex system of solar activity cycles, such as cycles of sunspots, solar flares, etc. This conclusion was later extended by other researchers to long-term cycles in climatology, using data from dendrochronology and radiocarbon analysis. Later, in his studies in the 1950s, Chizhevsky showed that the planets of the Solar System (including the Earth) are in the state of intracellular organs (organelles), while the Sun functions as the cell nucleus.

In the mid-1920s, Chizhevsky left the USSR for Europe, and then for several years in the USA. He was a visiting lecturer at Columbia University in New York, where he met Simon Kuznets (1901–1985), who was also born in Russia; he was sent by the communist government to New York in 1922 to "study the economics of capitalism", but then refused to return to the USSR. Chizhevsky's lectures were highly popular among scientists of that time. Simon Kuznets tried to convince him not to return to the USSR and to stay in New York. Svante Arrhenius (1859–1927), the famous Swedish physicist and chemist, told him the same; he offered an academic position to him and to stay in Sweden. But Chizhevsky did not listen to them, because he was sure in his influence and authority, which he had in the USSR. He returned to the USSR, where he headed a personal research laboratory and continued his studies.

However, fate decreed his life differently than he thought. His high-ranking patrons among the USSR officials disappeared one after another in the waves of the Stalin repressions. In 1933, his scientific work was banned in the USSR, and in 1936 his laboratory was closed. In 1939 he was elected Honorary President of the First International Congress on Biophysics in New York, but was unable to travel due to the Iron Curtain covering the USSR. In 1942, he was arrested and sentenced to 8 years in the GULAG camps for anti-Soviet propaganda (in private conversations, he compared his luxurious life in Europe and New York to his impoverished life in the USSR). He was released in 1950 and lived in exile in Kazakhstan until 1958, when he was allowed to return to Moscow. His health was severely undermined by the years he spent in the prisoner camps and his poor heart stopped beating five years later in 1964, when he was at the age of 67.

Later, in 1971, Simon Kuznets (USA) awarded the Nobel Prize in Economic Sciences for his aforementioned discovery in economics, which was directly connected with Chizhevsky's research.

Here we publish the first complete English translation of this fundamental study by Chizhevsky, performed by me without any omissions or shortenings, in contrast to the very concise English translation published over fifty years ago in the journal *Cycles* (Jan. 1971, 11–27). I have committed myself to do this translation, because French as the language of international communication among scientists was replaced by English in the 1940s, and therefore most contemporary scientists cannot read Chizhevsky's fundamental monograph published in 1938 in Paris (except for native French speakers, who are not many). My very short corrections to the text are enclosed in square brackets.

We publish here this complete English translation on the 100th anniversary of the first edition of Chizhevsky's book (1924), from which I made this translation, i.e., we publish it in 2024, which is the year of maximum solar activity. — Editor's remark, D.R.

Summary

The principles of modern natural science have urged me to investigate whether there did not exist a correlation between the more important phenomena of Nature and events in the social-historical life of Mankind. In this direction, beginning in the year 1915, I have performed a number of researches, but at present I am submitting to the public only those which are directed towards determining the connexion between the periodical sunspot activity and 1) the behaviour of organised human masses and 2) the world historical process.

The following facts are based upon statistics gathered by me while submitting to a minute scrutiny the history of all the peoples and states known to science, beginning with the 5th century B.C. and ending with the present day.

1. As soon as the sunspot activity approaches its maximum, the number of important mass historical events, taken as a whole, increases, approaching its maximum during the sunspot maximum and decreasing to its minimum during the epochs of the sunspot minimum.

2. In each century the rise of the synchronic universal military and political activity on the whole of the Earth's territory is observed exactly 9 times. This circumstance enables us to reckon that a cycle of universal human activity embraces 11 years (in the arithmetical mean); see Fig. 2, Fig. 3 and Fig. 4, and also the historiometric cycle (Table 1).

3. Each cycle according to its historical psychological signs is divided into 4 parts (periods):

I. Minimum of excitability . . . . . 3 years;
II. Growth of excitability . . . . . 2 years;
III. Maximum of excitability . . . . . 3 years;
VI. Decline of excitability . . . . . 3 years.

The number of historical events in each cycle are distributed approximately according to the data for 500 years (15th–20th centuries) in the following manner (in the mean); see Fig. 1 for details:

Period I 5%;
Period II 20%;
Period III 60%;
Period IV . . . . . 15%.

4. The course and development of each lengthy historical event is subject to fluctuations (periods of activity and inactivity) in direct dependence upon the periodical fluctuations occurring in the Sun's activity. Formula: the state of predisposition of collective bodies towards action is a function of the sunspot periodical activity.

5. Episodical leaps or rises in the Sun's activity, given the existence in human societies of politico-economical and other exciting factors, are capable of calling forth a synchronic rising in human collective bodies. Formula: the rising of the sunspot activity transforms the people's potential energy into kinetic energy; see Fig. 5.

My studies in the field of synthesizing historical material have enabled me to determine the following morphological law of the historical process:

6. The course of the world historical process is composed of an uninterrupted row of cycles, occupying a period equaling in the arithmetical mean 11 years and synchronizing in the degree of its military-political activity with the sunspot activity. Each cycle possesses the following historio-psychological peculiarities:

a. In the middle points of the cycle's course the mass activity of humanity all over the surface of the Earth, given the presence in human societies of economical, political or military exciting factors, reaches the maximum tension, manifesting itself in psycomotoric pandemics: revolutions, insurrections, expeditions, migrations etc., creating new formations in the existence of separate states and new historical epochs in the life of humanity. It is accompanied by an integration of the masses, a full expression of their activity and a form of government consisting of a majority.

b. In the extreme points of the cycle's course the tension of the all-human military political activity falls to the minimum, ceding the way to creative activity and is accompanied by a general decrease of military or political enthusiasm, by peace and peaceful creative work in the field of state organizations, international relations, science and art, with a pronounced tendency towards absolutism in the governing powers and a disintegration of the masses. See Table 4.

7. The correlation with the sunspot maximum stand:

a. The dissemination of different doctrines political, religious etc., the spreading of heresies, religious riots, pilgrimages etc.

b. The appearance of social, military and religious leaders, reformators etc.

c. The formation of political, military, religious and commercial corporations, associations, unions, leagues, sects, companies etc.

8. It is impossible to overlook the fact, that pathological epidemies also coincide very frequently with the sunspot maximum periods (see Table 3).

9. Thus the existence of a dependence between the sunspot activity and the behaviour of humanity should be considered established.

One cycle of the all-human activity is taken by me for the first measuring unit of the historical process. The science concerned with investigating the historical phenomena from the above point of view I have named historiometria.

At present I am working on a plan of organizing scientific institutes for determining the influence of cosmic and geophysical factors upon the condition of the psychics of individuals and collective bodies, and devising a working method for them.

November, 1922 A. Chizhevsky

Dedicated to the memory
of the astronomer
Rudolf Wolf (1816–1893)

Social evolution proceeds under the direct influence of various economic, political and natural factors.

While the most serious attention has been paid to the detailed clarification of the laws of economics and politics, the study of the influence of natural factors has not received the necessary development.

Our work targets to reveal the rôle of some natural factors in the social movements of human groups.

This paper presents a brief and generally accessible extract from a special study of the influence of a powerful cosmic factor — periodic sunspot activity on the behaviour of organized masses and on the course of the world-historical process.

Introduction

With rare exceptions, in the entire history of Mankind we will not find facts of clear foresight by historical figures of the immediate future of their peoples and states or the final results of wars and revolutions. Historical events, when completed, always gave results different from those that were assumed at their origin. It seemed that what people and entire communities were striving for or wishing for was not what they turned out to be. Throughout its centuries-old culture, accompanied by the gradual development of the exact sciences, humanity has not clarified a single law according to which this or that historical phenomenon or event should proceed. True, the diversity of reactions to identical stimuli in human communities and the heterogeneity of responses to identical stimuli in the historical life of Mankind forced us to assume that chaos lies at the foundations of the fates of history, and the distribution of events in space and time is not subject to any laws.

This view was equally extended to short periods of history, to individual events — wars or revolutions, and to entire epochs, centuries and millennia, embracing human cultures and civilizations. Only the comparative method, applied to the study of history, has recently made some progress in the field of proving the opposite. The true rôle of the comparative method lies in the discovery of commonalities in the development of various historical events and in the discovery of precise rules for this development. Historians have succeeded in showing that both individual events of a more or less similar nature and long historical epochs have many identical features in their progressive movement; in other words, the events of history repeat themselves, which allows us to make appropriate generalizations (K. Lamprecht, O. Spengler). It is not for nothing that J. de Condorcet (1743–1794), in his famous work *Esquisse d'un tableau historique des progrès de l'esprit humain*, insisted on creating a hypothetical history of a single people by selecting facts from the history of all peoples and bringing them closer together.

History, until the present time, has, in all fairness, been more often recognized as a kind of knowledge than as a science.[1] Moreover, the skeptics of the late 17th and early 18th centuries were inclined to consider history simply a "conventional fairy tale" ("L'histoire n'est qu'une fable convenue" — an expression attributed to de Fontenelle, who is Corneille's nephew).

Indeed, the main property of science is a set of certain laws that subordinate phenomena in all their constituent parts. Identical phenomena, proceeding according to a certain law, must, other things being equal, yield the same results.

The failure of attempts to find historical laws involuntarily had led some researchers to the idea that human destinies are governed by predestination, which has the power to direct the course of the historical process in one way or another.

Others, recognizing chance as a characteristic phenomenon in history, already by this very fact considered history to be devoid of any lawfulness.

Finally, others — in free will, in the absence of visible external correctness in the historical actions of Man, saw the reasons due to which the course of historical phenomena continuously underwent various fluctuations that could not be either taken into account or classified.

Belief in the metaphysical dogma of free will was one of the main reasons hindering the objective study of history. And despite the fact that even today philosophers have not come to any definite conclusion on the question of will, scientists were forced to account for the absence of it even in the smallest and most insignificant actions on the basis of scientific achievements and to put forward a deterministic point of view to explain the most complex phenomena in the mental life of Man.[2]

Since the statistics of human actions, which has been widely developed since the remarkable works of A. Quetelet (1796–1874), in which he pointed out the regularity existing in them, i.e., when the constancy of various human actions was objectively revealed, the point of view on free will has changed: human manifestations had to be recognized as a reaction to stimuli by diverse agents of the external world.

Thinkers, whose knowledge did not flow from feeble self-affirmation, nor from the desire to distinguish themselves from the background of Nature and to exalt themselves above everything that exists, but from the ability to subtly feel the

[1] This opinion was ardently defended by Arthur Schopenhauer (1788–1860) in his opus *Die Welt als Wille und Vorstellung*.

[2] As an extreme expression of this view, one can point to the assumption made by P. P. Lazarev, a fellow of the Russian Academy of Sciences, based on the works of H. Zwaardemacker. The latter showed that the cause of the irritating properties of potassium salts found in the blood is their radioactivity. This Russian scientist considers it possible to assume that potassium salts accumulated in a certain place in the nervous system produce radioactive decay, which is the cause of irritation and excitation of certain centres in the brain; this should also entail the emergence of a thought process and cause certain actions in humans and animals (see his *Ionic Theory of Excitation*, Moscow, 1923, p. 149).

structure of Nature and directly understand the world as an indivisible whole, came to the same conclusion. The greatest poets Goethe and Tyutchev, with an extraordinary power of inner comprehension, expressed this in the following stanzas:

Nach ewigen, ehrnen,
Grossen Gesetzen
Mtissen wir alle
Unseres Daseins
Kreise vollenden.
Goethe

Imperturbable order in everything,
Complete consonance in Nature;
Only in our illusory freedom
We are aware of discord with it.
Tyutchev

Asserting himself, forming concepts for himself on the basis of personal experience, a person could assume that the course of events of a private or public nature is directly dependent on his arbitrariness. This led to the removal of the course of historical reality from a series of natural phenomena. Such convictions, having no points of contact with genuine science, forced one to see in history not a living consequence of the interactions of Man and the nature surrounding him, but only a posthumous record of events in the life of Mankind in the order of their successive ignitions and extinctions. Many branches of human knowledge made such great strides in the 19th century and in the two decades of the 20th century that they became necessary and irreplaceable in the practical life of people. But what has history given us? We would consider a person who would dare to speak about the "practical goals of history" not entirely sane. Despite the enormous amount of material collected by historians, the sophisticated methods of its development, despite the colossal work that scientists have accomplished, history, as it is, means no more than zero for the social practice of humanity.

History represents knowledge about the dead, about what is unnecessary for the ever-progressing life. It is an archive where inquiries have rarely been made and are being made, and the knowledge of which, all these "history lessons", have never taught anyone anything! People who were closely acquainted with history made the same mistakes, the same blunders that had already been committed. The latter occurred because the actors in history had no firm points of support, no well-founded landmarks in space and time that could guide their actions and direct the course of the events that they generated.

Thus, as long as Man believed in the teleological dogma of predestination, relying on super-rational intervention, as long as he saw something significant in his will, he could not stumble upon the path of discovering the laws that govern his daily activities, his centuries-old destinies.

It is also necessary to note the fact that the field of exact disciplines did not touch history as a whole at all, even at the time when it penetrated the fields of psychology, subordinating the processes of consciousness to physical and mathematical laws. True, in the middle of the 19th century, attempts were made to apply the laws of Nature to explain phenomena in human communities. The English historian H. T. Buckle (1821–1862), on the basis of the richest data collected by science in the field of history, geography, economics, statistics, in his work *History of Civilization in England* tried to show that the methods and principles of the natural sciences should be applied to history, for history is the interaction between Man and Nature. Buckle insisted on studying the influence of environmental conditions on a person using statistics. In his opinion, the laws of history can be learned only through statistical observations of the activity of mass people, revealing the regularity of their mass actions. Only through the knowledge of general laws can history reach the level of science, and therefore knowledge of individual facts and personalities does not represent any scientific value.[1]

Almost simultaneously with Buckle, the American chemist and historian J. W. Draper (1811–1882) in his outstanding work *History of the Intellectual Development of Europe* (1856) expressed the idea that the historical evolution of peoples is governed by natural laws and is influenced by physical agents of Nature. Due to the fact that physical phenomena proceed according to strict laws, and historical phenomena do not represent the result of the action of free will, but are subject to a certain pattern, which must be discovered sooner or later.

The good attempts of Buckle and Draper, despite all their obvious usefulness, did not lead to a comprehensive study of natural phenomena and the mass movements of humanity occurring simultaneously with them.

And again, the main reason for the absence of such studies must be recognized as a blind, but general conviction in the independence of human mental and social activity from any physical and chemical phenomena occurring in the world around Man.

However, modern scientists strive to reduce psychological phenomena to physiological processes, in which they seek

[1] French sociologists and philosophers go even further in this direction, recognizing statistical data on mass movements as the true essence of history. Bourdeau in *L'histoire et les historiens* (1888) sees the ideal of scientific history in depicting history in statistical figures and mass events in formulas, considering the verbal depiction of events to be the subject of literature. There is some truth in such assertions. The fact is that the mechanical explanation of natural phenomena is gradually giving way to statistical explanations. Since the works of Gustav Theodor Fechner (1801–1887), mathematical statistics has included the doctrine of mass phenomena (Kollektivmasslehre) and has acquired enormous significance in the matter of revealing mass phenomena (Massenerscheinungen). By statistical explanation of a phenomenon we must understand its consideration as the resultant of a large number of complex and unclear phenomena governed by the law of chance. The achievements of science place the statistical method at the forefront of natural science. Biologists and sociologists, thanks to the works of K. Pearson, H. Bruns and others, are already widely using it, trying to understand a number of laws of Nature with the help of statistics and believing that the latter are the laws of statistics.

and then find a physical-chemical basis, and in the latter — the mechanics of elementary particles. This circumstance allows one to penetrate more deeply into the essence of mental life, closely connected with the life of the whole human organism and the external world surrounding Man.

Therefore, should not the methods and principles of physics and mathematics be applied to the study of the historical process and social evolution? The domain of physics is the entire Universe, the whole of it, and therefore physics must have its say in examining any question in the world.

It must illuminate the face of history with its laws on matter, link a human with Mankind, humanity with Nature by establishing laws for organic beings analogous to the laws of the inorganic world. Mathematics in theoretical synthesis must reveal the forms of historical phenomena and reveal the historical paths of peoples and humanity. Modern exact science is gradually entering this path.

The successes of biophysics over the past decades are beginning to deprive Man and his thought processes of that mysterious aura with which these processes have been surrounded for so many millennia. This is happening as a result of the merging of sciences on the basis of physical and mathematical analysis. The latter, when applied to the study of mental processes, gradually eliminates misconceptions about the supernatural origin of consciousness, the functions of which are expressed in physical and chemical transformations and are subject to mathematical formulas. Thus, human will becomes accessible to experience, and Man himself is transferred from the field of miracles to a series of natural physical and chemical phenomena.

Between the latter there are never-breaking connexions and continuous interactions, and therefore every natural phenomenon is dependent on the influences of the environment around it: in the life of Nature everything is consistent and everything is causally connected with each other. The world is a complex system of dependent variables, and not a museum of individual phenomena, nor a list of motionless facts.

In the light of the modern scientific worldview, the fate of Mankind, without a doubt, depends on the fate of the Universe. And this is not only a poetic thought that can inspire an artist to creativity, but a truth, the recognition of which is urgently required by the results of modern exact science. To one degree or another, every celestial body moving in space relative to the Earth, during its motion, has a certain influence on the distribution of the lines of force of the Earth's magnetic field, thereby introducing various changes and perturbations in the state of meteorological elements and affecting a number of other phenomena occurring on the surface of our planet. Moreover, the state of the Sun, the primary source of all movement and all breathing on the Earth, is in a certain dependence on the general state of the electromagnetic life of the world in general and, in particular, on the position of other celestial bodies. Does not this connect the intellectual development of humanity with the life activity of the entire Universe by amazingly subtle, but at the same time majestic connexions? The world process, embracing all aspects of inorganic and organic evolution, is a phenomenon that is completely lawful and interdependent in all its parts and manifestations. A change in some parts, central and controlling, entails a corresponding change in all parts, peripheral and subordinate.

By including Man and his mental activity in the field of ordinary phenomena of Nature, modern science thereby gives grounds to assume a certain dependence existing between the manifestations of the intellectual and social activity of Man and a number of powerful phenomena of the natural environment. The life of the entire Earth taken as a whole, with its atmosphere, hydrosphere and lithosphere, as well as with all plants, animals and with Mankind inhabiting the Earth, we must consider as the life of one common organism.

Having adopted the above new point of view, it is necessary to admit a priori that the most important events in human communities, embracing entire countries with the participation of the masses of people, occur simultaneously with some fluctuations or changes in the forces of the natural environment. Indeed, any mass social event is a very complex system. To dismember, to break this system into several parts, simple and clear, and thereby simplify the understanding of the phenomena — this is the main task of natural-historical knowledge.

I have conducted a study of the course of historical phenomena in connexion with the periodic activity of the Sun.

The results of my research study in this direction are presented in *A Study of the Relationship Between the Sunspot-forming Activity and the Course of the World-historical Process, Beginning from the 5th Century B.C. and Until the Present Time*.[1]

Having discovered a known relationship between solar activity and the military-political activity of Mankind, I expressed my point of view on this phenomenon in the work *Fundamentals of Historiometrics*.

Here I present my proposed theory of periodic changes in the behaviour of organized masses of people, simultaneous with periodic changes in solar activity, as well as the principles of the 11-year cycle of general human, collective and individual, military-political and creative activity that I discovered. In addition, I established the basic and first unit of

[1] By "world-historical process" we mean *simultaneously* occurring social evolution in all human communities, dependent or independent of one another in their spatial position on the surface of the terrestrial globe. With this term we somewhat touch upon the long-expressed desire to unite history into a single whole. Thus, already in the 2nd century B.C. the Greek historian Polybius, and then 18 centuries later Bishop J. Bossuet (1627–1704) pointed out the need to develop a common view of history and establish a world-historical point of view. Bossuet in *Discours sur l'histoire universelle* (1681) wrote that, just as a single geographical map generalizes all countries and all peoples, so a common view of history would help to merge the histories of the development of various peoples into a single process of the world history of Mankind.

measurement for counting the time of the historical process and outlined the paths to discovering the *physical* laws that govern the course of social evolution.

I Social activities and general influence of the Sun

Taking into account the huge volume of the Sun, as well as the relatively small distance separating the Sun from the Earth, which is equal to the sum of 107 diameters of the Sun, it can be said that the Earth is under the direct and quite powerful influence of the central body of the Solar System.

The Sun is a colossal source of electrical energy, and its impact on the surrounding space can be divided into two main categories: radiation and induction.[1]

The radiation emitted from the Sun originates from the radioactive decay of its matter and carries with it negative and positive electric charges. The Sun is surrounded by an electromagnetic field extending beyond the outer planet of the Solar System — Neptune [Pluto had not yet been discovered at the time of writing], which is also influenced by the Sun, despite the fact that it is 30 times farther from the Sun than the Earth. Therefore, the terrestrial globe with its electromagnetic field is inside the electromagnetic field of the Sun, under its powerful action. The change in the relative positions of the planets and the Sun during their motion has some effect on the state of their electromagnetic fields. It is known that any motion of matter is simultaneously an electromagnetic phenomenon, since matter contains intra-molecular and intra-atomic electric fields that are set in motion when matter moves in space. Changes in the state of the electromagnetic field of the Earth are also influenced by fluctuations in the physical and chemical processes in the substance of the Sun. These processes, which reach enormous power during periods of maximum solar activity, cause electromotive forces to appear in many areas on the Sun; violent vibrations and ruptures of solar matter, motions of sunspot matter, etc. — all this should produce series of electromagnetic waves in the surrounding cosmic space.

The internal life of the Sun does not proceed uniformly, but continuously experiences rhythmic fluctuations of a more or less regular period, externally expressed in the appearance and disappearance of sunspots, their number, as well as other phenomena: sometimes solar activity increases and its face is covered with sunspots, reaching a maximum, then it decreases, falling to a minimum and thus undergoing the following four stages:

1. The stage of minimum;
2. The stage of increasing activity;
3. The stage of maximum;
4. The stage of degradation.

A complete cycle, which includes one maximum, one minimum and transitional stages, takes a period of time from 7 to 16 years (more often from 9 to 13 years). The periodicity of solar activity was discovered by H. von Schwabe (1851). In the arithmetic mean this period, as was found later, is equal to 11 years and, therefore, repeats itself 9 times in a century. Assumptions were also made that, in addition to the 11-year period of solar activity, there are also others — longer and shorter than 11 years. De Mairan (1746) already expressed the idea of long periods in solar activity and in the development of the polar lights. The Russian astronomer A. P. Gansky identified this period to be 72 years. Schuster (1906), using harmonic analysis, calculated a series of secondary periods following the 11-year period, namely: 4.48 years, 8.32 years, 9.25 years and 13.5 years. The most important period after the 11-year period, Schuster considers the period of 33.375 years — "one-third-century cycles", — which he found to be dependent on the period of revolution of the Leonid meteor shower around the Sun. Then, Dr. Elsa Frenkel (1913) found in solar activity a period of 200 and 68.5 days, which is similar to the period of revolution of Venus (224.7 days) and Mercury (87.9 days) around the Sun. Finally, H. Turner in the same year, on the basis of his hypotheses and calculations, came to the conclusion about the existence of a long-term period of 266 years.

The complexity of the spot-forming process [on the Sun] and the divergence of opinions about its periods forced me, due to the importance of solving this problem for my research, to inquire with the most important observatories about the latest (as of 1922) research results in this field.[2]

Based on a number of answers received, it can be said that, except for the 11-year period, none of the above periods has been firmly verified, and many eminent astronomers are inclined to doubt the real existence of some of them. However, it should be thought that the spot-forming activity of the Sun, in addition to the clearly detectable 11-year period, is subject to fluctuations of other periods, which have not yet been precisely established due to the insignificant amount of relevant material.

The reasons that force solar matter to perform rhythmic pulsations from century to century have not yet been clarified. However, external signs of increased vital activity of the Sun have been established with certainty: sunspots, prominences, torches, flocculi, filaments, alignments, the corona, and others, and their properties and relationships are now being clarified.

Of special interest are sunspots, because the question of the internal constitution of the Sun itself is reduced to them. As is known, spots appear on the Sun in two belts and for approximately 13–14 days, together with the Sun revolving

[1] Here I will not touch upon theories about the internal constitution of the Sun, its physics and chemistry, the temperature of its surface and internal parts, energy reserves, etc. The reader can find all this information in any astronomy textbook.

[2] Mount Willson Solar Observatory in Pasadena (Prof. Seth B. Nicholson), Eidgenössische Sternwarte in Zürich (Prof. A. Wolfer), Royal Observatory in Greenwich (Prof. F. W. Dyson), Steward Observatory in Arizona (Prof. A. E. Douglass) and others.

around its own axis, they pass along its disc, gradually disappearing behind its edge. Sometimes, after the same period of time, the same sunspots appear again. Sunspot formation has attracted the attention of scientists for a long time. And, despite the fact that many astronomers have carried out a number of observations and studies to explain the nature of sunspots and proposed a number of hypotheses (Herschel, Zöller, Faye, Secchi, Moreux), however, to this day this question is considered not to have been resolved in its final form and the "great mystery" of sunspots, in the words of Galileo (1564–1642), has not yet been revealed. Only little by little, thanks to the foundation of special solar observatories and the invention of amazingly precise instruments, scientists are beginning to penetrate into their nature. Outstanding works in this area should be considered the research of the American scientist George Ellery Hale and the French scientist H. Deslandres. Based on his spectroheliographic work, Hale put forward the bold idea that sunspots are colossal electric vortices. Meanwhile, it had long been proven that the essence of magnetism comes down to rotation and that during rapid rotation an electrically charged body generates a magnetic field (Rowland). Young in 1892 discovered the splitting of many lines in the spectrum of sunspots, but did not provide an explanation for this phenomenon. Finally, in 1908, a series of studies allowed Hale to discover the Zeeman effect (1896) — the splitting of spectral lines in a magnetic field — in the spectrum of sunspots, and thus the magnetic field of sunspots was proven. Based on these works, one can conclude that a sunspot is an enormous magnet. One pole of it is turned toward us, the other lies deep inside the substance of the Sun. The structure of sunspots (on the photos framed in the spectral line of hydrogen) turned out to be vortex-like ("solar vortices" according to Hale). Astronomers again had to return to the vortex theory of sunspots, proposed already by H. Faye. Indeed, Evershed and St. John noticed motions inside sunspots. Thus, using again spectral analysis, which is the most powerful method of research, a discovery of the greatest importance was made — the secret of the most grandiose electrical processes in solar matter. Consequently, the electrical essence of sunspot formation was discovered, but the reasons for the formation of sunspots themselves have not yet been clarified, despite all attempts.

Sir John Herschel (1792–1871) tried to explain sunspots by the fall of meteoric substance onto the Sun. Peirce (USA) and more recently Stephanie supported this hypothesis. The greatest English physicist Lord Kelvin (1824–1907) admitted such a possibility, explaining the acceleration of the equatorial motion of the Sun's mass by meteor impacts. H. Turner in 1913 made a splash with a similar hypothesis. Some astronomers explained the periodicity of sunspots by the influence of planets, such as Mercury, Venus, Saturn, Jupiter, the combination of whose revolution around the Sun was linked to the period of sunspots (Warren De la Rue, Balfour Stewart, etc.). Finally, Mrs. Maunder (1907) sought to show that the terrestrial globe also exerts an influence on the slowing down of the development of sunspots on the side of the Sun facing us.

Highly likely, the Sun is a huge resonator, quickly and sensitively responding to the motion of its Solar System and the influence of electromagnetic oscillations in outer cosmos. In this case, the cause of the appearance of sunspots should be sought inside the Sun itself, while we can admit the influence of external factors on their distribution in time and on the surface of the Sun, as well as on the variability of the strength of the sunspot-forming process.

During the period of maximum activity of the Sun, all phenomena on it assume grandiose proportions. The Sun throws up substances converted into vapors for millions of miles and emits streams of anode and cathode rays [proton and electron streams, respectively]. In this respect, the Sun is quite reminiscent of a radioactive body (A. A. Eichenwald), throwing out negatively and positively charged particles. The latter, rushing at considerable speed into cosmos, are driven away from the Sun by the pressure of light and are partly retained by the planets or their atmosphere. Streams of these particles, in the opinion of some scientists (Birkeland, Arrhenius, Nordmann, Paulsen, Villards), ionize the Earth's atmosphere, producing certain physical effects in it. Other scientists see the causes of these effects in the action of electromagnetic waves emitted by the Sun. The latter is less likely, since the magnitude of the magnetic fields on the Sun is insufficient to directly affect the Earth (Hale).

It should be noted, however, that the strongest perturbations of the Earth's magnetism always occur when large sunspots pass through the central meridian of the Sun (Loomis, Lord Kelvin, Terby, etc.). Ricco (1892) showed that magnetic disturbances lag behind by approximately two days from the time the spot is in the region of the central solar meridian. In the annals of astronomy, there are only a few cases, when anomalous movements occurred simultaneously on the Sun and on the Earth; these are the observations of Carrington on September 1, 1859, Trouvelot on August 16, 1885, and Hale on July 15, 1892. They try to explain the lag in the magnetic effect by the time it takes for particles of solar matter to travel from sunspots to the Earth (Arrhenius).[1]

The perturbative effect produced by the electrical processes on the Sun on many processes on the Earth is manifested with unvarying force with each increase in solar activity. Indeed, the periodic stresses of the Sun's spot-forming activity cause periodic fluctuations and disturbances in the physical life of the Earth. Below I cite several physical phenomena on the Earth, the relationships of which with the spot-

[1] We will not dwell on the discussion of the opinion of some scientists, which consists in the fact that the activity of the Sun and the physical phenomena on the Earth, synchronous with it, are co-effects of the same extrasolar cause, lying in the electromagnetic environment of outer cosmos. In examining this question, we, on the basis of weighty scientific data, and also, for the sake of easy understanding, accept the spot-forming process on the Sun as "causa efficiens".

forming process on the Sun have been surely established or are being established now:

— Magnetic storms (Sabine, Wolf, Gautier, 1852);
— Aurora borealis (Fritz 1853, Loomis);
— Cirrus clouds — cirrus, cirro-stratus, cirro-cumulus (Klein, Paulsen);
— Optical effects in the atmosphere — halos;
— Fluctuations of atmospheric electricity (Chree);
— Thunderstorms (Hess, Herbiger, Svyatsky);
— Movements in the atmosphere: cyclones, anticyclones, hurricanes, tornadoes, tropical storms (Meldrun);
— Coloration of the sky (Bush);
— Air temperature at the Earth's surface (Köppen, Nordmann, Mielke, 1913);
— Temperature of some seas (for example, the Norwegian Atlantic Stream);
— Polar icebergs;
— Precipitation (Symons, Moreux, etc.);
— Air pressure (Walker, Leist, Fedorov);
— Climate fluctuations or disturbances (Bogolepov);
— Earthquakes.

It should be noted that the parallelism of the three curves, which has long been accepted in science, is a graphic representation of the spot activity of the Sun, the frequency of the polar lights and the fluctuations of the Earth's magnetism. Assumptions have also been made about the influence of sunspot formation on the displacement of the Poles, St. Elmo's fire (Rudolph). Science is still too young to fully reveal the influence of the Sun. Perhaps the Sun is the cause of all regular, periodic phenomena on the terrestrial globe.

The influence of sunspot activity is not limited to the Earth. Scientists have managed to notice that sunspot activity affects many phenomena in cosmic space. The brightness of the colour of some planets, due to the increase in cloudiness and albedo on them[1] — Jupiter, Mars, Venus and the colour of the Moon during eclipses (Vogel, Danjon) change with the change in the number of sunspots. Comets, moving inside the Solar System, experience significant resistance during the periods of maximum solar activity, due to the abundance of electrical particles of solar matter in the space of the Solar System (Backlund). Finally, the tails of comets in the same periods of time have greater brightness, which allows ostronomers to discover more of them in these periods of time than in the intermediate years (Berberich, Bosler). In addition, it has been noted that the melting of polar snow on Mars occurs faster in the years of maximum solar activity than in the years of minimum (Antoniadi).

As for the dependence of the organic world of the Earth on the periodic activity of the Sun, this problem is still considered open in the literature on the subject. Meanwhile, the general influence of the Sun on the development of organic life has been carefully observed by many thinkers since ancient times and has been subjected to detailed study.

In my presentation of this influence, I will begin with the general influence and gradually move to the particular.

People have always felt their dependence on the Sun; they guessed that the destinies of the Earth are closely connected with the destiny of the Sun. Therefore, there is nothing surprising in the fact that from ancient times Man recognized this source of light, heat and life as his main god and represented him in anthropomorphic and zoomorphic images. The Hindu god of the Sun was Sūrya, or otherwise — Savitar[2], the Persian god of the Sun was Ormuzd; the Assyrians had Izdubar and Nimrod; the Babylonians had Marduk; the Egyptians — Osiris, Ptah, Ra; the Phoenicians — Hercules; the Greeks — Apollo, Helios, Phoebus; the Scandinavians — Odin; the Germans — Balder; the Slavs — Dazhdbog, Khore, Veles, Bel-bog, etc. The religions of the ancient East, the cults of Greece and Rome, the cults of Mexico and Peru, and finally the religions of the Lithuanians, Slavs, Germans and other peoples created sects worshiping the Sun and fire, as the earthly prototype of the former. Fire worship was developed in India and Persia. The hymns of the Rig Veda, composed in time immemorial, glorify the god Agni ("ignis" — fire); we find the cult of fire in the teachings of Zoroaster. Slavic holidays — Kolyada, the holiday of Marena, Kupala are associated with pagan rites of worship of the Sun. In Greece, temples were built to the Sun, such as in Corinth, Argos, Luxor. In Baalbek, a temple famous for its architecture was also erected to the Sun. On the island of Rhodes, at the entrance to the harbor, there was a colossal image of the sun god. The Greeks and Romans used sunlight to treat the sick, as indicated by Hippocrates, Oribasius, Antilius, Avicenna, Galien and Celsus. Entire cities were named after the Sun, for example, Heliopolis, near the Nile Delta. It can be assumed that Egypt itself ("Hakapta") received its name from its dedication to the god of the Sun — Ptah. Ancient art, fragments of which have come down to us, is full of deification of the daytime Sun. The cult of the Sun permeates the entire symbolism of the plastic art of the inhabitants of the White and Blue Rivers. Thus, the doctrine of the action of the central eternally life-giving fire, as the primary source of all that exists and the primary substance, occupies a central place in all mythologies, natural philosophies and arts of the peoples of the Old World.

The Sun served as the embodiment of the idea of the power of beauty and fertility. The Greeks called it "Βασιλενς Ηλιος", considering the Sun to be the main manifestation of life, the heart of the world, animating everything with its rays. Let us recall the great wisdom of the inscription on the ancient

[1] The ratio of the amount of sunlight that a planet's disc reflects to the total amount of light that falls on it.

[2] Sūrya and Savitar are names of the Sun in Sanskrit. They mean "to shine" and "to sound" (the root "sū" means "to fertilize"). The Sun was understood not only from the point of view of its "radiant power", but also its fertilizing, creative power.

temple of Diana in Ephesus: "... only the Sun with its shining light gives life!" Throughout ancient literature, medieval and modern poetry, one can hear an incessant hymn to our daily luminary — a song of praise, which, finally, in the words of the dying Turner, turns into a prayer: "the Sun is God!" And in our days, one outstanding French astronomer[1], taking into account, on the basis of the data of exact science, the greatest influence of the Sun on the Earth and Man, proposed that the French Astronomical Society petition the French government to establish a universal tax, insignificant in size, but fair in essence, for work on the study of the Sun, for Man's dependence on the Sun has no boundaries: "The Sun is one who shines for all and grows the crops of all, therefore, a priori, it seems fair that all people should contribute their share to solar research."

Even ancient thinkers attempted to determine the connexions between the state of the human organism and the fluctuations of the physical environment surrounding it, which depended on the Sun. The ancient Greek historian Herodotus (485–425 B.C.), while traveling, noted a number of facts showing the influence of natural conditions on the physical and mental development of Man. The famous Greek physician Hippocrates (460–377 B.C.), in his work "Περί αέρων υδάτων και τόπων" (which means "on the influence of air, water and terrain") made the first attempt at historical geography. The greatest philosopher of the Antique World, Aristotle (384–322 B.C.), was not alien to this issue. Strabo (born in 54 B.C.), Plinius the Elder (23–79 A.D.) and also Ptolemy (2nd century A.D.) studied the problem of the influence of climate on the development of Mankind. The same influence was pointed out by the Arab pragmatist historian Ibn Khaldun (1332–1406). Thinkers of the 16th–19th centuries, such as J. Bodin (1530–1596), S. de Montesquieu (1689–1755), J. Herder (1744–1803), K. Ritter (1779–1859), F. Ratzel (1844–1904), E. Reclus (1830–1905) and others tried to make all the variability of human races, characters, temperaments, as well as the historical destinies of peoples dependent on geographical conditions, mainly on climate. All this contributed to the creation of a special science about the influence of external nature on Man — anthropogeography. As an extreme expression of such views we can point to the so-called "geographical monism" or "geographical fatalism" (K. von Baer), the roots of which go back to the Middle Ages (Iohann Cochlaeus, 1479–1552).

But what is climate? This term should be understood as the average state of meteorological factors that create certain conditions for the existence of representatives of the organic world. The concept of "climate" is closely related to the concept of "life", and climatic conditions can only be considered in relation to the plant or animal world. The [ancient] Greeks believed that climate depends on the angle of incidence of the Sun's rays (climate, in Greek — κλίμα, κλίματος — means "inclination") and on the duration of illumination, i.e., on the geographical latitude of the place. However, ancient geographers overlooked the fact that the surface of the Earth is not the same and the terrestrial atmosphere contains vapors. The properties of the Earth's surface and the state of the atmosphere have a significant impact on climate. But the main factor of climate, its main element is still the radiant energy of the Sun. The great diversity of organic life on the Earth's surface is caused by those energy flows that burst into the atmosphere in the form of solar radiation. Is it worth dwelling on the long-known and well-known truth that the Sun is the only source for all forms of energy that we observe in the life of nature, beginning with the light breeze of zéphir [ζέφυρος, in Ancient Greek — light Western or Northwestern wind] and the gentle germination of plant seeds and ending with tornadoes and hurricanes, and also the mental activity of Man. All this is the work of the Sun, the creativity of the Sun.

From the point of view of modern science, all the most diverse and varied phenomena on the Earth — both the chemical transformations of the Earth's crust and the dynamics of the planet itself and its constituent parts, the atmosphere, hydrosphere and lithosphere, occur under the direct action of the Sun. It is known that the nature of chemical processes on the surface of the Earth changes, as a result of changes in temperature, with latitude, reaching the highest rate at the equator, while at the Poles we see only slow chemical reactions. There are, therefore, chemical zones of the Earth (A. Fersman) and they correspond to certain zones of the soil (V. Dokuchaev).

With a change in the latitude of a place and soil, its productive forces, the degree of its population, etc., change. The distribution of plant and animal species on the Earth's surface depends on the geographical location. As Alexander von Humboldt (1769–1850) showed and then Alphonse de Candolle (1806–1893) formulated in his work *Géographie botanique raisonnée* (1855), the lowest representatives of plants live in cold countries, the highest in hot countries. Each plant species is fully adapted to a strictly defined climate and has a precisely defined "climatic zone" of distribution. Today, four main groups of climates and corresponding zones of distribution of representatives of the organic world are distinguished (E. de Mortonne, I. Brunhes).

It has been established beyond doubt that green plants receive the energy they need for life directly from the Sun, which is thus the main source of their existence, facilitating the preparation of organic substances from inorganic substances. This is the global function of green plants, supporting the life and development of the entire animal kingdom. The process of photosynthesis occurs in the laboratory of chlorophyll grains. With their help, plants literally absorb the energy of the Sun's rays: the red rays of the spectrum dissociate carbon dioxide and synthesize carbohydrates that feed the plant (K. A. Timiryazev, 1843–1920). Solar heat, released in our organisms, furnaces and machine furnaces, determines all

[1] Henri-Alexandre Deslandres, Director of the Meudon and Paris Observatories, who carried out intensive studies on the behaviour of the atmosphere of the Sun.

our movements and all work performed in factories.

Then, the importance of green plants should be considered from another side — from the side of their cosmic role; representing an intermediate link between minerals and animals, plants again, by means of solar energy, complete the circle of chemical transformations and thus facilitate the turnover of substances on the Earth and the replacement of carbon dioxide with oxygen. The annual consumption and expenditure of atmospheric oxygen, according to some estimates, is equal to 400 billion poods [an obsolete royal unit of mass equal to 40 pounds]. The increase in the number of individuals of the animal and human world should cause a gradual decrease in the oxygen supply and an increase in the amount of carbon dioxide. B. Weinberg (1907) came to the conclusion that the period of existence of Mankind under such conditions will not exceed 1 000 years.

Of course, it is premature to make such a pessimistic conclusion.

It should be thought that plants, with the help of sunlight, will continue to restore the chemical composition of the air that is necessary for us.

Plants show extreme sensitivity to sunlight: they make independent movements towards the sunbeam (positive heliotropism), placing their leaves perpendicular to the latter. In the morning, the leaves turn to the East, at midday they are set parallel to the ground, and in the evening they lean towards the West (H. Vöchting), because, in general, plants show the ability to make various movements, like thinking beings (J. Bose). The leaves of many plants have special organs that serve to perceive light — a kind of "eyes" (G. Haberlandt). However, plants do not have the same inclination to every part of the spectrum: the greatest heliotropic effect is shown by ultraviolet and then infrared rays; yellow rays do not have a noticeable effect on plant growth. It is interesting to note that the ultraviolet part of the spectrum has a predominant effect on the development of flowers in plants (J. Sachs). In a word, plants have a great inclination to the Sun. The life-giving influence of our daily luminary is best proven by the spring awakening of the plant world, the richness and splendor of tropical forms. The luxury of vegetation is directly proportional to the strength of sunlight — these words of J. W. Draper sound like a prophecy that has come true.

But light has a destructive effect on most microorganisms, changing their chemical processes within them or disrupting chemical processes in their environment. It is known that in the light, in presence of oxygen, oxidation processes are enhanced, and in the air, under the influence of ultraviolet rays, hydrogen peroxide and ozone are formed. Consequently, light excites disinfectant properties, justifying the Italian proverb: "Where the Sun does not look, there comes the doctor."

The distribution of animals, according to P. L. Sclater (1829–1913) and Alfred R. Wallace (1822–1913), depends almost equally on the geographical factor: in polar and temperate countries, according to Wallace's work *Geographical Distributions of Animals* (1876), mammals and birds account for 1/3 of the total number of higher animals.

The physical development of Man and animals is also determined by climatic zones. In this regard, Isidore G. Saint-Hilaire in *Essais de zoologie générale* (1841) wrote that the majority of genera and species reach their maximum growth in the warmest countries and fall to a minimum in cold countries. For example, let us take the south of Russia: in most cases, the isoline of the maximum average height (169–170 cm) of people is superimposed on the isotherm of +10 and +15°C (Ivanovsky).

Thus, the evolutionary stage of representatives of the organic world is in a certain relationship with the degree of strength and quantity of radiant energy of the Sun falling on a given area of the Earth.

Charles Darwin (1809–1882) in his theory of the origin of species, defining evolution as a process of interaction between organisms and their environment, devotes little space to the direct significance of the radiant energy of the Sun, although this energy, as we see, determines the spatial distribution and relative quantity of various forms of flora and fauna. It must be recognized that the electrical structure of solar radiation, revealed by recent achievements in physics, must have not only a secondary, so to speak, facilitating effect on the organic world, but the energy of the Sun, highly likely, is the main factor in the evolution of plant and animal organisms — a factor that acts continuously in relation to geological time and the geographical position of the place. Perhaps the causes of organic evolution, which is believed to arise spontaneously, lie in disturbances in the physical state and chemical composition of the external environment under the influence of sharp fluctuations or disturbances in nature, associated with fluctuations in solar activity. Disturbances in the external environment, as we shall see later, entail corresponding changes in the physical chemistry of organic beings.

Now I shall focus attention on the effects of the direct impact of the radiant energy of the Sun on organic bodies, beginning with the simplest animal organisms (protozoa) and ending with highly organized Man.

The influence of the Sun on living organisms, in the present state of knowledge, cannot yet be expressed by one universal formula, therefore it will be necessary to briefly list the effects of the influence of sunlight on the constituent parts of the animal organism: on cells, tissues, muscles, blood, etc.

For example, ultraviolet rays first excite and then inhibit cells, which is explained by irritation of cell plasma (Hertel). Under the influence of light, there is an increase in oxidative processes in cells (Quincke) and an increase in gas exchange of living muscle and nervous tissue (Moleschott, Fubini). Light affects the movement of the ciliated epithelium of the frog's esophagus (Uskov). Tissue regeneration occurs incomparably faster in the light than in the dark (Godnev). Intracellular life is also in a certain dependence on light: ul-

traviolet rays, through the hydrogen peroxide they form, affect diastases (Agulhon). The effect of hydrogen peroxide is used to explain the effect of ultraviolet rays on milk (Romer). There are indications of the effect of sunlight on the hypobronchial glands of gastropods.

The change in gas exchange in animals under the influence of sunlight should be considered very important. Moleschott demonstrated in 1855 on a number of animals that light causes an increase in oxygen absorption and an increase in the release of carbon dioxide. In the same direction, I note the experiments conducted by Loeb, von Platon, Speck, Alexander, Ewald, Dürich and others. Nitrogen metabolism is also enhanced under the influence of general gas exchange (Godnev). The maximum effect relates to the yellow and violet parts of the spectrum (Kogan); darkness contributes to a decrease in nitrogen exchange.

A number of authors (Schmidt, Fubini) found a greater weight loss in illuminated cats and frogs than in those in the dark. However, there is an opposite opinion about the effect of light on weight (Borisov); it is believed that light has a stimulating effect on the body, which helps to increase the absorption of food; this can result in an increase in the weight of animals and an increase in their growth. The latter is confirmed by Edwards, Beclard, Férè and others in a number of experiments. Short-length light waves produce a particularly strong effect on growth, as well as on other processes in cells and tissues. Consequently, by influencing the life of cells and tissues, light undoubtedly produces not only a local effect, but also has a certain effect on the general condition of the body. The effect of the Sun on the human body is primarily manifested in the change in the chemistry of the skin pigment, which plays a very significant rôle in heat regulation, in protecting the body from pathogens, etc. The rôle of pigment in connexion with the influence of light on it has been studied by a large number of researchers.

The effect of sunlight on the skin causes hyperemia of the vessels with dilation of the capillaries. This process affects not only the capillaries of the skin, but penetrates into the area of the deep-lying vessels, lowering blood pressure, which continues throughout the entire period of light action (Lenkei, Behrig, Hasselbach, Nogier, Aimes). Not all rays of light have the same effect on blood pressure. Blue light increases blood pressure more than red and green (Spirtoff).

When exposing the body to insolation, one can notice an acceleration of the pulse, which, if the sunlight is intense enough, occurs about 10 minutes after the start of the exposure. This is explained by the rapid expansion of the skin vessels, which stimulates the heart to contract faster. Influencing the blood vessels, sunlight does not remain indifferent to the physical chemistry of the blood itself. As Rollier, Revillet, Behring, Marquès and Lenkei claim, exposure of the body to the Sun causes an increase in the number of red blood cells, accompanied by a proportional increase in hemoglobin and a corresponding decrease in poikilocytosis. Careful works conducted by d'Oelsnitz and Robin established the fact that in the first hours after insolation, there is a progressive increase in the number of leukocytes, as well as polynuclears and eosinophils.

Changes in the chemical composition of the blood necessarily entail corresponding changes in the general condition of the body and its nervous tone. Brown-Séquard also showed that light affects muscle contractility. Moleschott, together with Marmé, exposed frogs to light and found increased excitability of nerves and increased muscular performance. Then Fubini proved that nervous tissue exposed to light releases significantly more carbon dioxide than tissue in the dark, but under the condition of maintaining the central nervous system and muscle activity (Moleschott, Loeb). In a word, the influence of light and the Sun is not limited to the periphery of the body, but extends deep into it — right up to the centres of higher nervous activity.

The fact that sunlight plays a huge role in the body's reactions was known to a number of scientists almost since the time of I. Newton (1642–1727). The great scientist understood what an important role the life-giving forces of light play. "By means of the vibration of this force", he claimed in his famous work *Philosophiae Naturalis Principia Mathematica* (1687), "sensations are excited and the organs of animals are set into voluntary movement, while this force spreads from the external sense organs through dense networks of nerve fibers to the brain and then from the brain to the muscles."

In the nowadays there is a special branch of medical science — phototherapy, which deals with the treatment of various pathological and neuropsychiatric diseases using light. The general effect of the latter, according to V. M. Bekhterev, a fellow of the Russian Academy of Sciences, increases the excitability of neuropsychiatric activity in general. Just as in the case of plants and animals, different parts of the spectrum have a different effect on the human body and mental activity, since different colors cause corresponding changes in the speed of physical and chemical processes in the body, in blood circulation, in the functions of the brain, etc. As early as 1876, the observations of the Italian professor Ponza established the unequal influence of different colours on the mental state of the mentally ill persons.

Another famous Italian scientist, psychiatrist and criminologist S. Lombrozo (1836–1910), in his book *Genio e follia* collected interesting data on the influence of the season, i.e., about the influence of a greater or lesser amount of radiant energy of the Sun on the state of human mental abilities. He established the coincidence of the development of insanity with a sharp increase in temperature in spring and summer. The maximum of mental illnesses, according to Lombrozo, occurs in July, the minimum — in December.

He also says the same about brilliant minds, whose creative powers reach their peak in May and September, the minimum of creative activity occurs in winter, when this activity

flares up only on the warm days of this time of year.

Consequently, warm and bright months and days turn out to be fruitful not only for plant or animal nature, but also for the human mind.

Indeed, if we trace the conditions for the emergence and development of civilizations, then we will clearly see that the greatest centres of human mental life are initially localized in places with optimum temperatures. This applies to cultures: Chinese, Babylonian, Egyptian, Indian, Antique, Arabic.

The low developed tribes to this day live either in equatorial or polar countries. Indeed, the influence of geographical latitude in history is noticeable. For example, civilized and populous cities lie between the two extreme isothermal lines of +16°C and +4°C. Chicago, New York, Philadelphia, London, Vienna, Odessa, and Beijing lie on the main axis of the climatic and civilized belt with the 0°C isotherm.

Thus, the average amount of radiant energy of the Sun corresponds to the most developed race and culture; the minimum and maximum — are accompanied by a less developed race and culture. *The forces of external nature bind or release the hidden potential of human spiritual essence and compel the intellect to act or to die.*

There is an opinion that warm countries provide people with easy-to-obtain food during their leisure time, which allows them to devote a significant amount of time to mental activities. If this is partly true, then it is also true that the acceleration of physical and chemical reactions in the body can also contribute to a more intense flow of brain activity. Aristotle noted that a rush of blood to the head changes the normal state of people, making them "poets and prophets". It is now known that a change in temperature correspondingly changes the rate of reactions. According to J. H. van t'Hoff, a 10° increase in temperature increases the rate of chemical reactions approximately twofold. The relative increase in the rate of reaction with a temperature increase of the specified number of degrees is called the temperature coefficient. Reactions occurring in the dark have a temperature coefficient different from reactions occurring in the light, namely, a significantly smaller one. Since at high temperatures the coefficient becomes small, reactions in the light, or photochemical reactions, are quite similar to reactions occurring under the influence of high temperatures. Thus, chemical processes occurring in organic nature are directly dependent on the temperature and lighting imparted to them. Such a dependence has been established for the rate of assimilation of carbon dioxide by plant leaves, the rate of heart contractions, the spread of nervous excitation, mental processes, etc.

It is not difficult to consider what a huge rôle the Sun plays only as a source of heat and light in the life of the entire organic world: starting from the Poles, towards the equator, accompanying the geographic latitudes, together with the increase in the amount of radiant energy of the Sun falling on the Earth, the speed of physical and chemical reactions, the rise of the evolutionary ladder of the plant and animal kingdoms, the growth of plants, animals and humans, the speed of the onset of sexual maturity, marriage, birth rate, etc., increase accordingly.

If the gradual change in the amount of radiant energy of the Sun received by different parts of the Earth, due to the spherical shape of the Earth and the tilt of its axis, has such a decisive influence on the general development of the biopsychic and physical life of the planet, then the question arises: *Are not the powerful fluctuations of solar activity associated with the ejection into space of countless streams of electrically charged particles of solar matter and the radiation of electromagnetic waves also manifested in the organic nature of the Earth*?

II On the relationship between the periodic activity of the Sun and the synchronous periodicity of the oscillations of the world-historical process

Even the 18th century Danish astronomer Christian Horrebow (1718–1776) wrote that observation of solar activity would lead to the discovery of the sunspot period and "only then will the time come to investigate how sunspots affect bodies governed and illuminated by the Sun".[1] Highly likely, even at that time there were assumptions and guesses that sunspots could not but have some effect on the life of the solar world.

In the 19th century, indications appeared of the relationship between the periodic activity of the Sun and some phenomena in organic nature on the Earth.

One comparison made by Sir William Herschel (1738–1822) is not without interest. He tried to establish a connexion between crop failures and the price of bread with the sunspot period[2], and Fergusson investigated the issue of crop yield fluctuations in India. In addition to the price of bread, the price of table wines in France, as statistical calculations have shown, is also related to the period of sunspots. Thus, in years of minimums, the price of wine is higher than average, in years of maximums — lower. The English economist W. S. Jevons (1835–1882), who was educated in many ways, both philosophically and scientifically, — not afraid of being known as an original, — pointed out at that time the connexion between phenomena that at first glance may seem to belong to completely different branches of knowledge: in his work *Commercial Crises and Sun-Spots* (1878) he set out his theory of the connexion between industrial crises and the periodic course of solar activity.

The same problem was touched upon by W. S. Jevons in his other work.[3]

[1] Young C. A. *The Sun.* International Scientific Series, D. Appleton & Co., New York, 1881, 321 pages.

[2] Henry T. Buckle (1821–1862), in his book *History of Civilization in England*, Longmans, Green, & Co., London, 1882, vol. I, p. 32, pointed out that, according to statistical calculations, the number of marriages is not determined by personal feelings, character or temperament, but is in turn in a certain dependence on the price for bread.

[3] Jevons W. S. *The Variation of Prices. Investigations in Currency and Finances.* Macmillan & Co., London, 1882, pages 145–147.

Indeed, if meteorological conditions are in any way dependent on the activity of the Sun, then, by affecting harvests, they can cause certain economic and financial crises. The latter should affect the course of world trade, which is thus linked to cosmic phenomena.

Then there were fleeting indications of a connexion between the epidemics of Asiatic cholera and the increased activity of the Sun[1], between cod fishing off the coast of Scandinavia and the process of spot formation on the Sun[2]. They tried to establish a connexion between the periods of maximum and minimum sunspots and mass appearances of locusts, identifying these periods as 11 years (W. Köppen). Camille Flammarion, based on 30 years of observations, noted that the time of flowering of chestnuts in Paris reveals a clear periodicity equal to the period of solar activity. The French astronomer Abbot Théophile Moreux in Bourges showed that the influence of sunspots is manifested, in addition to the world grain harvest, also on the grape harvest, the time of lilac blossoming in France and the arrival of swallows. Moreux's diagrammatic curves perfectly illustrate the coincidences of these phenomena.[3]

In 1918, the US scientist A. E. Douglass (Director of the Steward Observatory in Arizona), published a study that established that the thickness of the annual layers of old trees (such as, for example, 1 000-year-old Sequoia trees and others in Southern California) is directly dependent on fluctuations in solar activity. His research touched upon a deep historical layer of time.[4]

So, this is how the question of the relationship between various states of solar activity and manifestations of organic life on the Earth stood at 1915, when we, observing the sunspot activity of the Sun in the summer months of 1915, discovered the following fact: some periods of increased solar activity coincided with the development and intensification of military events on many fronts of the World War.

Later, Moreux wrote in his article *Le Soleil et nous* that he had noticed the following curious phenomenon, namely: world exhibitions, for example, those in Paris in 1867, 1878, 1889, 1900 and in Ghent in 1910, coincided with the minima of solar activity[5], and some wars and military campaigns over several decades with its maxima. This issue has recently attracted the attention of some researchers.

In Russia, D. O. Svyatsky in 1917–1918 collected a small but interesting material concerning the same issue and published two notes in the journal he edited.[6]

V. M. Bekhterev, a fellow of the Russian Academy of Sciences, in his extensive work *Collective Reflexology*[7], speaking about the connexion between human activity and external nature, and then establishing the "law of dependent relations", touched upon this curious issue and pointed out that "dependent relations in the social environment are not limited to the circle of only the surrounding nature of our Earth, but have a significantly broader spatiality, extending into the depths of the Universe with its inexhaustible amount of world energy flowing to us".[8]

Whether the phenomenon of correspondence that we observed in 1915 was a simple coincidence or whether there really was some kind of relationship between phenomena on the Sun and military events on the Earth, but having become interested in these strange coincidences, I made the first attempt to find one or another explanation for them back then. Assuming that the starting point for the development of any event in human societies is the centres of higher nervous activity, I first of all focused on the question of what influence the formation of a sunspot can have on the behaviour of a person who, despite strategic, diplomatic and other obstacles, strives to intensify his military or social activity simultaneously with the intensification of the activity of our daily luminary. Then, using astronomical data on the Sun and the chronology of history, it was easy to verify the remarkable coincidences of some of the most important events in the life of Mankind over the past 300 years with the maximums of solar activity.

But the events that followed soon after tore me away from my current work for a long time, stopping the implementation of my planned research. Only when the excitement of the last revolution [the 1917 Revolution in Russia] had somewhat died down I got the opportunity to think about independent work and to renew in my memory the main principles of my theory.

Dissatisfied with the coincidences of solar activity and the activity of Man that I have discovered over a comparatively short period, I decided to trace whether the same dependence existed in historical epochs more distant from our time. This work of comparisons, as we will see below, contributed to the establishment of some extremely important facts that I laid as the foundation for a new understanding of the development of social events and the course of the historical process.

First of all, I have to turn to sources that testify to the state

[1] This problem was studied in detail and presented in my other work: Chizhevsky A. L. *The Influence of Periodic Activity of the Sun on the Emergence and Development of Pathological Pandemics.*

[2] Shokalski Yu. M. *Oceanography.* St. Petersburg, 1917, page 523.

[3] Moreux T. *Le problème solaire.* Ed. Bertaux, Paris, 1900, 343 pages.

[4] Douglass A. E. *Climatic Cycles and Tree-Growth. A Study of the Annual Rings of Trees in Relation to Climate and Solar Activity.* The Carnegie Institution, Washington, 1919, issue 289.

[5] It is interesting to note that the Russian Agricultural Exhibition planned for the summer of 1923 in Moscow will also coincide with a minimum of solar activity.

[6] *Proc. of the Russian Society of World Studies* (*R.O.L.M.*), 1918, vol. VI, no. 6 (30), page 310, and also 1919, vol. VII, no. 1 (31), page 39.

[7] 1921, pages 409–412.

[8] Ernest Millard attempted to establish the dependence of historical phenomena on such a natural factor as secular fluctuations in the Earth's magnetism in his work *Une loi historique*. He considered 500-year fluctuations in the Earth's magnetism to be a period in the development of human society (see *Historische Zeitschrift*, 1909, Bd. 102, 654). See also: Reclus E. *L'Homme et la Terre*, en 6 livres, Ed. Librairie Universelle, Paris, 1905–1908, Le livre I — Les Ancêtres, Chapitre 1.

of solar activity in the historical epoch.

Observations of the Sun, the number of spots have been recorded since 1610, since their discovery by Galileo (1564–1642), Johannes Fabricius[1] (1587–1615) and also Father Christoph Scheiner[2] (1575–1650). At first, these observations were not accurate, were random, telescopes were poor, and there were relatively few observers (in England, the Sun was observed by 6 people, in Germany — by 5, in France — by 4, and in the Netherlands — by 1).

Only in a short period of time, since the observation methods were established and the network of observation points was expanded[3], do we have reliable material on the activity on the Sun. But the periods of the first observations, the data about which were carefully collected by Rudolf Wolf (1816–1893) in his *Sonnenflecken Literatur* (1856) provided the opportunity to outline the dates of the maxima and minima of the sunspot activity, which was already given by Wolf in 1749 and then processed and continued to this day by A. Wolfer in tables and graphs (he published in *Astronomische Mitteilungen*, Zürich).

As for the epochs standing older than 1610, astronomy, except for some random indications, had no material for judging the distribution of solar activity cycles in them. Only some information from ancient Chinese (Chinese Annals), Arabic, Russian and Armenian chronicles, as well as from Western European city chronicles and annals (Chroniken der deutschen Stadte), partly collected by me, partly from already prepared data (de Mairan, Arago, Hiragama, Svyatsky), helped to outline the approximate epochs of maximum solar activity stresses for the period of time from the first Chinese observation in 188 A.D. to the aforementioned period with significant gaps, sometimes reaching several decades.[4]

This information concerned mainly some meteorological and optical phenomena developing in the atmosphere usually during the time of maximum solar activity. Sometimes there were also direct indications of the size, shape and number of sunspots, observed, of course, with the naked eye. All this data was not distinguished by accuracy and therefore required careful study, verification and careful systematization.

The very first steps in this direction revealed to me a truly amazing picture: the fluctuations of the historical process turned out to be simultaneous with the fluctuations of the physical and chemical processes in solar matter.

Further work showed that *although the historical life of Mankind does not calm down for a minute and continuously flares up now in one, now in another part of the Earth — at the moments of maximum solar activity it receives almost complete development over the entire surface of the planet.*

First of all, I had to develop a method of statistical accounting in equal units and classification of historical phenomena involving masses of people. This work presented many difficulties. It was necessary to resolve the question of what to take as a unit of accounting. Any historical event can be considered both in relation to quality (the significance of the event in the historical life of the people, its influence on other events, etc.), and in relation to quantity (for example, the number of people participating in the event, etc.). However, neither qualitative nor quantitative accounting of all events turned out to be completely impossible, because what could be precisely established for one event was inaccessible for another. In addition, a number of incidental phenomena (the duration of events, the space covered by the event, etc.) made it difficult to establish the feature of the event that interests us.

It was necessary to choose a *general method*, i.e., one that would be suitable for accounting for any historical phenomenon. To accomplish our task, I had decided to take as a unit of measurement the following:

1. The beginning (the first rise of the masses of people) and
2. The highest point of social tension (if such can be determined)

} of each mass event of more or less major historical significance.

My main attention was paid to the dates of the emergence of historical events, i.e., the dates of the first rise of the masses of people for achieving one or another goal.

The final conclusion was obtained after a long work as a result of a detailed statistical study of the history of the majority of states and peoples [they are listed below], inhabiting all five continents of the globe and known to science, starting from 500 B.C. and ending in 1914, i.e., for 2 414 years.

In order to get acquainted in detail with the history of all the listed peoples, countries and states, I used the sources and manuals in ancient and modern languages that were available to me at the time I was living through.

[1] Johannes Fabricius was the first to lay the foundation for solar physics by describing his observations in the opus *De maculis in sole observatis et apparente earum cum sole conversione narratio, cui adjecta est de modo eductionis specierum visibilium dubitatio* (1611).

[2] From the manuscripts of Thomas Harriot it is evident that this English astronomer was a competitor [to Galileo] in the discovery of sunspots, for he first observed them on December 8, 1610.

[3] Kew [a district of London], Zürich, Chicago, Greenwich, Medon, Cape of Good Hope, Kodaikanal, Dehra-Dun, Mount Wilson and others.

[4] While the solar corona was well described by Philostratus and Plutarch, the first date of sunspots being noticed on the Sun should be considered to be 188 A.D., according to Chinese records collected and published by the Japanese astronomer Shin [Makoto] Hirayama (*Observatory*, 1889, v. XII, page 218). They were based on a table of 45 observations of solar Fridays for the period 301–1205 A.D., compiled by the Chinese encyclopedist Ma Duanlin (1245–1322).

True, the evangelists Matthew, Mark and Luke point to the darkening of the Sun, which allegedly occurred after the death of Jesus Christ. Ovid (*Metamorphoses*, XV) and Virgil (*Georgica*, I) speak of the darkening of the Sun at the death of Caesar in 44 B.C. Similar phenomena have been repeatedly described and can be explained by other causes, and not by the presence of colossal sunspots, for example, the so-called, "dry fogs" that sometimes obscure the light of the Sun and were mentioned by Johannes Kepler (1571–1630) and Gemma Frisius (1508–1555) [born Jemme Reinerszoon], a Dutch astronomer in Louvain.

1. Europe:
   Greece,
   Rome,
   Italy,
   Germany,
   Gaul,
   France,
   Iberia,
   Spain,
   Portugal,
   England,
   Ireland, Scotland,
   Holland,
   Netherlands,
   Norway,
   Sweden,
   Denmark,
   Switzerland,
   Hungary,
   Austria-Hungary,
   Turkey,
   Romania,
   Russia,
   Lithuania,
   Poland,
   Czech Republic,
   Bulgaria,
   Serbia, etc.
2. Asia:
   China,
   Tibet,
   Mongolia,
   Japan,
   Korea,
   Central Asian peoples,
   Huns,
   India,
   Indo-China,
   Ceylon,
   Indonesia,
   Siberia,
   Asian Russia,
   Afghanistan,
   Arabia,
   Eastern Roman Empire,
   Turkey,
   Persia,
   Palestine, Israel,
   Other ancient peoples.
3. Africa:
   Egypt,
   Carthage,
   Mauritania,
   Sudan,
   Abyssinia,
   Morocco,
   Congo,
   Other African nations,
   European colonies, etc.
4. America:
   Canada,
   California,
   Texas,
   Other United States,
   Mexico,
   Peru,
   Brazil,
   European colonies, etc.
5. Australia:
   European colonies, etc.,
   Tasmania,
   Oceania.

This work allowed me, on the basis of quantitative relationships, to state the following basic provisions characterizing the course of the world-historical process:

1. On different continents of the Earth, in different countries, among different peoples, dependent or independent of each other in political or economic terms, as well as in relation to the territory they inhabit, the main moments of their historical life, associated with the movement of large masses of people, tend to be synchronous; the number of historical events occurring simultaneously in different parts of the Earth gradually increases with the approach to the maximum of solar activity, reaching the greatest number in the epochs of maximums, and decreases with the approach to the minimum of solar activity.

   This allows us to consider each cycle of historical events of the world-historical process as *universal*.
2. In each century, the universal cycle of historical events is repeated exactly 9 times. Throughout the world history of Mankind, beginning with 500 B.C. and until the present time, in each century I have discovered 9 clearly outlined concentrations of the initial moments of historical events.

   Thus, it can be considered that each cycle of the general historical, military or social activity of humanity is equal, on average, to 11 years.
3. The epochs of concentrations of historical events are divided among themselves by epochs during which the number of new historical events falls to a minimum.
4. The epochs of concentrations of historical events coincide with the epochs of maxima of solar activity; the epochs of rarefaction coincide with the epochs of minima of solar activity.

   For the time since 1610 about the last provisions must be considered fully established, in view of the significant amount of historical data, and then the accuracy of observations of solar activity.[1]
5. More or less prolonged historical events, continuing for several years and receiving a decisive manifestation in the era of maximum solar activity, as well as the evolu-

[1] In the beginning of my research, I assumed that the abundance of mass movements recorded by history, regardless of their intensity, would have to harm the establishment of quantitative relationships in different periods; however, even minor mass movements of peoples and small episodes, taken on a par with major historical phenomena, could not prevent the discovery of a periodic pattern of concentrations and discharges.

True, in such a case the difference in the number of events during periods of the cycle [of solar activity] opposite in intensity was sometimes not so clearly revealed; but this is simply explained by the presence of a significant number of secondary and minor phenomena taken into account. The objections that can be made in this direction find a sufficiently weighty rebuff in the following words of P. P. Lazarev, a fellow of the Russian Academy of Sciences: "For the construction of a theory it is especially advantageous if experimental methods and observations do not immediately provide data with a high degree of accuracy, and thus make it possible to ignore the mass of secondary accompanying phenomena that complicate the establishment of simple empirical patterns. In this regard, for example, the observations of Tycho de Brahe, which gave Kepler the material for creating his laws, were precisely sufficient in accuracy to characterize the motions of the planets around the Sun in the first approximation. If, on the contrary, Kepler had obtained those most precise observations that can be had in our time, then, of course, his attempt to find an empirical law could not have led to simple and sufficiently clear results due to the complexity of the entire phenomenon and would not therefore have given Newton the material from which the theory of universal gravitation was created" (Lazarev P. P. *Research in the Ionic Theory of Excitation*, Part I, Moscow, 1916, page 6). In this regard, we remind the reader of one scholastic axiom, which was pointed out by Sir W. Hamilton (Sir W. Hamilton. *Discussions on Philosophy*. 2nd edition, London, 1853, page 630): "Frustra sit per plura quod fieri potest per pauciora" (it would be futile to cite more numerous reasons for something whose origin can be explained with the help of fewer of them).

tion of ideologies, mass sentiments, etc., accompanying these events, proceed according to a general historical cycle, undergoing the following clearly detectable [successive] stages:

I. The stage of minimum excitability;
II. The stage of increasing excitability;
III. The stage of maximum excitability
IV. The stage of decreasing excitability.

These four stages (let us call them *periods*) tend to coincide completely with the corresponding eras of solar activity: minimum of sunspots, an increase in the number of sunspots to their maximum, their maximum, and then decrease from the maximum with a transition, again, to a minimum of sunspots.

As is known, the transition from minimum to maximum solar activity occurs somewhat faster than the transition from maximum to minimum, i.e., sunspot formation increases faster than it dies down.

Based on the considerations provided in the item 5 [of the above list], I have found it possible to divide each historical cycle synchronous with the solar cycle into 4 periods:

Period I (minimum excitability) = 3 years;
Period II (increasing excitability) = 2 years;
Period III (maximum excitability) = 3 years;
Period IV (decreasing excitability) = 3 years.

The statistical accounting of world history events for 500 years (from the 15th to the 20th centuries) that I carried out using the method indicated earlier showed their distribution over 4 periods of the cycle, namely:

During Period I (3 years) of the cycle..... 5% of all historical events begin;
During Period II (2 years) of the cycle..... 20% of all historical events begin;
During Period III (3 years) of the cycle..... 60% of all historical events begin;
During Period IV (3 years) of the cycle..... 15% of all historical events begin;

and, therefore,

During 1 year of Period I of the cycle..... 1.7% of all historical events begin;
During 1 year of Period II of the cycle..... 10% of all historical events begin;
During 1 year of Period III of the cycle..... 20% of all historical events begin;
During 1 year of Period IV of the cycle..... 5% of all historical events begin.

The above allows us to consider one world historical cycle, consisting of 4 periods, as a model, as the basic unit of time measurement of the historical process, due to the [discovered] fact that the *internal structure of each historical cycle corresponds to the internal structure of all other historical cycles*; then, using the comparative-historical method, I conducted a study of all of the psychological and social manifestations of the mentioned [discovered] cycle, in order to then synthetically derive the laws governing the development of events in each period of the cycle.

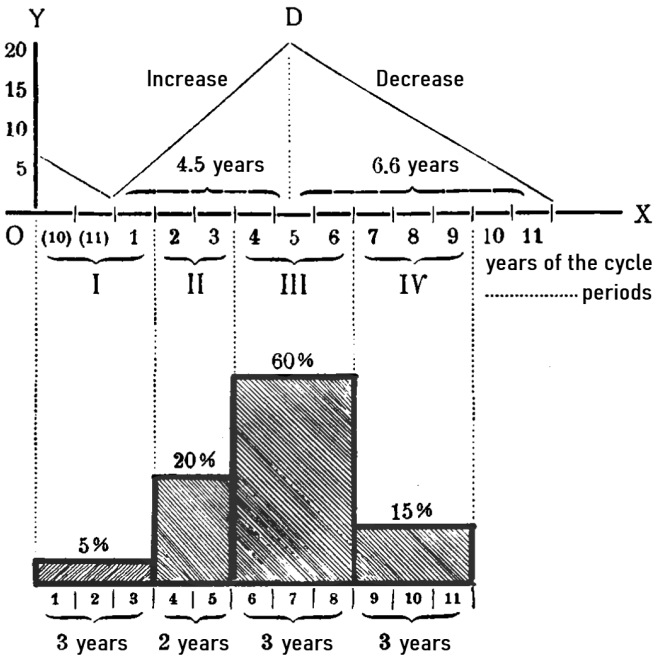


Fig. 1: Percentage ratio of occurrences of historical events to years and periods of the cycle. Average output for 500 years (15th–20th centuries).

I call the new branch of knowledge that arose on the basis of these considerations *historiometry*.[1] The first and basic unit of measurement for counting historical time is one cycle of solar activity, equal, on average, to 11 years.

I call this unit of historical time measurement a *historiometric cycle*, according to the above introduced terminology. Based on some data, we can make an assumption about the existence of other (multiples of the basic) periods in the historical life of Mankind. This issue is currently under my investigation.

A clear confirmation of all that has been said above can be found in the historiometric table and graphic representation of the fluctuations of the world-historical process presented here, compiled from the data attached to [my work] *A Study of the Relationship between the Sunspot-Forming Activity and the Course of the World-Historical Process, Beginning with the 5th Century B.C. and Until the Present Time*.

As we have just said, throughout world history we have discovered 9 historiometric cycles in each century. For ease

[1] Measuring historical time using physical units.

Table 1: Historiometric table for the period from the 5th century B.C. to the 20th century A.D.

	5th century B.C.		4th century B.C.		3rd century B.C.	
№№	11-year periods	Historiometric cycles	11-year periods	Historiometric cycles	11-year periods	Historiometric cycles
	(500)					
1	(489)	494—487	(389)	396—390	(289)	286—278
2	(478)	480—479	(378)	382—376	(278)	275—271
3	(467)	470—460	(367)	371—362	(267)	266—260
4	(456)	457—453	(356)	355—351	(256)	256—249
5	(445)	450—447	(345)	344—338	(245)	243—237
6	(434)	435—431	(334)	335—326	(234)	230—227
7	(423)	428—422	(323)	323—321	(223)	225—215
8	(412)	418—410	(312)	311—307	(212)	212—206
9	(401)	407—399	(301)	301—295	(201)	202—195
		2nd century A.D.		3rd century A.D.		4th century A.D.
№№	11-year periods	Historiometric cycles	11-year periods	Historiometric cycles	Solar activity (histor. chron.)	Historiometric cycles
1	(101)	101—106	(201)	197—201	301 ●	303
2	(112)	114—116	(212)	209—216	311	311—314
3	(123)	———	(223)	221—226	322	323
4	(134)	132	(234)	231—234	342	340
5	(145)	147	(245)	242	354 ●	351
6	(156)	162—167	(256)	248—251	359	357—363
7	(167)	173	(267)	260—269	374 ●	371—378
8	(178)	178	(278)	272—277(285)	388	383—391
9	188	184	(289)	295—296	395	394—397
		8th century A.D.		9th century A.D.		10th century A.D.
№№	Solar activity (histor. chron.)	Historiometric cycles	Solar activity (histor. chron.)	Historiometric cycles	Solar activity (histor. chron.)	Historiometric cycles
1	(701)	———	(797)	798—802	(896)	899—904
2	(712)	711—712	807	808—812	905	907—915
3	(723)	717—720	(818)	823—824	919—930 (?)	921—929
4	(734)	732—733	830	832—833	940	937—941
5	745	737—740	840 ●	841—846	(948)	944—947
6	(755)	752—759	848 (?)	856—859	956	951—955
7	765	———	860	865	(966)	961—969
8	778	772—782	874	875—878	974	973—978
9	786	787—793	(885)	885—891	979—993 (?)	981—988
		14th century A.D.		15th century A.D.		16th century A.D.
№№	Solar activity (histor. chron.)	Historiometric cycles	Solar activity (histor. chron.)	Historiometric cycles	Solar activity (histor. chron.)	Historiometric cycles
1	1307	1303—1307	1402	1398—1403	(1500)	1499—1502
2	(1312)	1311—1315	(1403)	1408—1415	(1510)	1509—1512
3	1325	1322—1330	(1424)	1419—1422	1520—1527	1517—1528
4	(1336)	1337—1340	1431	1427—1434	1537	1531—1536; 1542
5	1353 ?	1345—1353	1446	1443—1456	1551 ●	1549—1553
6	1365	1356—1365	1461	1458—1464	1560 ●	1558—1563
7	1372 ●	1368—1372	(1472)	1469—1471	1572 ●	1566—1573
8	1383	1377—1385	(1483)	1476—1485	1581 ●	1578—1582
9	(1394)	1388—1396	1490	1489—1495	1588 ●	1585—1592

Table 1: Historiometric table for the period from the 5th century B.C. to the 20th century A.D. (*continued*).

2nd century B.C.		1st century B.C.		1st century A.D.	
11-year periods	Historiometric cycles	11-year periods	Historiometric cycles	11-year periods	Historiometric cycles
(189)	191—189	(89)	90—82	(1)	6 – 9
(178)	186—183	(78)	78—72	(12)	14—19
(167)	171—165	(67)	69—62	(23)	———
(156)	156	(56)	58—51	(34)	———
(145)	149—143	(45)	49—41	(45)	42—45
(134)	135—133	(34)	33—31	(56)	58—59
(123)	126—118	(23)	27—25	(67)	64—70
(112)	113—108	(12)	16—12	(78)	78—85
(101)	105—101	(1)	———	(89)	91

5th century A.D.		6th century A.D.		7th century A.D.	
Solar activity (histor. chron.)	Historiometric cycles	Solar activity (histor. chron.)	Historiometric cycles	Solar activity (histor. chron.)	Historiometric cycles
401	401—406	**502**	507—510	**603**	602—604
(412)	408—415	(513)	515—517	(614)	614—618
(423)	419—420	**535**	529—536	**626**	622—628
(434)	429—433	(546)	539—543	(634)	633—637
450 ●	448—455	(557)	551—555	(645)	641—642
(467)	465	**566** ●	566—568	(656)	653
(478)	476	**577** ●	575	(667)	668—670
(489)	486—493	**585** ●	581	(678)	681—187
(500)	496	(596)	———	(689)	695—697

11th century A.D.		12th century A.D.		13th century A.D.	
Solar activity (histor. chron.)	Historiometric cycles	Solar activity (histor. chron.)	Historiometric cycles	Solar activity (histor. chron.)	Historiometric cycles
1005	1000—1004	**1104** ●	1103—1106	**1202** ●	1201—1205
1014	1012—1015	**1118** ●	1113—1119	(1213)	1211—1216
(1025)	1026—1030	**1129** ●	1124—1132	(1224)	1223—1228
1039	1035—1041	**1137** ●	1135—1139	**1238—1242**	1234—1238
(1050)	1044—1052	**1145**	1143—1147		1239—1246
(1061)	1056—1059	**1157**	1154—1162	(1253)	1255—1256
(1072)	1068—1073	(1168)	1166—1176	**1269**	1265—1270
1078 ●	1075—1085	**1185** ●	1182—1188	**1276**	1275—1282
1096	1093—1100	**1193**	1191—1197	**1292**	1285—1293

17th century A.D.			18th century A.D.			19th century A.D.		
Solar activity		Historiometric cycles	Solar activity		Historiometric cycles	Solar activity		Historiometric cycles
Max.	Min.		Max.	Min.		Max.	Min.	
1605 ●	1610.8	1596—1607	1705.5	1712.0	1700—1711	1805.2	1810.6	1797—1809
1615.5	1619.0	1612—1618	1718 2	1723.5	1714—1722	1816.4	1823.3	1812—1822
1626.0	1634.0	1624—1632	1727.5	1734.0	1728—1734	1829.9	1833.9	1824—1833
1639.5	1645.0	1635—1643	1738.7	1745.0	1737—	1837.2	1843.5	1835—1843
1649.0	1655.0	1647—1657	1750.3	1755 2	—1750	1848 1	1856.0	1845—1856
1660.0	1666.0	1658—1664	1761 5	1766.5	1756—1764	1860.1	1867.2	1857—1868
1675.0	1679 0	1666 —1677	1769.7	1775.5	1768—1775	1870.6	1878 9	1870—1877
1685.0	1689.5	1682—1689	1778.4	1784 7	1778—1781	1883.9	1889.6	1879—1888
1693.0	1698.0	1690—1698	1788.1	1798.3	1787—1794	1894.1	1901.7	1891—1900

Fig. 2: Average curves of fluctuations of the world-historical process for the period from the 5th century B.C. to the 20th century. The abscissa (horizontal line) shows the years, the ordinate (vertical line) shows the number of occurrences of the most important events in the world history of Mankind. The dots show pre-telescopic and then — astronomical data on the intensity of the Sun's activity; the dashes show its minima.

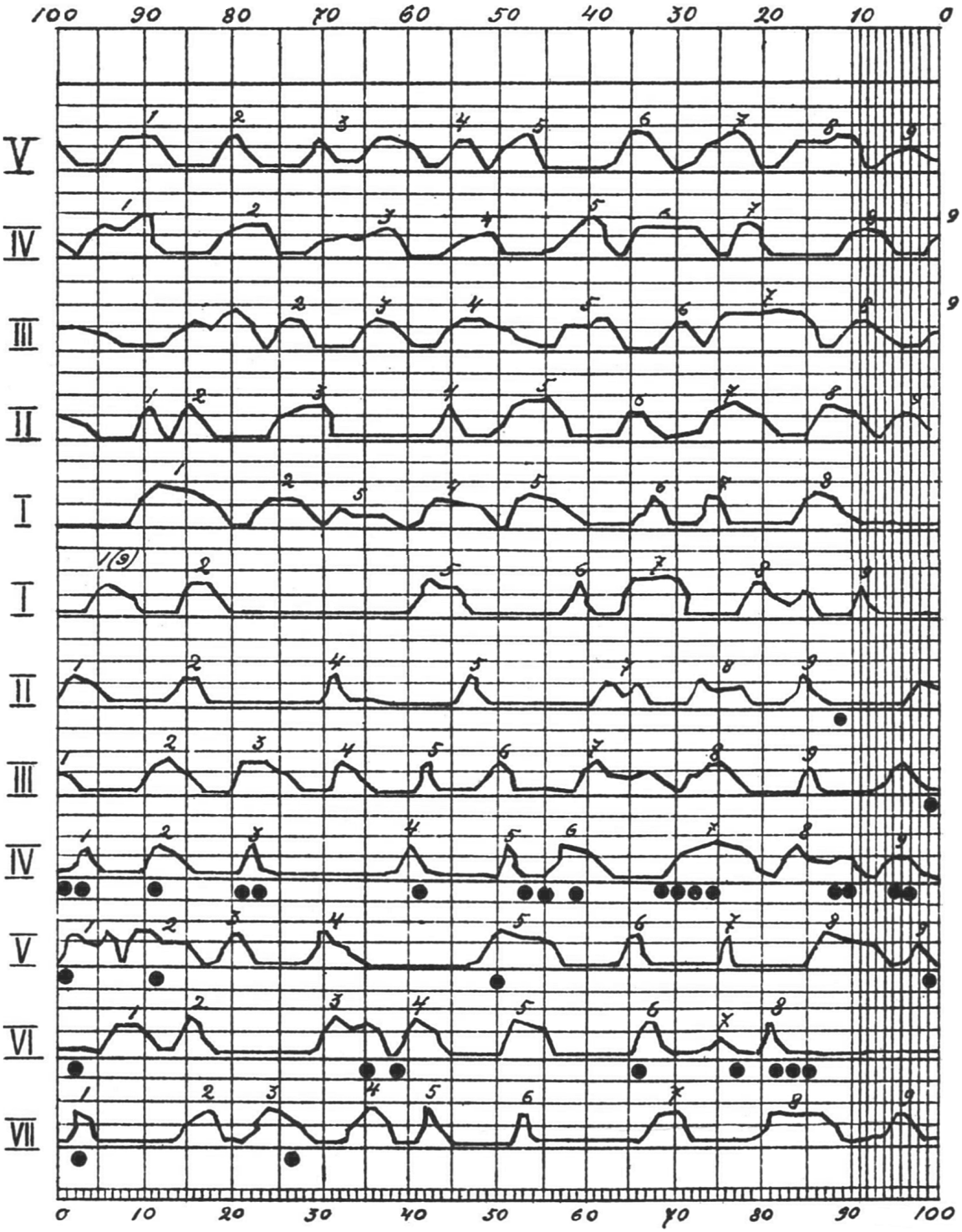


Fig. 3: Average curves of fluctuations of the world-historical process for the period from the 5th century B.C. to the 20th century. The abscissa (horizontal line) shows the years, the ordinate (vertical line) shows the number of occurrences of the most important events in the world history of Mankind. The dots show pre-telescopic and then — astronomical data on the intensity of the Sun's activity; the dashes show its minima (*continued*).

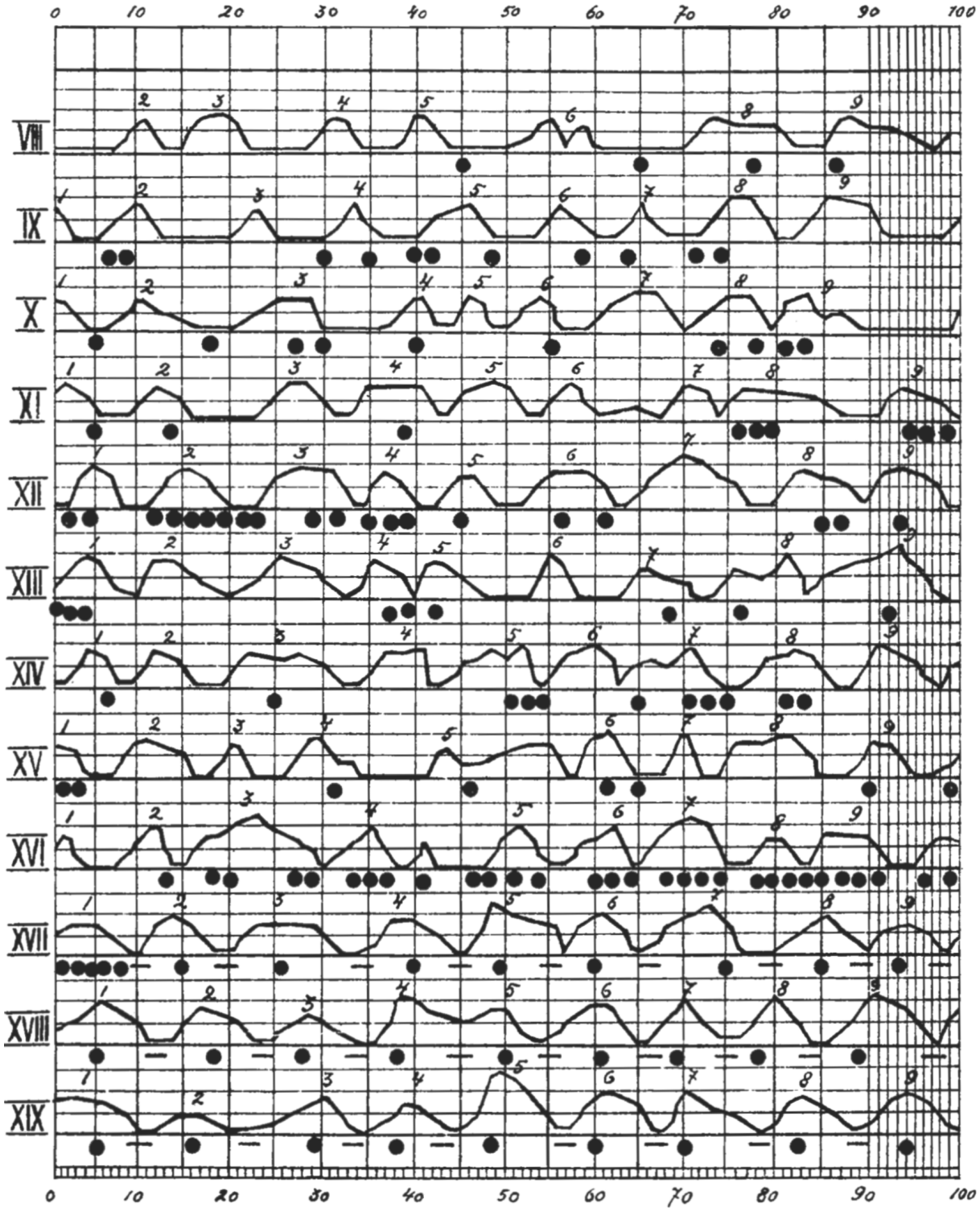


Fig. 4: Parallelism of the curves of sunspot activity (lower curve) and the global military-political activity of humanity (upper curve) from 1749 to the present time (1922).

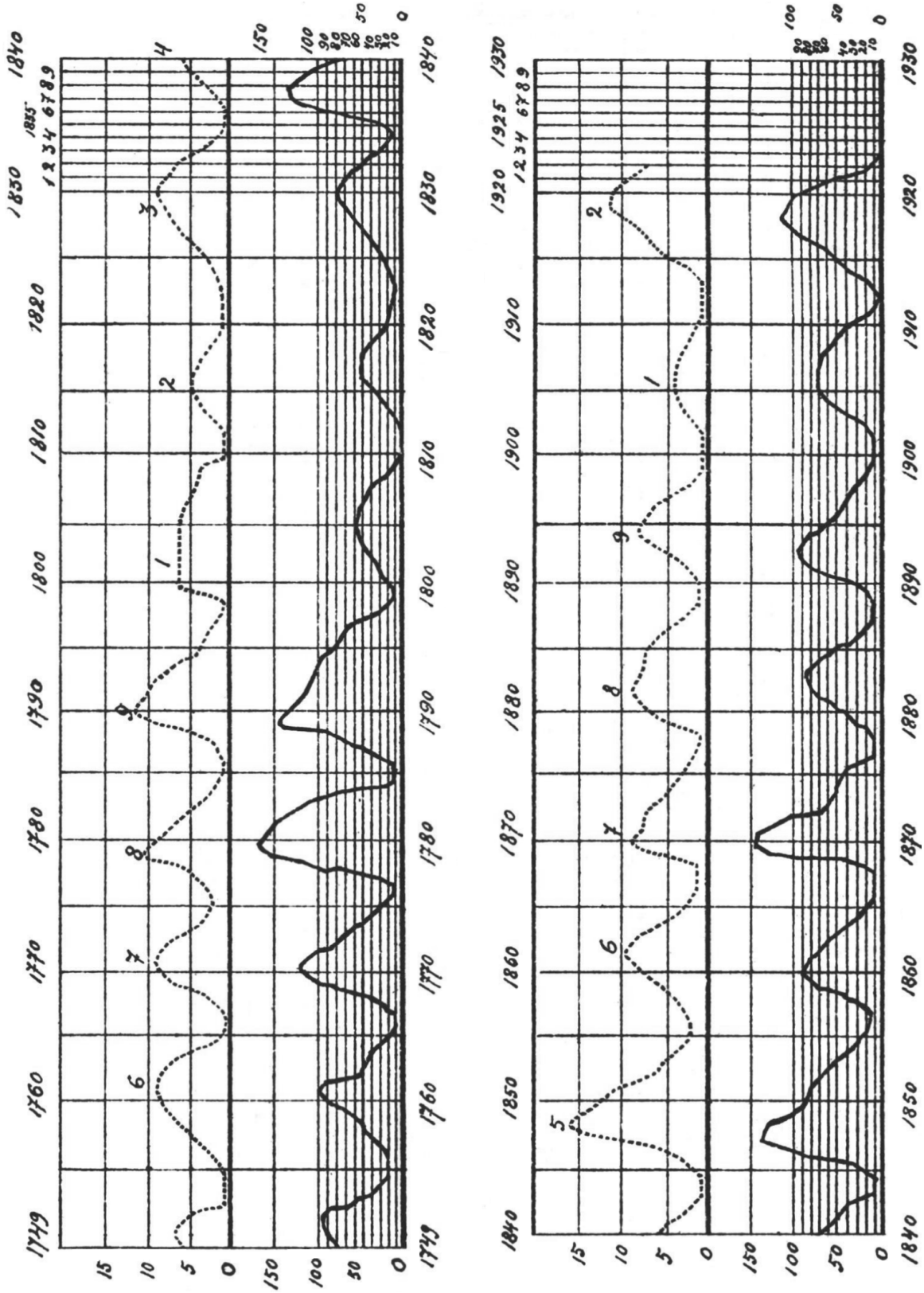
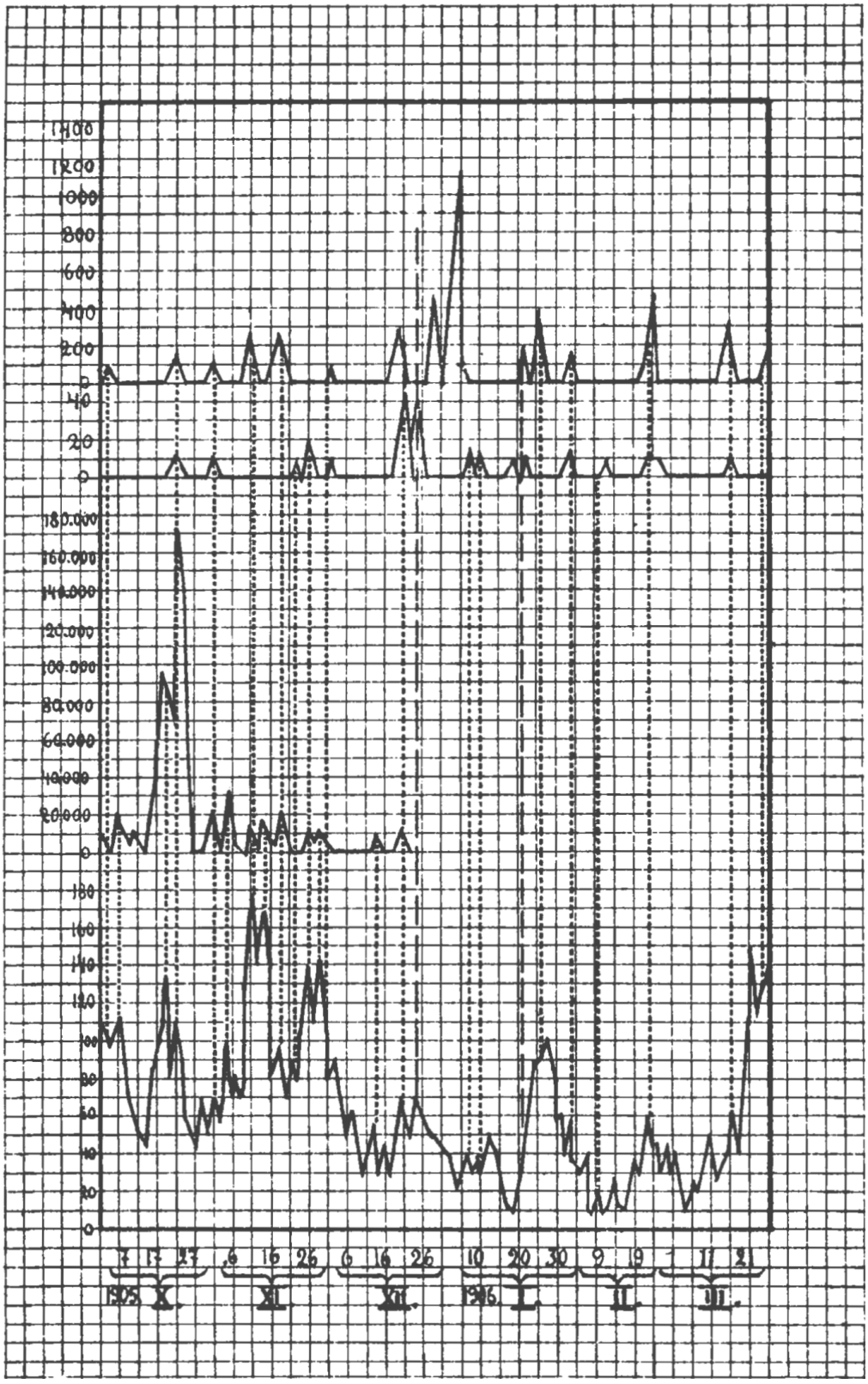


Fig. 5: Coincidences of increases in sunspot formation (lower curve) and outbreaks of revolutionary activity of the masses of people in Russia for the period from October 1, 1905 to April 1, 1906 (rallies and strikes, assassination attempts, immediate repressions).



of distribution they are numbered (from 1 to 9) and then collected in a table, the first attempt[1] at constructing which is attached here and to which significant amendments must be made during further study of the issue.

This table only shows the sizes of clusters (concentrations) of newly emerging historical events, as well as the sizes of pauses between them, i.e., the time of comparative calm and tranquility.

In addition, the historiometric table compares the following to clarify the relationships between the activity of the Sun and the [social] activity of Mankind:

1. From the 5th century B.C. to the 16th century A.D. — equal 11-year time intervals (numbers in brackets).
2. From the 2nd century A.D. to the 12th century — historical data on the state of the sunspot activity of the Sun (probable epochs of maxima are typed in bold; the most reliable of them are marked with dots.[2]
3. From the 17th century to the 20th century, astronomical data on the maxima and minima of solar activity according to the latest data.[3]

But the historiographical table does not show the moments of the highest tensions of the ubiquitous and general activity of Mankind.

The latter is clearly represented by the curves in Fig. 2 and Fig. 3, which should be considered fair only in general terms, due to the possible inaccuracy of historical data and some involuntary accounting errors.

The abscissa (horizontal line) shows the years, the ordinate (vertical line) shows the number of initial moments of the most important events in world history. The dots under the curves show the dates before telescopic observations, which testify to the intensity of the Sun's activity in the historical era, and then, starting from the 17th century, also astronomical data. The minima are indicated by dashes. When examining the curves, it is easy to notice that in most cases the curve seems to move away from the dots upwards; the dashes, on the contrary, seem to attract it to themselves. This means that the increase in solar activity is accompanied by the intensity of the combined activity of humanity and vice versa: its decrease coincides with a general calm.

It should be considered very important that most of the rises of our curve reach the highest point of the rise, the so-called points of greatest density, after which they gradually descend. This shows that each historiometric cycle, like the cycle of sunspot activity, has a moment of maximum tension, when events in the human environment erupt everywhere and intensely.

Some inaccuracy of the found coincidences means only the insufficiency of pre-telescopic observations and partly incompleteness of information about historical events. This has been completely eliminated over the last 4 centuries, when our curve (see Fig. 4) completely coincides with the average curve of solar activity.

The curves presented in Fig. 4 for the period from 1749 to 1922 are the best proof of this. Here we observe almost complete rectilinearity of the coincidence of the curves and the equal value of the corresponding ordinates.

As for the period of ancient history and partly the Middle Ages, as can be seen from Fig. 2, even in these eras we see in each century exactly 9 clearly outlined concentrations of events in world history and moments of maximum tension in human activity. As a result of all the above, it is necessary to admit that the fluctuations of the historical process in ancient times were also closely connected with the fluctuations of the sunspot-forming activity of the Sun and were subject to the same regularity.

III Social and psychological characteristics of one complete historical cycle

The motivation for dividing each [historical] cycle into 4 periods was the data obtained as a result of studies of historical events that developed in parallel with the corresponding changes in solar activity. Analyzing the course of each event separately and then comparing its known stages with similar solar activity stages of other historical events, it was not difficult to arrive at the conclusion that, despite the absence of any connexion between them, they all flow along an identical channel, making similar rises, turns and falls at certain moments. The most diverse events of world history were involved in this analysis, beginning with the ancient Greek and Roman uprisings and military campaigns and ending with the revolutions and wars of modern ages. Formal correspondences in the development of historical phenomena, sometimes having nothing in common with each other either in space or in historical time, but possessing a certain parallelism of evolution, are a motivating reason to assume the existence of some periodically acting factor, independent of local time or spatial conditions and endowing the course of various historical events with an internally obligatory, almost universal regularity and morphological identity. The distinctive features of the latter, although not stationary, are subject to fluctuations only within insignificant limits.

Synthesizing the collected material, I have obtained for each period of the historiometric cycle the following characteristics, briefly outlined here, a kind of ideal of the form underlying each historiometric cycle, which is free from various accidents and superficial phenomena of temporary or local significance.

[1] A more detailed experience of constructing a historiometric table, indicating the activity of the Sun in the historical era according to Douglass and Danjon, is attached to my mentioned work *A Study of the Relationship between the Sunspot-Forming Activity and the Course of the World-Historical Process, Beginning with the 5th Century B.C. and Until the Present Time*.

[2] *Proceedings of the Russian Society of World Studies* (*R.O.L.M.*), 1918, vol. VII, page 232.

[3] *Meteorologischen Zeitschrift*, Heft 10, 1916, Seiten 327–1922.

Period I of the historiometric cycle (the period of minimum excitability)

The characteristic features of this period are the following: disunity of human masses, indifference of the human masses to political and military issues, peace-loving mood of the human masses, compliance, tolerance, etc.

The appearance of these psychological signs in the historically active human masses in the 1st period of the cycle is usually accompanied by the absence of any desire for any struggle for an idea or right, and therefore entails easy capitulation, surrender, throwing down of arms, flight from the battlefield, etc.

Such behaviour of individuals or entire groups of people forces the ruling circles of the state to appropriate measures: concluding a series of truces with the enemy and, finally, peace; capitulation under harsh conditions, opening of diplomatic relations, declaration of neutrality, then disbandment of troops, etc.

In the memoirs of contemporaries and in historical studies, this period is noted for its general peace-loving mood, unwillingness to enter into any disputes, the end of most military actions and the triumph of the principle of non-intervention in international and national military-political life. Historians try to explain these facts by the exhaustion of moral and physical strength, mental fatigue after the unrest experienced, the breakdown of state unity, the cessation of the influence of the previously unifying cause, incapacity for combat, the fall or departure of the [former] leaders who had lost the trust of the masses of people and power over them, etc.

The aspirations of humanity in other fields of social activity also change: the flow of social life, falling into the channel of calm and peace, gets the opportunity to apply its quiet course to the achievement of other goals, to the solution of other problems.

Here the spiritual activity of Man begins, cultural values are created, pure art and science are placed in the corner of social life, replacing the stormy turmoil of recent days and devaluing with their achievements everything created hastily and precariously. In the period of minimum, humanity strives for calm, rests from the worries of previous years and gathers physical strength for the inevitably approaching new era of [social] unrest.

A study of the historical events that took place in the 1st period allowed us to establish a number of facts, according to which the period of minimum excitability contributes to [the following actions]:

1. The conclusion of peace treaties;
2. Conquest expeditions of a non-mass character;
3. Capitulation;
4. Occupation;
5. Maximum reduction of parliamentarism;
6. Strengthening of autocracy or rule by a few.

Period II of the historiometric cycle (the period of increasing excitability)

The psychological and historical complexity of this period required very extensive research, as a result of which I have collected considerable data relating to this period. Here I am forced to limit myself to only a general remark.

Already the beginning of this period in historical studies is characterized by a significantly greater rise in the excitement of human masses than in the preceding period. There is still no unity of the masses of people; only little by little do the parties and groups that had fallen apart during the period of minimal excitability begin to reorganize, leaders are outlined, programs are defined. The power of suggestion manifests itself among the human masses: statesmen, military leaders, orators, the press are regaining their importance. Questions, political and military, begin to appear from behind the horizon of public life and gradually become more acute. The tendency to perseverate homogeneous thoughts is noticeable everywhere, filling the mental activity of the human masses. In spite of the will of individuals, the concentration on the same military or political themes, in the presence of, of course, favorable reasons for this, gradually increases; ideas circulating among the human masses begin to dominate.

There is still hesitation and indecision in resolving important state issues, the conclusions have not yet matured completely, but preparations for war may already be thundering, the international situation is becoming complicated. However, the rulers do not yet decide to enter into open struggle or declare war: they are still hesitating, waiting for the right moment and anticipating its gradual growth of the general excitement of the masses of people. Indeed, soon, in a year or two, and sometimes less, the unanimous demand of the masses of people, aimed at resolving one or another issue, gains the upper hand. Now even persons who are far from military or political affairs are forced to join one or another political or military group.

At the end of the 2nd period, which can gradually assume a stormy character and reveal the impatience and nervousness of the masses of people, we notice one of the most important phenomena of the military-political life of communities, namely: the desire to unite the various nationalities that make up a given community for the purpose of defense or attack, and the merging of various political groups to counter other political groups.

The significance of this period is that it lays the foundation for the further development of historical events during a given cycle in a given human community and, in part, even predetermines their course during the period of maximum excitability.

The period in question does not always and in all human communities occupy the same period of time; its duration or brevity is determined by the state of solar activity on the one hand, and by the diversity of political, economic and other

factors on the other. In addition, this period, depending on the same reasons, takes on various forms of manifestation.

During the 2nd period, three main phases should be distinguished in the order of their gradual development: 1) the emergence of ideas among the masses of people; 2) the grouping of ideas, and 3) the identification of one main idea among the masses of a given human community by the initial moment of the 3rd period.

1. The emergence of main ideas during the first phase of the period of increasing excitability is directly dependent on internal state policy, economic and international military-political factors, which in this case are of equal importance: the economic condition of the state, the degree of organization and stability of power and the state apparatus; the international situation — the threat of war, blockade, occupation, etc., as well as on various moods and ideas wandering among large masses of people. If at a given moment in a given community there are no factors of dissatisfaction with the existing system or order of things, the above phenomena may not arise, which will cause a more or less calm course of the historiometric cycle. However, there are still no guarantees that sharp complications will not arise in the further development of the cycle; indeed, almost always, even with minimal presence of exciting causes, the subsequent period can be marked by some private events with local participation of human masses.
2. The bearers of ideas that have arisen in this way become a psychic centre for the formation of groups of people united by one basic idea. This process takes place in accordance with class consciousness, the financial level and the personal qualities of each individual. The groups of people that have formed in this way can put forward a new leader from among themselves in order to subordinate their psychic imbalance to a certain psychic centre, where incoming ideas are summarized, transformed into uniform directives and creating certain formulas of action for the organized group.
3. The third phase develops from the second and consists of: a) the identification of one supreme idea that absorbs many group ideas; b) the unification of a number of separate groups around the supreme psychic centre that subordinates the mass [of people], and c) the mass focusing [of people] onto one idea.

All three phases of the 2nd period sometimes develop quite mechanically, without the organizing participation of active individuals, completely unexpected effects of mass unity, for which they prepare for the approaching beginning of the 3rd period of the historiometric cycle — the period of maximum excitability. Thus, the need matures to resolve, first of all, the first fundamental question that worries the masses in the human community.

Period III of the historiometric cycle (the period of maximum excitability)

This is the main stage of development of each cycle, resolving the world-historical problems of humanity and founding new historical epochs. It incites humanity to the greatest follies and the greatest benefactions: it embodies ideas in life by means of the shedding of blood and the clanking of iron. If we wished to give a comparative-historical characteristic of this period, we would have to repeat the main events of world history: all of them, as the comparisons of the activity of the Sun and Man have shown, occurred in epochs of intense solar activity. In this period, the greatest revolutions and the greatest clashes of peoples took place, beginning new eras in the life of humanity and justifying with this the terrible formula of Heraclitus the Dark (ca. 535–475 B.C.): "Polemos panton esti pater kai basileus" — war is the father and king of everything. The parallelism of the activity of two substances remote from each other — solar matter and brain matter — manifests itself with particular clarity and clarity precisely during this period.

Here we cannot consider the significant amount of the [historical] material collected by me during the study of the period of maximum excitability. In [my work] *Fundamentals of Historiography* this problem is devoted many pages. Here I will point out only those main factors, the presence of which in the human masses determines the emergence and development of decisive events in human communities:

1. The stimulating effect of popular leaders, military leaders, orators, the press, etc. on human masses;
2. The stimulating effect of moods and ideas circulating in the human masses;
3. The speed of excitability from the unity of the psychic centre;
4. The size of the territorial scope of the mass movement of people;
5. The integration and individualization of the masses of people.

Never does the influence of leaders, military leaders, orators, the press, etc., reach such a tremendous force as during the period of maximum intensity of the sunspot-forming activity of the Sun. During this period, sometimes one well-timed word or one gesture is enough to move entire armies and the masses. One wave of the leader draws under the banners heterogeneous nationalities, which are part of the state, opposing parties, which make up the human community. In this era, the leader's word – his winged word – does an amazing job: the masses of people listen to him, obey him, while the whole streams of exhortations that were heard at every step during the period of the minimum could not lead to the desired result. Now even the leader's name, pronounced aloud, causes a powerful surge of inspiration. The masses follow the leader blindly, without thinking, carried away by a

whirlpool of acute excitement and ecstasy.

The power of the leaders' influence mechanically advances gifted individuals above the masses of people, without regard for traditional norms and established laws. And so, at the top of mass movements we see the greatest military and political geniuses that humanity has ever known, spiritual leaders, champions of freedom, founders of various human associations. All of them, having broken through the thickness of nations, as bright embodiments of the aspirations of the human masses of the given moment, are already leading them and with their help lay the foundations for new human formations, new forms of social life, new types of spiritual quests. Such advances, as a special study of general history shows, can only occur in the case of the unity of the masses of people, and the latter is observed exclusively in epochs and moments of increased activity of the Sun.

Of no less importance are ideas that appeal to the human masses during the period of maximum excitability. In this case, the influence of oral agitation, as well as the press, can acquire a decisive significance on the outcome of one or another political or military movement.

The period of maximum excitability may just be called the period of the emergence of the face of human masses and the sounding of the voice of the people. Historians are at a loss before the facts, which indicate that ideas which no one dared to speak of a year or two ago were now expressed openly and boldly; the human masses became more impatient, more restless, more excited; they began to raise their voices, to demand and to arm themselves. Demonstrations became more malicious and hostile, popular assemblies did not proceed peacefully: the masses of people imperiously demanded, sword in hand, recognition of their decisions; impulses were no longer restrained and, immediately seized upon by the masses of people, led to the overthrow of everything that agitated and disturbed the minds. Individual whims and pranks immediately became law, and punishment was meted out to anyone who attempted to contradict them; the [human] population was seized by a profound hatred for their enemies, who were given over to extermination, being paralyzed by some wondrous magic.

During the period of maximum excitability, sometimes the slightest pretext is enough for the human masses to flare up, rise up in uprising, or volunteer to a war. Even one rumor, put into circulation among the human masses, can lead to general unrest and uprising. What usually causes calm discussion during the period of minimum, at the time in question excites the human masses and leads to uprisings, wars, bloody episodes. The masses of people thirst for movement, the troops are restrained with difficulty, the soldiers are inclined to mutiny, and the people — to anarchy. In a word, the excitement increases unusually and the human organism seems to demand a discharge. This is explained by the fact that the combination of the above reasons causes a sharp change in the nervous and mental tone of the human masses, increasing their nervous and mental reaction to external stimuli. Individuals are unable to suppress their heightened reflex excitability, exhibiting very significant reactions even to weak and insignificant stimuli.

The memoirs of contemporaries testify to the astonishing speed of the spread of popular uprisings and mass [social] movements in general, which took place during the period of maximum excitability. Here, for example, are several descriptions of the speed of the spread of uprisings, taken from various sources: the uprising engulfed the country with extraordinary speed; in a few days, huge areas were raised to their feet; the entire population joined the rebels, as if by the wave of a magic wand; the uprising spread throughout the state with the speed of a hurricane; the uprising broke out almost simultaneously in different parts of the country; attracting huge crowds of people to its banners; the roar of the uprising rolled over the entire country with the speed of a thunderclap; the flames of international war engulfed vast spaces and the entire population — from small to great took part in the uprising. It is not for nothing that Titus Livius called social conflicts "infectious pestilence".

In addition to the speed of spread of mass movements of people, it is also worth noting the significance of territorial scope. Indeed, an uprising that began somewhere in one state can, given certain conditions, penetrate into neighboring countries. History knows examples when wars, uprisings and other mass movements, in a short period of time, covered huge areas — the lands of many peoples and even entire continents.

The basis of the above is the unanimity of the masses of people, which is especially clearly outlined in this period when resolving any military or political issues. Now, at the call of a leader, tens, hundreds of thousands of people can gather under the battle flags, inspired by one thought, one desire. In place of hostility, unanimity reigns and a common thought inflames minds. This unanimity in a period of maximum excitement is capable of miracles; even recent enemies can become friends in order to confront together the strongest and most formidable danger or to resolve a common and important issue for all. At such moments, nationality, party affiliation, and social status are partly obscured; private feuds subside and all who must, hasten to the designated assembly points. In a word, in the name of any military campaigns, uprisings, etc., complete agreement and peace are established in the country between the contradictory and previously hostile elements of the state. At such moments the whole country, as one person, is ready to pursue the intended goal. This consciousness of unity and complete solidarity in the masses of people destroys all disputes and squabbles. Mental contagion or mutual suggestion reaches its highest point, and the human masses turn into a collective personality — the [human] collective becomes individualized.

This brings with it various phenomena characteristic of any struggle, and mass movements of people usually undergo

abnormal deviations. Sometimes the height of the struggle reveals the entire vast area of human madness, instability and passion. Elemental violence, bitterness, frenzy, thirst for revenge, epidemics of murder, panic, pogroms, devastating raids, desperate battles, mass exterminations, bloodbaths, as well as uprisings, mutinies, coupled with the manifestation of fanaticism and heroism — reach their apogee. Crowds of people can rejoice at the sight of the most terrible violence, atrocities, murders. They invent the most excruciating executions. Madness is embodied in life. What was considered impossible and wild in the period of minimum excitability, in the period of maximum may well go hand in hand with morality and the loftiness of the ideals pursued. Before these impulses and manifestations of both the masses and individuals, as a result of the extraordinary state of psychic excitement, the feelings of danger, self-preservation, even instinct must die out.

Thus, the ground is prepared for the solution of questions of a world-historical nature — the ground on which systems of human communities are erected. Here events occur that hardly have equals in other periods of the historiometric cycle. We state the fact that the greatest revolutions, wars and other mass movements of people that created systems of states, laid the foundation for turning points in history and shook the life of Mankind on the territories of entire continents, tend to coincide with the epoch of maximum tension of solar activity and develop the highest intensity at the moments of its highest tensions.

The study of historical events that took place in the 3rd period allowed us to establish a number of facts, according to which the period of maximum excitability contributes to:

1. Unification of human masses;
2. Advancement of leaders, military leaders, statesmen;
3. Triumph of ideas supported by the human masses;
4. Maximum development of parliamentarism;
5. Democratic and social reforms;
6. People's power and limitation of autocracy;
7. Uprisings, unrest, riots, rebellions, revolutions;
8. Wars, campaigns, expeditions;
9. Emigrations, re-settlements, persecutions and other outbreaks of mass human activity.

Several examples from the huge number of coincidences of solar and human activity encountered throughout world history can serve as an illustration of the above.

The numbers indicate the dates of the eras of maximum solar activity (according to annals, chronicles and astronomical data) *completely synchronous* with the most important historical events (deviations do not exceed 2–3 years).

Based on this list, we can assume that such outstanding figures of antiquity as Miltiades, Themistocles, Cimon, Pericles, Lysander, Pelopidas, Epaminondas, Hannibal, Marius,

Turning points in world history:

1492 — fall of the Muslim states in Spain; discovery of America; beginning of Modern History;

1789 — the Great French Revolution; beginning of Modern History;

1917 — Revolution in Russia, which has a historical significance for the world.

The most important uprisings and revolutions:

1306 — the great uprising in England;
1358 — the great uprising in France;
1368 — the great uprising in China;
1381 — the great uprising in England;
1526 — the great uprising in Germany;
1648 — revolution in England;
1789 — revolution in France;
1830 — the July Revolution (France);
1848 — the February Revolution (France) and the pan-European crisis;
1860 — uprising in Italy;
1870 — the Paris Commune;
1917 — revolution in Russia.

Crusades:

1094–1096 — 1st Crusade
1147 — 2nd Crusade
1187 — 3rd Crusade
1194 — 4th Crusade
1212 — Children's Crusade
1224 — 5th Crusade
1270 — 7th Crusade

P.S. The Crusade that began in 1248 (minimum solar activity) was not carried out by masses of people, but by Louis IX with a small number of troops.

The Great Migration of Peoples:

Years: 374; 409; 449–451–452; 568.

Mass persecution of Jews:

1093 — Southern Europe;
1144 — Germany and Italy;
1182 — France;
1215 — Western Europe;
1290 — England;
1306 — France;
1348 — Europe;
1391–1394 — Spain, France;
1481 — Spain;

1491–1494 — Spain, Lithuania;
1704 — Ukraine;
1830 — Europe;
1849 — Europe;
1881–1882 — Russia, Hungary, etc.

Persecution of Christians:

Years: 303; 362; 575; and others.

Bloody episodes of world history:

1185 — massacre of the Latins in Thessalonica;
1204 — destruction of Byzantium;
1520 — massacre in Stockholm;
1560 — massacre in Vassy;
1572 — St. Bartholomew's Day massacre in France;
1588 — London executions;
1739 — Delhi massacre;
1768 — Uman massacre;
1792 — September massacres in France (the next minimum — in 1799);
1860 — massacre of Christians in the East;
1896 — massacre in Constantinople and many others.

The rise of popular and spiritual leaders, reformers, military leaders and officials:

395 — Alaric;
444 — Attila;
536 — Vitiges;
536 — Belisarius;
622 — Mohammed;
719 — Charles Martel;
1096 — Peter of Amiens;
1146 — Bernard of Clairvaux;
1306 — Robert the Bruce;
1365 — Wycliffe;
1367 — Tamerlane;
1381 — Wat Tyler;
1402, 1412 — Jan Hus;
1420 — Ivan Zizka;
1429 — Joan of Arc;
1489 — Savonarola;
1519–1525 — Luther, Zwingli, Vasa, Müller;
1537 — Ignatius Loyola;
1605 — False Dmitry;
1605 — Vasily Shuisky;
1612 (max. 1615) — Minin, Pozharsky;
1625 — Zhmaila;
1625 — Richelieu;
1626 — Wallenstein;
1637–1639 — Pavlyuk, Gunya, Ostranitsa, Alexander Leslie;
1648 — Bogdan Khmelnitsky;
1648 — Oliver Cromwell;
1683 — Eugene of Savoy;
1769 — Haider Ali;
1777 — Lafayette;
1777 — Washington;
1788 — Suvorov;
1805 — Wellington;
1839 — Shamil;
1848, 1860 — Garribaldi;
1870 — Moltke;
1870 — Gambetta;
1917 — Kerensky;
1917 — Lenin.

Sulla, Spartacus, Catelina, Vercingetorix, Caesar, Germanicus, Civilis and many others first appeared on the arena of public life or first acquired public significance in the epochs of maximum sunspot activity.[1]

Let us pay attention to Table 2, which represents the time distribution of all the most important battles from the 5th century B.C. to the year 1 A.D.

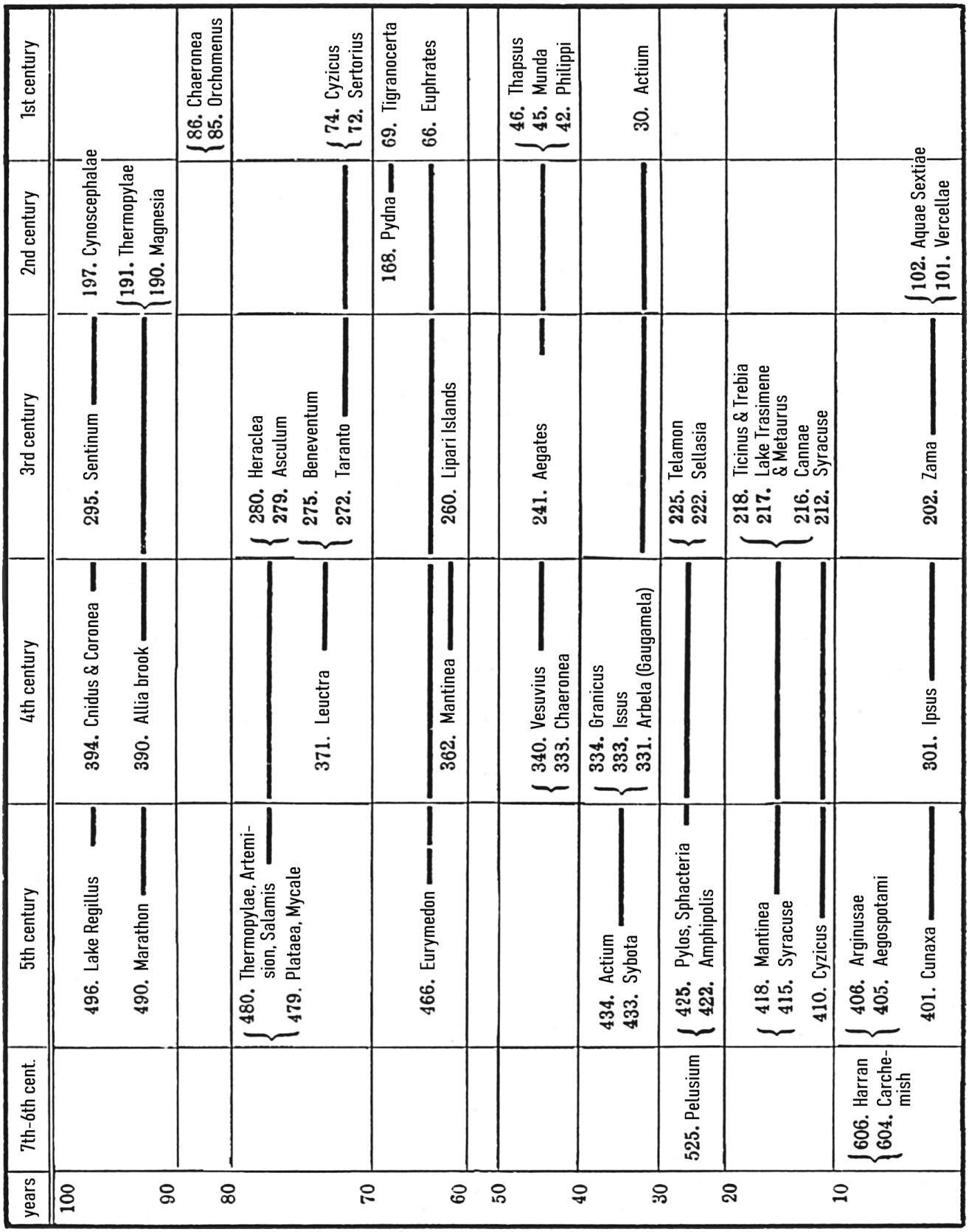
Having arranged the dates of the most remarkable battles of antiquity for these 5 centuries by centuries and decades, it is easy to discern two striking patterns that are observed in the distribution of these events in time. The first of them is the amazing coincidence of the digits standing in place of the units and tens of any historical date of one century with the digits standing in place of the corresponding units and tens in the historical date of another century or after one, two or three centuries. For example:

496–394–295–197	340–241–42
490–390–191/190	433–333/331–30
480/479–280/279	525–425–225
371–272–74/72	418–218
168–69	410–212
466–66	606/604–406/405
362–260	401–301–202–101/102

Another pattern is observed in the distribution of these same dates in each century. It turns out that the dates of the indicated battles are separated from each other, in most cases, by numbers multiple of 10–11 years, i.e., by the time inter-

[1] From the historiometric table it is easy to see that the listed persons came to the fore precisely in the middle of concentrations of historical events.

Table 2: The most important battles of the 7th–1st centuries B.C.



375–476 (101 years) . . . . . the main waves of the Great Migration of Peoples;
622–632 (10 years) . . . . . the era of Muhammad's activity;
1224–1235 (11 years) . . . . . the main waves of the Tatar invasion to Russia;
1380–1480 (100 years) . . . . . the main stages of the overthrow of the Tatar yoke;
1389–1448 (59 years) . . . . . the main stages of the struggle of the Turks with the Christian world; the 1st and 2nd battles on the Kossovo field;
1460–1471 (11 years) . . . . . the main stages of the War of the Scarlet and White Roses in England;
1481–1492 (11 years) . . . . . the main stages of the struggle with the Moors in Spain;
1489–1498 (9 years) the era of Savonarola's activity;
1562–1572 (10 years) . . . . . two bloody episodes: the massacre in Vassy and the St. Bartholomew's Day Massacre;
1614–1789 (max.–max.) . . . . . the years of two convocations of États généraux in France; from 1614 (max. solar activity) to 1789 (max. solar activity) États généraux were not convened at all;
1702–1714 (12 years) . . . . . the War of the Spanish Succession;
1789–1804 (15 years, max.–max.) . . . the final stages of the republican system of the Great French Revolution;
1830–1848 (max.–max.) . . . . . July Revolution — February Revolution in France, and also pan-European crisis;
1848–1860 (max.–max.) . . . . . Garibaldi uprisings;
1905–1917 (max.–max.) . . . . . 1st and 2nd revolutions in Russia.

val between one and another maximum of solar activity. For example:

5th century: 490–480; 466–433; 433–425; 425–415; 415–405;
4th century: 390–371; 371–362; 362–340; 340–381; 381–301;
3rd century: 280–272; 272–260; 260–241; 241–222; 222–212; 212–202;
2nd century: 197–190; 190–168; 168–102;
1st century: 86–74; 74–66; 66–46; 46–30.

Here are some more examples showing the same multiple dates for many historical events (many similar examples could be given); see on top of this page.

Thus, according to the epochs of solar activity maxima, from maxima to maxima, and sometimes through several maxima, the historical life of nations fluctuates, following the indications of this cosmic factor. These fluctuations can be found throughout the history of Mankind. If we, for example, try to outline the main stages in the life of the states of Ancient Greece and Ancient Rome, we will be convinced of their remarkable distribution.

All other mass phenomena in human communities are in the same connexion with the activity of the Sun, namely:

1. Formation of religious, military, political, artistic, trade corporations, associations, unions, leagues and partnerships, etc. For example:

Lombard Cities League . . 1167 (max. sol. activity)
Hanseatic Cities League . . 1241 (max. sol. activity)
Swiss Cities League . . . . . 1352 (max. sol. activity)
Swabian Cities League . . . 1381 (max. sol. activity)
Cambrai League . . . . . 1508 (max. sol. activity)
Ratisbon League . . . . . 1524 (max. sol. activity)
Schmalkaldic League . . . . 1530 (max. sol. activity)
Sacred Union League . . . . 1576 (max. sol. activity)
Maximum activity of the Sacred Union . . . . . 1587–88 (max. sol. act.)
Augsburg League . . . . . 1686 (max. sol. activity)

2. The spread of various teachings — political, religious, etc.; the spread of heresies, religious unrest, pilgrimages, political conspiracies are subject to the same regularity. For example, social theories were spread mainly during periods of maximum excitement: the Genève and Lyon anarchists (1880–1882), the Paris and Liège anarchists (1892).

   Let us briefly trace the history of the revolutionary movement in Russia in the 19th century (according to Prof. Alphons Thun and others):

1815 . . . . . the literary society "Arzamas";
1816 (max.) . . . . . the first political society in Russia;
1817 . . . . . the first secret society in Russia;

1825 (max. begins) ... the Decembrist uprising;
1837 (max.) ..... Stankevich's circle;
1848 (max.) ..... Petrashevsky's circle;
1861 (max.) ..... the abolition of slavery in Russia;
1862 ..... unrest in Russia;
1868 (min.) ..... "The Bell" magazine closed due to falling circulation;
1869 (max. in 1870) .. beginning of the spread of socialist teachings;
1870 ..... "People's Cause"; a brief revival of "The Bell"; Tchaikovsky's circle;
1871 ..... the Nechayev trial;
1872 ..... activities of the anarchists Bakunin and Lavrov; movements "going to the people"; Dolgushin's society;
1875 (to min.) ..... disorganization of socialist propaganda in Russia;
1876–1877 ..... the revolutionary societies "Land and Freedom", "Common Cause";
1878–1879 ..... maturing of solar activity was marked by the transition to terrorism;
1879 ..... the revolutionary workers' organization "Executive Committee";
1880–1881 (to max.) .. the revival of the revolutionary movement: peasant unrest, riots, armed resistance to the police and troops, assassinations, murders, mass Jewish pogroms;
1879–1882 ..... the revolutionary societies "People's Will", "Black Redistribution", "Corn"; "Free Word", "Baltic Federalist", "Truth" and others;
1887 (to min.)–1895 .. lull in the revolutionary movement in Russia.

3. Localization of excitation on various ideas, entertainment, spectacles, etc. The ideas of all 8 crusades, without exception, originated and were especially intensively spread during the periods of maximum solar activity. The idea of doomsday, which was supposed to happen in 1 000 A.D., began to excite the medieval world 10 years before the expected event (993 — max. sol. act.). The idea of the "peace of the Lord" arose in 1030 (max.), then spread throughout Europe in 1040 (max.). The Fronde in France 1648–1653 (max.); the Dreyfus trial 1894–1896 (max.) and many others.
4. Mass morbid manifestations of human neuropsychic activity develop mainly in the periods of spot formation tension. For example[1]:

1374 ..... St. Vitus' Dance;
1500 ..... mental epidemic in Ouverte;
1630 ..... mental epidemic in Madrid;
1642 ..... mental epidemic in Louviers;
1728, 1738 ... Saint-Médard mental epidemic.

5. It is also impossible not to note the fact that pathological epidemics and pandemics very often coincide with the period of maximum.

Let us now focus our attention on the development of cholera epidemics (cholera asiatica).

Historical information about cholera is small. According to Ozanam, cholera was known even in the time of Hippocrates, raged mainly in China, when it was described by the Chinese doctor Jang Chon Ko. According to Haeser, the cholera epidemic in the first half of the 11th century affected significant areas in India, part of the Asian continent and appeared in Constantinople.

The first precise indications of devastating cholera epidemics in the 14th century are found in Persian writers between 1364 and 1376. Russian chronicles mention observations of sunspots in 1365. Chinese chroniclers (according to Hirayama) wrote about large spots on the Sun, visible to the naked eye in 1370, i.e., just during the period of the strongest cholera epidemics described by the Persians. According to Riegler, the cholera epidemic appeared in Constantinople, Syria, Arabia, Egypt shortly before the conquest of Byzantium by the Turks.

The French traveler Sonnerat described a devastating cholera epidemic in India, where it claimed about 60 000 victims in three years from 1768 to 1771. An increase in solar activity was noted by Jean Gaspard Staudacher in Nürnberg and other observers in 1769, i.e., exactly during the period of the spread of cholera in India. There is undoubted evidence of significant cholera epidemics on the Coromandel Coast in 1774–1780. Maximum solar activity was attributed to 1778. An epidemic is known in Tranquebar, Madras and other places in India in 1787–1790. Maximum sunspot formation was noted by astronomers in 1788. Since about this time, thanks to the development of medical knowledge, strict records have been kept of the epidemic spread of cholera, which periodically makes round-the-world trips and systematically visits Europe, where it first appeared in 1830 (max. solar activity), if you do not count its short-term, quickly extinguished stay in the city of Astrakhan in 1823 (min. solar activity).

In studying the spread of cholera epidemics and pandemics (i.e., general epidemics), I adhered to the order currently accepted in medical epidemiology, although it should be noted that dividing cholera movements into any periods is not entirely accurate. The fact is that cholera never disappears from the Earth, but only calms down from time to time, concentrating in some area, in order to again conquer vast areas with the same force. These periods of calm strikingly

[1]The question of the dependence of the development of mental epidemics on solar activity is presented by me in a separate other work.

Sunspot activity		Pandemic number	Cholera pandemics		
Maximum	Minimum		Beginning of the pandemic	Period of maximum spread of the pandemic	End of the pandemic
1816	1823	1	1816	1817	1828
1829 1837	1833	2	1827	1829—31 + 1837	1833 +
1848	1856	3	1844	1848	1857
1860 1870	1867 1878	4	1863	1863—66 1870—72	1875
1883	1889	5	1883	1883 – 86	1889
1894	1900	6	1890	1892,94	—

Table 3: The relationship between the development of cholera pandemics in the 19th century and sunspot activity.

coincide with the lull in the sunspot-forming activity on the Sun. On the contrary, with the increase in the vital activity of our daily luminary, cholera epidemics sometimes take on a general, threatening character.

What has been said is expressed with sufficient clarity in Table 3, borrowed, in some abbreviation, from my special study of this issue.

Plague epidemics and pandemics somewhat deviate from exact simultaneity with the course of periodic processes on the Sun, but statistical calculations show that the state of the Sun and the state of humanity associated with it are also reflected in the development and spread of plague microorganisms. Over a period of several centuries, plague pandemics coincided with the era of solar activity maxima about 30 times, with the era of minima — 8 times; between maximum and minimum — 6 times, and between minimum and maximum — 2 times[1].

The most severe epidemics of infectious diseases, as comparisons have shown, also very often coincide with solar activity maxima.

Period IV of the historiometric cycle (the period of decreasing excitability)

The period of decline in excitability is even no less interesting from a historical and psychological point of view than the periods preceding it. It can also abound in major events, but usually only those that arose earlier are completed during this period.

The period of decline in excitability is, as it were, an echo of the stormy period of struggle and unrest that preceded it, the highest degree of tension of which has already passed, and a general need for calm and peace is felt. If there is a war, its heat gradually dies down, sluggishness is observed in military actions, their tempo slows down.

Now for the first time one begins to feel satiety with war, robbery, blood. Observance of military obligations and treaties is no longer necessary; allied countries do not provide combat support; separatism begins to appear more and more often; military alliances disintegrate.

The still continuing movements of troops resemble the convulsions of a dying person, and crowds of soldiers with the same impatience thirst for peace as they recently thirsted for war. At this time, the movement of enemy troops, if the latter are still sufficiently disciplined, does not meet with serious resistance. Meanwhile, so recently the entire country met the appearance of enemies with fire and sword. Gradually, armies turn into a disobedient herd and quickly thin out; soldiers scatter in crowds, rushing home, and the general warlike mood in the masses is replaced by a peace-loving one.

Leaders, commanders, orators lose those forces that in the preceding period fettered the masses and forced them to obedience. The masses are already subject to suggestion with difficulty.

Newly emerged wars or uprisings do not flare up, but quickly subside, ending in peace on lenient terms. If a year or two earlier it would have been possible to raise an uprising, now it does not work and all attempts will lead to nothing. Historians are often surprised by the fact that the elements of opposition do not gather together, as was the case in the life of the country so recently, do not rebel, do not rise up simultaneously in many places, but, on the contrary, hesitate, do not decide, acting by their slowness in a destructive way on all military or political alliances.

This lack of unanimity in the 4th period of the historiometric cycle can be called a stumbling block on which any newly-begun uprising, any mass activity risks being wrecked, since concentrated action, due to the reduction and relaxation of the connecting forces, becomes impossible. The military campaigns or invasions that were started are prepared without enthusiasm, even with obvious lack of sympathy. The enthusiastic mood of the masses of people in favor of reforms, popular representation, wars, uprisings, and so on weakens, giving way to complete indifference. Indeed, everyone expresses a tendency toward reconciliation, and talk of peace begins. These talks are heard in the most warlike countries.

The decline in the degree of unanimous communication of the masses of people causes disputes and discord in groups, unions, and states. The latter circumstance makes all human groups ineffective and indecisive.

The above in its complex totality leads to a renunciation of recent claims, and demands that were previously defended with foam at the mouth are reduced to a minimum.

Finally, the general decline in excitability is replaced by a psycho-physical state that can be called enervation. Popular assemblies and representations are dispersed without protest, uprisings are easily suppressed, wars do not flare up, and also

[1] My study of this issue is not yet complete.

Table 4: Schematic presentation of data from one complete historiometric cycle.

Sunspot activity of the Sun					
1 sunspot formation cycle	The arithmetic mean is 11.124 years				
Periods of the cycle	Number of spots 5.16 years		Number of sunspots 5.96 years		
Period №№	I.	II.	III.	IV.	
Relative number of sunspots	Minimum	Number of spots and their groups is increasing	Maximum	Number of sunspots and their groups is decreasing	
Social activity of human masses					
1 historiometric cycle	The arithmetic mean is 11 years				
Periods of historiometric cycle	3 years (arithm. mean)	2 years (arithm. mean)	3 years (arithmetic mean)	3 years (arithmetic mean)	
Names of the periods	Period of min. excitability (era of irritation)	Period of increasing excitability	Period of maximum exitability (era of concentration)	Period of decreasing excitability	
Relative number of historical events	Minimum of mass social movements	Growing number of mass social movements	Maximum	Decreasing number of mass social movements	
Number of hist. events, % (aver.)	5%	20%	60%	15%	
Number of hist. events per year, % (average)	1.7%	10%	20%	5%	
Socio-psychological behaviour of human masses during each period of the cycle	Differentiation of human masses, indifference to social problems, peaceful moods among the masses, compliance, tolerance, depression, static state of the masses, etc.	1. Rise of the ideas of social order, collective concentration begins; 2. Grouping of the ideas and masses; 3. Emergence of a single basic idea and the unity of the masses	1. a) Affecting human masses by popular leaders, mil. commanders, mass media, orators, etc. b) Affecting by the ideas circulating among the masses. 2. a) Rapid rise of mass movements; b) Wide territory covered; c) Integration of the masses; d) Individualization of groups; e) Dynamic state of the masses	Progressive slowness of society's reactions to stimuli; degradation of concentrated action, enthusiasm, inspiration, etc.	
Comment		Phenomena that develop in society if there are exciting factors of a military, political or other nature			
Historical phenomena that occur during each period of the cycle	Conclusion of peace treaties, non-massive invasions of conquest, capitulations, occupations, maximum reduction of parliamentarism, strengthening of autocracy	Indecision in resolving military and political issues, preparation for war, complication of foreign affairs, beginning of conspiracies, determination of military and political tendencies	Rise of leaders, military leaders, and officials; triumph of ideas supported by human masses; triumph of parliamentarism; democratic and social reforms; democracy, limitation of autocracy. Revolutions, uprisings, turmoil, rebellions, wars, invasions, emigrations, resettlements, persecutions, and other outbreaks of mass human activity	Disintegration of military and political organizations, separatism, renunciation of international or domestic claims, dispersal or disintegration of popular assemblies, completion of events that began in the previous period	

peace negotiations are mechanically caused by the depressive state of the masses of people, which is often facilitated by physical exhaustion and fatigue.

Such is, in brief, the morphological identity of all historical cycles — "universal" changes in the behaviour of the active masses of humanity during each historiometric cycle.

Here we schematize in a certain way the historical phenomena connected with the state of solar activity. There can be no doubt that all these phenomena are much more complex and intricate than they are presented here. But, using this schematization, which in many respects should be considered as *preliminary*, we can move forward in an objective study of this question. Let us now dwell on some general remarks concerning the course of the historiometric cycle.

Changes in the behaviour of humanity are especially prominent in the development of long-term historical phenomena. Here, stages of enormous energy, upsurge and inspiration, then a gradual decline of this energy with a transition to a state of fatigue and apathy are clearly outlined. Then, after some time, a general revival, excitement, growing agitation and finally a rise in political or military enthusiasm, characteristic of the period of maximum, are again observed. Long-term historical phenomena that began with the second period of the historiometric cycle provide an ideal example of changes throughout the cycle. All major historical events, covering entire countries and lasting for several decades, were subject to cyclic fluctuations in their development, which is easy to see when studying any [historical] event in connexion with changes in sunspot formation processes on the Sun.

True, such a clear distinction between the various periods of the historiometric cycle is not always feasible; sometimes it is necessary to simply grope our way to their definition, guessing the boundaries by the mood of the masses of peoples, by their aspirations, by the spirit of history of the given moment.

As is well known, the disturbance of solar matter, expressed in the appearance of sunspots, sometimes arises somewhat faster than it subsides, although the time interval between the minimum and the next nearest maximum is, on average, almost equal to the time interval between the maximum and the next nearest minimum.

The number of historical events and, most importantly, the degree of intensity of their development tend to follow in all details the changes in the curve of solar activity, but in some periods of the historiometric cycle they undergo significant deviations. Thus, sometimes general human activity reaches its maximum shortly before the maximum of solar activity and remains at the same height for some time at the beginning of the 4th period. It also happens that the maximum of general human military and political activity does not occur exactly simultaneously with the solar maximum, but is somewhat delayed. But if we draw the average curve of several periods of the sunspot-forming activity, it completely coincides with the average curve of several historiometric cycles. This shows the undoubted connexion that exists between these two phenomena.

In addition, irregularities are often observed in relation to the gradual increase in the number of historical events with an average increase in solar activity. Then the curve of the historiometric cycle only vaguely resembles the sinusoidal course of the phenomenon; it is more like the daily course of the temperature of a typhoid patient, like the teeth of a semicircular saw. Here, sharp rises and falls, shifts and interruptions are observed. All of them depend on the most diverse, incalculable, private, military and political reasons that occur in human communities. However, it should be noted that rises and falls in the course of the curve of the historiometric cycle can arise as a result of sharp fluctuations in solar activity. This is a fact of the greatest importance.

It should also be added here that the rapid increase in sunspot formation after a minimum sometimes causes a series of historical phenomena that quickly fade away, but arise again by the period of maximum excitation, gradually increasing the intensity of their manifestations.

The aforementioned questions, as well as many other questions concerning the theory we are substantiating, are investigated and presented in my other works.

Having completed a brief review of the characteristic features of each part of the historiometric cycle and having established the relationship between the activity of the Sun and humanity, we present here the *basic morphological law of historiometry*, formulated by me as follows:

The basic morphological law of historiometry: The course of the world-historical process is made up of a continuous series of cycles, each of which lasts for a period of time equal in average to 11 years, and which are synchronous in the magnitude of their activity with the periodic spot-forming activity of the Sun.

Each cycle has the following historical and psychological features:

1. At the midpoints of the course of the cycle, the mass activity of humanity on the entire surface of the Earth, in the presence of economic, political or military stimulating factors in human communities, reaches maximum tension, expressed in pandemics, revolutions, uprisings, wars, campaigns of conquest, migrations, creating new formations in the life of individual states and new historical epochs in the life of humanity, and accompanied by the integration of the masses of people, the revelation of their activity and the rule of the majority.
2. At the end points of the cycle, the tension of universal human activity of a military or political nature decreases to a minimum limit, giving way to creative activity and accompanied by a general decline in politi-

cal or military enthusiasm, peace and calmed creative work in the field of organizing state foundations, international relations, science and art with the disintegration and depression of the human masses and the strengthening of absolutist tendencies of power.

All conceivable deviations from the above basic law are caused by reasons that lie outside the mentioned cosmic factor, and are only a consequence of the main events that arose during the period of maximum excitability, but did not have time, for one reason or another, to end within the period that caused them.

IV The influence of geophysical and cosmic factors on the behaviour of individuals and groups of people

The successive changes in the global activity of Mankind during each of the cycles required an explanation from the point of view of modern biophysics.

However, it was necessary to clarify first the question of how the activity of the Sun influences the centres of the higher nervous system of Man — directly or indirectly, i.e., directly on the organ of mental activity or with the participation of such factors as famine, which arose as a result of drought (which, in turn, could be a consequence of the activity of the Sun) and caused war or the high cost of food, which prompted the people to revolt, etc. The study of this question showed that the indirect factor, although often accompanying, is by no means necessary.

In fact, the same number of concentrations of historical events in each century and their simultaneity in many regions of the Earth quite clearly indicate that these phenomena are caused not by some local natural factor with a limited area of action, but by some forces that strictly periodically influence humanity, regardless of what area of the globe it inhabits. Here, precisely this simultaneity of mass unrest or even disturbances throughout the globe is striking. Therefore, it is necessary to conclude that the disturbing forces act everywhere at one and the same absolute time.

If the course of historical events were left entirely to itself and not a single cosmic factor influenced it, we would never have discovered in it regular fluctuations of a more or less precise period and their simultaneity throughout the entire territory of the planet.

From what has been said, it follows that there is some extraterrestrial force that influences the development of events in human communities from the outside. The simultaneity of the fluctuations of solar and human activity serves as the best indication of this force.

So, for now we must admit that the electrical energy of the Sun is that external natural factor that influences the course of the historical process. Now let us turn to an examination of the dependence that exists between the human organism and the various fluctuations of the space surrounding it. It should be remembered that this dependence between Man, as well as animals and plants — on the one hand, and the inorganic world — on the other, is extremely strong, although subtle to the point of elusiveness.

The environment in which our organisms are immersed is constantly mobile and is subject to the most diverse micro and macro-oscillations and pulsations. The slightest deviation from a strictly horizontal surface, the movement of air or any nearby body, changes in the strength of sunlight, temperature and degree of humidity, soil emanation, etc., continuously fluctuate the potential of atmospheric electricity, since the atmosphere itself is a huge electric field.

Our organism, the colloidal system of which undergoes continuous changes, has a refined sensitivity to all external influences and fluctuations. Experiencing these fluctuations that disrupt the balance, the [human] organism is forced to continuously expend a certain amount of energy to restore this balance.

Many of these fluctuations do not reach the threshold of consciousness, and, usually, strong and healthy organisms react weakly to them; the process of restoring balance occurs unconsciously. But sharp fluctuations in the physical environment even in strong organisms cause certain disturbances, change the sign of the tone of higher nervous activity and create what in society is called a "change of mood", without any apparent reason.

Herbert Spenser (1820–1903) considered life as maintaining a mobile equilibrium, as a continuous adaptation of internal relations to external ones.

The famous Russian physiologist I. P. Pavlov, a fellow of the Russian Academy of Sciences [who won the Nobel Prize for Physiology or Medicine in 1904], wrote the following about these equilibrations: "As a part of Nature, each animal organism is a complex isolated system, the internal forces of which, every moment, as long as it exists, as such, are balanced with the external forces of the environment. The more complex the organism, the more subtle, numerous and varied the elements of balancing. For this purpose, analyzers and mechanisms of both permanent and temporary connexions serve, establishing the most precise relationships between the smallest elements of the external world and the most subtle reactions of the animal organism. Thus, all life from the simplest to the most complex organisms, including, of course, Man, is a long series of increasingly complex balancing of the external environment to the highest degree. The time will come — albeit a distant one — when mathematical analysis, relying on natural science, will embrace all these equilibrations with majestic formulas of equations, including in them, finally, itself." [1]

Another Russian scientist, the famous meteorologist Prof. A. V. Klossovsky, wrote the following regarding the influence of external phenomena on the body: "Organic life on the

[1] Pavlov I. P. *Twenty Years of Objective Study of Higher Nervous Activity (Behavior) of Animals. Conditioned Reflexes.* State Publishing House, Moscow-Petrograd, 1923, page 77.

Earth's surface occurs under the direct influence of a number of continuously changing climatic factors. Quantitative and qualitative changes in each of these factors entail corresponding changes in the functions of our body and, under certain unfavorable conditions, can cause a number of morbid phenomena. In general, the vital activity of our body is closely connected and dependent on meteorological factors." He then continued: "Changes in the quantity and voltage of solar insolation and atmospheric electricity also play an important role. If we could plot the changes of each of the numerous meteorological elements over a known period of time, then perhaps the curve of morbidity and mortality would be the result of a kind of interference of all meteorological elements. Finally, the influence of meteorological conditions is reflected in the activity of our organism not only directly, but also indirectly. These factors consist in the fact that they create more or less favorable conditions for the development and reproduction of pathogenic bacteria." [1]

Diseased and nervous organisms, like the precise and sensitive instruments of a physicist, already sense to a significant degree the slightest fluctuations of the environment. This same phenomenon is clearly expressed in persons deprived from childhood or by nature of the main sense organs, for example, in the deaf-blind-mute. Possessing only the sense of touch and smell, they acquire amazing abilities to recognize many changes in the space around them, which can by no means be called a mere refinement of the senses remaining to them. The most diverse phenomena of the external world, beginning with the influence of objects on air layers and ending with the recognition of the mood of people around them, right up to guessing thoughts — are transmitted to them directly, without direct contact (Helen Keller).

For sick human organisms, insignificant changes in the physical environment sometimes play a rôle; these changes, affecting the entire system of the organism, make a person experience a range of diverse sensations, and sometimes make it possible to foresee the onset of some meteorological or volcanic phenomena several hours or even days in advance. In the scientific literature, there are indications that there are some individuals who predict, on the basis of various changes in their organism, earthquakes, thunderstorms, tornadoes and weather fluctuations in general. This is explained by the fact that all major meteorological and tectonic phenomena are preceded by known fluctuations in the physical environment. For example, before earthquakes, magnetic storms break out a day or more before, which are believed to appear as a result of violent movements of magma in layers of the Earth's crust, significantly removed from the surface. There are also indications that volcanic phenomena affect the force of magnetism (Fitzroy, Orlov). It is known that magnetism, in turn, has a very strong effect on the nervous system of sick and mentally abnormal people, who, blindfolded, automatically obey the slightest movement of a magnet in the hands of a doctor, and can assume the most unnatural poses for a healthy person. According to the observations of the Japanese seismologist [Fusakichi] Omori, some animals exhibit remarkable sensitivity to ground vibrations. According to the ten-point Forel-Mercalli scale, even the lightest earthquakes are felt by very nervous people, while all others remain completely indifferent to micro-vibrations of the soil. But there are individuals with such a heightened activity of the nervous system that some time before the onset of an earthquake, detected later by the most accurate and sensitive seismic devices, they sense its approach. For example, at the [railway] station Ala in South Tyrol on January 27, 1897, two underground tremors were observed, which were predicted by a hysterical girl 1/4 and 1/2 hours before.[2]

A number of nervous and pathological diseases are closely connected with periodic or non-periodic changes of the electric or magnetic field surrounding the organism, which depend on the position of the celestial bodies. It has been known since ancient times that the position of the Sun and the phases of the Moon influence many diseases. For example, attacks of sleepwalking or a temporary semi-catalepsy of the human organism coincide with the new moon; acute brain disease — epilepsy also most often appears during the new moon, which gives reason to talk about the influence of the Moon on it; neuro-rheumatic diseases such as: sciatica, lumbago, migraine, tic, etc., as has been noted by patients, are in some relationship with the celestial bodies. The new moon worsens many nervous diseases — neuralgia, tabes, etc. We should also note the fact that women and female animals have a better chance of getting pregnant when their periods coincide with the full moon. In the medical literature there are indications of the possible influence of the Sun and Moon on other diseases and functions of the human body. Arrhenius showed[3] that various changes in atmospheric electricity associated with the position of the Moon affect menstruation, birth rate, mortality, epilepsy, etc. Med. Dr. Dexter (London, 1904) published his research on the influence of meteorological factors on attention, behaviour, success in studies, as well as on the manifestation of crime, drunkenness, suicide, etc. Lehmann and Pedersen (Copenhagen, 1907) collected interesting data on the relationship between meteorological factors and human performance. We have already spoken above about Lombroso's work in this direction.

On the same issue, some interesting thoughts have recently been expressed by Nordmann. This French astronomer believes that even the most insignificant fluctuations in the external environment should influence the general state of the

[1] Klossovsky A. V. *Climatology in Connexion with Climatotherapy and Hygiene.* Mathesis, Odessa, 1904.

[2] Klossovsky A. V. *The Physical Life of Our Planet Based on Modern Views*. Mathesis, Odessa, 1908, page 38.

Milne devoted a special work to this issue, published in 1896.

[3] Arrhenius S. *On the Influence of Cosmic Conditions on Physiological Functions. Scientific Review*, 1900, no. 2, page 297.

human nervous system and change his mental activity. In the laboratory instrument — the electroscope — Nordmann sees one of the powerful forces of the future state, a regulator of the social structure, the behaviour of citizens and the welfare of the country. Here the words of the English psychiatrist [Henry] Maudsley involuntarily come to mind: "We vibrate in unison with such individual influences of heaven and earth that our science cannot yet measure." And not only humans are capable of responding to all these external changes, but also animals and plants, whose condition sometimes (for example, at the moment of the onset of atmospheric fluctuations) clearly reveals the abnormal state of their organism. The French entomologist Fabre published his very curious observations on the degree of sensitivity to external fluctuations of some insects. Among plants there are also species that show certain changes with fluctuations in humidity, pressure and potential fluctuations of atmospheric electricity. The vital functions of plants are closely connected with the development of a significant amount of electricity and, conversely, under the influence of electricity the vital activity of a plant undergoes certain changes. Undoubtedly, fluctuations in the electric and magnetic field, arising from cosmic or geophysical causes, have a huge impact on the life, development and morbidity of all plant and animal organisms.

It is known that the electrical action of sunlight on the atmosphere causes a number of chemical transformations in it. Ultraviolet rays of sunlight produce a chemical action. They transform an oxygen molecule O_2 into an ozone molecule O_3. As early as 1874, Moffat tried to prove that in years of increased solar activity the average amount of atmospheric ozone is greater than during the minimum.[1] Then, under the influence of electricity, nitrogen in the air partially combines with hydrogen, water vapor and oxygen, forming ammonia compounds, nitrites and nitrates. Finally, exposure to sunlight causes the so-called Hallwachs photoelectric effect — the outflow of negative electrical charges from many rocks on the Earth's surface (Stoletov, Righi).

A change in the chemical composition of the air is inevitably followed by a disruption of normal functions in the organism and a change in the course of chemical reactions in some of the most important organs.[2] The latter, through blood circulation, can affect the state of the psyche, stimulating or depressing it, since modern science holds the view that psychic activity is a product of physico-chemical transformations in the nerve centres.

Therefore, it is very significant that until now no extensive research and observations have been made into the influence of periodic fluctuations in solar activity on the course of organic life on the globe in general and the psychic life of Man and animals in particular. True, the absence of work in this direction is justified by the fact that only recently has the science studying the higher nervous activity of Man taken the proper ground of physico-mathematical analysis. Until now, the influence of the environment on the nervous system has been studied primarily in relation to subjective reactions. But an objective observer states the real relationships that exist between the observed phenomena, confirming them with a mathematical formulation.

The study of nervous activity in some laboratories is now carried out using the methods of physics and chemistry and the application of mathematical analysis. The works of leading US and European scientists (J. Loeb, W. Nernst, etc.), among whom a prominent place is occupied by P. P. Lazarev, a fellow of the Russian Academy of Sciences and the Director of the Institute of Biological Physics (Moscow), who works in this field, have shown that nervous activity is based on a physico-chemical process.

Any irritation of the ends of the sense organs causes a chemical reaction in them, accompanied by the movement of ions. This movement is successively transmitted along the constituent parts of the nerve to the nerve cells and causes the appearance of corresponding reactions here, perceived by us as sensations. The latter, therefore, can arise only in the case of a physico-chemical process.

[1] Above we have already seen how the movement of cholera, plague and other infectious diseases flexibly corresponds to the course of solar activity. The idea that the spread of cholera is predisposed by the increase in negative electricity in the atmosphere has been repeatedly expressed by different scientists (Inozemtsev, Grauvogel and Schweickart).

[2] Already de Lamarck (1744–1829), and more recently Eimer, claimed that the biological process is determined entirely by external influences. This would mean that the diverse (physical and neuropsychic) variability of living organisms should be considered as a reaction to external influences, such as air pressure, temperature, light, water, climate, food, the entire surrounding physical and chemical environment, etc. Indeed, science knows many facts that fully confirm this point of view. For example, the convergence of the eyes of the embryos of the fish Fundulus occurs due to the addition of magnesium chloride to the water in which they are located; the enlargement of the gills in the tadpoles of one frog (rana arvalis) is caused by a decrease in the amount of oxygen in the water containing them. The experiments carried out in this direction by Loeb are very instructive. Thus, external influences can modify organisms and affect the state of their bio-tonus. This variability of organisms under the influence of external agents has the following physico-chemical basis: the fact is that proteins, which represent a special most important part of organisms, are distinguished by chemical instability and, like colloids, have the ability to easily change their physical state.

On the other hand, in the organism itself there are organs whose activity can determine one or another state of the neuropsychic sphere. The studies of hormones (Sterling) showed the greatest valence of the functioning of the glands of the internal secretion. In addition to the fact that the development of the organism and the nervous formations in it, as well as the development of the sexual sphere, growth, vegetation, variability of appearance and mental activity depend on the chemical products produced by the pineal, thyroid glands, pituitary gland, etc., — in addition to all this, it has been established that the functioning of these internal laboratories, which are most important for the entire organism, changes greatly under the influence of external factors: an increase in temperature predisposes the thyroid gland to accelerated functions; carbohydrate and fatty foods inhibit the internal secretion of the pancreas, etc. The latter, in turn, affects the general state of mental activity, stimulating or inhibiting it. Consequently, one of the important elements that create the final result of a person's neuropsychic activity, his behaviour, must also be considered the chemical functions of his internal organs. All this gives rise to a complex set of interdependent phenomena of external and internal order.

The act of thinking is accompanied by a physico-chemical reaction that exhibits periodicity. These reactions, which take place in the nerve centres of the cerebral cortex, are accompanied by the appearance of periodic electromotive forces that cause electromagnetic processes in the surrounding space.

The above provisions are a consequence of the totality of data available to modern biophysics and a necessary conclusion of Lazarev's ionic theory of excitation.

But if every act of thinking is accompanied by electromagnetic waves, it must be assumed that the corresponding nerve centres can serve as successors to these waves and thus directly perceive thought.

The hypothesis of direct transmission of thought has already been repeatedly expressed from the point of view of other theories, and this question can be considered close to a final solution. V. M. Bekhterev, a fellow of the Russian Academy of Sciences, wrote on this subject: "Is it possible for one individual to directly induce another, i.e., for one person to influence another without the use of any signs or other intermediaries in this matter? The question posed in this way, as it seems to me, has been resolved in a positive sense." [1]

In order to discover the direct transmission of thought, many researchers have conducted experiments on animals and humans, which confirmed the possibility of direct communication (Richet, Lehmann, Bekhterev, etc.). In this case, the phenomena of suggestion — individual and mass suggestions — can be explained by electromagnetic excitation of the centres of one individual by the corresponding centres of another.

History abounds with eloquent facts of mass suggestion. In fact, not a single historical event has occurred with the participation of masses of people, where suggestion suppressing the will of individuals could not be noted. This suggestion in some cases was not limited to just a certain group of people, but covered cities and entire countries, and traces of it were preserved for a long time in political or military parties, passed on from generation to generation and reflected in various artworks. Thus, suggestion in the course of the historical process and the psychic evolution of Mankind acquires enormous significance of primary importance. Its role was formulated by [Gabriel] Tarde.[2]

Based on known data, which still need verification and substantiation, it can be assumed that the power of suggestion — the influence of individuals on human masses — increases with the intensification of the sunspot-forming activity. Our analysis of numerous historical events has shown that the influence of orators, popular leaders, and military leaders on human masses does not always have the same strength and fluctuates not only periodically according to the stages of the solar cycle, but even according to the seasons. The first can be obtained from the fact of the integration of the masses in the 2nd period of the cycle and their unity during the period of maximum excitement. The second was noted by sociologists who studied the behaviour of crowds.[3]

Therefore, the assumption arises that the increase in the sunspot activity associated with the increase in its electrical energy has a very strong effect on the state of the electromagnetic field of the Earth, in one way or another exciting human masses to action and promoting suggestion. Chemical reactions within the human organism, taken as a whole, with sharp fluctuations or disturbances in the voltage of the electrical state of the atmosphere and soil, inevitably undergo changes, which should be reflected in the general state of the organism all the more sharply and quickly, the stronger and more sudden these changes are. In addition, perturbations of the magnetic and electrical fields of the Earth should produce quite direct, corresponding paroxysms in the nervous, as well as vascular systems of the organism. Thus, a complex of indirect and direct effects is obtained.

Significant disturbances on the Sun, accompanied by the radiation of electromagnetic waves and radioactive decay of solar matter, cause in human masses, in the presence of a factor uniting them, an explosion of unity, unanimity, immediately disposing them to certain actions. Consequently, *increases in solar activity transform the potential energy* (*energy of accumulation*) *of human masses into their kinetic energy* (*energy of movement*).

Studying ancient annals, chronicles and annals of Asian and European peoples, we often encountered descriptions of social or military movements, linked to simultaneously occurring celestial phenomena, mainly with the northern lights, halos around the Sun or Moon and other optical effects that occur during large spots across the central meridian of the Sun. Ancient superstition attributed mysterious forces influencing people to these celestial phenomena, considering them — signs (signum). In the quivering lights of the polar lights (aurora borealis), in the circles around the Sun (fascia), etc., our ancestors saw omens of wars, natural disasters and pestilence. The noises accompanying meteorological phenomena were taken by them for threatening and punishing "voices of prophecy" (voces exprobationis).

During World War I, we observed strange coincidences of the appearance of large spots on the Sun and the immediate intensification of military actions on many fronts. We made the first observation in mid-June 1915, when a large group of spots passed the central meridian of the Sun, when the polar lights, seen in Russia and North America, shone in the north, and magnetic storms continuously disrupted the movement of telegrams and people stubbornly and cruelly measured their strength in sea and land battles: Germans vs Russians, Austrians vs Montenegrins, Germans vs Englishmen. These observations laid the foundation for our research in this field.

[1] *Ibid.*, pages 122–123.

[2] Tarde G. *Les Lois de l'imitation*: *étude sociologique*. Ed. Félix Alcan, Paris, 1890.

[3] Tarde G. *L'opinion et la foule.* Ed. Félix Alcan, Paris, 1901.

We can also cite two striking examples, noticed by many, confirming the above in the most illustrative way: let us recall that the February and October revolutions in Russia, as well as the revolutions in Germany and Austria, were preceded by unusually powerful upsurges of the sunspot-forming process on the Sun.

There are indications that on days of a large number of sunspots, the number of psychomotor excesses increases significantly. In order to discover such a connexion, I conducted a special study, which showed that the days of the greatest unrest among the masses of people, the days of mass sociopolitical movements coincided in time with major perturbations in the substance of the Sun. These amazing coincidences in their significance give such a probability to the positions we express that they fully justify a thorough and painstaking study of the subject.

Thus, historical events develop by means of a series of shocks caused by fluctuations in the sunspot-forming process on the Sun. The speed of action of these shocks, as well as the magnitude of their intensity, in all probability, are in a certain dependence on the elements of each individual fluctuation in the substance of the Sun, also caused by the position in a particular period of the sunspot-forming cycle.

Fig. 5 graphically depicts the complete coincidence of outbreaks of revolutionary activity of the human masses in Russia in the period 1905–1906 with episodic jumps in solar activity. True, the mathematical theory of correlation, when applied to these curves, will not give indications of a linear dependence, but the latter nevertheless perfectly illustrate the above formula. It can be said that social evolution, like evolution in the inorganic (shift laws, quantum theory) and organic (mutation theory) world, does not occur smoothly, but by means of sharp disturbances.

Thus, rapid episodic increases in solar activity can cause sharp changes in the mental state of human masses and sharply change their behaviour. Equally rapid falls in solar activity obviously cause changes in the mental state of the opposite nature. In other words, the *state of predisposition to the behaviuor of organized masses of people is a function of the activity of the Sun*.

Consequently, the critical resolution of mass movements of people is in a certain dependence on the course of the sunspot-forming processes on the Sun, as well as on the rotation of the Sun around its axis. This latter is noted by us because the rotation of the Sun can cause the disappearance or appearance of disturbed areas of solar matter, disrupting the course of some processes on the Earth.

There is every reason to recognize that there is a direct relationship between the periodic activity of the Sun and the social activity of humanity.

The possibility of such a dependence was perfectly foreseen by P. P. Lazarev, a fellow of the Russian Academy of Sciences, on the basis of his works in the field of his ionic theory of excitation: "The mechanical view of the nature of higher nervous activity, which controls all human actions, has made such great strides in the field of natural science in recent times that it should become the basis for the study of mass phenomena in human society in the future. *The study of social phenomena in connexion with geophysical and cosmic phenomena should shed some light on the general law governing the mass actions of people, and provide the possibility of scientific substantiation of the laws of human society*" (here the Italic is mine A. L. Chizhevsky).[1]

Perhaps, to an absolutely objective observer, the mass activity of people would appear to us as jumping elder balls in the simplest experiment proving electrical influence, or moving iron filings obeying every displacement of a magnet. The known properties inherent in the elder balls or filings can manifest themselves only when they receive a certain impulse from the conductor of an electrostatic machine or a magnet.

Therefore, it would be completely erroneous to assume that the periodic activity of the Sun is the main cause of these or those historical events. Every such event is a dynamic reaction of human masses from all the political and economic, as well as natural stimuli acting on them, changing their behaviour and determining the intellectual and social development of Mankind. The term "behaviour" applied to military-political movements of human masses would be entirely appropriate and should signify an attempt not at a historical-sociological, but at an objective natural-scientific study of mass phenomena among humanity.

V Prospects and conclusion

The theory of the dependence of human mass behavior on cosmic influence that we are substantiating is a conclusion from the main provisions of modern biophysics and can serve as some confirmation of them. The remarkable successes of this science in the field of studying higher nervous activity by means of physical and mathematical analysis force us to assume that Man, with his entire being, must be under the influence of powerful cosmic and geophysical factors.

And despite the fact that the greatest minds, beginning with Newton (1642–1727) and Kant (1724–1804) and ending with von Helmholtz (1821–1894) and Poincaré (1854–1912), have long recognized the physical-mathematical method as the highest and only scientific way of knowing Nature, even in our time there are scientists who hold opposing views and consider introspection and direct impression to be the best way of knowing Man and Nature, and naive realism to be the best philosophy. Convictions of this kind, devoid of a serious scientific basis, have an extremely detrimental effect on the development of some sciences, which to this day are filled with pseudo-scientific terms and an overwhelming abundance of dialectical material. But it is to be hoped that the social sciences, important to Man, will soon, thanks to the advances of

[1] Lazarev P. P. *Physicochemical Foundations of Higher Nervous Activity*. Moscow, 1922, pages 59–60.

biophysics, be able to establish their positions on human relationships by applying precise disciplines. This will be an important step forward towards discovering the regularity in the social evolution of Mankind, the laws of which are undoubtedly no exception to the general principles of Nature.

Since the time of the ancient Chaldean thinkers, regularity has been elevated to the basis of the world process, and modern science with each of its forward movements only confirms this philosophical view of ancientry. Indeed, if chaos were realized in the world, obviously, not only would we, thinking beings who appeared as a result of a million-year manifestation of regularity, not exist, but also less complex, but equally amazingly coordinated organic and inorganic formations. We observe regularity both in the motion of celestial bodies that make up the visible stellar world, and in the motion of electrons that make up the atoms of matter. The functions of living organisms, which have their own periods and phases, are also subject to it. Indeed, the surrounding nature has been the source of the conviction in the human mind since ancient times that the regular periodicity or recurrence of phenomena in space and time is the fundamental property of the world, which is governed by the same laws, which apply equally to all parts of nature, regardless of how Man divides and dissects them: both inorganic and organic matter, with all its mental activity, are subject to the same principles common to the entire Universe.

Therefore, with necessary compulsion, the consequence follows that the historical development of humanity, taken as a whole, must proceed in a certain, completely lawful manner, according to the resultant of all the internal forces of social order and external forces of the surrounding nature acting on humanity.

The theory of the physical foundations of the historical process that here allows us to state the fact of the presence of a certain kind of rhythm in the mental activity of all humanity and periodic fluctuations in the course of the world-historical process, as an expression of this rhythm. Consequently, both the collective life of all Mankind and the life of individuals are subject to strict and unchanging laws of rhythm, which can be discovered through research that covers in its material the actions of large human masses and large periods of historical time.

Various phenomena and events of the world history of Mankind, in the light of the theory presented here, acquire a new meaning and significance. Of extreme importance, both in a purely scientific and practical sense, is the establishment of the fact that historical and social phenomena occur *not arbitrarily, not whenever, not indifferently with respect to time*, but are subject to physical laws in connection with the physical phenomena of the world around us and can arise *only when* the entire complex set of interactions of political, economic and other factors in the human world and physical factors in the world of inorganic nature is favorable to this. Thanks to the regularity to which the course of events in time is subject, every phenomenon in the life of individual communities or in the international life of all Mankind receives a certain explanation, *elevating history to the level of exact disciplines endowed with exact laws*. We have already said above that science is knowledge of the measurable. To make history a science, and not a "conventional fairy tale", to free it from metaphysics, from the arbitrariness of subjectivism, from everything incommensurable, to give it, as well as its sister, sociology, measuring units and laws — this is the direct task of the near future.

On the way to this, even with the first experiments, perhaps weak and insufficient, the changes and gradations of the mood of the masses of people and the military or political events associated with them become clear to us. We see that all of them are not accidental, but, on the contrary, are subject to laws that compel the masses of humanity, in the presence of disposing reasons, to strictly defined actions. Thus, little by little, the exact sciences begin to penetrate the chaos of history, to measure it with units of historical time that have equal significance and to explain phenomena that occurred in very distant epochs. History is turning into a science of the living, of the necessary, of the near. Events covered with centuries of dust come to life again and begin live intensively and significantly. Every historical figure, every historical phenomenon becomes understandable to us. All of them occurred under the direct influence of the same periodic disturbances or calms in the nature of the Earth that are occurring now and will most likely occur in the distant future of humanity. Now history is given a place not next to Nature, but in it itself, as Karl Ritter said. Therefore, in our opinion, it will be necessary to create other methods for studying history than those that have been accepted until now.

A deep and comprehensive formulation of this problem reveals a whole series of facts, large and small, requiring the most careful scientific analysis. I have considered a significant part of them, to the best of my ability, in my other works. Therefore, here I consider it necessary only to briefly dwell on those points that urgently require illumination, study and resolution.

From the above, it was easy to conclude how amazingly flexible historical events, accomplished by human masses, follow the imperative orders of our daily luminary.

Elemental changes in processes on the Sun, in one way or another, entail changes in material processes in the organs of higher nervous activity, and these latter violate the line of behaviour of all Mankind, the line that we call the historical process. Therefore, the question arises: are we not in bondage to the Sun, are we not in slavery to its electrical forces? If you like — yes, but our bondage is relative, and we ourselves can control the chains that are put on our wrists and the work that is destined for us to do. The Sun does not enforce us to do this or that, but it makes us do something. But humanity follows the line of least resistance and plunges itself into the oceans of its own blood.

As we have seen before, the maximum of solar activity promotes the excitement and unification of the masses in the name of fulfilling some general need, put forward by economic and other reasons. During this period, rulers, military leaders, and leaders appear and mass actions begin: wars, uprisings, etc. However, all these movements are not necessary: everything depends on the events that preceded them. Thus, for example, if a war has already been waged before the period of maximum excitability, then the general excitement can result in the desire for peace — peace at any cost. The conclusion of peace in the 3rd period of the cycle is not an exception to this theory; on the contrary, in this case it was the result of the same manifestation of human masses, the general demand of the masses. History knows excellent examples of mass agitations of people during the period of maximum, having nothing in common with bloody events, namely: religious movements, pilgrimages, the rise of parliamentarism, localization of public attention on trials, reforms, constructions, etc. This gives reason to cherish the wonderful hope that the future culture will find ways of humanely using mass upsurge by means of preliminary propaganda of some socially important and interesting matter, and its implementation during the period of maximum excitability. Then collective theatrical art, collective artistic creativity, with the participation of the masses of people, scientific expeditions, sports competitions, the organization of grandiose structures, cities, canals and so on will have to replace the bloody slaughter usual to Mankind.

It is easy to conclude what an important rôle propaganda or the presence of some idea in the masses of people plays. In the brief essay on the 2nd period of the cycle, we indicated that in most cases it is precisely in this period that certain ideological trends arise in human masses, which determine the course of the entire cycle, manifesting themselves in the form of popular movements during the period of maximum excitability. The life of ideas in human masses during the 2nd period of the cycle is what should interest every statesman.

Indeed, if an idea is given and implanted which is readily accepted by the masses of people as an expression of their desires at the given moment, the government's cause will be won, because the masses will be with them. The harmonious balance of the people and the government will be maintained. But if there is disagreement among the statesmen who give tone and direction to all the [governmental] apparatus of the country, if they fail to approach the human masses psychologically and skillfully and introduce into their midst some ideas which symbolize their aspirations and needs, and finally, if this or that mechanism which unites the masses functions poorly, this government will never succeed in achieving the precise realization of its goals. The relationship between the government and the people is subject to fluctuations depending on the period of sunspot activity. Taking this point of view, one can understand the true significance of the official mass media and political literature in general. At moments of maximum excitement, when sensitivity to the perception of ideas reaches its highest degree, the slightest fluctuation in the political situation is sometimes enough to undermine the old and give birth to a new object of social concentration and thereby change the mood of human masses and lead them to other decisions, to other political results. We do not yet know, but we dare to assume that the movement of ideas and teachings in the human masses is in a certain relationship with the gradual changes in the influence of the cosmic factor considered here. A comparative study of this problem would allow us to establish the laws of their evolution and resolve one of the most interesting and important problems of sociology. The question of whether all possible manifestations of the intellectual and social activity of Mankind are dependent on a *series* of influences of cosmic factors and even on a certain number of them is also not without scientific significance. There is nothing incredible in the assumption that the presence of a periodically acting factor causes a number of such phenomena which, although they do not have precise boundaries in time, the periodicity of which can be discovered through careful research.[1]

Thus, the significance of the presented theory should be considered from the point of view of political science. This theory indicates to the state authorities the methods of action that are in accordance with the mental state of the masses of people who are dependent on the fluctuations of the electric energy of the Sun. The greatest mistakes and failures of rulers, military leaders, and leaders of the people could often be caused by the fact that, without taking into account the state of the mental predisposition of the human masses, they either demanded from them the impossible, not corresponding to the state of their psyche, or mistakenly counted on their support at a time when the masses were deprived of the unity that binds them together, external factors had not begun to exert their influence on them, or the latter was already ending. From this assumption, which has good grounds, it is not difficult to draw a conclusion about the horizons that are opening up for the leaders of the people, diplomacy, strategy, etc. Without fear of falling into the spirit of science fiction novels, one could say that from now on there will be no more false steps, unsuccessful attempts, illegitimate aspirations!

The state power must know about the state of the Sun at any given moment. Before making this or that decision, the government must know about the state of our daylight: is its face bright, clear or darkened by spots? The Sun is a great military-political indicator: its readings are infallible and universal. Therefore, the state power must align itself with its arrows: diplomacy — by the monthly arrow, strategy

[1] Attempts have been made repeatedly to find and define these principles of periods that are constant for all cultures and peoples, beginning with Giambattista Vico (1668–1744) and his work *Principi di una scienza nuova intorno alia commune natura delle nazioni* (1726) and ending with Ottokar Lorenz (1832–1904) "Die Geschichtswissenschaft in their Hauptrichtungen und Aufgaben kritisch erortert" (1886) and the bold concepts of our contemporary Oswald Spengler in his *Der Untergang des Abendlandes* (1920).

— by the daily arrow. Before each battle, military commanders must know what is happening on the Sun. Consequently, the immediate branches of historiography should become one of the most important experimental sciences of political science, and astronomy — an applied science. The time before the historiometric understanding of social phenomena can be, in all fairness, compared with those distant epochs when the navigator did not yet know the compass and had not learned to distinguish directions by the stars. His fragile ship was arbitrarily drawn by the water element, and he did not know where to return the rudder, so as not to wander on the waves, exposing himself to danger at any moment.

The division of all history into cycles — units of historical time — has the task, as we have already seen above, of a comparative study of the four main parts of each cycle and the derivation of laws of behaviour of large human masses. In the work cited earlier, I show, on the basis of well-known data, the possibility of establishing such laws. Of course, even the most detailed analysis of general history is by no means sufficient for this. Direct observation and study of the behaviour of human masses in all states on the Earth from the point of view of the principles briefly outlined here are also necessary.

Then, when these laws will be established empirically, carefully verified and converted into causal ones, by introducing causal connections, Mankind will acquire new knowledge — foresight of the near future. This knowledge is so far characteristic only of the exact sciences, which predetermine the entire course of this or that phenomenon. It is easy to conclude about the greatest consequences that follow from the implementation of the above: *tantum possumus quantum scimus*.

Then the possibility of forecasting the near future will open up, both in relation to time, and in relation to the quality and intensity of military or political events, which until now neither knowledge of history nor the wisdom of statesmen has provided. Now we have in our hands a simple but effective scheme: the nature of the Sun and the Earth rages — people are agitated; the nature of the Sun and the Earth has calmed down — people have calmed down. Therefore, politicians or military leaders should not cherish hopes for the possibility of this or that event. They must know what will really appear with that immutable necessity which characterizes the phenomena of the physical world, completely independent of personal hopes or governmental plans.

Not only the field of military or political science will gain from the study of the behaviour of human masses according to the periods of solar activity — the establishment of laws governing each period will entail a revision of many aspects of human life and the establishment of firm limits for diverse collective and individual activity. Then it will be possible, with the aim of greater productivity of work, to establish norms and forms of activity for each individual in the field of his special profession. Such a delimitation of human life according to the hours of solar activity may give Man the means of extracting from his psyche the maximum of its energy. Then the methods of upbringing, education and professional work will have to be radically modified.

Moreover, we are convinced that further study of the influence of cosmic and related geophysical factors on human behaviour will have to open up the most extensive horizons for amazingly curious research. Perhaps the eternal and everyday episodes in the life of individual human groups, families, clans, societies, not to mention peoples, nations, states, — are in direct connection with one or another influence of these factors.

Discords and agreements in families, associations, partnerships; the stormy or peaceful course of parliamentary sessions, at which state questions of primary importance are discussed, leading the country to one or another decision; the height of battles or truce on the fronts of wars or revolutions — all of them, on the average, depend on the given state of the central body of our system, on the changes it introduces into the physical environment of the Earth.

Fluctuations in the personal life of individuals are to one degree or another subordinated to the course of the periodic activity of the Sun or are even caused by it. This is especially clear and distinct in the lives of great statesmen, rulers, military leaders, reformers, etc. It is enough to take the biography of any of them to be convinced of the constant correlation between the life of a given person and the changes in the course of the synchronous curve of relative Wolff numbers. This is a fact worthy of astonishing attention and study. Let us take as an example the life of Napoleon Bonaparte (Napoleon I), who troubled Europe for such a long time. It turns out that he, this giant of personal tyranny, had to submit with precision and obedience in his actions to the inexorable influence of the cosmic factor. Thus, the height of his activity can be attributed to the era of maximum solar activity; conversely, the minimum of the military-political activity of this Corsican coincides with the minimum of sunspot formation. This is clearly evident in the period from the end of 1809 to the beginning of 1811, when, according to Wolf's table, we have a minimum of spots and Napoleon did not undertake a single campaign of conquest, only made a number of bloodless acquisitions, and Napoleon himself found time in this era to think "pro domo sua". This period was the apogee of his peaceful autocracy and a time of quiet cabinet work. Meanwhile, the year of the preceding maximum (1804) raised the name of Napoleon to an unattainable height of glory and crowned him with the imperial crown, and the year of the following maximum (1816) placed him on the island of St. Helena. Napoleon's consulate began precisely at the minimum of solar activity (1799), when the revolutionary masses of France had become quiet, and absolutist inclinations could freely flare up in this ambitious artillery officer.

From this it is easy to understand what a great significance for many social sciences a comprehensive study of the question touched upon here must have; the solution of the lat-

ter may entail a radical break in the most diverse aspects of social life that have taken root among Mankind. Its solution will immediately have to be reflected in jurisprudence, diplomacy, labor, artistic and scientific creativity, not to mention, of course, the military or political branches of knowledge.

We do not at all pretend to the absolute reliability and, even less, the categorical nature of our considerations and statements on this subject. They must only show that an objective study of the connexion between some and other phenomena of Nature, which have hitherto been considered independent of each other, can throw light on the most diverse cases of the mental and social life of Man.

Of course, no truth is obtained immediately, like "deus ex machina"; a whole series of diverse, sometimes mutually contradictory and mutually exclusive hypotheses and theories precede it. Even in such an exact science as the "queen of sciences" — astronomy — we encounter essentially diametrically opposed opinions on the most important astronomical problems; this is especially evident on the question of the structure of Mars. But the task of a synthetic judgment is precisely to embark on the path of broad generalizations and find a relationship between the phenomena that seem to belong to completely different areas of knowledge and life without fear or apprehension before a judgement of blindly prejudiced, sometimes ignorant criticism. These attempts are led by a combined knowledge of philosophical, natural and historical disciplines.

Therefore, if one may not agree with some of the propositions briefly expressed in this work, this only shows that every truth is necessarily preceded by a time of searching, experimentation, disagreement, and debate. I am also sure that there will be skeptics who, without taking the trouble to familiarize themselves in detail with the theory and other of my studies, on which this theory is based, will deny and dispute it. But we know that bare denial is always fruitless. It is better to doubt something than to refute it, for doubts lead to discoveries. The most unsuccessful assumptions also indirectly direct us to them, stimulating our minds to research.

In the field of exact knowledge, discoveries can be divided into two categories. The first of these are those which represent additions to previously established truth, its continuation, an extension of its boundaries. To verify them, only a certain amount of patience and a quite ordinary mind are required. But there are discoveries which involve a radical break with old views on the nature of a given phenomenon. To evaluate such a discovery, an appropriate expert with a broad intellectual horizon must be selected, a kind of "knight without fear and reproach", who, without fear of the loud judgments of the ignorant, could defend the discovered facts in the face of an astonished and distrustful world. Such knights are not often encountered: the history of science is full of examples of the opposite nature. We meet such examples everywhere; there are many of them in the last century. At the end of the 1840s, ideas about the conservation of energy met with a harsh attitude from their contemporaries, and the most important scientific journal *Annalen der Physik und Chemie* did not accept von Helmholtz's famous memoir. Robert Mayer has had his share of troubles. And there are tons of such facts! I believe that a favorable attitude toward a new, sufficiently substantiated theory or a new method is an indispensable sign of a high mind, for it indicates the breadth of its intellectual sphere and the ability to think independently. Most people are not endowed with these qualities: their knowledge conceals in its foundation school rules, forever memorized, and their minds do not know how to respond with due sensitivity to newly discovered truths, which always seem false to them and the facts cited in their confirmation, a simple accident or, even worse, a manipulation. It would be completely unfounded to think that the materials cited in this article were chosen with the calculation to produce an effect. Due to the novelty of the issue under study, mistrust and surprise at the conclusions obtained, we foresee such judgments. It would also be unfounded to think that our curves, which, in fact, can easily be given any form, pursue the same goal and do not correspond to the actual state of affairs. More credulous people may assume, however, that when proving something, a person involuntarily strives to choose for proof what he needs, discarding everything that hinders or harms the course of the proof.

I consider it my duty to categorically reject such assumptions and accusations, and I refer anyone who will not consider it a hassle to check the materials to my main research cited in the Introduction. From this point of view, I consider the question exhausted in a positive sense, despite the additions and corrections that may follow in future work in this direction (for my work is by no means finished), but which will only change the configuration of the mentioned curves to an insignificant degree. The probability of the reliability of the main provisions of the question under study is so great that it leaves no room for fundamental objections. I do not overestimate the results of my work and regard my work as the first modest initiative that can give rise to deeper and more complete research. However, no matter how successful the objections made to me, no matter how convincing and even supported by appropriate arguments, I still have every reason to think that no dialectic, no matter how talented it may be, is capable of belittling conclusions based on facts, numerical relationships and the latest achievements of science. These achievements, I repeat here once again, require an exact explanation of all the phenomena of Nature, devoid of any metaphysical premises, including Man with his diverse mental activity. And in the field of the exact sciences, nothing should be astonished, nothing should be denied a priori and nothing should be neglected. The history of scientific thought abounds in examples of gross errors. Let us recall at least the most prominent philosopher and scientist of the last century, Auguste Comte, who in 1842, several years before the brilliant works of Bunsen and Kirchhoff, in his work *Cours de*

philosohie positive denied the possibility of ever accurately knowing the chemical composition of celestial bodies.

Science is moving forward with slow steps, revealing the regularity in all manifestations of the organic and inorganic world. The time has not yet come to subject the social evolution of Mankind to precise laws and embrace one general universal theory, as has been done for the cosmic bodies of the Solar System, but we must believe that this time will come, as it is already approaching, to establish the regularity of stellar movements, previously considered to be unrelated to each other and arbitrarily occurring in the infinity of space. And just as a number of astronomers in many conutries of the world diligently accumulate materials about the stars in the form of radial velocities, proper motions and distances to the stars, so the immediate task facing scientists is to study the influence of the slightest fluctuations in the environment on human mood and behaviour.

For these purposes, special scientific institutes should be organized in all countries of the world to keep the most accurate records of all social fluctuations and movements in their origins, development, and modifications. Strikes at factories and plants, walkouts, meetings, peasant unrest, manifestations of mass enthusiasm, demonstrations, episodes involving crowds of people, and so on, not to mention, of course, larger events, should be subject to accurate records, diagnosis, and classification. The methodology for this work is currently being developed by me[1]. From the data collected, graphs of fluctuations in individual types of mass human activity in each country, and then on the entire Earth, will be constructed. Finally, daily data on various types of mass activity will be compared with daily data from astronomy and meteorology. These comparisons will have to reveal the relationship that exists between these two phenomena — and in this way provide access to the field of studying the laws governing human actions under the influence of cosmic and geophysical factors.

In the international and national organization of such institutions I see the guarantee of the future well-being of all Mankind. We must remember that the influence of cosmic factors is reflected more or less uniformly on all the billions of human individuals who now inhabit the Earth — sol lucit omnibus, — and it would be crime to ignore the study of their influence, no matter how subtle and elusive at first glance it may not be.

In 1927–1929 we should expect the onset of the maximum of solar activity. If we allow the existence of periods of 60 years (Young) and 35 years (Lockyer), which are added to the main oscillation of 11 years, then the nearest future maximum should be especially intense (maximum maximorum), since the maximum of 1870 was distinguished by great strength. In all probability, in these years, due to the presence of factors of a socio-political nature, major historical events will occur that will again change the geographical map. It would be very desirable by this time to prepare the possibility of a scientific experiment in the field of research into the behavior of individuals and human masses. The latter can be realized only if the researchers meet with sympathy from the government. Otherwise, such an important field of knowledge for humanity will languish in vain for a long time, remaining unnoticed and unstudied by anyone.

It may take many decades of hard work before the plans that are only being projected now are realized. Much work remains to be done, and it is not we who will have to reap the fruits from the tree that we have planted and nurtured. But such is the lot of workers in science: it bears fruit not to those who are ready to die for it and, indeed, sacrifice their lives, but to those who treat it, if without hatred, then, probably, without love and filial devotion.

But those who, in the name of science, are ready to endure all privations and all troubles, starving for years and walking in rags, have one great consolation, one great joy, worth all the blessings and all the pleasures of the world, making them independent of human vulgarity and human judgments, and elevating them: they are closest to the knowledge of the secret laws that govern the mighty life activity of Nature. They already know its internal mechanisms, grasp the connections between shafts and wheels and, in indescribable delight, approach that lever, one push of which is capable of immediately changing the distribution of the parts of the eternally working mechanism and thereby regulating the phenomena of Nature itself — phenomena that until that moment moved in mysterious ways. They are approaching the possibility of controlling great events.

In unity there is strength! I believe that the world solidarity of scientists will help to overcome all difficulties and break down all barriers in the name of protecting life on the Earth and transforming it.

When Man acquires the ability to control the events of his social life entirely, those qualities and impulses will develop in him which sometimes even now shine on his forehead, but which will shine ever brighter and stronger, and finally will completely illuminate with a light similar to the light of the Sun the paths of perfection and well-being of the human race. And then it will be justified and proclaimed: the closer to the Sun, the closer to the Truth.

November 1922, supplemented in 1923

[1] See the work to be published: Chizhevsky A. L. *The Necessity of Creating International Scientific Institutes to Study the Influence of Natural Factors on the Behavior of Individuals and Collectives.*