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THE THEORY OF FRACTALS AND POETRY

Abstract

The paper highlights the ways in which scientific poetry influences human activity over time and in the modern era of its development. It asserts that the pursuit of knowledge remains as relevant today as it was thousands of years ago, now built on deeper understandings of the nature and structure of the universe acquired throughout human existence on Earth. The article emphasizes that the path to truth is dual: through science and art. Attention is also drawn to the fact that among scientific poetry dedicated to rational sciences, there exists a form of scientific poetry written not by "professional" poets but by experts in various fields of science and technology. A comprehensive study is conducted on the theory of fractals, a new geometry of nature that, unlike Euclidean geometry, can describe numerous irregular and fragmented forms in the surrounding world.

The article highlights the significant contributions of poet-thinker Mykola Rudenko to the development of fractal theory, as he expressed profound insights in poetic form that were later confirmed by scientific research.

Keywords: *scientific poetry, new geometry of nature, fractal, self-similar structures, verse.*

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Анотація

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У статті оприявнено способи впливу наукової поезії на діяльність людства у часовій тяглості, а також на сучасному етапі його розвитку. Стверджено, що питання пізнання світу залишаються актуальними для людства, як і тисячі років тому, і що вони лише ґрунтуються на більш глибоких знаннях про природу та структуру Всесвіту, яких набуло людство за час свого існування на Землі. Закцентовано увагу на тому, що шлях пізнання істини – двоєдиний: наука й мистецтво. Для прикладу наведено фрагмент Нобелівської промови С.-Ж. Перса (Стокгольм, 10 грудня 1960 року), у якій він ствердив своє розуміння і трактування поєднання наукового і мистецького мислення. Звернено увагу й на те, що серед наукової поезії, яка присвячена раціональним наукам, можна виокремити наукову поезію, яку пишуть не "професійні" поети, а фахівці різних галузей науки й техніки. Вони у віршовій формі описують свої знання, почування, сприйняття тих чи тих наукових явищ, відкриттів, спостережень, гіпотез, здогадів, технічних досягнень, фахових особливостей тощо.

Безпосередньо здійснено комплексне дослідження теорії фракталів, яка стосується нової геометрії природи, що, на відміну від "Евклідової геометрії", спроможна описати багато неправильних і фрагментованих форм у навколишньому світі. Ці структури в різних координатах простору і часу бувають різними, хоч почасти можуть бути самоподібними. Закцентовано увагу на тому, що значний вклад у розвиток теорії фракталів вніс також і поет-мислитель Микола Руденко, оскільки митець у поетичній формі висловив такі глобальні здогади, які пізніше знайшли підтвердження у багатьох наукових працях.

Оприявнено поетичні твори Миколи Руденка, Мері Мієрс, Вільяма Блейка, Теда Гюза, Персі Біші Шеллі,

Samuel Taylor Coleridge та ін, які стосуються теорії фракталів і описують їх у розмаїтті природних об'єктів і навіть у невидимих об'єктах (звукових, хвильових), які людина не може спостерігати зором, але здатна відчути іншими органами чуття. Тобто поети у віршові формі оприявнюють наукові постулати про Всесвіт який є багатогранним і багатоаспектним, хоч складається із самоподібних структур, які однак не є штампом, а творінням, бо є подібність, але немає копії.

На підставі вищезазначних студій зроблено висновки, що хоч на наукову поезію, так звану "poesia doctus" звертали увагу багато дослідників, розглядаючи її з різних боків, однак повного її опрацювання до сьогодні ще не маємо, а відтак вважаємо, що цей бік поетичного мистецтва є перспективним і ще чекає на своїх дослідників.

Ключові слова: *наукова поезія, нова геометрія природи, фрактал, самоподібні структури, поетична форма.*

Introduction

Scientific poetry is a form of poetic art thematically linked to science, that is, poetry in which the content of the work is determined by a scientific component. The term "scientific poetry" was introduced by French theorist René Ghil ("*Treatise on the Word"*, 1896), who advocated for the unity of science and poetry.

The earliest examples of scientific poetry emerged in ancient times when human consciousness was still mythopoetic by character and had not yet diverged into distinct scientific and artistic modes of thinking (Volkov, 2001: 362). Such examples include Ancient Greek cosmogonic and astronomical lyric poetry, as well as philosophical didactic poems ("*Theogony"* by

Hesiod, "*Astronomy"* by Cleostratus, "*On the Nature of Things"* by Lucretius, "*Georgics"* by Virgil, etc.) (Hromiak et al., 2006:486).

During the Renaissance period scientific poetry encompassed both direct descriptions of natural laws and philosophical reflections on the Universe, evolution, and mathematics. For instance, John Donne (1572–1631), a leading figure in metaphysical poetry, described the scientific revolution spurred by Copernicus and Galileo's discoveries:*"And new Philosophy calls all in doubt, / The element of fire is quite put out; / The Sun is lost, and th'earth, and no man's wit / Can well direct him where to look for it."* ("*An Anatomy of the World"*, 1611) (Donne, 1611).

Oliver Goldsmith's (1728–1774) poem '*The Traveller"* (1764) contains scientific observations on nature and geography:*"And, as a bird each fond endearment tries / To tempt its new-fledged offspring to the skies, / He tried each art, reproved each dull delay, / Allured to brighter worlds, and led the way."* (Goldsmith, 1764)

Renaissance romantics often turned to science, combining it with natural philosophy, thinking about science as a means of understanding nature. William Wordsworth (1770—1850), in "*The Tables Turned'* (1798), wrote:*"Sweet is the lore which Nature brings; / Our meddling intellect / Misshapes the beauteous forms of things: / – We murder to dissect."* (Wordsworth, 1798*)*

At the present stage of human development, the issues of world intellection remain as relevant as they were thousands of years ago. They are only based on deeper knowledge about the nature and structure of the Universe that humanity has acquired during its existence on Earth. The path to genuineness is a dual one: through science and art. Alfred Tennyson (1809–1892), in

"*In Memoriam A.H.H."* (1850), contemplated the theory of evolution even before Darwin's work was published: *"Are God and Nature then at strife, / That Nature lends such evil dreams? / So careful of the type she seems, / So careless of the single life."* (Tennyson, 1850).

The relationships that appear in theories, proofs, and laws of various branches of science are formulated at the level of feelings and sensations of certain connections. The greatest challenge in research is often the verbal articulation of these relationships, which are traditionally presented in scientific articles, treatises, theses, and reports but can also be formulated in poetic form (Vivat, 2013:7).

Saint-John Perse, in his Nobel lecture (Stockholm, December 10, 1960), expressed his view on the intersection of scientific and artistic thought: *"When we recognize the drama of modern science, which even in mathematical absolutes encounters its rational limits; when we see how, in physics, two great dominant doctrines propose, on one hand, the general principle of relativity, and on the other, the quantum principle of uncertainty and indeterminism, permanently limiting the certainty of physical measurements; when we hear the greatest scientific genius of our century, the founder of modern cosmology and creator of the most grandiose intellectual synthesis constructed in mathematical equations, invoke intuition in aid of reason and declare: 'Imagination is the true foundation of scientific idea,' thereby demanding for the scientist the right to artistic vision –should we not also regard poetic tools as legitimate as logical ones? Indeed, every intellectual creation is fundamentally 'poetic' in the true sense of the word; and given the equivalence of sensory and spiritual forms, the work of the scientist and the work of the poet have an identical purpose from the outset"* (Pers,2000*)*

A striking example of the poeticization of physics and quantum mechanics, where the scientific fact is presented in rhythmic form is seen in John Updike's "*Cosmic Gall"*: *"Neutrinos, they are very small. / They have no charge and have no mass / And do not interact at all. / The earth is just a silly ball / To them, through which they simply pass, / Like dustmaids down a drafty hall / Or photons through a sheet of glass." (*Updike, 1960*)*

The renowned physicist and astronomer Heinrich Hilmi also shared his perspective on scientific poetry: *"…scientific poetry is neither a toy nor a mere translation of scientific ideas into a more accessible language, but rather an extension of scientific understanding through information that cannot be conveyed by logic alone but is accessible through imaginative thought."*

This article explores poetic predictions, hypotheses, and insights related to scientific discoveries.

Analysis of Recent Research and Publications

Many scholars have studied scientific poetry, also known as *poesia doctus*, examining it from various perspectives. For instance, Olga Shaf analyzed geometric figures in the poetic world of Emma Andiievska, while Herodot Heglov researched the scientific poetry of Nobel laureate Sully Prudhomme. H. M. Shevtsiv explored numerical symbolism in *Poetry and Truth* by Johann Wolfgang von Goethe. Marko Pavlyshyn examined the poetry of Vasyl Stus through the lens of the still-unresolved problem of squaring the circle. Lyudmyla Mnykh investigated numerical correlates in the works of 20th-century poets. Some aspects of this topic have also been addressed in our previous research (Vivat, 2011). However, in our view, scientific poetry

remains insufficiently explored and underrepresented in the global context.

Problem Statement and Its Connection to Key Scientific Objectives

This study aims to examine one particular segment of scientific poetry—the poetic interpretation of fractal theory. To achieve this goal, the following objectives have been set: to explore the phenomenon of scientific poetry creation across different historical periods and cultures; to clarify the conceptual manifestation of fractal theory in scientific literature; to analyze the process of understanding fractal theory and its representation in the world poetry; to trace the influence of fractal theory on scientific theories across micro-, macro-, and meta-dimensions, as reflected in both Ukrainian and global poetry.

To obtain reliable data, the study employs descriptive, inductive, and deductive methods, along with componential and contextual-interpretative approaches.

Presentation of the Research Findings

Poetry has increasingly integrated into science and artistically realizes scientific material from the point of view of aesthetics, ethics and morality. It transforms scientific thought into imagery, channeling it into a spiritual realm. Thus, the 20th-century art and science have become deeply intertwined, causing poly-tendency in the thematic plan (Vivat, 2011:193). Over time, scientific poetry has branched out into several thematic streams. The primary ones include those that represent lyrics dedicated to philosophical problems (the origin and structuring of the universe, fundamental elements of existence, primary colors, chaos/cosmos, the universal law of struggle and unity of opposites, etc.), philological aspects (word formation, poetic

artistry, genre studies), and poetry connected to rational sciences. The latter category includes themes such as the dimensionality of the world, numerical correlates, integrals, global scientific theories and laws (the general and special theories of relativity, the theory of multiple worlds, the theory of wave propagation in random media, Archimedes' principle, the law of rational heat exchange, etc.) (Vivat, 2013:10).

Among scientific poetry devoted to rational sciences, a distinct category of *poesia doctus* stands out – scientific poetry written not by "professional" poets but by specialists in various scientific and technical fields. These individuals use verse to describe their knowledge, emotions, and perceptions of scientific phenomena, discoveries, observations, hypotheses, insights, technical achievements, and professional peculiarities.

A striking example of *poesia doctus* is found in the works of Klym Churyumov, a corresponding member of the National Academy of Sciences of Ukraine, Doctor of Physical and Mathematical Sciences, and professor. His poetry collections for children include "*Mathematics for Kids"*, "*For Kids About Professions"*, "*For Kids About Animals"*, "*For Kids About Boats"*, among others.

Other scientists also express their reflections in poetic form. For instance, astronomers publish their observations of celestial objects in the English-language journal *Astropoetica*, poetically describing their features and emotions associated with these observations. The *Aerospace Portal of Ukraine* features Ukrainian-language poetry about space, while English-language samples of this poetry are also widely available.

English poetry about space and science spans centuries, from Milton's cosmic vision to Smith's reflections on modern astrophysics. Whether embracing the beauty of the universe or grappling with scientific concepts, poets have long sought to

capture the mystery and grandeur of space through verse.

Milton's "*Paradise Lost"* (1667) presents a theological and scientific vision of the cosmos, reflecting both classical and emerging astronomical ideas of the 17th century: "*Space may produce new Worlds; whereof so rife / There went a fame in Heav'n that he ere long / Intended to create, and therein plant / A generation, whom his choice regard / Should favour equal to the Sons of Heaven*" (Milton, 1667).

William Blake often used scientific and mystical imagery in his poetry**,** particularly regarding the creation of the universe**:** "*When the stars threw down their spears, / And watered heaven with their tears, / Did he smile his work to see? / Did he who made the Lamb make thee? "(*"*The Tyger*" (1794)) *(*Blake, 1784).

Alfred Lord Tennyson envisioned space travel and the exploration of the cosmos long before it became reality: "*For I dipt into the future, far as human eye could see, / Saw the Vision of the world, and all the wonder that would be; / Saw the heavens fill with commerce, argosies of magic sails, / Pilots of the purple twilight, dropping down with costly bales*" ('*Locksley Hall'*) (Tennyson, 1835).

Robert Frost speculates on cosmic destruction using fire (heat, energy) and ice (cold, entropy): "*Some say the world will end in fire, / Some say in ice. / From what I've tasted of desire / I hold with those who favor fire. / But if it had to perish twice, / I think I know enough of hate / To say that for destruction ice / Is also great/And would suffice*" *(* "*Fire and Ice*" *(1920)) (*Frost, 1920*).*

One of the major scientific breakthroughs of the 20th century was the development of fractal theory, which made it possible to study the world in which we exist from a previously unknown side of the existence of matter.

In 1975, Benoît Mandelbrot published an essay outlining fractal theory, formulating a new geometry of nature that, unlike Euclidean geometry, could describe many irregular and fragmented forms in the surrounding world. His concept defined a family of figures known as fractals, derived from the Latin *fractus*, meaning "fragmented" or "broken". Fractal approach to studying the world around us enabled scientists to study structures that did not fit within the frameworks of Euclid's geometric constructions and Isaac Newton's translational mechanics (Mandelbrot, 2004*)*. These structures, while different in various spatial and temporal coordinates, often exhibit self-similarity.

Mandelbrot's essay was initially published in French in 1975 and translated into English in 1977. However, the theory was preceded by numerous studies that laid the foundation for its development. Mandelbrot acknowledged influences from scholars such as G. Cantor, G. Peano, H. Lebesgue, F. Hausdorff, A. Besicovitch, B. Bolzano, C. Osgood, W. Sierpiński, and others (Mandelbrot, 2004*)*.

Notably absent from this list is Mykola Rudenko. And this is not surprising given that he did not approach the subject from a scientific standpoint. However, we can confidently say that the poet-thinker Mykola Rudenko also made a significant contribution to the conceptual development of fractal theory. His poetic insights foreshadowed global ideas that later found validation in scientific research.

For example, in his poem "*Shadows"* (1964), the author uses the metaphor of frost patterns on a windowpane resembling a forest or clouds figures resembling earthly natural objects: *"Winds herd sheep across the sky, / Their wings tinged with twilight's glow. / And a white stallion leaps on the meadow, /*

Like a drifting white cloud that falls into the grass." (Rudenko,2004:86*)*.

In the poem "*Forest on the Windowpane"* (1967), he invites readers to ponder the mystery of self-similar structures creation – forest patterns on a frosted window, or similar figures that can be observed in the flames of fire – perceiving them as manifestations of the highest essence of existence in nature:
"It struck me as I gazed, / That here lies some profound essence: / Fire and the depths of cold / Bear the same images within." (Rudenko, 2004:186*)*.

The forest on the window is also mentioned in the novel-treatise "The Formula of the Sun", where M. Rudenko puts into the mouth of the main character of the novel an idea-guess or an idea-prediction about the creation of self-similar structures in nature: "*And on the window glass, frost drew such patterns that not every artist would be able to. < ... > They were trees with amazing branches that resembled fern leaves. I didn't know if such trees existed – only later did Vasyl explain that almost the same ones grow in Australia. But I had the impression that I had already seen these trees somewhere, they cannot be absent, they are so natural. And even if you can't find them on the entire planet, they must grow somewhere. Maybe on some other planet. And frost turned out to be just an impeccable photographer, he took these images somewhere in the boundless Cosmos and, as if playing, threw them on our windows. < ... > Nature has certain laws of motion, and it is these laws, like frost on a window glass, that create the corresponding forms of living organisms that turn out to be the most appropriate. Ultimately, these laws boil down to the eternal struggle between heat and cold, light and darkness, etc."* (Rudenko,2005:38*)*.

In the poem "Reflections" (1970), the poet is again fascinated and interested by reflections on water that repeat

living nature, that is, create self-similar structures. He returns to this theme already in 1981 (“Contemplation of Clouds”), however, against the background of this scientific problem, the poet builds others that concern not only purely scientific, but also moral and ethical principles of being.

A self-similar structure, according to the correct statement of M. Rudenko, is a human-being himself as an integral part of nature:*"Only then does this trap disappear, / When you embrace the ancient truth: / You are a smart thinking fragment / Of the universe’s living reflection."* (“*In the Living World”*) (Rudenko,2004:105)

In a lyrical miniature “*Can You Encompass the Universe at Night?”* (2002) the image of a shell created by a snail reminds to the lyrical character a self-similar structure – the spiral architecture of a galaxy (Vivat, 2011:216*).*

It is worth noting that the ideas of self-similarity, infinite complexity, chaos, and order can be found in poetic works long before the formal "discovery" of fractals, not only in the poetry of Mykola Rudenko.

For instance, William Blake (1757–1827), known for his visionary poetry, often incorporated the concepts of infinity and self-similarity. A fractal image – the whole world contained in a tiny particle – appears in his poem *Auguries of Innocence* (1801): *"To see a World in a Grain of Sand, / And a Heaven in a Wild Flower, / Hold Infinity in the palm of your hand, / And Eternity in an hour" (*Blake, 1801).

The theme of infinity in nature, the power of nature recurring at different levels of existence, resembling a fractal structure, is also found in the works of Percy Bysshe Shelley (“*Ode to the West Wind”*). Similarly, the imagery of natural symmetry, repetitive patterns, and the interconnection between the microcosm and macrocosm—resonating with fractal

aesthetics – appears in Samuel Taylor Coleridge's (1772–1834) poem "*Kubla Khan"*, where the poet creates a multi-layered world in which identical motives unfold at different scales: *"In Xanadu did Kubla Khan / A stately pleasure-dome decree: / Where Alph, the sacred river, ran / Through caverns measureless to man / Down to a sunless sea"* (Coleridge, 1816).

Coleridge intuitively created a fractal poem not only in imagery but also in structure, proving that fractality exists not only in mathematics and nature but also in the art of words.

Gerard Manley Hopkins (1844–1889) introduced the concept of *inscape* – the inner, unique form of things – which resembles the idea of self-similarity in fractals. His celebration of natural fractal patterns, the diversity, and the structured chaos of nature can be seen in "*Pied Beauty"*: *"Glory be to God for dappled things / For skies of couple-colour as a brinded cow"* (Hopkins, 1985)

The poetry of Ted Hughes (1930 –1998) is deeply infused with a connection between humans and nature, often reflecting the complexity and repetition of the world's structure. Images of chaos and rebirth – reminiscent of the fractal process of self-development – appear in his poetry collection *Crow (Examination at the Womb-Door)*: *"Who owns those scrawny little feet? Death. / Who owns this bristly scorched-looking face? Death. / Who owns these still-working lungs? Death. / Who owns this utility coat of muscles? Death. / Who owns these unspeakable guts? Death. / Who owns these questionable brains? Death. / All this is death's. / But Crow owns the end."* (Hughes,1960)

Here, the fractal structure is embodied in the rhythmic repetition of questions and answers, creating an effect of infinity. The image of the Crow survives through repetition, just as fractals in nature continue to evolve through self-similarity.

Although these poets did not use the term "fractal," their works reflect the ideas of scientific poetry – endless structures, self-similarity, and the interconnection between the microcosm and macrocosm.

In 2011, a book titled *Science Poetry*, edited by Neil Harding McAlister and Zara McAlister, was published in Canada, featuring an introductory article by the editors. This collection includes English-language poems classified thematically into different fields of science: a) Basic Science, b) Human, c) Environment, d) Machine, e) Cosmos (McAlicter & McAlicter, 2011).

The collection includes Mary Myers' poem *Fractals*, which resonates thematically and ideologically with Mykola Rudenko's poetry about the fractal nature of the universe.

Mary Myers writes with fascination about infinite repetitions in nature, self-similar structures, fractals, and their intriguing variations and transformations in her poem *Fractals*: *"In endless repetitions / the arguments recycle: / fractals are just geometry, / formulae describing a relationship / of numbers; / others observe fractals / as organic, morphing / shapes, self-similar, / when magnified: / the spiral of the nebula / is the echo of a spirochete, / a dynamic series / of cyclic feedback systems, / in endless repetition. / John Muir saw a glacier fractal / that traced its shape across / Yosemite, similar delineations / in ice, then stream meanders, / canyon walls and moraines, / perimeters of forests, / and flight paths of the birds. / This preservationist / who peered through time / discovered hidden similarities / in endless repetition. / I am enmeshed within / a fractal called ecology / an energetic hoop, / where every voice, at single / knots within this web, sends / tremors throughout the weave / in unforeseen systemic waves, / touching jaguars, and bristle / cones, and hearts, and / cells and stars, and ears / in*

*endless cyclic permutation" (*McAlicter& McAlicter, 2011, p. 30)

Since the diversity of fractals in their infinite repetition and transformation is almost unimaginable, attempts have been made to classify them. A generally accepted classification divides fractals into three types: geometric, algebraic, and stochastic.

The poetess provides examples of observing fractal structures in the diversity of natural objects, as well as in invisible phenomena (sound, wave patterns), which humans cannot perceive visually but can sense through other means. In other words, she recognizes that the world consists not only of visible objects but also of systems beyond our sensory perception, which nonetheless have a fractal structure.

These same ideas permeate the poetry of Mykola Rudenko. Throughout his life, the poet saw himself in the universe and the universe within himself as a single whole, without distinguishing between micro-, macro-, and metaspheres, since all of them follow the universal laws of Nature. However, Rudenko emphasizes that self-similar structures, abundant in nature, are creations rather than mere stamps—there is similarity, but no exact copy, because nature does not stamp, it creates (Vivat, 2011 : 216) : *Uniformity, like beads of glass, / In Nature's realm you'll seek in vain. / No fingerprint nor leaf's design / Repeats the same, though tried again. / Tell me, O Nature, all these green /Adornments Earth so long has worn Would stamping patterns not be easier? / Yet Earth replied, so soft, yet sworn: / "I do not stamp, I live and breathe." / Have you beheld, in all you see, / A soulless copy, dull and bare? / No two alike – no souls the same. /That is life. / And death? A mere cliché."* ("*Uniformity, like beads of glass* …") (Rudenko, 2004).

Self-similar structures, though repetitive, are not mechanical stamps or mere imprints; they are living, open systems, constantly in motion, transformation, and interpenetration – just like everything in the universe, as Rudenko believed, and rightly so.

Conclusions and Future Research Prospects

This study has explored the impact of poetry on scientific thought, tracing the phenomenon of scientific poetry across historical periods. The conceptual articulation of fractal theory in scientific literature, particularly in Mandelbrot's essay, has been clarified. The poetic representation of fractal theory in 20th-century poetry has been examined, along with its influence on micro-, macro-, and meta-dimensions in both Ukrainian and global poetry.

Although many researchers have explored *poesia doctus* from various angles, a comprehensive analysis remains incomplete. Therefore, scientific poetry remains a promising field awaiting further scholarly investigation.

References

Blake, W. (1784). *The Tyger*. Available at: https://english-online.org.ua/materials/01a1331815345db [in English]

Blake, W. (1801). *Auguries of Innocence*. Available at: https://www.siue.edu/~voller/Common/AnimalTales/blake_auguries_of_innocence.pdf [in English]

Coleridge, S.T. (1816). *Kubla Khan* or A Vision in a Dream. Available at: https://poets.org/poem/kubla-khan [in English]

Donne, John. *An Anatomy of the World*. Bartleby. Available at: https://www.bartleby.com/357/169.html [in English]

Frost, R. (1920). *Fire and Ice.* Available at: https://www.poetryfoundation. org/poems/44263/fire-and-ice [in English]

Goldsmith, O. (1764). *The Traveller*. Available at: "The Traveller and its success" from The Cambridge History of English and American Literature [in English]

Hopkins, G.M**. (**1985). *Poems and Prose*. Penguin Classics. Available at: https://www.poetryfoundation. org/poems/44399/pied-beauty [in English]

Hromiak, R. T., Kovaliv, Yu. I. , Teremko, V. I. (2006). *Literaturoznavchyi slovnyk-dovidnyk* [Literary dictionary-encyclopedia]. Kyiv, VTs «Akademiia».[in Ukrainian]

Hughes,T. (1960). *Examination at the Womb-Door*. Available at: https://allpoetry. com/ Examination-at-the-Womb-Door [in English]

Mandelbrot, B. (2004). *Fractals and Chaos: The Mandelbrot Set and Beyond*. Springer[in English] .

Milton, J. (1667). *Paradise lost.* Available at: https://www.yorku.ca /earmstro/ text/ParadiseLostBk1.pdf [in English]

McAlicter, H. N., McAlicter, Z. (2011). Science Poetry. Perry, Ontario, Canada [in English].

Pers, Sen-Zhon. (2000). *Poeziia. Nobelivska promova* (Stokholm, 10 hrudnia 1960 roku). Pereklad M. Moskalenka.[Poetry]. Kyiv, Yunivers. [in Ukrainian]

Rudenko, M. D. (2004). *Vybrane. Virshi ta poemy* (1936-2002) [Selected Poems]. Kyiv, Dnipro. [in Ukrainian]

Rudenko, M. D. (2005). *Formula Sontsia. Roman-traktat*.[The formula of the Sun. Novel-treatise.]. Ternopil, Dzhura. [in Ukrainian]

Tennyson, A. (1850). *In Memoriam A.H.H*. Available at:. https://poets.org/poem/memoriam-h-h [in English]

Updike, J. (1960). *Cosmic Gall*. Available at: https://www.physics. mcgill.ca/~ crawford/PSG/PSG21/204_97_L21.9_cosmicgall.html [in English]

Vivat H. I. (2011). *Kontseptsiia mnozhynnosti intertekstualnoho dyskursu u tvorchosti poetiv-dysydentiv (I. Kalynets, M. Rudenko, I. Svitlychnyi, V. Stus)*. dys. dokt. fil nauk. Kyiv. [in Ukrainian]

Vivat H. I. (2013). *Naukova poeziia XX stolittia* [Scientific Poetry of the 20th Century] Odesa, VMV [in Ukrainian]

Volkov, A. (2001). *Leksykon zahalnoho ta porivnialnoh o literature znavstva* [Lexicon of General and Comparative Literature]. Chernivtsi: Zoloti lytavry. [in Ukrainian]

Wordsworth, W. (1798). *The Tables Turned* Available at: https://www.poetry foundation.org/poems/45557/the-tables-turned [in English]

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