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Concept Paper

Shaping an Image of Science in the 21st Century: The Perspective of Metamodernism

Anita Pipere * and **Kristīne Mārtinsone**

Department of Health Psychology and Pedagogy, Rīga Stradiņš University, LV-1009 Rīga, Latvia; kristine.martinsone@rsu.lv
* Correspondence: anita.pipere@rsu.lv

Abstract: In a contemporary world facing countless multifaceted crises and challenges, science can still serve as one of the most powerful tools to deal with the ordeals of our time. However, the scientific community needs to provide space for reflection on novel ways of developing its centuries-old heritage and unlocking its potential for the benefit of the world and humanity. The purpose of this article was to deliberate on the image of contemporary science within the framework of the new philosophical paradigm of metamodernism. Following historical strands related to metamodernism and science, the authors encircled the general features and elaborated the main philosophical principles of metamodernism. The main task was to identify elements of contemporary science that conform to the philosophical principles of metamodernism. Thus, several features of science and research, such as the structure of science, scientific truth, metanarratives of science, scientific thinking, system of science, interaction of scientific disciplines, dialogue of science with society and politics, open science, digitalisation of science, etc., were interpreted through the perspective of the ontological, epistemological, axiological, and methodological principles of metamodernism. This article ends with a summary of the main points of the discussion and practical implications of the presented ideas.

Keywords: axiology; epistemology; metamodernism; methodology; modernism; ontology; postmodernism; science

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1. Introduction

At the beginning of the 21st century, the world is facing many multifaceted crises and challenges, like climate change, geopolitical crisis, global economic inequality, political polarisation, cybersecurity, pandemics, immigration crisis, artificial intelligence and automation, mental health and well-being, water scarcity, biodiversity loss, and others. These are some of the most pressing crises facing the world today; however, these predictable challenges may be coupled with those we have not heard of yet, and it is clear that the next generation will live in a radically different world. It should be noted that these crises are interconnected and often exacerbate each other, making them more difficult to address. Managing these crises will require a coordinated and collaborative response and networking from governments, businesses, communities, organisations, institutions, and individuals. Science stands out as one of the most powerful agents that can promote global prosperity for humanity and contribute to the solution of the above-mentioned and future problems.

In this article, we conceptualise science in the broadest sense of the word, considering all branches of science as "certain big questions are too complex to be addressed one-dimensionally" [1], thus applying the pluralistic approach and the interdisciplinary view, characteristic of the new paradigm of metamodernism, which is described later in this article. Furthermore, viewing the fields of science as cultures (see [2,3]) and recognising the need for a dialogue between the cultures of the natural sciences, the social sciences, and humanities (and even art) could be a reasonable way for humanity to approach the above-mentioned crises and challenges.

Exploring the role and functions of science in this changing and challenging world, it appears that the role of science changes steadily as it transposes its aims and tasks from the specific monodisciplinary problem-solving in the traditional organisational framework to the well-regulated global aid for humanity to tackle complex problems and their side effects [4]. One of the indices for such changes is the increasing significance of science and scientific knowledge in different areas of life, which had been partially covered by the term "knowledge society" and has now evolved into an even more complex term of a post-knowledge society [5,6]. However, even since the first decade of the 21st century, scientists themselves have seemed to be aware that science is not the only subject that creates knowledge and that scientific knowledge is not the only type of knowledge [4].

The changing role of science in the second decade of the 21st century is also observed in the shift in practising science: it became more open (e.g., open science), cooperation-orientated (e.g., multi-, inter-, transdisciplinary), and more interdependent on a global scale, which also is reflected in new trends of science policy (e.g., responsible research and innovation). Especially during pandemics, we observed new approaches to scientific processes based on collaboration, new ways of spreading knowledge using digital technologies, and new tools for collaboration [7]. We already can anticipate the dissolution of quite recent boundaries between scientific disciplines, an increase in diversity in science, an orientation toward inclusive science (e.g., much larger involvement of women and persons with special needs), the sharing of scientific data and resources, T-shaped skills of scientists (deep knowledge in their discipline and broad knowledge in different other branches), etc. [8].

Notwithstanding these new developments, apparently, the large number of the above-mentioned complex problems might have been created by narrow and fragmented views of science and its functions and aims. Today, the natural and social sciences and humanities need a new perspective and explanation of the world, as well as a radical change in approaches to the solutions of global issues, since understanding these problems in a framework of narrow and rigid paradigms clearly has been irrelevant to the multidimensional character of these problems. All the complexities and questions that have not yet been answered call for a new awareness of science and research and the image of mature and smart science. Our handling of the given topic, developed in the traditions of conceptual papers and ingrained in the discourse of the philosophy of science, is an exercise to align the main features of this new image of science with a developing paradigm of metamodernism.

The methodological approach to this work will be based on three stances: the academic work experience and positions of the authors as scientists, the tripartite position of the authors as philosophers, namely as thinkers, artists, and mathematicians, and the Johan Mounton Three Worlds framework for human inquiry [9,10], adapted to the needs of our discussion.

To start with, our own experiences and positions as scientists, along with our interest in topics such as sustainability, complex problems, and the digital revolution, have shown us the path leading to critical reflection on science and analysing the features of science evolving at the beginning of the 21st century. We see our own interdisciplinary focus on philosophy, psychology, education, health science, and sustainability as an example of the kind of holistic, dynamic, and inclusive approach to research and problem-solving that is required in a metamodern perspective. Additionally, an involvement in the editing and writing of books on research in social sciences, health, education [11–13], etc., covering the substance of the philosophy of science, was an important precondition and "test site" for this work. Especially, the introductory chapters of our book, *Methodology of Scientific Work: An Interdisciplinary Perspective* [13], can be seen as the main source of inspiration for the topic of this article.

We could also reflect on our metapositions as authors of this work, written from the perspective of philosophers integrating three identities, those of thinker, artist, and mathematician [14]. As thinkers, we were searching for new ideas and novel concepts, improvising on found ideas in an artistic way through images and metaphors, while as mathematicians, we were deeply absorbed into our "own inner perpetual flux of cosmic explorations and artistic escapades" (ibid, para. 1), examining the beauty of proposed ideas.

Another more content-orientated background for this article is Mounton's three realms or worlds of human inquiry that comprise a specific form of knowledge and the relevant goal of knowledge creation [15]. World 1 encloses everyday life and problem-solving knowledge orientated toward coping with daily tasks and challenges; this world consists of our physical surroundings, social practise, and human beings. This world is used to bolster the urgency of the topic of our discussion and to lay the pragmatic context for the necessity of a renewed image of science. In World 2, the phenomena of everyday life are transformed into scientific objects of investigation with the aim of gaining the truth about the objects of the natural and social worlds. This world embraces the system of science and epistemological and methodological elements of scientific inquiry, and this world is extensively described in the following sections. Finally, Word 3 entails the philosophy of science and critical inquiry about World 2, thus denoting the application of new ideas to the realm of science as a cultural and social activity and scientific inquiry with all its technical and methodological dimensions [10].

On these grounds, this article aims to contemplate the image of science within the framework of the new philosophical paradigm or the cultural code of metamodernism. The main tasks of this theoretical work, based on the historical strands related to metamodernism and science, will be to concisely summarise the new paradigm of metamodernism described in our previous publications [13,16] and conceptualise our recently developed transversal principles of metamodernism [16] for contemporary and future science and research. Although the principles of metamodernism for the first time were outlined in our previous article [16], the following presentation provides a more detailed and contextualised elaboration of these principles, establishing our perspective on science in the 21st century. The application of the principles of metamodernism in shaping the image of science (in the broadest sense) is the novel contribution of this article.

In what follows, we first elaborate on the cultural codes preceding metamodernism, thus uncovering its historical roots and predecessors. The historical discourse continues with a brief outline of the epistemological foundations of science and research in modernism and postmodernism. The main part of this article focuses on two subjects. First, we will briefly outline metamodernism as a new cultural code and describe its main philosophical principles, then the principles of metamodernism are conceptualised for contemporary science and research to improvise the future image of science. This article concludes with a snapshot of the main points of the discussion and the practical implications of the subject matter.

2. Predecessors and Contemporaries of Metamodernism

It has already become a tradition, or bon ton, before embarking on the description of metamodernism to take a little detour through previous cultural codes or stages, whatever they are called in different contexts, discourses, or disciplines. However, this is not just the traditional historical preview characteristic of textbooks. The consideration of these stages is helpful in constructing a deeper understanding of metamodernism and its principles that follow later in this paper. Now, we try to list the main features of the four stages, namely indigenous, premodern, modern, and postmodern, taking into account that most often metamodernism is compared with modernism and postmodernism (e.g., [17]). Even more, Brent Cooper [18] invites us to be cautious with terms like modernism, postmodernism, and metamodernism, as they are superordinate terms that organise discourse, including the meaning of other words, and multiordinal terms with multiple meanings. Thus, articulating them as simple formulae or successions of stages could clearly be misleading. However, to reach the objectives of this article, we start with this simplistic linear structure, which, closer to the end of the section, is challenged and devalued.

Indigenous stage. This stage of cultural evolution was prevalent 50,000 years ago in hunter–gatherer and horticultural societies where oral narratives, face-to-face exchanges, and magical/mythic ritualistic practises for cultivating participatory meaning-making are key characteristics [19] (para. 8). It provided the first systems of "social epistemology" or "mythic" knowledge. Daily life is led in a small group with small power differences, although wise elders and shamans/medicine (wo)men have higher status in the group. Nature is animated by spirits, and humans are an integral part of nature. About 10,000 to 12,000 years ago, humans began the agrarian way of life, which allowed them to establish permanent settlements and create new social arrangements and the earliest forms of writing, thus beginning human written history [20].

Premodern stage. From medieval times, one can see the emergence of premodern formal systems of justification. The great religious and philosophical traditions, as well as belief systems, consist of sacred written texts, offer a formal narrative for what is and what ought to be, and function to coordinate huge numbers of people [19]. The political system of feudalism is based on the metaphysics of supernaturalism and the epistemology of mysticism and/or faith. Humans are subjects to God's will, and their ethical discourse is based on collectivism [21].

Stage of modernism. The philosophical roots of modernism can be traced as far back as the Enlightenment/Industrial Revolution about 300 years ago, though, in some cultural domains, it asserted itself around the turn of the twentieth century, especially after WWI. Modernism is about putting hope in reason, rationality, science, and notions of progress and invention; modernists consider themselves to be seeing past the veils of traditional culture into an uncovered objective truth [22]. Likewise, the freedom, superiority over nature, and political program of capitalism gave a boost to the Industrial Revolution, modern science and technology, and a better quality of life in technologically advanced societies. This allowed for grand narratives, legitimising social actions and practises, and defining the shared sense of purpose, like an optimistic vision of life, expectations of unremitting social progress, and an illusory future of happiness [23,24].

The metaphysics of modernism stems from realism (naturalism) and is determined by the subject–object relationships, exposing the detachment of the subject from the objective world, as instigated by Descartes [25]. Epistemologically, modernism is rooted in objectivism, which emphasises the role of experience and reason. The theory of tabula rasa [26], denigrating any pre-existing innate ideas, and the concept of autonomy are used to explain human nature, which supports the ethics of individualism and the idea of universal human rights [21].

However, recent developments have brought the idea of a new phase of modernity: simple modernity becomes a reflexive modernity that features the transition from an industrial society to a risk society [27–29], defined by the distribution of goods (wealth) and "bads" (pollution, contamination, and other byproducts of production). Other characteristics of a risk society are a looming apocalypse, disbelief in the power of science to prevent potential catastrophes, and more and more disparate suggestions for the management of technological environmental issues. According to Baxter [30], "Uncertainties of science have come much more into focus in society in general. As we recognise the limits of science, the social structures/systems in which decisions are made have garnered more attention. Thus, our ontological security about being safe in the world has been shaken, whereby institutions in society (e.g., welfare state, personal insurance) are questioned for their ability to protect us long term" (p. 303). Both modernity in general and its phase of reflexive modernity present a realist ontology and objective truth judged from a disengaged perspective [24]. However, reflexive modernity opposes perfect knowledge of reality, suggesting that we are condemned to create biased versions of reality.

In response to the critiques of postmodernism, besides reflexive modernism, new theories of modernism have been proposed. One of these is liquid modernity, which highlights the aftermath of accelerated social differentiation and alienation. Zygmunt Bauman has suggested that liquid modernity erodes frontiers and boundaries and emphasises openended meaning. He also noted the impact of globalisation, migration, and technology on the redefinition of subjectivities [31]. Additionally, liquid modernity values the transient and immediate over the permanent and long-term. This fluidity is characterised by a lack of commitment and a constant search for new experiences and possibilities. Bauman argues that this is a result of the increased mobility and interconnectedness of people and information in the modern world, as well as the erosion of traditional social structures and institutions.

Stage of postmodernism. Starting from the second half of the twentieth century with massive social movements (civil rights, feminist, antiwar) inspiring the changes in existing power structures, the philosophical discourse of postmodernism featured broad scepticism, subjectivism or relativism, disbelief in reason, and growing perceptivity to the political and economic ideology [32] (para. 1). Since one of the main axes of postmodernism is the critique of modernism, let us compare both stages, as was succinctly carried out by Yousef [17].

> *Although modernists believe in rational thought, postmodernists believe that many things are irrational. Modernists place a strong emphasis on science, whereas postmodernists are antiscientific. Although modernists believe that there are universal values and tend to be somewhat optimistic, postmodernists believe that only local values are important. Modernists favour organisation; postmodernists believe that life is chaotic and fragmented. Modernists favour unity and wholeness, whereas postmodernists believe in multiculturalism and plurality. Modernists believe that life is purposeful; postmodernists believe that life is meaningless or that meaning is purely subjective and relative. Modernists believe that one can define morality, whereas postmodernists believe that morality is relative.*
>
> (pp. 36–37)

Considering the very critical attitude of postmodernists toward metaphysics, we can, however, discern that the main idea of postmodernism revolves around the opposition to naïve realism (the objective reality detached from the humans). Reality for them is a conceptual construct, an artefact of scientific practice and language [32]. Pulling together some important epistemological dimensions of postmodernism, we can refer to the idea of Wittgenstein [33] on the application of language systems for the contextualization of mundane knowledge construction. Postmodernists/poststructuralists like Derrida [34] and Foucault [35,36] affirm the impending coalescence of truth with social power. However, the main cause of the crisis of modern meaning might be "a fracturing information ecology at the interface of science, policy, and public discourse" [37] (p. 3). Postmodernism opposes the single, self-contained, and consolidating grand narrative of life [38] and repudiates the optimism of modernism, meanwhile admitting the unknowable nature of knowledge, the incoherent spirit of history, and leaning towards nihilistic irony and distrust [20,39,40].

At the present moment, one could raise the challenging question of whether postmodernism is exhausted and some new-fashioned phase of cultural evolution has already materialised, hinged on the ubiquitous critique of postmodernism. Further on our presentation, we elaborate on this point of view [18,41–43], indicating that "today we can notice the confluence and coexistence of previous stages or cultural codes, in opposition to the view that modernism and postmodernism are over and fully substituted by the new stage of metamodernism" [16], (p. 12). Indeed, the coexistence of these cultural stages, blending the elements from previous stages with contemporary discourses, in a way, patterns the makeup of a new cultural code of metamodernism and, as is shown in the following sections, represents one of the principles of metamodernism. However, before moving toward a discussion of this confluence and refocusing our attention on science in metamodernism, we provide a brief insight into the epistemology of science in modernism and postmodernism, which subsequently facilitates the comprehension of the area under discussion.

3. On the Epistemology of Science in Modernism and Postmodernism

A detailed comparison of science as a philosophical and sociocultural phenomenon in modernism and postmodernism goes beyond the scope of this article. Thus, we apply a simplified approach and present only some nuances of the epistemology of science, focusing on scientific knowledge and its usage in both paradigms. For a comparison of these two epistemological paradigms in science, we suggest the dual metaphor, hierarchy (tree) in modernism and network (rhizome) in postmodernism.

In the cultural code of modernism, science has a dominant position, seen as a source of truth and progress, whereas natural sciences take the lead among all areas of scientific inquiry. The representatives of natural science perceived the world as an orderly place ruled by the simple laws of physics proposed by Newton; a clockwork speaking the language of mathematics. This kind of world could be understood, predicted, and controlled by a human (certainly masculine) operator (Lechner, 1989, as cited in [24]). The development of natural sciences would also allow for the domination of nature, thus providing for all human needs.

Despite the knowledge discovered since the beginning of the 20th century pointing out that the world should not be described only in mechanic terms and that it is not only characterised by linear causality, until the second part of the last century, the hierarchical or pyramidal approach dominated the modernist understanding of knowledge and proof. Even today, this hierarchical approach is popular in several fields of science, based mainly on positivism. These disciplines preserve the perspective that the objective view of the real world is possible and that the scientific method provides knowledge objectively reflecting the real world.

The three vivid expressions of the hierarchical approach are pyramids of knowledge, the scientific inquiry system, and evidence-based practice. From these, the pyramid of knowledge and the system of scientific inquiry are wider, whereas the pyramid of evidence appears to be narrower in scope. All these pyramids are defined by the fact that a higher-level pyramid (generalisation) represents higher-level knowledge/discipline/evidence. Also, at least in terms of knowledge, a higher level of knowledge can be reached by accumulating empirical knowledge at a lower level [16].

The hierarchy of knowledge is embodied in the DIKW pyramid (Data, Information, Knowledge, Wisdom), reflecting the classical understanding of structural and/or functional relationships between the components of the pyramid [44–46]. Each subsequent level of the DIKW hierarchy envisages a higher level of generalisation. In turn, the hierarchy of scientific inquiry introduced in the last century usually discerns five levels, namely the general scientific level, based on the ideas of philosophy and philosophy of science, as well as the levels of a specific field of science, branch of science, subbranch of science, and the level of specific research. The third example of hierarchical knowledge is evidence-based practice (EBP), which in its broadest sense is defined as the process of decision making in specific professional activities, using the best research-based evidence, the competence of the expert, and the choice of the client (patient). In its narrow sense, EBP means the application of the best evidence to make reasonable decisions in professional practise. The EBP is based on a rigorous hierarchy of evidence, prioritising certain types of inquiry. Although this hierarchy has enriched the understanding of research with discussions that illuminate the strengths and limitations of different types of research, it is clear that in this modernist hierarchy of evidence, for example, quantitative research certainly dominates over qualitative and process-orientated research, or experimental approaches prevail over nonexperimental approaches [13].

If the hierarchical pyramids (trees) primarily mirror the faith in science, objective knowledge, and its evidence with strictly hierarchical structures, then the metaphor of network or rhizome (grass) is a property of postmodernism and characterises many up-to-date complex processes and phenomena (including knowledge and its structure). For the first time, the concept of rhizome as the representation of a knowledge structure was introduced in the book by Gilles Deleuze and Felix Guattari, *A Thousand Plateaus* [47].

The philosophy of rhizome tries to explain knowledge by comparing the rhizome and the tree. If the tree is described by hierarchy, linearity, and a sensible model, the rhizome is an unbounded, distributed, semiotic, and interdependent system of the scaffold. In opposition to the dualistic structure of the tree, the rhizoma is a relational (with interdependent elements), polymorphic (existing in different forms), open, and heterogeneous (structurally diverse and consisting of various elements) network [48].

At the beginning of the 21st century, rhizomatics, notwithstanding its abstract nature, has been applied at an increasing rate in natural, social sciences, humanities, and art to explain ecosystems, neural networks in the brain, human identity, issues of knowledge acquisition, the Internet, social networks, etc.

We come back to the above-mentioned metaphors of hierarchy (tree) in modernism and network (rhizome) in postmodernism in the next section of the article.

4. Metamodernism: Introduction and Philosophical Principles

The inventory of published works on metamodernism shows the continuous growth of literature in different formats and related to varying disciplines and discourses; however, in this work, we only provide a short introduction to metamodernism and emphasise the principles of philosophy of science in the context of ontological, epistemological, and axiological discourses of metamodernism, based on our previous theoretical interpretation of this subject matter [16].

To start with the historical preconditions, as inferred in the section on the predecessors and contemporaries of metamodernism, the chronological continuity of previous stages of cultural evolution, evolving in the transversal coexistence of all knowable stages of cultural evolution or cultural codes as "parallel universes" and the interlinkage of components from different stages, delineates the contemporary cultural code of metamodernism. In particular, most of the milestones of metamodernism come from modernism and postmodernism; however, we can also observe the containments and traces of indigenous and premodern stages, such as, for instance, the growing recognition of the spiritual dimension of life [49].

On the whole, contextual architecture or contemporary triggers of metamodernism are linked to the present-time conditions of the world or, in other words, crises of late globalisation [50]. These crises presumably "exemplify the manifold failures of reflexive modernism or reflect the incapability of postmodernism to deal with a global situation" [16], (p. 7), oscillating between the complex and disrupted states of the world. Another link between the current state of the world and metamodernism is evident in the emergence of "wicked problems", exhibiting features of metamodernism in dealing with practical life problems—joining modernistic beliefs on science, technology, progress, and postmodernist views on instability and degradation as an essential part of life [24].

The term "metamodernism" was coined by Masud Zavarzadeh in literary theory [51] and later was adapted by other scholars [52–64], etc., from different fields. For the first time, it was extensively described in foundational theory by Dutch philosophers and cultural theorists Timotheus Vermeulen and Robin van den Akker in *Notes on Metamodernism* [65]; thus, it seems reasonable to qualify metamodernism as belonging to the 21st century.

According to the suggestion that metamodernism, like many emerging phenomena, can be viewed from various angles [65,66], in our previous paper [16], we addressed metamodernism both as a phase of cultural evolution and as a philosophical paradigm [67,68]. Several authors have already recognised the promising potential of metamodernism as a paradigm of thinking, a new zeitgeist, or a major philosophical framework [64,68–70].

In what follows, we review the central aspects of contemporary philosophy of metamodernism in its ontological, epistemological, axiological, and methodological positions, summarising these elaborations in several principles for their subsequent usage in the field of science and research. The given principles already were derived and formulated in our previous article [16], but here, they are elaborated, detailed, and contextualised a step further. Thus, a short summary of the philosophical principles of metamodernism, presented in Table 1, is followed by a wider interpretation of the given principles.

Table 1. Philosophical Principles of Metamodernism (based on [16]: pp. 9–12]).

Aspects of Philosophy	Key words/Concepts/Ideas	Principles of Metamodernism
Ontology	Metaxis (oscillation), simultaneity, ontological paradox	Participatory worldview Paradoxical, though holistic, simultaneity caused by oscillations
Epistemology	Subjective/objective truth, grand narratives	Protean awareness The paradoxical understanding of truth and grand narratives
	Metaxis-based thinking, dialogue, polylogue	Consulted inquiry (individual/group/society) Metaxis-based thinking and dia/polylogue
Axiology	Rhizomatic social relations and values, hierarchical social relations and values	Sensible living The negotiation between rhizomatic and hierarchical social relations and values
Methodology	Pluralism	Unrestricted Research Pluralism as the possibility of telling one story in several ways

Ontology. Based on the ontological concept of metamodernism—metaxis, originated by Plato and understood as oscillation between two or more entities—we come to an ontological paradox, interpreting oscillation through simultaneity and not just inscribing the movement "between innumerable poles on a multidimensional continuum of energies and intensities, but inhibiting all of them at once" [65,67,71], as cited in [16], p. 9. Generally speaking, oscillation is all about processes and relationships between numerous entities, although the poles of the continuum could also be described as some objective and stable reality (objects). This "challenging and paradoxical, though holistically oriented simultaneity, caused by oscillation in and between different dimensions (physical, natural, social, psychological, spiritual, etc.) of the world" [16], p. 9 can serve as the ontological principle of metamodernism.

It seems that one of the most relevant frameworks for the ontology of metamodernism is the participative worldview, described already at the end of the 20th century as a systemic, holistic, relational mindset, indicating that our experienced reality is cocreation between the givenness of the cosmos and human perception. In this outlook, individuals and communities are embodied in their world, cocreating their world [72]. Although some authors at the beginning of the 21st century juxtapose a participatory worldview with a mechanistic worldview, i.e., stressing that the latter is more about objects while the former highlights processes and relationships [73–75], Reason and Bradbury [76] already implicitly point to metamodernistic oscillation. They admit that a participatory view, on the one hand, "competes with both the positivism of modern times and with the deconstructive postmodern alternative", while on the other hand, it "also draws on and integrates both paradigms: it follows positivism in arguing that there is a "real" reality, a primeval givenness of being (of which we partake) and draws on the constructionist perspective in acknowledging that as soon as we attempt to articulate this we enter a world of human language and cultural expression" (p. 7). In terms of oscillation and simultaneity, Wagle [77] emphasizes participation as a give-and-take relationship in every sphere of the living world and points out that a participatory worldview is about a "give, take, and emerge" relationship between and among everything that exists in the cosmos. In metamodernist literature, participation has already been discussed as an art form and called "participatory art"—displayed through the involvement of many people who receive the creative rewards of participation as a politicised working process [78]. Furthermore, writing about metamodernism as a societal and political project, Henriques [19] emphasises that metamodernism, as a political project, among other things, is driven by participatory processes.

Epistemology. The epistemological idea of metamodernism can be expressed as a protean awareness of the world related to the matters of truth and internal/external inquiry in the world associated with the ways of reaching truth.

The first principle of metamodernist epistemology related to the protean awareness of the world is the "paradoxical understanding of truth and grand narratives, stressing the oscillation and free space allowance for knowledge and meaning production" [16], (p. 10). Proteus was a Greek sea god who could tell the future, but when he was asked a question he did not want to answer, he would change shape. Denigrating the subject–object metaphysics of modernism and emphasising the contextual nature of our understanding of the world, aligning with its paradoxical nature, metamodernism chooses the paradoxical understanding of truth. The "local" truth or our personal interpretation of our lives and their meaning are the supreme truth for us; however, this type of truth is rarely evident or accepted by others [69]. Therefore, the truth can be subjective and objective simultaneously. Regarding grand narratives as a way to make meaning about the world, which is so important for modernism, it seems that metamodernism itself is not a grand narrative; however, it renders the space for beliefs in grand narratives, neither requiring nor denying such narratives [16].

The second principle of metamodernist epistemology revolves around metaxis-based thinking and dia/polylogue "envisaging the contextual negotiation both within the territories of theoretical abstractions, individual mental, and communal social life" [16], (p. 10). Evidently, the metamodernist thinking style, used in different types of inquiry (both in daily life and in scientific discourse), is based on the constant vacillation between the endpoints, which can be more than two. This locomotion does not demand an equilibrium, just the sustainment of both poles, since sometimes they are observed as unequal entities, potentially prioritised in discordant situations and contexts [79].

Dyadic oscillation in the power of communicating entities defends against one-sidedness and advocates dialogic thinking, which means finding some interface or tools for reconciliation between distinctive perspectives. Exactly this intersection of disparate positions might lead to successful collaborative activities toward the solution of problems [65].

We see the dialogue in metamodernism as a particular instance of polylogue, a transaction between an immensurable collection of positions and orientations, each of them listened to and deemed worthy of creating new knowledge, but, at the same time, linked with awareness of contrapositions that will never be fully resolved, only transcended [16].

Methodology. As a methodological device used in science, metamodernism could throw open modernist notions, disclose benefits, learn from them, and restore novel potential by interlinking contrasting or even antagonistic perspectives [69]. When talking about social sciences, humanities, and art, it becomes noticeable how metamodernistic approaches, visions, and principles gradually enter research in these fields and demonstrate their benefits and sociocultural relevance (e.g., [67,80–82]). It seems like the metamodernist methodology could be based on and connected with pluralism [83,84], which is already taking root in ontology, epistemology, and axiology. Therefore, ontological pluralism, at least in the social sciences, suggests the metaphor of traversing (or oscillating) between and across the myriads of worlds, archipelagos, dimensions, or worldview "bubbles", and epistemological pluralism shows that "seemingly most objective results of studies should be coupled with an awareness of their limitations and complementary nature" [16], (p. 11) and that new knowledge should be reached in dia/polylogue between all involved in a given problem, while axiological pluralism could be explained as persistent negotiation between the values of society, researcher, and research participants. Thus, the next principle of metamodernism—pluralism—can be explained by saying that "one story can be told in different ways" [85], as cited in [16], (p. 11), thus allowing unrestricted research with all diversity of approaches, forms, applicable tools, methodologies, research participants, etc.

For now, the last (or just as well the first) philosophical principle of metamodernism, not related to any particular aspect of philosophy but linking them all and applied as a cross-cutting approach to all phenomena dealt with in a metamodernistic framework, has already been mentioned in this article. It is the principle of coexistence of previous stages of cultural evolution (especially modernism and postmodernism), blending the elements from previous stages with contemporary discourses. The interlinkage and oscillation of these components from modernism and postmodernism were clearly discernible in each aspect of metamodernist philosophy. Exactly this principle can be used as a salient guideline to establish the metamodernistic approach to any entity or subject matter.

Although elements and essential features of metamodernism are now beginning to emerge in fields such as cultural studies, literature, architecture, and art, they are not yet conceptually debated or decoded in the field of science; this is the task of the next section.

5. Conceptualising Metamodernism for Science and Research

Recalling the countless problems and challenges the world is encountering today and will be confronting in the future, it seems reasonable to recognise science as an indispensable form of knowing [86], with at least some features and elements that provide hope for the alleviation of these crises.

Coming to the main part of this article, we might *ask if metamodernism* is already witnessed in science as a form of human cultural and social activity and if this new cultural code could bring at least some relief to the contemporary metacrisis of humanity, considering the leading-edge search for novel perspectives on life, society, and thought [87]. Conventional 20th-century channels of academic communication, like journal articles and scientific monographs, show some acceleration of the distribution of scholarly ideas on metamodernism. In terms of the alliance between metamodernism and science, we can notice quite a large number of specific treatises; however, pursuing our specific goals, in the following section, we move from general philosophical ideas of metamodernism to their specific interpretation in the field of science, based on the six philosophical principles of metamodernism mentioned above. We are not pretending to fully explain these principles in a totality of dimensions and aspects of science and research; however, we hope that the facets touched upon inspire other scholars to address and expand these matters.

5.1. Principle 1: Simultaneity Caused by Oscillation

The efforts to attune the ontological discourse of metamodernism with science and research can be at the outset undergirded by our description of science in modernism and postmodernism, provided above, especially dwelling upon the dyadic imagery of tree and rhizome. On the one hand, different essential classifications in the discourse of science (knowledge, disciplines, proofs) conform with the metaphor of a pyramid (hierarchy) or tree, typical for modernism. On the other hand, since the 1980s–1990s, we can already recognise the ongoing progression of a novel image of a network (rhizome), explicated, for instance, in the heterogeneity of data, knowledge, or the interlacing of areas denoting postmodernism. Finally, since the early days of the 21st century, the observers of science have borne witness to the ontology of metamodernism [17,65]. It seems to unfold in constant oscillation from ordered aggregation to the ideology of network (exposed in specific milieus and domains) by means of mutual inclusion and altering polarity (three or rhizome) contingent on the particular situation [16].

Let us illuminate both approaches, depicting the poles between which one can notice the oscillation of contemporary scientific inquiry, in terms of the philosophical principle of metamodernism. The hierarchical approach suggests the organised systemic description of scientific inquiry in general. Viewed from this angle, a researcher should have a clear understanding of how certain types of knowledge, research methods, and scientific disciplines are perceived, used, and theoretically justified in a given structure of science.

This awareness can be inherited between individual scholars, departments, institutions, and entire disciplines or fields of science. The existence of such a legacy is important because awareness of the position of the researchers (in a wider context, the identity of the researcher) is necessary to define and justify the placement of the researchers, for instance, in interdisciplinary or transdisciplinary collaboration.

However, despite the benefits of the hierarchy within scientific inquiry when reflecting on one's position as a researcher or as a scientific discipline, it can no longer be a reliable source of evaluation for current realities. The ongoing rapid development of science encourages the perpetual process of integration and differentiation. On the one hand, while the "tree of science" (Arbor Scientiae by the medieval philosopher Ramon Llull (1232–1315)) is growing, it unleashes new branches, new scientific disciplines, and subdisciplines of disciplines, increasing narrower specialisation. On the other hand, simultaneously, in addition to the trends of differentiation and detailed expertise, we can notice the progression toward integration and interdependence of scientific disciplines [88,89] or, in other words, the rhizomatic development of relational, polymorphic, open, and heterogeneous networked science [90]. These two realities and identities (narrow and focused or diffused and integrated) cannot exist without the other, and it seems that at least in the foreseeable future, we will witness the coexistence and oscillation between the narrow disciplines' hierarchical approaches from one side, and the open, networked science from the other side.

Also, the aforementioned ontological worldview of participation can become a viable framework to illustrate the just-described perspective on the scientific work in metamodernism. A participatory worldview enables scientists (especially in applied fields) to draw on the approaches of positivist science and promptly position this knowledge and techniques within an individual and societal context. For example, "Participative medical practitioners do not throw away medical training, but take it to work with patients in diagnosis and healing. Ecologists can draw on their scientific perspective to provide villagers with useful information about local forests and work with them toward better management" [76] (p. 7).

5.2. Principle 2: The Paradoxical Understanding of Truth and Grand Narratives

Trying to picture science today, it could be compared with the prophetic Proteus, who could tell the future, but, when asked questions about the future, changed his shape. Modern science can forecast the future, and indeed, even more—"prediction is the ultimate purpose of science, which seeks to determine the future evolution of phenomena that occur in nature" [91] (p. 100). However, according to Ron, "science is but the development of logical systems with predictive capabilities" (ibid., p. 100). Prediction in the field of social sciences is even more complicated, forcing one to choose between explanation and prediction [92]. The paradoxical understanding of truth in science both as a subjective and objective entity can be treated, to give an example, according to the relativistic view on science in metamodernism suggested by Freinacht. He stresses that "science is always contextual and truth always tentative; reality always holds deeper truths. All that we think is real will one day melt away as snow in the sun" [86] (p. 364). However, by oscillating back from this overly relativistic stance, we can say that all fields of sciences (natural, social, and humanitarian) simultaneously produce subjective and objective truth if viewed from different angles and evaluating these results from different discourses.

In modernism, science was mythologised, scientific (objective) truth was prioritised, and scientific progress was conceived as a grand narrative. An optimistic response to the tragedy [65], determining the proactive involvement of the community despite the seriousness of the crisis, aligns metamodernism with the grand narrative of modernism, seeing science as a vehicle of progress and a saviour in crises. Although, as suggested by reflexive modernism, the use of science "for progress" was probably one of the factors that caused these crises in the first place, it would be unreasonable and unimaginable to reject the help of science in dealing with complex issues of our time. However, the narrative of science could be woven into the larger metanarratives of today, such as, for instance, sustainability [93], search for meaning [94], or global digitalisation [95]. Ironically, science can still be used as a tool both to reinforce and denounce these larger metanarratives, again pertaining to the oscillatory and diverse nature and purpose of science in metamodernism.

5.3. Principle 3: Metaxis-Based Thinking and Dia/Polylogue

Looking for the illustration of this principle in science and research and recognising science and research mostly as an epistemological endeavour, it appears that both individual and group inquiry in the world constituted by metaxis-based thinking and dia/polylogue is very deeply rooted and observed at different levels and dimensions of science. To highlight this epistemological principle, we cover the level of scientific thinking, the system of science and interaction of scientific disciplines, the dialogue of science with society and politics, and, finally, the dimension of open science and digitalisation of science.

Scientific thinking. In dealing with crises or trying to find solutions to problems in a rapidly changing and complex modern world, one of the social and scientific narratives, originating from modernistic thinking, is meeting an ever-increasing complexity with even greater complexity [96]. Science (at the global, national, institutional, and individual level), as all other human-made and human-inhibited systems, currently seems to give in to "unintentional complexity" [97], if we only look at, for example, particularly visible organisational complexities related to science. Another essential complexity of scientific work is the complexity of thinking. One of the problems with such thinking is the continuous production and reproduction of demi-reality—explicit beliefs and implicit assumptions that do not correspond to reality and refer to people's disconnection from self, others, and nature that produces deception, denial, grandiosity, oppression, alienation, and fragmentation ([98], Collier, 1994, as cited by Murray [96]).

Murray [96] discerns five causes for the production of demi-reality using cognitively complex thinking, namely disastrous differentiation, noxious composition, deadly abduction, pernicious generalisation, and tyrannic integration. Thus, disastrous differentiation (similar to analysis and deconstruction) creates some serious issues like (1) focusing on one thing meaning nonattendance to other, possibly, more important things; (2) engaging in analysis and breaking something into parts may inhibit perception of the whole, as well as context; and (3) too salient differentiation can lead to disregarding properties that are not in common. Noxious composition means seeing patterns in data which contain only noise; besides, the composition can lead to unnecessary complications, disrupting the work and productivity of the entire system. Vicious abstraction designates abstraction as often leading to a disregard for the context and creation of universalised abstractions. The other problem with abstraction is the trend to treat abstract concepts as if they were concrete entities, which leads to magic thinking applied to rational narratives in different spheres of life. Pernicious generalisations can lead to (1) biases in how boundaries of emphasis are drawn, (2) inappropriate generalisations to a wider context or different domain, (3) treating imprecise and biased boundaries as definitive and given in nature, and (4) moving away from specifics and details. Tyrannical integration describes integration as a culminating step following differentiation, composition, abstraction, and generalisation, thus assimilating all the pathologies mentioned above.

Modern scientific inquiry cannot avoid all these cognitively complex forms of thinking, and we should ultimately not reject them as completely inappropriate for metamodern thinking. Rather, scientists should not allow them to cause a demi-reality and should use them reflectively, critically, and intersubjectively. We agree with Murray [96] that undoing, unlearning, and releasing complexity is much harder than building on complexity in any human system, especially in scientific thinking. Likewise, it should be noticed that simplicity has already been an important facet of scientific work, in terms of scientific theories ("other things being equal, the simplest theory consistent with the data is the best one"), statistical data analysis, or stating hypotheses, although this approach has caused wide and still ongoing philosophical discussions [99].

Yet, it is not just the release of complexity that would help scientists reorient their thinking toward the paradigm of metamodernism. The concept of wisdom is currently observed in fields like education [100,101], etc., and is defined as the "ability to respond to actual or potential problems with decisions that maximise flourishing for all affected parties, now and in the future" [100] (para. 32). Some authors even show the potential to philosophise in a dialogical way toward wisdom [102]. As such, wisdom is a necessary prerequisite for scientific thinking within the framework of metamodernism. Although Bracher [100] describes the following four cognitive functions as necessary for wise decision making in the context of pedagogical practice, they could also be relevant for scientific inquiry (at least for applied research). These four functions suggest that (1) the causal analysis is the first stage of systems thinking that allows system mapping while solving a problem, since the causes of a problem are points of possible intervention; (2) prospecting forward causal reasoning comprises anticipation of the consequences of possible interventions; (3) social cognition, the process of understanding causes of human behaviours, is essential for transdisciplinary research; and (4) metacognition can be used to understand, monitor, and direct one's own cognitive processes. In the same way, scientists also have a duty to develop their transformational creativity, that is, creativity used to make the world a better place and to make a positive, meaningful, and potentially lasting difference in the world [103]. Scientists from different disciplines today should be organisationally and mentally prepared to answer the following: (a) Who benefits from a course of action and how great are the benefits? (b) Who loses from a course of action and how great are the losses? (c) Who is not affected by a course of action? (d) What is an optimally fair and just assessment of the relative costs and benefits? (ibid.).

System of science and interaction of scientific disciplines. According to Hofkirchner [104], the traditional classification of scientific disciplines in the paradigm of positivism is created as a hierarchical system, where the highest level is philosophy, followed by formal sciences, real-world sciences, and applied sciences. It is postulated that these scientific disciplines have strict boundaries, and even in the case of interaction between these disciplines, they avoid fundamental internal changes. The new systemic look on science, coinciding with the dialogical principle of metamodernism and determining the theoretical background for the epistemological dialogue between the scientific disciplines, which will be described further, envisages semipermeable boundaries and interaction in the up and down directions between all scientific disciplines. Any discipline of science can be described as one that reveals and characterises general systemic relationships between the phenomena of the world. Thus, formal sciences ensure formal and nonformal methods to understand systems; sciences of the real world deal with different systems of the real world, material systems, living (material) systems, and social (live) systems, but applied sciences offer artificial designs of these systems [105].

Thus, along with the differentiation of disciplines and the specialisation of researchers, other practices (multidisciplinary, interdisciplinary, transdisciplinary studies) play an increasingly important role, requiring the scientist to view the importance of his/her studies in a wider context and to identify the links of his/her explorations with other disciplines and the urgent needs of society [106]. This suggestion in every way also coincides with the interdisciplinarity-related principle of metamodernism of Abramson [66], indicating that metamodernism responds to crises, asking for changes in and reappraisals of established scientific structures.

During the 20th century, we observed the gradual development of approaches, seeking the combination of several scientific disciplines and the knowledge of social stakeholders based on practical experience. To understand the differences between various forms of interaction of scientific disciplines, we provide a brief overview of each type of interaction, discerning monodisciplinary, multidisciplinary, interdisciplinary, and transdisciplinary research.

In monodisciplinarity, to solve a certain research problem, only one scientific discipline or even one subbranch of this discipline, the area of academic research and education with its scientific journals and academic institutions, is involved [107,108]. In the future, we will still need the development of single scientific disciplines based on efficient approaches to structuring knowledge and meaningful types of organisation of scientific communities [109]. Moreover, it seems logical that before the dia/polylogue with other "partners", individual disciplines initially need to reach some "self-awareness" and engage in critical self-evaluation and self-analysis [110].

The first step toward interdisciplinarity in scientific attempts to deal with real-life problems is multidisciplinary research, embracing the common work of researchers of different disciplines to study the problem, synthesise the knowledge, and provide conclusions [111]. More than one discipline is involved in dealing with the problem in a complementary way, and each discipline approaches the problem from its specific perspective [107]. The "main" discipline asks for the help of other disciplines to address the specific problem, allowing these disciplines to maintain their specifics and coordinate their common work, which, at the level of each discipline, is performed rather detachedly and autonomously [112,113]. Upon completion of the project, all disciplines involved "return to their place" [108].

The next step in developing the interaction of scientific disciplines in a wide range of contexts [114] is interdisciplinary research, which envisages the interaction between two or more disciplines. All disciplines involved jointly coordinate the research process. Methods from one discipline are transferred to other disciplines for new applications, analyses, or the creation of new disciplines or research fields [111,115]. This approach is divided into narrow interdisciplinarity, covering disciplines with compatible paradigms and methods (e.g., history and literature), and wide interdisciplinarity, combining disciplines difficult to integrate (e.g., natural sciences and humanities) [113]. In the context of integration, researchers analyse the links between different disciplines, and disciplines are synthesised and harmoniously combined into a coherent whole [116,117]. To participate in interdisciplinary interaction, disciplines must master and integrate the logic of other disciplines, without losing their own scientific rigour [111]. This kind of exchange is democratic and dialogical in nature, as it stipulates the development and use of a common language for different disciplines and the learning of high-level integration skills.

The internal scientific dialogue between disciplines is maintained and strengthened in transdisciplinary research, the most developed form of disciplinary interaction and the highest stage of research activity [114]. Although, in the principles of metamodernism, Abramson [66] emphasises interdisciplinarity, transdisciplinarity (TD) could be the more relevant form of interaction of scientific disciplines and society to deal with complex social problems in the context of the metamodernist paradigm. TD research in general can be characteristic of team research, providing a knowledge-based contribution to solving complex problems in real life in collaboration between representatives of different disciplines and social partners (stakeholders). In fact, the participation of social partners embodies the main difference in TD research from interdisciplinary studies. TD research envisages the reciprocal learning of representatives from different disciplines, interdependent learning between scientists and social partners, and integration and interactive reflection of scientific disciplines, as well as integration and reflection between disciplines and social agents [66,107]. TD combines different disciplines: natural sciences, engineering, social sciences, humanities, etc. [118]. As a scientist partner in TD projects, representatives and decision makers from different layers of society, public agencies, the private sector, and civil society can be involved, as TD research aims to create knowledge and make it available for decision making through public participation. TD research is a natural step in the development of scientific cooperation, exceeding the limits of interdisciplinarity (limits of disciplines) and the margins of dialogue, since it pertains to the reflective reciprocal learning process that involves not only scientists but also the greater society [119]. There are various possibilities of dia/polylogues for how to integrate knowledge from science and society. First, scientists can act as catalysts in their cooperation with stakeholders. In other cases, scientists and practitioners can jointly lead the research process. Finally, social partners can also play a central role in leading TD research [120]. Thus, in TD research, oscillation can be detected at several levels of exploration: at the level of scientific disciplines, areas of science, knowledge, communication between academics and society, etc.

Speaking of the grand narratives or metanarratives of metamodernism, one such narrative in the societal and scientific life of the 21st century would be sustainable development, which as a paradoxical, contradictory, and simultaneously problem–solution-orientated process could unite researchers and community members from a large number of different areas [93] in integral transdisciplinary research. To reach a nascent conclusion about metaxis in the integration of scientific disciplines, first, it seems that monodisciplinarity in its essence resembles the principles of modernism, multidisciplinarity, and interdisciplinarity, having several features of postmodern philosophy, while transdisciplinarity echoes the principles of metamodernism. Furthermore, today, we can witness the coexistence of all kinds of interactions, still with strong monodisciplinarity, blossoming interdisciplinarity, promising transdisciplinarity, and oscillation between them, when individual scientists, research teams, and institutions migrate between these forms to deal with different research problems and contextualities.

Dialogue/polylogue of science with society and politics. It is evident that the epistemological stance of metamodernism is closely tied to solutions to wicked problems (both with human and technological origins) and crisis management in a risk society. Some features of metamodernism seem to be relevant to make these problems at least less savage by perceiving them as if they were resolved, focusing on the reconstruction of workable solutions and generating metanarratives as a response to a crisis [121]. The most useful principle of crisis management aligned with metamodernism is dialogue and collaboration even between enemies, as well as the creation of peculiar alliances [65,121]. In dealing with contemporary crises, Murray [96] professes that a more hierarchical and depth-orientated understanding of the relationship between complexity and simplicity (reason and compassion, logic and intuition, progress and tradition, transcendence and embodiment, etc.) can inform collective sense-making and undertaking to make decisions about when it is best to increase complexity in a system (e.g., through learning, reflection, and adaptation), release complexity (e.g., through healing, deconstruction, or recovery), or do nothing and remain alert as situations take their course ("do no harm").

In the age of metamodernism, societies and politicians must realize that it is not only the assessment of the situation, the discovery of problems, and the critique of perpetrators but also the engagement of all layers and groups of society in constructive and scientifically valid activities that would help to find the solutions of the issues. To deal with wicked problems, we not only have to overcome general distancing and alienation but also to involve possibly larger and diverse communities from formal and informal contexts. Thus, since the beginning of the 21st century, individuals, organisations, and communities have already had to navigate an increasingly complex and multidimensional reality [66], process an increasingly larger volume of information with ever-increasing speed [122], and grasp the changes in the role of science in these processes. To develop innovations in all spheres of life, social understanding of the role of scientific research in the creation of knowledge and the treatment of various issues is of great significance. For instance, in the age of general fake news, for more than a decade, scientists have played an important role in the promotion of fact-based discussions and politics [123,124].

However, the paradox of metamodernism evokes the question of whether scientific recommendations can be effective and influential in an age where the status of science and/or scientists seems to be as low as ever [125]. In this context, the collaboration of scientists with politicians to deal with national and international-level issues seems especially significant. Governments around the world implement different policies regarding investments in education, science, and technology, which have an implicit effect on scientific research. Such investments ensure a relatively high number of doctoral degree graduates and a larger number of workplaces for scientists and technology experts. Furthermore, education has strong links to science and research, not only in the form of evidence-based practice but also in curriculum and teaching methods: research is featured as one of the teaching methods for the 21st century, and research skills are already being developed in kindergarten [126–128].

Open science and digitalisation of science. In one of the discourses, metamodernism is described as an open-source grand narrative [69], trying to overcome and reconcile the hierarchical nature of modernism and postmodern detachment [17]; one of the metamodernist principles speaks of the shrinking of the distance between individuals in the digital age, while other principles call for collaboration and recognise diverse subjectivity, enriching our worldview [65], thus connecting to our epistemological principle of metaxis-based thinking and dia/polylogue. Precisely, this context intonates the concepts of open science and the digitalisation of science.

Fecher and Friesike [129] have identified five schools of open science, all of which claim different aspects of recognising the need for diverse subjectivity, collaboration, and dia/polylogue in science and research. The infrastructure school of open science delves into the technological architecture of science (to create open platforms, forums, tools, and services), the public school relates to the accessibility of knowledge creation (Citizen science, science blogs, etc.), the measurement school is concerned with alternative impact measurement (altmetrics, peer review, impact factors), the democratic school refers to the access to knowledge (open access, open data, intellectual property), and the pragmatic school deals with collaborative research (wisdom of crowds, network effect, open data, open codes).

One of the most controversial manifestations of the 21st century is global digitalisation and digital transformation in all spheres of human life [130]. A deeper analysis shows the obvious intersection of open science schools with the phenomenon of the digitalisation of science that is connected with such concepts as e-science, cyberscience, networked science, etc. Digital science is optimistically described as a radical transformation and innovation of the nature of science thanks to the integration of ICT in the research process and the openness and sharing culture inherent in the age of the Internet. This kind of science is more open, global, collaborative, creative, and closer to society, as it is based on the use of e-infrastructure [131]. The trend of the digitalisation of science is also embedded in the Horizon Europe Research and Innovation Funding Programme until 2027 [132], which is a continuation of Horizon 2020.

If modernism views science and scientific progress as the grand narrative and postmodernism harshly criticises the traditional hierarchical ways of scientific work, in metamodernism, science opens up to the new subnarratives coming from the oscillation between the rhizomatic relationships of all elements of scientific research (e.g., researchers and their social partners, different types of knowledge, research methods) and the still hierarchical ethos of many scientific organisations, scientific disciplines, levels of knowledge, etc. In this given context, in relation to the emphasis on openness, collaboration, and digitalisation of science, we provide a brief dossier on different models of science, thus showing the dynamics of different features of science starting from modernism and postmodernism to the paradigm of metamodernism. In its essence, this classification to some extent overlaps the schools of open science, with the difference that the succession of models provided below (Science 1.0–6.0) emphasises the chronological development of science.

Science 1.0 is a classical and traditional model of science conceived in the 17th and 18th centuries and widely used until today. This model draws on the historical principles of modernism comprising objectivity, reliability, independence, and controllability, and it is orientated toward deductive research on the natural world and processes to create knowledge about the world. However, recently, we have witnessed the emergence of other models, starting from Science 2.0 to Science 6.0, which put the emphasis on larger interdisciplinarity, participation, and collaboration, paying more attention to individual and social factors and indicating the directions of scientific development in the digital age. Thus, for example, Science 2.0 denotes the use of digital technologies and the Internet in scientific research, such as data sharing and scientific collaboration, thus promoting the reproducibility of research results and the speed of the research process [133].

Science 3.0 reflects greater public participation and collaboration within scientific research to ensure the conformity of research with the needs of society [134], while Science 4.0. pictures even broader digitalisation and automation in close conjunction with Industry 4.0, encompassing computerised tools of scientific research, artificial intelligence, virtual and augmented reality, big data, and automated data analysis in order to facilitate and improve the scientific research process [135]. This model also covers the questions of data privacy and other issues that can be caused by the dominance of digital technologies in scientific research methods. Science 5.0 is still a new idea, emerging together with Society 5.0 and Industry 5.0 [136], which is orientated toward the solution of complex global problems and challenges, integrating science, technologies, and society. The model of Science 6.0 has not yet been widely discussed; however, some scientists already speak about a scientific model that envisions the integration of human beings and nature and cooperation in fields such as synthetic biology, quantum technologies, biomimicry, and other new directions of science and technology [137]. Starting with Science 2.0, one can notice the characteristic nuances of both postmodernism and metamodernism, while the paradigm of metamodernism, chronologically and discursively, would be the most consistent with the visions of Science 3.0–6.0.

An important and ambivalent question in the context of the digitalisation of science relates to the usage of artificial intelligence (AI) in science. The use of AI in planning, executing, interpreting experiments, and developing new models for solving research problems is regarded with enthusiasm. There are many excellent examples of advances in AI toward full-time colleague status in physics, biology, healthcare, and social sciences [138]. However, new and rather uncontrolled applications of AI in other spheres have been met with caution. One such issue has recently been brought up by the discussion of the usage of AI in scientific publications. The release of the AI chatbot ChatGPT in November 2022 instigated discussions in academia among scientific publishers and scientists about the legitimate usage of large language models (LLMs) in scientific research and publications. Although ChatGPT has already been credited with formal authorship by several preprints and published articles, Springer Nature journals, for instance, have established rules about the ethical use of LLMs. To maintain the transparency and integrity of scientific research, no LLM will be accepted as a credited author of an article, and the use of LLMs should be acknowledged in the article [139].

Actually, in the metamodernist ethos, talking about the multiple types of knowledge and the diverse creators of knowledge, it is reasonable to ask how far we would go in acknowledging the "voice" of AI as one of the voices in polylogue in scientific research and communication, and, foreclosing the future, we could wonder if we would live to see how AI became not only a productive research tool but also an autonomous partner in scientific research.

5.4. Principle 4: Negotiation between Rhizomatic and Hierarchical Social Relations and Values

What plays the decisive role in the development of science: academic freedom or the interests of society? To what extent can scientists independently and freely choose the themes and designs of their research? And to what extent should they consider the interests, values, and needs of society? The fourth principle of metamodernism indicates the need for negotiation between the interests and values of society and those of science and scientists. Actually, the axiological principle was already implicit in the above description of the epistemological principle of metamodernism, speaking about the interaction of scientific disciplines and pointing to the possible oscillation between the dialogical forms of scientific interaction. In the discourse of scientific interaction, the axiological principle of metamodernism emphasises the value aspects and negotiation within a single discipline, between disciplines in mono- and interdisciplinarity, and between disciplines and social partners in transdisciplinarity. This negotiation also encompasses the axiological justification of the chosen research problem, values of different types of knowledge, values of various research participants, research ethics, etc. For instance, in relation to the selection of a research focus, this principle of metamodernism would be tied in with the reasonable negotiation between short-term and immediate gains of society boosted by scientific progress and the long-term sustainability of sensibly living on Earth reinforced by close collaboration and networking between scientific innovations on one side and individual human development and societal activities on the other.

As one of the feasible examples for this "negotiation-based" principle of metamodernism in science, we can mention responsible research and innovation (RRI), which is forging its way into the new Horizon Europe Programme (2021–2027) [132]. The European-based discussion of ways to gain balance between scientific autonomy and scientific development in public interest during the last decades has resulted in this concept, staging a new phase in understanding relationships between science and society. According to the normative definition, "RRI is an approach that anticipates and evaluates potential implications and societal expectations with respect to research and innovation, with the goal of supporting the design of inclusive and sustainable research and innovation" [140]. Already, in 2019, a joint declaration was signed by a large number of large-scale EU-funded RRI projects, urging the European Commission to introduce RRI as the main objective in Horizon Europe, maintaining this approach across the program and providing resources for strengthening the RRI knowledge base [141].

Academic definitions of and approaches to RRI share various threads, with an emphasis on the dimensions of anticipation, inclusiveness, reflexivity, and responsiveness [142–146]. This can be further articulated as a grand vision for "(. . .) taking care of the future through collective stewardship of science and innovation in the present" [146] (1570).

The widely cited article by Owen and colleagues from a decade ago proposed three emerging features of RRI underpinning various aspects of negotiation between science and society. The first feature (science for society) stresses science for society, democratising the governance of intent to focus on societal challenges. The second feature (science with society) focuses on the institutionalised responsibility of science to society in terms of research direction and calibration of developmental trajectory in the face of uncertainty, while the third feature (reframing responsibility) asks for a re-evaluation of responsibility regarding innovation as a future-orientated, uncertain, complex, and collective enterprise [147]. A more recent systematic review of RRI [148] has suggested the main drivers (e.g., public engagement), tools (e.g., social experimentation), outcomes (e.g., sustainability impact), and barriers (e.g., multiple values) of RRI. Although RRI is a rapidly growing ideology, it causes some confusion and controversial issues in terms of motivation, theoretical conceptualisation, and the translation of RRI into the practice of researchers. Like many other innovations in their initial stage, RRI struggles with uncertain goals, processes, and products [147]. Furthermore, according to Delgado and Åm [142], who hint at the challenges of RRI and wide interdisciplinarity, "in practise, scientists can experience difficulties adjusting their research interests, background, or trajectories to what funders consider more socially relevant territories" (p. 3).

5.5. Principle 5: Methodological Pluralism

One of the metamodernist features of science relates to the pluralistic understanding that "different sciences and paradigms are simultaneously true; that many of their apparent contradictions are superficial and based on misperceptions or failures of translation or integration" [86] (p. 366).

The methodological literature already features metamodernism as a possible methodological device for academic research, e.g., [68,82]. The principle of methodological pluralism in the metamodernist perspective denotes that a scholar (particularly in social sciences) could potentially oscillate between two standpoints. On the one hand, a researcher could traditionally pick out their methodological approach from either modernism or postmodernism and, depending on their decision, which of these strategies would be the best aligned with the given research problem. On the other hand, a great example of methodological pluralism can be mixed method research that would be used to comprehensively explore the prevalent multifaceted social phenomena blending modernist and postmodernist strategies. However, the difficulty lies in the fact that in using methodological pluralism in a creative way, researchers should be aware of both methodologies, irrespective of their personal inclination [121]. It has to be admitted that this dilemma is much rarer in natural sciences and humanities, whose general ontological and epistemological frameworks are mainly embedded in modernism (former) and postmodernism (latter), while in the social sciences, this oscillation between methodologies is already evident and growing. One more proposal, mitigating the radical idea of complete surrender of modernism and postmodernism to metamodernism, if applied to science, is metamodernism as a methodological tool that is useful for blending contradictory perspectives of modernism and postmodernism [70], as mentioned above.

A more extensive elaboration on metamodernism as a methodological tool specifically in the social sciences is presented in our recent publication [16]. We offer our approach not only to methodology but also to the ontology, epistemology, and axiology of metamodernism in social sciences in the framework of the six principles of metamodernist philosophy mentioned above, showcasing the advancement of the social sciences through the three interdependent patterns, namely, monodisciplinarity, inter-/transdisciplinarity, and the social sciences as social practice.

It seems that the social sciences, because of their specific status among all other research areas and their already ambivalent nature, are pioneering metamodernism in their methodology. It remains to be seen whether the other branches of science will also be willing and able to define metamodernism as representing their culture.

5.6. Principle 6: Coexistence of Stages of Cultural Evolution

The transversal principle of coexistence of previous stages of metamodernism as "parallel universes" and the recognition of the linkage of components from previous stages as the determining force of metamodernism in the field of science have been supported by Freinacht [86]. Writing about science in metamodernism, he acknowledges that "there are substantial insights and relevant knowledge in all stages of human and social development, including tribal life, polytheism, traditional theology, modern industrialism, and postmodern critique" (ibid. p. 364). As was already mentioned, the cohabitation of world visions and wisdom from previous cultural stages would be both the symbolic manifestation of science (in all its fields and branches) in the 21st century and a safeguard against the fallibilities of taking too narrow a path.

Although there is still the challenging need ahead to search for and investigate the specific ways in which different fields and branches of science can borrow or take over (fully or partly) particular world vision, wisdom, and methods from the previous stages of cultural evolution in order to deal with the urgent problems mentioned at the beginning of this article, the conceptualisation of metamodernism through the set of the forenamed six principles could be reached, for instance, in one more framework of science and scientific development, in addition to the schools of open science and Science 1.0–6.0, namely, a framework of postnormal science [149–151].

Postnormal science (derived from the "normal science" defined by Kuhn [152]) deals with the management of complex problems, paying attention to previously ignored aspects such as uncertainty, value orientation, and the diversity of legitimate perspectives. Environmental and social problems cannot be viewed or managed as simple systems; these phenomena will always show anomalies and bring surprises. The main assumptions of postnormal science, already almost 30 years old, are defined as (1) the scientific management of uncertainty and quality, (2) the diversity of perspectives and responsibilities, and (3) the intellectual and social structures reflecting the activities of problem solutions [153]. Postnormal science is looking for answers to the question "What if..." and tackles problems associated with high risk, uncertainty, and multiple values, as well as situations that do not always allow us to reach an objective solution. One more very important feature is the new method of knowledge creation by the extended peer community already outlined in the description of transdisciplinarity, open science, and RRI. Such a community ensures a dialogue between all partners, without regard to their status or qualification [149,151]. The mentioned intricacies conjoin postnormal science with other aforementioned principles of metamodernism in science.

6. Conclusions

In the contemporary world engaged in the endless cycle of different challenges, science can still serve as a powerful tool to solve the metacrises of our time, provided that the scientific community is involved in the contemplation of the new ways and modus operandi of how science can better serve humanity and the world, while unlocking its potential that has evolved throughout the long history of its development. Science remains one of the main agencies for personal development and the improvement of life quality, as well as human, social, economic, and environmental sustainability, despite the countless challenges and problems encountered by science and researchers at the beginning of the 21st century. Besides the numerous management and technical issues and improvements of science and research, which undoubtedly determine the quality of contemporary scientific outcomes, science needs to establish a commitment to revise its philosophical heritage and look for critical reflections on how the scientific conventions and paradigms are determined by current cultural, economic, political, etc., backgrounds [154].

The purpose of this article was to discern the discourses and movements in contemporary science, research activities, and research processes that are consistent and align well with the suggested philosophical principles of metamodernism. The authors also outlined some future perspectives and challenges for the development of science, considering its development in the context of metamodernism as a new stage of cultural evolution. In the present work, metamodernism, which is suggested as the philosophical framework for the contemporary state and future development of science, highlights the paradoxical and oscillating nature of truth and knowledge. It also emphasises the contextual and subjective nature of our understanding of the world and the importance of negotiation and dialogue between different positions and values. In this framework, beliefs in grand narratives are allowed but not required, and the aim is to transcend contradictions rather than resolve them. Thus, metamodernism recognises that there may be inconsistencies between different ideas, but it does not see them as a problem but rather as an opportunity for growth and development.

Looking back at the methodological tools for this theoretical exploration, we tried to consistently implement all three methodological stances (experience of authors, identities of philosophers, and the Three Worlds framework) throughout the discourse. On the metalevel, one can even observe the oscillation between these stances, when nuances of our previous experience and ideas fuse together with one or another identity of a philosopher, thus allowing the reader to navigate between and from one world of human inquiry to another. This treatise is a plausible continuation of our ideas and opinions, already set out quite extensively in books and monographs on science and research methodology, as well as grounded in our recent publication on metamodernism and social sciences. The field of social sciences is a well-known and frequently addressed field for us, while in this article, we stepped back and widened our focus on science in general. The expansion of metamodernism principles in the field of philosophy of science and conceptualisation of these principles in terms of contemporary science and research within the Johan Mouton Three Worlds framework for human inquiry could be considered as the novel, integrating, and harmonising agenda of the presented work. World 1 was presented in the contextual and pragmatic background of this article: global and local real-world crises and problems, asking for immediate solutions and assistance from science; World 2 was explicitly illustrated through science as a practice mainly emphasising epistemological and methodological aspects of this practice. World 3, which could be metaphorically represented as a metascience or, in a given context, science in metamodernism, was represented in a reflective analysis and intellectual reconsideration of the pragmatic and epistemic nature of science (Worlds 1 and 2) [9,10].

The ultimate mission of this work was to weave together several stories to show the intertwining nature of these Three Worlds of inquiry. The historical threads showed the historical and at the same time still viable roots and predecessors of metamodernism, as well as the epistemological features of science and research in modernism and postmodernism. The leading thread of the writing contained two successive conceptualisations. The first conceptualization was based on metamodernism as a new cultural code and reinforced the main philosophical principles of metamodernism introduced in the previous article [16]. The ontological principle of metamodernism denoted the paradoxical, though holistic, simultaneity caused by oscillations and was described as a participatory worldview. The epistemological principles of metamodernism represented (1) the paradoxical understanding of truth and grand narratives, identified as protean awareness and (2) metaxis-based thinking and dia/polylogue, located as a consulted inquiry by the individual, group, and society. The axiological principle of metamodernism, namely the negotiation between rhizomatic and hierarchical social relations and values, was substantiated as sensible living, while the methodological principle of metamodernism emphasised pluralism as a possibility of telling one story in several ways, thus pointing towards the unrestricted research. The last philosophical principle denoted the coexistence of different stages of cultural evolution as "parallel universes" and showed metamodernism as the interconnection of previous cultural stages.

The second pioneering conceptualisation, based on the outlined philosophical principles of metamodernism, pertained to the contemporary situation in science and research and showed future trends in science. The ontological principle of simultaneity caused by oscillation was interpreted as the continuous oscillation from the hierarchical system of science and research to the network approach, embracing one another and changing polarities from pyramid to net according to the situation. The epistemological proposition, related to the paradoxical understanding of truth and grand narratives, was grounded on the suggestion that science produces both subjective and objective truth, depending on the context, and evaluates these results from various discourses. Also, science can be used both to reinforce and denounce the large metanarratives of today (e.g., sustainability, search for meaning, or global digitalisation). Other epistemological principles of metaxis-based thinking and dia/polylogue were represented by the discourses of scientific thinking (complexity–simplicity, prerequisite of wisdom), the system of science (semipermeable boundaries between disciplines), and the interaction of scientific disciplines (mono-, multi-, inter-, and transdisciplinary research) and the dialogue/polylogue of science with society and politics, as well as open science and the digitalisation of science. The axiological principle of metamodernism shows the necessity of constant negotiation between the concerns and values of society and science and was illustrated by the rising movement of the ambiguous issue of RRI. The methodological principle of pluralism was explained by the idea that different sciences, paradigms, and approaches are simultaneously true, while the principle of coexistence of different stages of cultural evolution could become the signifier of the further development of science in the 21st century.

In terms of the practical implementation of our ideas, at first, it should be mentioned that similarly to postmodernism, metamodernism initially emerges in the thinking of representatives of humanities, cultural studies, art, and architecture, then social sciences, education, health care, and only then, possibly, will it knock on the door of the most conservative modernist bastion, natural sciences, engineering, and IT. Therefore, several aspects of the presented work may be easier to perceive and include in a mental map by scientists from the fields of social science and humanities than by natural scientists or representatives of technological areas.

Second, it seems that this article would bring some novel insights and inspiration for secondary and tertiary education, especially for university teachers and researchers, as well as university curriculum developers, to help them in educating, nurturing, and mentoring young researchers for the 21st century. Interestingly, in a future workforce, we will need skills which already are essentially important for scientists in order to participate in mono-, inter-, multi-, or transdisciplinary scientific projects in the context of metamodernism. Among them are analytical thinking and innovations, active learning, creativity, originality and initiative, technology design and programming, critical thinking and analysis, solution of complex problems, leadership and social impact, emotional intelligence, reasoning, problem-solving, ideation, and system analysis and assessment [155].

Due to limited space, it was not possible to cover all possible aspects and details of how science would be integrated into the paradigm of metamodernism. This paper was our exercise in the subjective interpretation of very broad and negotiable discourse in a quite lapidary way, thus unavoidably ingraining the biases and stereotypes of authors and their preferences for this specific methodological treatise.

Scholars all over the world are already encountering metamodernism in various contexts of their work, in different disciplines and fields of science, even if they are not using exactly this term. Using different pathways, small streams have to find their way and flow into nearby rivers, ponds, or other bodies of water. Similarly, each scientist will have to find their own position or direction in this movement, which is still discernible only in the form of seemingly accidental "anomalies" and only for the well-trained observer. However, we would like to note that in our opinion, science changes and develops in self-determined ways, which amazingly aligns well with the paradigm and principles, oscillating together with global and local life events, sometimes in very unexpected and unpredictable ways. Only the future will show whether and in what way science will establish its place in the challenging story of metamodernism.

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