Chaos, Solitons and Fractals 158 (2022) 112065

Contents lists available at ScienceDirect

Chaos, Solitons and Fractals

Nonlinear Science, and Nonequilibrium and Complex Phenomena

journal homepage: www.elsevier.com/locate/chaos

The infinitely fractal universe paradigm and consupponibility

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ARTICLE INFO

Article history:
Received 27 December 2021
Received in revised form 24 March 2022
Accepted 29 March 2022
Available online xxxx

Keywords:
Consupponibility
Assumptions
Falsifiability
Infinite universe
Fractal
Neomechanics

ABSTRACT

The inability of Albert Einstein and quantum physicists to resolve whether the laws of nature operate exactly or probabilistically impacted scientific methodology. Karl Popper further compounded the problem by stressing empirical falsifiability and proposing causes cannot be proven because of *infinite regress*. For these and other reasons, many investigators either downplayed propositions of cause or even ridiculed them. With causality vilified, metaphysics took a back seat to empirical science. In Earth sciences, however, causality remains a top priority. Thus, a significant interdisciplinary rift developed in established scientific procedures. Yet, some physicists still wanted to know why their equations worked, and some still postulated causality despite its diminished stature. Metaphysics has a rightful place in science and revive a forgotten approach, consupponibility, for testing metaphysical assumptions and theories. A set of fundamental assumptions and theories are consupponible if they exist without contradicting one another. Importantly, a single contradiction among the set falsifies the entire paradigm. To demonstrate the concepts associated with fundamental assumptions and a paradigm, this work analyses a paradigm based on infinitely fractal matter. Just like Popperian falsifiability, a large set of prohibitive fundamental assumptions allows proponents, opponents, and undecided investigators a means for falsifying the infinitely fractal universe model if the paradigm incorrectly describes the universe. That is, the goal is never to prove the paradigm, which is impossible. Instead, the goal is to attempt to disprove the paradigm by finding contradictions. Repeated failures to disprove the paradigm increase the likelihood of its correctness.

1. Introduction

A rigorous framework for conducting scientific research remains elusive. Historically, philosophers of science and metaphysicists have taken on that role, but endless disagreements among them worked against establishing a consensus for conducting scientific research. The work here focuses on testing theories within the physical sciences. Accordingly, this work concentrates on philosophy of science, which deals with foundational problems that arise when conducting research. These include questions about the aims of science, its methods, the nature of scientific theories, the relationship between theory and observation, the structure of concepts such as causation, explanation, confirmation, experiment, model, reduction, and probability, and the rules that govern theory-change [1].

Because of the ongoing disagreements, Lowe [2] considers metaphysics as the most mocked and least understood part of philosophy, and those opposed to metaphysics portray its practitioners as highly speculative while dreaming up abstract pictures of the universe. The metaphysical propositions are widely ridiculed by poets, playwrights, novelists, and journalists, as well as by other philosophers [2]. The Logical Positivists of the early 20th Century rejected all metaphysical speculations as meaningless since they could not be verified by scientific experiment. In the later part of the 20th Century, Wittgenstein [3] criticized systematic metaphysics as an intellectual disease resulting from false pictures of the world being transformed into linguistic grammar.

While agreeing that, as a rule, metaphysicists are the culprits by painted themselves into this uncomfortable corner of contradictory conjectures, some metaphysical thought is commendable and worthy of further scrutiny [4–6]. To understand how metaphysics became the most mocked part of philosophy [2], this work reviews key points in metaphysical development and discusses associated problems. If forced to explain the current state of metaphysical contradictions in a single word, it would be *finity* (the idea that the universe is finite). It is shown how assumptions of a finite universe and completely empty space contrast with infinity assumptions, and then shown how an assumption of infinitely fractal matter eliminates the contradictions inherent in finite universe assumptions. This work encompasses the entire gamut of scientific research, including fundamental assumptions, scientific theories, empirical evidence, mathematical models, peer review, and post publication review.

The history of how metaphysical thought influenced science is extensive and complicated, yet necessary to understand the current plight

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https://doi.org/10.1016/j.chaos.2022.112065

in science. These key contributions are then amalgamated into a non-contradictory framework for conducting research. In addition to contemporary rules for falsifying empirical models, the proposed framework provides a means for falsifying a scientific paradigm. The review begins by acknowledging key contributions from the most influential science historians, philosophers of science, and metaphysicists of the 20th Century.

1.1. Metaphysics

Metaphysics is the branch of philosophy that studies being, matter, motion, space, time, and causality [4,7–9], and science is the body of systematic or orderly thinking about a deterministic subject-matter [4]. Collingwood [4] contributed significantly to metaphysical thought, yet many of his key ideas remain unrecognized or underutilized. A metaphysical framework is important because if an investigator pursues science while maintaining incorrect assumptions about the nature of the subject-matter, then mistakes will likely infect work based on the false premises [4]. Examples of acknowledged metaphysical errors include the geocentric system in astronomy, the physiology of the four humours, and the chemistry of phlogiston. Despite inappropriate metaphysics, astronomers, physiologists, and chemists still made significant advances. Replacing these failing paradigms [10,11] with improved metaphysical frameworks was instrumental in elevating scientific thought to a higher level. Collingwood [4] describes metaphysics as one branch of the science of thought involving studies of absolute presuppositions. Metaphysics arose out of the mere pursuit of knowledge. That pursuit, called science, is an attempt to think in a systematic and orderly manner. In low-grade or unscientific thinking, researchers are generally unaware of their absolute presuppositions [4]. Later, Borchardt [5,6] uses the term fundamental assumption in the same context as Collingwood's absolute presupposition. The terms “assumption” and “fundamental assumption” are used here instead of Collingwood's “relative presupposition” and “absolute presupposition”, respectively.

Collingwood [4] also addresses the anti-metaphysics movement. That is, those who regard metaphysics as a delusion and an impediment to progress and even demanding its abolition. The typical 19th Century conviction was that all questions about fundamentals were settled, and on no account must be reopened. This is what recent philosophers mean by calling 19th Century metaphysics dogmatic, superficial, and hypocritical [4]. Psychologists often criticize metaphysics, but Collingwood [4] counters that psychology is the science of sensing, and it does not involve rational thinking (a requirement for metaphysical structure). Sensation has no element of self-criticism (thinking) and is limited to seeing, hearing, touching, smelling, tasting, and experiencing the emotions associated with them [4]. Because metaphysics focuses on logical reasoning, a contradiction serves as a legitimate reason to reject a set of propositions. A complete set of fundamental assumptions and associated scientific theories are defined here as a paradigm [11]. Collingwood [4] provides six key definitions for constructing a paradigm: (a) propositions are statements about a natural process; (b) every question involves an assumption; (c) when something causes a question to arise, the question is referred to as the logical efficacy of that thing; (d) to assume is to freely treat a proposition as being unequivocally true even when it cannot be proven, whereas to suppose is to tentatively consider a proposition as true with the hope that further testing will determine its validity; thus, all assumptions are suppositions, but not all suppositions are assumptions; (e) an assumption is one that stands relative to a question and is relative to another question as its answer; (f) a fundamental assumption is one that stands, relative to all questions to which it is related, as an assumption, but never as an answer. Thus, fundamental assumptions are those taken for granted, and never questioned. Fundamental assumptions are not verifiable and cannot be proven or disproven. In science, the logical effectiveness of a fundamental assumption does not depend on it being verifiable. Thus, fundamental assumptions are unprovable beliefs that all scientists employ [4–6]. For example, the proposition that the universe is infinite is a fundamental assumption because studies of large-scale structure are limited to the observable universe, and thus prevents disproof. Section 3.1 contains additional examples, with a special focus on a set of deterministic fundamental assumptions and their indeterministic counterparts.

Collingwood [4] noted that an individual often reacts with a “ticklish” response when fundamental assumptions are questioned. Think of this as the emotional part of science that few want to admit to, and many want to avoid mentioning at all costs. Collingwood [4] believed that some natural scientists despise metaphysics because they dislike having their fundamental assumptions questioned. Kuhn [11] discusses this same phenomenon as founders of new paradigms generally have little success in changing the minds of scientists aligned to an established paradigm that is failing. Section 2.3.2 contains examples of famous paradigmatic disputes, where strongly held opposing views led to bitter battles before a new paradigm eventually achieved acceptance. As a rule, young scientists and those new to the field (still making up their minds and still establishing personal fundamental assumptions) determine whether a new paradigm provides an enhanced framework for conducting scientific investigations [10,11].

Collingwood [4] stated that modern researchers pride themselves on having abolished magic and pretend they have no superstitions. In reality, we are as superstitions as ever. Thus, it is a special characteristic of modern European civilization to habitually frown upon metaphysics and to deny the existence of fundamental assumptions [4]. In summary, metaphysical historians attempt to find the fundamental assumptions that individuals and groups have embraced at various points in time. All conjectures of cause involve assumptions. Kant [12] postulated that all events have causes. More specifically, all causes in nature operate according to laws [4]. But proponents of quantum physics and special relativity often dismiss this deterministic approach to scientific investigations.

1.2. Approaches to scientific investigations

Even though fundamental assumptions cannot be proven, they are useful in one of two ways: (a) the ordinary scientist agrees with them, treats them as being true, and conducts research accordingly, or (b) the metaphysicist tries to understand the implications of a fundamental assumption. Accordingly, Collingwood [4] introduces the concept of a set of fundamental assumptions deemed as logically *consupponible*. To be consupponible, all assumptions must exist without any one of them contradicting any other assumption in the set. This concept might seem self-evident. Yet, metaphysicists failed to embrace the consupponibility requirement until Borchardt [5,6] adopted it while defining a set of ten fundamental assumptions of science (Section 3.1). If just one assumption or postulate associated with a paradigm contradicts another, then the contradiction falsifies the entire paradigm. After falsifying a paradigm, one must seek an alternative consupponible framework while also avoiding the usage of an untestable ad hoc to keep the falsified paradigm alive.

In addition to consupponible logic, another approach involves a variety of statistical methods for testing beliefs in terms of probabilities. The goal of statistics is to use objective criteria to evaluate beliefs that might be biased by personal desires, prejudices, faulty logic, and careless methodology [13]. Of course, all statistical tests rely on certain assumptions being met regarding the population being investigated. Statistical results are only valid if the underlying assumptions about the population are correct. The efforts of Fisher [14] and Popper [15] helped popularize null hypothesis testing for statistically falsifying inappropriate empirical models. Even then, null hypothesis testing has limitations [16] and only gives the likelihood of a hypothesis being rejected, but never rejects it with 100% certainty.

Nowadays, probabilities linked to experiments from quantum physics and biological labs are often given as evidence that the universe is indeterministic [17], but not everyone agrees. For instance, Workman [18] interprets quantum probabilities deterministically. After presenting a framework for structuring scientific investigations (Section 2), it is shown how an indeterministic set of fundamental assumptions forces one to think far differently from an alternative deterministic set of fundamental assumptions (Section 3). As one example, those who work with indeterministic assumptions must treat probabilities as evidence of an acausal universe, whereas those who work with deterministic assumptions treat probabilities as a by-product of insufficient skills and/or observer ignorance. Stated differently, the deterministic view is that if a researcher cannot replicate an experiment with sufficient accuracy and precision, then either the model is missing a key variable, or the measurements are from a substandard measuring device.

Likewise, rather than treating causality as a fact (every event has a finite set of causes, which is unprovable), causality is treated as a sequence of assumed infinite causes. The distinction between treating causality as a fact versus treating it as an assumption might seem trivial. In actuality, the difference is major. It is the difference between being dogmatic (it is a fact that should never be questioned) and being vulnerable to error (it is an assumption that could be wrong).

Historically, finding causes has been important in sciences such as geology, medicine, and biology. In the natural sciences, it is common to determine cause via correlation. But doing so is never straightforward. If A and B are correlated, there are five possibilities: (i) A causes B, (ii) B causes A, (iii) a third unknown factor causes both A and B, (iv) the correlation is a coincidence, or (v) A causes B and B causes A, which is generally considered invalid because it invokes circular reasoning. Scenario (v) is mentioned only because some consider this as a valid possibility, especially when postulating causality via a feedback loop. Metaphysicists generally postulate it is impossible to prove causes because one cannot prove if every effect has a cause, ad infinitum, referred to as infinite regress [4,15,19]. Throughout this work, these logical possibilities are discussed as they relate to finite versus infinite causes, with a special focus on infinite regress. Popper [15] considers infinite regress as a severe problem, whereas Borchardt [6] treats infinite regress as a fundamental assumption. A simple change in mindset – from infinite regress being a problem to being a fundamental assumption – immediately changes the nature of many metaphysical problems. The seemingly unsolvable metaphysical problems discussed here are turned upside down, and suddenly become solvable in terms of consupponibility (Sections 3 and 4). While causes cannot be completely ruled out from the standpoint of null hypothesis testing of empirical models, a set of metaphysical postulates can be disproven based on contradictions found among its assumptions and theories.

While the scientific framework is generally thought of as a strict methodological approach for studying natural and experimental processes, Feyerabend [20] portrays science quite differently – stating that science is essentially an anarchic enterprise. In the Feyerabendian view, the only principle that does not inhibit progress is that *anything goes*. For example, new hypotheses are sometimes useful even when they contradict well-confirmed theories and/or well-established experimental results. Science might advance by proceeding counter-inductively, and hypotheses contradicting well-confirmed theories sometimes provide insights that cannot be obtained in any other way [20]. Proliferation of theories is beneficial for science, while uniformity impairs its critical power. No theory agrees with all observations within its domain, yet it is not always the theory that is to blame. And facts are constituted by older ideologies, and a clash between so-called facts and theories may be evidence of progress [20]. While generally agreeing with the Feyerabendian worldview, it is important to distinguish between the role of imaginative minds in formulating new ideas (which indeed is often anarchic and individualistic) and a scientific framework (which can be logical and rigorously structured). Feyerabend [20] often focuses on contributions from imaginative individuals, whereas the focus here is on the divergent components of science (Section 2). A neomechanical framework is used to interpret results and develop consupponible hypotheses of an infinitely fractal universe, both of which are independent of the archaic ways in which scientists often conceptualize experiments and then devise theories. Theoretical development proceeds along the lines of the principle of parsimony, also referred to as the principle of simplicity, Occam's razor, or Ockham's razor. Philosophers generally prefer parsimony when evaluating theories because failing explanations can always be bolstered with imaginative ad hoc hypotheses to prevent them from being falsified. Thus, simpler theories are preferable to more complex theories riddled with ad hocs because simpler theories also tend to be more testable [21–25]. Scientists are inclined to justify simplicity on inductive grounds [26]. That is, scientists select new hypotheses based partly on criteria that have been generated inductively from previous theoretical choices. Choosing the most parsimonious of the alternative hypotheses has generally worked best. Hence, scientists continue to use this as a rule of thumb and are justified in doing so [26]. However, Fitzpatrick [27] is critical of the inductive grounds for using parsimony, wondering why long-run convergence toward the truth should matter when it comes to predicting the outcome of the next experiment. While having nothing against an ad hoc on philosophical grounds, a theory that employs an untestable ad hoc is less attractive than a competing theory which can be tested and supported without the ad hoc. The cosmic inflation ad hoc [28] serves as an example. To prevent falsifying the Big Bang Theory, Guth [28] devised the cosmic inflation hypothesis so that all known rules of science were briefly suspended. In this way, Guth postulated that a finite universe expanded far faster than allowed by the speed of light constraint. To an indeterminist, this ad hoc might seem possible, but because there is no way to measure events at this critical time, the cosmic inflation hypothesis cannot be tested. That is, it is not falsifiable. One either believes in it or not, but the cosmic inflation theory is untestable. Conversely, a determinist would search for a consupponible hypothesis to explain Hubble's cosmological redshift within the context of an eternal rule-based framework.

Divergent philosophies about causality and determinism portray an image of confusion, suggesting the irrelevance of metaphysics. However, this type of criticism is unjustified because the diverse ideas of the great 20th Century philosophers often involved unrelated aspects of scientific research. It is still possible to merge these divergent ideas into a consupponible framework. Bohm [29] noted that developments in relativity and quantum theory failed to fit with mechanical philosophies. He interpreted this as requiring a radically new approach beyond mechanics – an approach that assumes *infinity* and is referred to as neomechanics [6]. Bohm [29] further states that the usual interpretation of quantum theory does not give a clear idea of the extent of this change because it functions solely as a mathematical algorithm – a set of rules, permitting only the calculation of the probable results of a statistical ensemble of similar measurements. Feyerabend [20] writes about epistemological anarchism and thus portrays conceptions of scientific theories and experiments as an archaic process in which anything goes. Conversely, Popper [15,30] was not so concerned about how theories were conceptualized, but how a theory can be disproven if it is false. He proposed demarcating hypotheses as either scientific (being falsifiable) or pseudo-science (untestable). Popper's contribution was that a well-defined and prohibitive empirical model can be falsified, but he proposed that explanations of cause cannot be falsified because of *infinite regress*. In a slight twist to Popper's approach, Lakatos [31, 32] proposed tolerant skepticism toward untestable hypotheses because many of the important empirical models took years to develop from their early untestable states. Russell [33] also considers tolerance as the ideal for conducting research because it has two sources: (a) the realization that one might be mistaken, and (b) the belief that free discussion will promote the view that one favors. This latter opinion must be held by anyone whose ideas are formed on rational grounds. Conversely, dogmatists fear that free discussion would show their beliefs to be groundless, and that is why a dogmatic theorist favors censorship. The Western world has generally (but not always) learned that tolerance and free discussions tend to promote intellectual progress, social cohesion, and prosperity [33].

Russell [33] and Lakatos [32] describe the ideal for all scientists to be tolerant of competing ideas. This is because science is, among other things, to be objective and open-minded. However, Kuhn [10,11] doubts that most scientists from a prevailing paradigm will tolerate competing ideas, especially when their livelihood is intricately tied to the paradigm. As evidence, Kuhn cites personal acquaintances, the novels of Sir Charles Snow, and a cursory reading of the history of science – all of which provide substantial evidence of intolerance. Although the collective scientific enterprise is ideally open-minded, the individual scientist is very often not [10]. Whether research is predominantly theoretical or experimental, before a project begins, investigators usually know all but the most intimate details of the result to be achieved. Kuhn states that if the expected result is quickly forthcoming, well and good. If not, investigators will struggle with the apparatus, equations, and explanations until the study yields results conforming to those foreseen from the start [10]. This essentially describes the unshakable approach taken by those dogmatically aligned to the fundamental assumptions associated with a paradigm. Conversely, open-minded researcher will take an opposite approach when negative results appear, and ask: What is wrong with this theory? Thus, true innovation comes with great difficulty and duress for its founders. Proponents of a new scientific theory seldom present it in a way that convinces its opponents. Instead, proponents of a failing paradigm gradually die one at a time, and a rising generation of scientists choose the new paradigm if it leads to discoveries that would not be possible under the outdated one [10,11].

Strongly held convictions often serve as a precondition for success in the sciences. Though preconception and resistance to innovation could very easily choke off scientific progress, their omnipresence is symptomatic of characteristics upon which the continuing research depends. Kuhn [10] collectively refers to these as the dogmatism of mature science. Linked to this, scientific education instills in students what the research community gained with difficulty from a deep commitment to a particular way of thinking. That commitment can be replaced by another paradigm, but it is never easily given up. In this way, the research community can become entrapped with dogmatism [10].

By and large, these diverse views from prominent 20th Century philosophers remain just as true today as they were then. By taking the best ideas from the best philosophers, a deterministic scientific framework is devised that includes consupponible fundamental assumptions. Fundamental assumptions are the unprovable beliefs that all researchers hold. Most scientists are either unaware of their assumptions, or when aware, prefer never to discuss or publicly state their assumptions in research. Nonetheless, neglecting such a key aspect of science (either consciously or unconsciously) inhibits progress. Unfortunately, many individuals believe their fundamental assumptions should never be questioned, which leads to a dogmatic approach. Accordingly, this work proceeds with the Collingwood [4] worldview of fundamental assumptions being a critical part of science that must be brought into the open, discussed, and then analyzed logically – just like all other aspects of science.

2. Scientific framework

Here, science is defined in terms of two frameworks: paradigmatic and empirical. In turn, each framework has two key components: the paradigm consists of fundamental assumptions and scientific theories, whereas the empirical realm consists of evidence (observations) and models of physical processes (generally mathematical formulations). While a paradigm is linked to an empirical framework, the empirical framework can be contained within multiple paradigms. For instance, a specific empirical model could be a component of multiple paradigms and competing paradigms could contain some of the same fundamental assumptions.

The primary purpose of a scientific framework is to allow others to understand the complete thought process of proponents of a particular paradigm. Just as with empirical falsifiability [15], a complete scientific framework allows those who are unsure of the validity (or opposed to) a particular paradigm a means for identifying contradictions and falsifying the framework in its entirety. A secondary purpose is openness. As mentioned in Section 1, fundamental assumptions remain the hidden part of science. However, to understand the merits of various beliefs, fundamental assumptions must be brought to the forefront firstly by being clearly stated, and then openly discussed for their merits. After considerable discussion and experimentation, most investigators will likely settle on a handful of scientific frameworks for further consideration. Eventually, the scientific community reaches a consensus on the preferred framework based on its success in producing innovations as well as explaining causes in a coherent and comprehensible manner.

2.1. Paradigmatic framework

A paradigm consists of a collection of fundamental assumptions and scientific theories. For a researcher who considers a set of fundamental assumptions to be true and the basis for the individual's way of thinking, the paradigm serves as a guide to developing scientific theories and constructing empirical models. In turn, the theories might contain secondary assumptions derived from the fundamental assumptions. In this sense, a paradigm provides a holistic approach to solving scientific problems. Because the assumptions upon which a paradigm is based must be consupponible, any contradiction among them will logically falsify the paradigm. Any attempt to falsify a paradigm abides by the principle of parsimony, with untestable ad hoc hypotheses being inadmissible.

2.1.1. Fundamental assumptions

Kant [12] noted that mathematics established a path for scientific investigations since the early Greeks, and physics did the same beginning with Galileo. He argued something similar must be done with metaphysics. His solution was evaluating the consequences of assumptions. For instance, in physics, instead of making observations and then asking what they proved, Galileo first framed hypotheses based on assumptions and then devised experiments to test them. Collingwood [4] agrees that metaphysics must follow this approach and get a firm grip on its fundamental assumptions. Yet, even while understanding the need, neither Kant [12] nor Collingwood [4] presented a set of consupponible fundamental assumptions to work with. This work proceeds toward achieving the goal of consupponibility (Section 3.2) by presenting a set of ten fundamental assumptions referred to as the neomechanical assumptions of science.

An assumption is fundamental if it cannot be proven or disproven, and it has an opposite that cannot be proven or disproven [5,6]. Although unprovable, fundamental assumptions are useful for developing ideas about how physical processes operate either in laboratory experiments or naturally occurring in the universe. All investigators conduct research based on fundamental assumptions, which are often either unstated or not consciously known [4–6]. Unconscious assumptions can take the form of deferring judgements about the nature of the universe to experts from various disciplines without fully understanding what the experts believe. This can lead to circular reasoning and/or confusion if each expert defers judgements about assumptions to other experts. This is especially problematic if none of them ever clearly state their fundamental assumptions.

2.1.2. Scientific theories

Hypotheses and theories are essentially metaphysical conjectures about being, change, matter, motion, space, time, and causality. A scientific proposition starts as a hypothesis, and then becomes a generally accepted theory after repeated successful testing of its predictions. However, even when a theory is widely accepted as being true it cannot be definitively proven because of infinite regress [15]. However, Collingwood [4] suggests using consupponibility as a means for falsifying a theory based on the set of fundamental assumptions linked to it. Borchardt [5,6] employs consupponibility by using ten neomechanical assumptions, one of which treats *infinite regress* as an assumption rather than as a problem. Lange [34] suggests using a Bayesian framework for putting metaphysical explanations back into empirical models. While this approach might be helpful, and thus has some merit, consupponibility [4–6] is employed as the ultimate criterion for evaluating causality.

2.2. Empirical framework

The empirical realm of scientific investigation involves both evidence and models. In general, this part of science is already firmly established and requires minimal adjustments. Thus, discussion of this portion of the framework is brief.

2.2.1. Evidence

Researchers gather empirical evidence in the form of observations and measurements of physical processes. The measurements are then commonly used to either develop a mathematical model to simulate a process or to test an existing model developed from other observations and measurements. When evidence is gathered to test a well-defined empirical model, it provides a means for falsifying the model, if the model is indeed incorrect [15,30]. This is how modern scientists can test empirical models even when they are unaware of their own fundamental assumptions.

2.2.2. Mathematical models

A model provides specific rules for simulating a physical process. Modern physics has developed to a point where mathematical models dominate the literature. Because mathematics provides a concise means for defining complex processes, physicists and astronomers generally prefer mathematical models for simulating most physical processes – while either ignoring causality or relegating it to a secondary concern. As such, a mathematical model is an empirical formulation of a theory, but technically says nothing about causality. However, geologists frequently reverse these concerns by first focusing on causality with little emphasis on precise models to simulate geological processes.

This geological approach has drawn the ire of some physicists, and even prompted some geologists [35,36] to ask: Is geology really a science? Davis [35] notes that geologists are simply not held in very high esteem by many academics outside of the Earth and planetary science discipline. Harrison [36] gives further details about the philosophical division between geology and physics. As an example, Harrison describes a hypothetical scenario of an inspiring presentation given at a seminar. After the presentation, telling a geologist that it was a great story might evoke a smile, but telling a physicist the same thing might risk a punch in the mouth. The fragmentary nature of the rock record and the extraordinary timescales involved lend themselves to theoretical frameworks that embody multiple assumptions. New results introduced into such a geological framework either support it or require *ad hoc* adjustments to prevent falsification. Although this gives the appearance of valid science to some geologists, the underlying assumptions of the narrative are not challenged [36]. Popper [37] argued that the theoretical sciences are mainly interested in finding and testing universal laws, whereas the historical sciences take all kinds of universal laws for granted and are mainly interested in finding and testing singular statements. Harrison believes that while science is clearly distinguished from mythology by its emphasis on verification [15], its practitioners may be as subject to the same existential need to identify causes. Without recurring self-appraisal, Earth sciences lapse into wells of mistaken belief that momentarily reward the community with an unearned sense of scientific knowledge. This intellectual inertia partially reflects the inevitability of planetary sciences being more tolerant of untestable hypotheses relative to other physical sciences. While that is understandable given the challenge that historical sciences face in attempting to understand processes that have operated for billions of years, overly elaborate models invoking speculative mechanisms that cannot be tested (not subject to falsification) tend to crowd out other, possibly better, models from the geological arena [36]. While understanding and agreeing with Harrison's reasoning, both sides of the philosophical division have relevant points. Geologists correctly believe that planetary processes have causes, and they want to find those causes. Conversely, physicists and astrophysicists understand that determining cause is highly problematic and controversial, and thus they focus on Popperian falsifiability [15,30] while mostly ignoring causality. To bridge this gap, a scientific framework is developed for both falsifying contradictory theories as well as embracing the prevalent Popperian approach for falsifying erroneous empirical models.

2.3. Peer review

The scientific framework would be incomplete without defining the process by which scientific theories are eventually accepted or rejected. Even if a brilliant individual devises a new theory about a process, the individual alone does not determine its fate. The ultimate decision rests on peers who read, study, and experiment with a novel theory before deciding if it is useful in research. Peer review has two parts. The first step is journal review, which if accepted, leads to publication of a manuscript. The second step is post publication review, which is generally the most important component of peer review. Journal reviews commonly involve commentary from only two or three interested parties. This limited review gives incomplete feedback. Conversely, post publication review involves a far wider audience. Those most interested in a new idea might be willing to spend considerable time testing and experimenting with the idea. This section discusses problems inherent with both types of peer review.

2.3.1. Journal review

Critics of journal peer review have claimed that ethical transgressions, such a breach of confidentiality, theft of ideas, personal attacks, and bias, frequently undermine the quality and integrity of the review process [38,39]. Different solutions to these problems have been proposed, including using open (or unmasked) peer review, providing additional education and training for reviewers, disclosing conflicts of interest, and developing codes of ethics for reviewers and editors [38,39]. Although most scientists agree that ethical problems can occur in journal peer review, evidence has been anecdotal, consisting of personal accounts published in news stories, letters, or commentaries [39,40]. From a survey conducted by Resnik et al. [39], authors complain most about incompetent reviewers (61.8%) and biased reviewers (50.5%).

Based on reports such as these and our personal experiences, the major problem with peer review is more likely related to opposing reviewers rather incompetent reviewers or biased reviewers. The perception of bias is always in the eye of the beholder. When opposing fundamental assumptions and opposing theories are strongly held by both the author and the reviewer, the reviewer believes the author is biased, whereas the author thinks the reviewer is biased. Because fundamental assumptions about scientific processes are often strongly held and unlikely to be altered by logical reasoning [4,11], the opposing reviewer problem will likely persist regardless of how journal managers attempt to minimize it.

A prominent example of peer review flaws comes from the experiences of the Swedish inventor of plasma physics Hannes Alfvén [41], who proposed that the so-called empty interplanetary and interstellar space consists of highly charged particles that explain aurorae, Van Allen radiation belts, magnetic storms from Earth's magnetic field, terrestrial magnetosphere, and dynamics of the Milky Way galaxy. Chapman and Bartels [42] strongly opposed the ideas from Alfvén because they challenged the Einsteinian view of completely empty space. Thus, only minor journals published Alfvén's papers. His disputes with senior editors intensified to the point where, even after winning the 1970 Nobel Prize in physics, major journals still adamantly rejected Alfvén's papers [43]. Likewise, another future Nobel prize winner, Dan Shechtman [44] encountered publication problems when quasi-crystal structures were observed that defied conventional predictions from quantum chemistry.

Teixeira da Silva and Dobranszki [45] suggest post-publication peer-review as a solution to traditional peer-review that allows for the continuous improvement and strengthening of the quality of science publishing. However, post-publication peer-review already takes place in a variety of forms. Many of the same problems occur in the pre- and post-stages of peer review. While the problems are similar regardless of the stage, it is important to distinguish the distinct roles played by minor journals, journal editors, journal philosophies, and reviewers.

There is anecdotal evidence that at least a few editors are highly certain whether an article will be accepted or rejected before reviewers are selected. This might be described as editor bias. If an editor is biased, the editor can select reviewers accordingly. If the editor opposes the paper, then selecting opposing reviews is likely; if the editor favors the paper, then selecting neutral or supportive reviewers is likely. While confidentially discussing this possibility, most editors suspect this type of bias is minimal, if it happens at all. However, if it does happen, what is currently perceived as reviewer bias, might be partially explained as editor bias. While editor and reviewer biases are unlikely to be eliminated, to speed up the entire process, journals can revert to a process like that employed nearly a century ago – by having journal editors decide within two weeks whether to reject or tentatively accept a manuscript. Tentative acceptance would be defined as an 80% to 95% probability of acceptance. Two reviewers would then be assigned to make suggestions for improvements with the primary goal being revisions to make the manuscript publishable. In this way, overworked reviewers, who are already in short supply, will receive some relief. Accordingly, authors should also recognize that editors and reviews will always be biased (just as the author is). Most authors would gladly settle for a quick rejection (within two weeks) rather than waiting three months, six months, or even longer to receive notification of the rejection.

2.3.2. Post publication review

Whether research is published in a minor, mid-level, or major journal, post-publication peer review ultimately decides its fate. Intense scrutiny, from a diverse set of investigators, involving numerous give-and-take exchanges that persist over lengthy periods ultimately determines the viability of research. Obviously, publication is the vital initial step; however, post-publication review tends to be more diverse, and collectively more objective, and thus the most important part of peer review. While generally agreeing with much of Popper's logic and suggestions, Lakatos [32] disagrees with demarcating theories as either falsifiable or unscientific. Like Collingwood [4] and Feyerabend [20], Lakatos [32] favors tolerance toward incomplete theories as they undergo intense review after their initial publication.

Some examples illustrate the need for tolerance. For instance, the Copernican theory scarcely improved upon geocentric predictions of planetary position until the time of Kepler [11]. Then the late 17th century publication of *Principia*, and the subsequent acceptance of Newtonian mechanics, finally advanced the Copernican paradigm to a fully developed state. Thus, it took nearly two centuries for the undeveloped Copernican theory to evolve into its highly falsifiable Newtonian formulation.

A similar paradigm shift transformed geological worldviews, beginning as an undeveloped theory of continental drift [46]. As often happens when postulating revolutionary ideas, Alfred Wegener [46] was widely criticized, his evidence mocked, and his character maligned [47]. However, rather than taking offense, Wegener took the assaults as an opportunity to refine his ideas and address valid criticisms. By the late 1960s and 1970s, continental drift ideas eventually developed into theories of seafloor spreading [48], plate tectonics [49], and episodic openings-closings of ocean basins (Wilson cycle). Because there were similar developmental periods for all sciences, Lakatos [32] suggests tolerant skepticism toward undeveloped scientific theories – considering theories collectively as research programs rather than viewing them as isolated conjectures. With time, anomalies, inconsistencies, and ad hoc gimmicks might eventually be explained as a research program progresses [32]. Here, a research program is part of a paradigm.

Even after Shechtman [44] struggled to publish his Nobel-winning observation of a five-fold quasicrystal structure in an electron microscope, the most intense battle came later during post-publication scrutiny. Established quantum chemistry prohibited the quasicrystal structure that Shechtman observed [50]. A principal founder of quantum chemistry, Linus Pauling [51], steadfastly doubted the veracity of the observations described by Shechtman [44]. An intense confrontation developed. Based on the conviction of their underlying assumptions, each approached the problem differently and asked different questions. Pauling [51] believed quantum chemistry was correct as stated, and asked: What is wrong with Shechtman's observation? Conversely, Shechtman [44] believed his observation was correct, and asked a different question: What is wrong with Pauling's theory? While neither cannot be faulted for acting on their beliefs, this example illustrates why assumptions are so critically important. Assumptions often influence the types of questions an individual will ask, and then try to answer. While defending his findings, Shechtman encountered resistance from his employer and was asked to leave his job [52]. However, Shechtman persisted, eventually won the 2011 Nobel Prize in chemistry, and contributed to a paradigm shift in chemistry, physics, and materials science [50,53]. Conversely, Pauling [51] continued his dogmatic stance toward his own theories and automatically assumed Shechtman's observations were flawed. Instead of considering the possibility that his own theory was not entirely correct, Pauling needlessly instigated an intense attack against Shechtman's character and observations.

The experiences of renowned Irish quantum physicist John Stewart Bell provide another example of initial resistance to unconventional ideas. In the early 1950s, Bell submitted a theoretical study of dielectric-loaded waveguides to a magazine, only to have one referee reject it for being too short and the other to reject it for being too long [54]. Similar opposition arose when Bell challenged John von Neumann's approach to quantum measurement. Bell supported the deterministic idea of hidden variables in quantum theory [55]. This demonstrates how competing fundamental assumptions (deterministic versus indeterministic) led to drastically different interpretations of the same quantum phenomenon.

Again, these are not isolated instances of dissent leading to novel theories. Similar confrontations happen quite often. By their nature, scientists are skeptical of new ideas. In fact, a scientist must be skeptical to perform well. However, skepticism must be combined with tolerance [32] to allow a new theory or worldview time to address the barrage of questions from inconsistencies, errors, and/or omissions that are raised after publication. For a new theory to survive, the key factor is how proponents handle criticisms from opponents and skeptics (i.e., those who question an idea but remain undecided). William Herschel's discovery of Uranus in 1781 exemplifies the benefit of adroitly handling criticism. Based on expected gravitational perturbations from Jupiter and Saturn, astronomers found that the orbit of Uranus did not quite match the path predicted by Newton's gravitational law [15]. Something was amiss. Rather than treating this as a failure, in 1846, John Couch Adams and Urbain Leverrier calculated and predicted the location of a missing planet. Then, Johann Gottfried Galle quickly found the planet, later named Neptune, in the predicted location [15]. In addition to addressing criticism, Neptune's discovery was viewed as a triumph of gravitational law and mathematical physics. Popper [15] concludes that after lengthy debates, the scientific community eventually chooses the hypothesis that survives intense scrutiny and criticism. Because undeveloped theories often require considerable time to reach a developed falsifiable state [32], it is appropriate to revise Popper's demarcation into three classes – falsifiable scientific theories, pseudo-science, and undeveloped scientific ideas. Admittedly, the distinction between pseudo-science and an undeveloped scientific idea will be blurry until the undeveloped idea matures into a scientific formulation.

3. Neomechanical paradigm framework

This section contains a scientific framework considered to be consupponible. After presenting the associated fundamental assumptions, examples show how the assumptions can be applied to devise non-contradictory hypotheses. Many incorrectly believe that scientific measurements alone serve as the basis for devising hypotheses. As already discussed, fundamental assumptions used in combination with scientific measurements lead to theoretical developments. With a specific set of observations serving as a starting point, hypotheses developed from finite universe assumptions (such as temporal, spatial, and/or material finity) are dramatically different from hypotheses developed from the infinite universe paradigm [6,56]. The degree to which fundamental assumptions influence hypothetical development cannot be overemphasized. The numerous examples in this section demonstrate how applying different assumptions to the same observations generally leads to drastically opposing hypotheses.

In its entirety, the proposed framework is referred to as the infinite universe neomechanical paradigm. Overall, researchers currently gather evidence and develop models by appropriate means. Measurements of processes provide evidence. Current procedures for gathering evidence are generally acceptable. This empirical aspect of science can proceed unchanged, other than revising mathematical models that simulate physical processes by appending ± uncertainties to all equations. For instance, the equation $E = mc^2$ is revised to $E = mc^2 \pm \sigma$ to coincide with the neomechanical assumptions. Even though one, two, or a handful of variables might almost perfectly explain a process, there will still be some error, however miniscule, from the infinite causes assumed to exist for every process in the neomechanical paradigm. That is, within the neomechanical framework, physical processes can never conform perfectly to mathematical equalities.

Most of our suggestions focus on metaphysical aspects of research. The major differences with conventional scientific frameworks are twofold: (a) the fundamental assumptions associated with neomechanics are clearly stated upfront, so reviewers do not have to guess how researchers arrive at a conclusion, and (b) the neomechanical interpretations of evidence and models generally differ drastically from standard interpretations. By interpreting results within the constraints imposed by the *Ten Assumptions of Science* [5,6], an individual is forced to choose from a limited set of options to explain causes while striving to keep the explanations consupponible with the fundamental assumptions.

The neomechanical framework assumes all processes within an infinite universe have an infinite sequence of causes that precede the event, but this is not the same as infinite laws of nature. For instance, if the physical laws are identical at all scales of the universe, then finite laws can be used to explain infinite causes. The paradigmatic framework is defined as the fundamental assumptions and associated definitions upon which all theories are deduced. Taken individually, none of the assumptions or definitions can be proven or disproven. However, taken collectively, a single contradiction would falsify the framework in its entirety. That is, if the fundamental assumptions, relative assumptions, and definitions are not consupponible, then they are collectively falsified (without ever knowing which of the individual assumptions are false).

3.1. Neomechanical fundamental assumptions

The *Ten Assumptions of Science* [5,6] are employed as a set of fundamental assumptions for developing neomechanical hypotheses. Isolated phenomena are then analyzed to deduce expected causes based on the Ten Assumptions. These analytical exercises never prove causes. Instead, they explain what the causes are expected to be only if the Ten Assumptions are valid. These mental experiments might be difficult for a novice uncomfortable with thinking in terms of a complete set of fundamental assumptions. This type of analysis often requires comparisons between expectations from the Ten Assumptions and expectations from opposing finite universe assumptions.

Based on our own experiences, it might take an individual considerable time to think through the implications of the Ten Assumptions before becoming comfortable with instantly switching between finite universe and infinite universe assumptions. Accordingly, this section interprets causes of various phenomena in neomechanical terms. To differentiate between the deterministic neomechanical assumptions and their indeterministic counterparts, the opposing assumption immediately follows every neomechanical assumption. These assumptions and some tentative interpretations are given in Borchardt [5,6] and Puetz and Borchardt [56]. Here, the Ten Assumptions are only briefly described, with the primary goal being the assembly of a metaphysical framework for including the assumptions as a means of falsifying paradigms. All interpretations here supersede those given in Puetz and Borchardt [56]. While reading these fundamental assumptions and their opposites, keep in mind that none of them can be either proven or disproven – which is why they are fundamental assumptions.

3.1.1. Materialism

Materialism is the deterministic view that physical matter is the only reality. It is assumed that all being, processes, and phenomena can be explained as manifestations of matter [6]. (The opposing indeterministic assumption of **immaterialism** is rejected, which is the belief that material things have no reality except as mental perceptions.)

3.1.2. Causality

Causality is the deterministic view that all effects have an infinite sequence of materialistic causes [6]. (The opposing indeterministic assumption of **acausality** is rejected, which is the ability to stand outside of the confines of conventional cause and effect, thus granting an entity immunity to falsifiability.)

3.1.3. Uncertainty

Uncertainty is the deterministic view that it is impossible to know everything about anything, but it is always possible to know more about anything [6]. (The opposing indeterministic assumption of **certainty** is rejected, which is the Einsteinian type of belief that it is possible to exactly know the nature of the universe without error, which, in turn, invariably presumes the universe is finite in space and time while simultaneously consisting of fundamental forms of matter.)

3.1.4. Inseparability

Inseparability is the deterministic view that matter and its motion cannot be separated. Specifically, just as there is no motion without matter, there is also no matter without motion [6]. (The opposing indeterministic assumption of **separability** is rejected, which allows for matter to exist without motion, motion to occur without matter, matter to be considered as motion, motion to be considered as matter.)

3.1.5. Conservation

Conservation is the deterministic view that matter and the motion of matter neither can be created nor destroyed [6]. (The opposing indeterministic assumptions of **creation and destruction** are rejected, which postulates that matter can be both created and destroyEd.)

3.1.6. Complementarity

Complementarity is the deterministic view that all types of matter are subject to divergence and convergence from other matter [6]. (The opposing indeterministic assumption of **noncomplementarity** is rejected, which is the belief that either matter or motion can diverge from one part of the universe without converging on another part.)

3.1.7. Irreversibility

Irreversibility is the deterministic view that all processes are unique and irreversible over time [6]. (The opposing indeterministic assumption of **reversibility** is rejected, which is the belief that things can go back to a previous state, and consequently, that it is possible to travel back in time.)

3.1.8. Infinity

Infinity is the deterministic view that the universe is infinite in terms of time, the types of matter, and its size [6]. (The opposing indeterministic assumption of **finity** is rejected, which includes the beliefs that the universe had a beginning and will have an end, that finite elementary particles exist, and largest structures exist.)

3.1.9. Relativism

Relativism is the deterministic view that all matter has characteristics that make them like other types of matter as well as characteristics that make them unlike all other matter [6]. This might be thought of as an assumption of uniqueness, with all matter being similar yet unique over all time. (The opposing indeterministic assumption of **absolutism** is rejected, which is the belief that some components of matter are identical while being completely different from other types of matter.)

3.1.10. Interconnection

Interconnection is the deterministic view that all matter is interconnected. That is, between any two objects exist other objects in motion, which constitutes an endless interposition of objects containing matter as well as space [6]. (The opposing indeterministic assumption of **disconnection** is rejected, which is the belief in both “closed systems” that operate completely independent of the external environment and “perfectly empty space” in which no matter exists.)

3.2. Neomechanical definitions

Semantics and definitions are critical in understanding concepts. The neomechanical paradigm demands precise definitions of multiple concepts, which are collectively referred to as neomechanical definitions. Like fundamental assumptions, definitions are important because they might not be derived from other presuppositions [4] or they might not be immediately clear from fundamental assumptions, such as the Ten Assumptions (Section 3.1).

Definitions and fundamental assumptions are critical for at least four reasons: (a) they contain succinct statements of what an individual believes without going into a voluminous treatise aimed at justifying the beliefs and statements; (b) they acknowledge opposing views, and include statements of unprovability by admitting to the possibility that an assumption is false; (c) they clarify intent when the same word has different meanings in various branches of science; and perhaps most importantly, (d) they define a paradigm in the form of a broad collection of detailed statements which, in turn, provides individuals who are proponents, undecided, or opponents of the paradigm a means for falsifying it if the associated assumptions, definitions, and theories are found to be non-consupponible [4–6].

Some neomechanical terms are defined unconventionally, which might make them difficult for the reader to initially accept. Nonetheless, it is imperative to define these words uniquely to make them consupponible with our assumptions and hypotheses.

3.2.1. Universe

In the neomechanical paradigm, the Universe consists of everything that exists. Thus, if something exists beyond the observable regions of the universe, it is still part of the Universe. Therefore, terms such as island-universe, multiverse, and parallel-universe are oxymorons that only muddle concepts. Thus, these words have no place in the neomechanical paradigm. If something exists beyond the observed regions of the universe, then the object must be part of a Universe much larger than previously imagined, but certainly not another universe. At the Smithsonian Museum of Natural History in 1920, Harlow Shapley and Heber Curtis debated the size of the Universe and the existence of island universes. Curtis [57] contended that Andromeda and other such nebulae existed beyond the Milky Way, calling them island universes. Later, the term island universe was abandoned, and the term galaxy was used when an immense number of spiral bodies were found with characteristics like the Milky Way. Thus, astronomers now consider galaxies as part of a Universe much larger than astronomers imagined in the 1920s.

A comparable mistake is being made in modern times, with the oxymoron multiverse being used by those who believe that billions of other large objects exist beyond the observed regions of the universe. In addition to assigning these unobserved objects an infinite number of properties, Ellis and Silk [58] conclude that cosmologists should heed mathematician David Hilbert's warning: although infinity is needed to complete mathematics, it occurs nowhere in the physical Universe. Conversely, in the neomechanical paradigm, the universe is postulated to be infinitely large, containing an infinite number of material objects larger than the observable universe, with infinite causes contributing to infinite effects. However, the physical laws that describe how the infinite universe operates can be reduced to a finite set of fundamental assumptions (Section 3.1), a few key neomechanical definitions, and finite equations with infinite possible settings for the parameters.

3.2.2. Dimension

The word dimension, along with many other words, has multiple meanings dependent on a particular academic discipline. Physicists commonly postulate the universe has an undetermined number of dimensions. Einsteinian space-time models postulate the universe has 4-dimensions, whereas El-Nabulsi [59] favors a 7-dimensional universe, Bhowmick and Rama [60] favor a 10-dimensional universe, and Sloan and Ferreira [61] propose a universe with infinite dimensions. In general, these physicists seem to be referring to the dimensionality of their mathematical models rather than the spatial dimensions of the universe, but it is seldom clear if the physicists differentiate between the two.

In mathematics, vector spaces are characterized by their dimension, specifying the number of independent variables in the formulation. Infinite-dimensional vector spaces arise naturally in mathematical analysis, and when applied in combination with a topological study, this type of model can address issues such as proximity and continuity. Similarly, a mathematical matrix is a rectangular array arranged in rows and columns, which are often used to represent variables or properties of physical objects. A specific matrix is said to have dimensionality equal to the number of rows × the number of columns. In geometry, matrices are often used for defining geometric transformations such as rotations and coordinate changes. In numerical analysis, problems are often solved by reducing appropriate variables to a matrix computation. This can involve matrices with huge dimensions. These types of mathematical dimensions contrast with spatial dimensions, which are typically given in a 3-dimensional Euclidean space. This gives numbers (coordinates) to uniquely define the position of an object or its size. Common Euclidean coordinate systems include Cartesian coordinates (x, y, z: length, width, height); spherical coordinates (ρ, θ, φ: radial distance, polar angle, and azimuthal angle); and the Global Positioning System (GPS) coordinates (latitude, longitude, elevation).

When referring to the dimensions of the universe, this work always refers to a Euclidean coordinate system. Employing parsimony, space is defined in 3D Euclidean terms, and the motion of an object is defined in terms its 3D spatial change in position, (i.e., it moved from (x_1, y_1, z_1) to (x_2, y_2, z_2)). Accordingly, neomechanical time is not a spatial dimension, as often postulated when interpreting Einsteinian space-time dimensionality. Instead, time is the duration of a motion (i.e., the movement lasted t_2-t_1 seconds). The familiarity of Euclidean 3D space simplifies other neomechanical explanations, making them comprehensible without treating mathematical dimensions as spatial dimensions. For these reasons, mathematical models that simulate physical processes can employ unlimited variables, factors, and/or parameters, but neomechanics prohibits non-Euclidean spatial dimensions.

3.2.3. Determinism and causality

Like the word dimension, confusion can arise when using words such as determinism, deterministic, indeterminism, and indeterministic simply because these words have different meanings in mathematical, statistical, and metaphysical contexts. In mathematics, computer sciences, and physics, a system is said to be deterministic if randomness is not involved and a future state of the system can be predicted exactly. However, the neomechanical assumption of *uncertainty* prohibits exactness. In our philosophy, determinism is the view that all events are determined by an infinite number of physical causes. This deterministic view is a direct consequence of treating *infinite regress* as a fundamental assumption rather than as a problem [15]. The opposing philosophy of indeterminism is the idea that certain events might not have material causes. For instance, quantum physicists employ indeterminism by stating that events can have immaterial causes with probabilistic outcomes.

3.2.4. Universal constants

In the neomechanical paradigm, there are no universal constants. This statement is a consequence of *relativism* (Section 3.1.9): the assumption that all things have characteristics that make them like other things as well as characteristics that make them unlike all other things, which implies that all objects and motions are unique. Stated differently, it is assumed that no objects or motions are exactly alike or exactly different. Nonetheless, for convenience and application, the research community often defines constants as they are measured today. Organizations such as the *National Institute of Standards and Technology* (NIST) and the *International Bureau of Weights and Measures* (IBWM) define most of the constants used in science and trade. However, these constants are determined by measurements made in the present. Thus, they do not represent their values in the distal past, or what their values might be in the future.

As an example, consider the constant of 24 h in a day. Without getting involved with adjustments associated with leap-years and leap-seconds, an hour is conventionally defined as $^1/_{24}$ of a day. A conventional day is defined as the time it takes Earth to complete one rotation about its axis, which is 24 h. However, the current constant of a 24-hour day was considerably shorter billions of years ago. Fig. 1 illustrates variation in the number of hours per day throughout Earth history, based on gravitational constraints [62] and paleontological data [63]. Eq. (1) gives the linear least squares fit from the data, where h is hours per day, and t is time in million-year units.

$$h = 24 - 0.00417673t \tag{1}$$

Earth's rotational period has gradually slowed since it first formed, often attributed to ongoing lunar retreat [64]. As its rotation slowed, the number of hours per day increased from ~5 h at 4.5 Ga, to ~16 h at 2 Ga, and to ~24 h at present (Fig. 1). Likewise, other celestial objects undergo similar spin-down times (such as galaxies, stars, planets, and other natural satellites), which are primarily determined by variables such as mass, age, and masses of proximal bodies [65–67]. This serves as an example of why it is assumed there are no perfect constants in nature. So-called natural constants might be reasonably accurate at present. Moreover, even a modern-day constant will always have some uncertainty in its current value and might be increasingly inaccurate when extrapolating too far into the future or past.

3.2.5. Accretion

Accretion is the neomechanical process by which an object or body increases mass. Synonyms include fusion, bonding, coalescence, merging, and coupling. Neomechanical accretion (gain of mass) is to be distinguished from neomechanical gravitation (a pressure), which are often muddled in conventional explanations. For instance, the conventional astrophysical definition of accretion is the accumulation of particles into a massive object by gravitationally attracting more matter, typically gaseous matter, into an accretionary disk. This contrasts with the neomechanical explanation, where mass is accreted primarily from the rapid rotation of a large mass of particles. Astronomical objects such as galaxies, stars, and planets, are believed to form via accretionary processes [56].

3.2.6. Fractal matter

Heretofore, to discuss these concepts and concisely define the types of postulated matter, all matter is defined as being components of infinitely divisible and infinitely integrable fractal matter. The word fractal

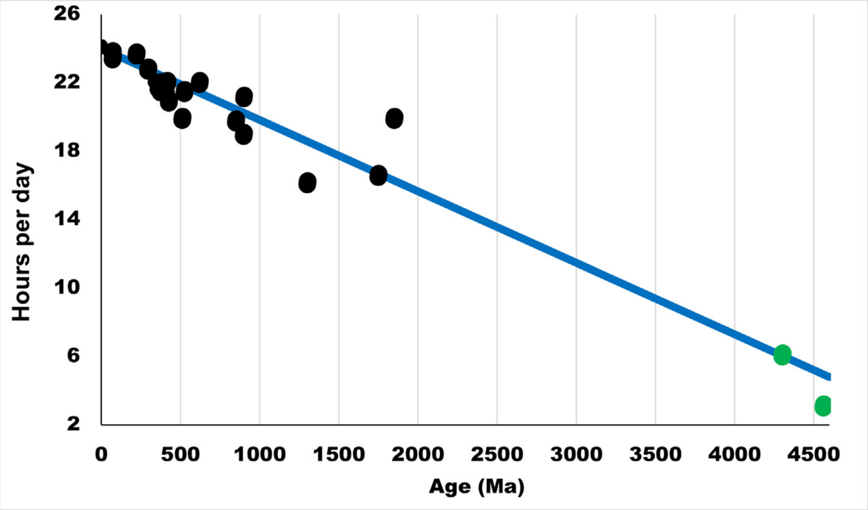

Fig. 1. Hours per day on Earth as a function of time. Estimates determined from: Green dots represent angular velocity estimates from gravitational constraints [62]; black dots derived from paleontological data [63]; and blue line is the linear least squares fit, with the y-intercept set to 24 h per day, at present (Eq. (1)). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

is often used with a subscript (M), which denotes matter, and an index (i) which denotes the relative scale of the matter. Thus, the term $\text{fractal}_{\text{Mi}}$ refers to fractal matter at scale i. In this classification system (Table 1), atoms and molecules are defined as $\text{fractal}_{\text{M0}}$, and asteroids, planets, and stars are defined as $\text{fractal}_{\text{M+1}}$. All classification and subclassification systems are arbitrary. Thus, the classification boundaries here are never meant to be perfect delineators. The classes are generally devised from the need to differentiate among the various components of matter when devising hypotheses. Size, composition, concentration, relative abundance, and density are among the important considerations. The word "fractal" is chosen because it differentiates from previous concepts of distinct, single types of matter. Fractal matter concisely and correctly portrays the neomechanical concepts of similarity, infinite integrability, and infinite divisibility of matter. For subsequent analyses, fractal matter is defined in two ways. When referring to a single class of matter, the convention is $\text{fractal}_{\text{Mi}}$, and when collectively referring to all types of matter smaller than scale-i, the convention is $\Sigma\text{fractal}_{\text{Mi}-1\text{ to }-\infty}$.

The scales below $\text{fractal}_{\text{M0}}$ differentiate between the neomechanical model of matter and other hypotheses of minuscule and/or unseen matter. This clearly differentiates between a single type of unseen matter, such as the modern concept of massless dark matter [68] or the aether of the ancient Greeks, and the neomechanical postulate of infinite types of detected and undetected matter ($\text{fractal}_{\text{M}+\infty\text{ to }-\infty}$). The Greek concept of invisible matter is described as an aether of classical elements evolved to the gravitational aether of Fatio [69] and later LeSage, and then to Newton's luminiferous aether wind [70]. The failure of the Michelson and Morley experiment [71], designed to detect the hypothesized aether wind, dealt the hypothesis a serious blow. However, this failed experiment did not logically falsify other hypotheses of undetected matter, it only falsified the luminiferous aether wind hypothesis. Einstein's ever-popular special relativity assumed space was perfectly empty and eventually made aether theories taboo. Yet, the idea never completely died and took on new forms afterward. Over the past century, evidence from galactic rotations required some type of nonluminous matter [72–74]. For numerous reasons, physicists such as Dirac [75], Rothwarf [76], and Buchanan [77] have supported the need for some type of aether in cosmological models. But none of these come close to the neomechanical concept of fractal matter, which assumes matter is infinitely divisible and infinitely integrable.

3.2.7. Decay

Decay is the neomechanical process by which an object or body loses mass. Decay is the antonym of accretion and used here to include any type of matter in which mass decreases (not limited to atomic decay). In various disciplines, terms such as fission, splitting, dividing, separation, rifting, and dissolving are treated as types of decay.

3.2.8. Torque

In physics and mechanics, torque is the rate of change of angular momentum, which is the rotational equivalent to a linear force. Depending on the field of study, torque is referred to as the moment, rotational force, or turning effect. In the neomechanical paradigm, torque is primarily used to quantify the rotational intensity of a cosmological vortex as it accretes matter. Vortices apply to all scales of matter, and include spiral galaxies, rapidly rotating young stars, rotating planets, rotating atoms, etc. Torque contributes to the rate of angular momentum, and by implication, the rate at which mass is accreted [78,79].

When applied to galaxies, tidal torque theory initially described perfect rotations without spin-down times [80,81]. However, a rotation without a gradual reduction in angular velocity is a type of perpetual motion. This is incompatible with our neomechanical paradigm where all types of matter encounter resistance from the infinite types of adjoining (and sometimes undetectable) matter. More recent studies [82,83] indicate that galaxies gradually spin-down from environmental resistance (just like stars and Earth). In this scenario, resistance from neomechanical $\Sigma\text{fractal}_{\text{M}+2\text{ to }-\infty}$ causes the gradual reduction in galactic rotations.

Table 1
Some neomechanical components of infinitely fractal matter.

Type	Compositional description
$\text{fractal}_{\text{M}-3}$	Composed of $\Sigma\text{fractal}_{\text{M}-4\text{ to }-\infty}$
$\text{fractal}_{\text{M}-2}$	Composed of $\Sigma\text{fractal}_{\text{M}-3\text{ to }-\infty}$
$\text{fractal}_{\text{M}-1}$	Composed of $\Sigma\text{fractal}_{\text{M}-2\text{ to }-\infty}$
$\text{fractal}_{\text{M0}}$	Atoms and molecules, composed of $\Sigma\text{fractal}_{\text{M}-1\text{ to }-\infty}$
$\text{fractal}_{\text{M}+1}$	Asteroids, planets, and stars, composed of $\Sigma\text{fractal}_{\text{M0 to }-\infty}$
$\text{fractal}_{\text{M}+2}$	Star clusters and galaxies, composed of $\Sigma\text{fractal}_{\text{M}+1\text{ to }-\infty}$
$\text{fractal}_{\text{M}+3}$	Galaxy clusters, composed of $\Sigma\text{fractal}_{\text{M}+2\text{ to }-\infty}$
$\text{fractal}_{\text{M}+4}$	Superclusters, composed of $\Sigma\text{fractal}_{\text{M}+3\text{ to }-\infty}$
$\text{fractal}_{\text{M}+5}$	Super massive objects ~ size of observed universe, composed of $\Sigma\text{fractal}_{\text{M}+4\text{ to }-\infty}$

3.2.9. Gravitation

Gravitational pressure is the neomechanical process by which the collective mass of one type of matter (solid, liquid, or gas) presses against the collective mass of another type of matter (solid, liquid, or gas). This definition differs from the conventional concept of gravity being an attraction between masses. In the neomechanical model, accretion, decay, and gravity are related but distinctly different processes. Accretion is the rate at which an object gains mass, decay is the rate at which an object loses mass, and gravity is the rate at which a single object moves toward another object. These distinctions are important because neomechanical gravitational pressures remain intact even after an object ceases to accrete matter and remains intact after the object starts decaying. It is assumed that Newton's Third Law of Motion applies, and unobserved matter must exist to exert an offsetting pressure to counterbalance the gravitational motions of observable baryonic matter.

Based on assumed infinitely divisible and infinitely integrable matter, a simple deduction is that the universe has no largest object and no smallest object. Therefore, in neomechanics, there can be no upper limit on the mass of a single object and zero is the lower limit for mass, which of course, is an ideal limit that is never reached. Even while the total baryonic mass within the observable universe is estimated to be 1.5×10^{53} kg [84], there is no neomechanical constraint for an object encompassing an area far larger than the observable universe. The assumed infinite types of unseen fractal matter are postulated to produce the power law gradients responsible for gravitation and the observed distributions of matter (Supplement S1, gravitational layering).

3.2.10. Solidification

Solidification is the process by which one type of matter is converted from a gas-like or liquid state into a solid-like state. The traditional chemical definition of solidification refers only to atoms, describing the transition to an orderly solid structure from a disorderly liquid state. Here, the definition is broadened to include any type of matter while also dropping the orderly and disorderly qualifiers. For instance, near the galactic core, stars orbit with a constant angular velocity [85]. Thus, the inner galactic stars rotate as a solid, just as the atoms in Earth's crust and mantle rotate with a constant angular velocity. The solidification process is assumed to apply to all types of matter at all scales of the universe.

When a particular scale of matter solidifies ($\text{fractal}_{\text{Mi}}$), all lower scales of matter ($\Sigma\text{fractal}_{\text{Mi}-1\text{ to }-\infty}$) become its gravitational medium. For a spiral galaxy, multiple scenarios exist. Well within the Schwarzschild Radius, $\text{fractal}_{\text{M0}}$ concentrations are too high to allow sufficient space between them, and thus fission occurs and $\text{fractal}_{\text{M0}}$ disintegrates into its $\text{fractal}_{\text{M}-1}$ components. After disintegrating, $\text{fractal}_{\text{M}-1}$ becomes the solidified matter, and $\Sigma\text{fractal}_{\text{M}-2\text{ to }-\infty}$ becomes the gravitational medium. Beyond the galactic event horizon and extending to distal galactic radii, fractal_{M0} is the solidified matter (atoms and molecules), and $\Sigma\text{fractal}_{M-1 \text{ to } -\infty}$ is the gravitational medium. At the galaxy cluster scale, fractal_{M+2} is the solidified matter (star clusters and galaxies) and $\Sigma\text{fractal}_{M+1 \text{ to } -\infty}$ is the gravitational medium. The relationship between a fractal_{Mi} solid-like object and its $\Sigma\text{fractal}_{Mi-1 \text{ to } -\infty}$ gravitational medium is assumed to extend to all scales of the universe.

3.2.11. Density

In neomechanics, density is defined conventionally as a measurement of the mass per unit of volume for a single object, but with an addendum that this only applies to solidified matter at a given scale. That is, at a given scale, density only refers to individual solid-like structures found at that scale. Based on *interconnection* (Section 3.1.10), there must be some space and some matter between any two objects. This implies the collective density of all types of matter can never become infinite. Thus, neomechanics prohibits singularities and infinite density.

Furthermore, the density of objects found at a scale fractal_{Mi} mimic the collective density of $\Sigma\text{fractal}_{Mi \text{ to } -\infty}$. Initially, this might seem impossible because in normal addition, adding things together makes the total larger than its individual components. However, it is assumed the components of fractal_{Mi} are never perfectly solid, and instead assumed to consist of smaller types of matter and space, which in turn consists of still smaller types of matter and space into infinity. By calculating density in terms of assumed infinitely divisible matter and space with some matter between any two objects, the collective density for all components of an object, at all scales, will never deviate too far from the mean density observed at a particular scale. Contradictions with this concept only arise after treating an object as a perfect solid or treating any space as perfectly empty – both of which are prohibited by the assumptions of Interconnection and Infinity.

Concepts associated with the density of matter and the density of its components are demonstrated by (a) the relative sizes of atoms and stars (Supplement 2, atomic and stellar radii), and (b) the distribution of mass within atoms and stars (Supplement 2, atomic and stellar radii). The mean and median nuclear radii of all atoms is 4.7208 and 4.8816 f. (or 4.7208×10^{-5} and 4.8816×10^{-5} Å) respectively [86]. This contrasts dramatically with the mean and median covalent radii of 152,302 and 146,500 f. [87]. These radial estimates are rather crude because there is little hope of defining a theoretically sound atomic radius that is valid for a given element in a wide variety of molecular structures [87], a problem that is compounded by numerous models of atomic radii, such as Pauling's metallic radii, van der Waals radii, Slater's covalent radii, and the ionic radii of Shannon and Prewitt. With these caveats considered, Cordero et al. [87] revisited the problem and found crude approximations for atomic radii from interatomic distances in crystal structures. Based on these rough estimates, the covalent radius of a typical atom is ~30,000 to 32,300 times larger than its nuclear radius.

Likewise, in astronomical units (AU), the Sun's radius is 0.00465 AU [88], whereas the radius to the outer Kuiper Belt is 50 AU [89], the radius to the outer Oort Cloud is 10,000 AU [90], and the distance to the nearest star, Proxima Centauri, is 268,770 AU. Thus, the outer Kuiper Belt radius is 10,742 times larger than the solar radius; the outer Oort Cloud is 2.15×10^6 times larger than the solar radius, and half the distance to Proxima Centauri is 2.9×10^7 times larger than the solar radius. The immense distances between atomic and stellar nuclei and their outer gravitational radii begs the question: What lies between the nuclei and the outer boundaries (~30,000× the nuclear radii)? In neomechanics, the answer is infinite types of fractal matter exist between them. Within these systems, the relative distributions of baryonic masses are: 99.86% of the Solar System mass lies within the Sun [91], and a comparison of estimated atomic nuclear weights with electron weights shows that >99.99% of atomic weights lie within an atom's nucleus.

Historically, the hypothetical structures of atomic models have changed in line with neomechanical expectations. As scientific methods improve, investigators continually find matter is divisible. This evolution of ideas ranges from the perfectly solid atoms of Dalton [92] hypothesized to be indivisible basic forms of matter, to Thomson's model consisting of positively and negatively charged components [93], to the Bohr planetary model of atoms [94], to Schrodinger's quantum model [95], and to a model with atoms consisting of quarks [96]. The discovery of ever smaller atomic parts is equivalent to the ongoing discovery of ever larger cosmological objects over the past hundred years (galaxies and star clusters existing within galaxy clusters, and galaxy clusters existing within superclusters). Based on the assumption of infinitely fractal matter, the ongoing discoveries of both larger and smaller types of matter are expected to continue as measurement methods further improve.

Fig. 2 further demonstrates the distribution of detected and undetected mass at any scale of the assumed infinitely fractal universe. Solid-like fractal_{Mi} at any scale are illustrated as red circles with different radii and masses and consist of solidified fractal_{Mi-1} (blue dots of various sizes and masses) within the circles and gas-like fractal_{Mi-1} beyond the circles. In turn, $\text{fractal}_{Mi\text{-}2}$ fills the space within and beyond the fractal_{Mi-1} components (blue dots), with the fractal divisions continuing into infinity. The illustration (Fig. 2) incorrectly portrays the concentrations (referred to as number density in astronomy) which is a topic further discussed in subsequent sections. The main points are that the collective density from all types of baryonic and undetected matter can maintain a stable density that never approaches infinite density, and the mass at any single astronomical object is highly concentrated near its core.

3.2.12. Concentration

Concentration is a measurement of the "number density" of a particular type of matter within a specific volume. Traditionally, concentration refers to how much of a substance is present in a mixture of substances – often used to quantify mixtures of chemical solutions. Here, concentration is primarily defined to convey the density of the

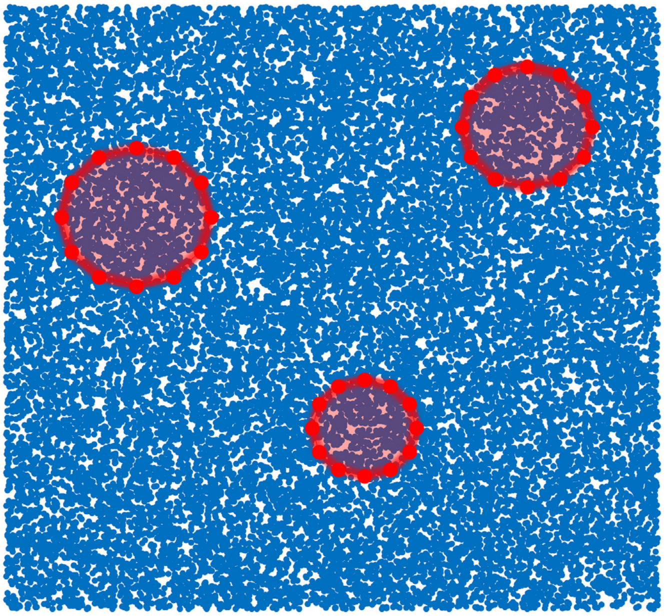

Fig. 2. Illustration of the neomechanical concept infinitely fractal matter densities. Red circles designate three solid-like objects at the fractal_{Mi} scale, and small blue circles designate the more abundant fractal_{Mi-1} bits of matter, which are solidified within the circles and exist as a gas-like medium outside of the circles. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

assumed gravitational medium through which all solidified matter moves, at all scales. Accordingly, it is paramount to distinguish between the density of an individual solid-like object (or a class of solids with equivalent densities) and the relative concentrations of visible and invisible gas-like solutions within and surrounding a solid-like object. Also, the related term “relative abundance” quantifies the percentage of one type of matter relative to another type of matter within a specific volume.

3.2.13. States of matter and viscosity

In the neomechanical worldview, perfect solids and perfect gasses are ideal states of matter that are never achievable. Thus, all forms of matter, at all scales, can be considered as materials with varying degrees of viscosity. A perfect solid would have no internal movements, which does not happen in nature because all so-called solids have vibrational frequencies. Thus, solid-like matter has a very high viscosity which minimizes movements within its confines, whereas gas-like matter has extraordinarily low viscosity. For instance, the Earth's mantle is generally thought of as a solid; however, processes related to volcanism and subduction cause movements within the mantle of the order of centimeters per year. Trench subduction rates reach 16 to 18 cm/yr close to slab edges [97,98] and rates fall to as low as 2 cm/yr far from slab edges [97]. Subduction moves this slowly because upper mantle viscosity is about 10^{25} cP [99,100]. This compares with the viscosities of gas-like air (0.02 cP), liquid H_2O (0.89 cP), and sticky peanut butter (2.5×10^5 cP). Even though the terms solid and gas are used within this work, the entire range of possible states of matter can be more accurately defined in terms of viscosity, with perfect solids and perfect gasses being the idealized endpoints. Between the idealized endpoints of the viscosity continuum, the term liquid refers to matter near 1 cP.

The concept of all matter having variable viscosity (between 0 and infinity) is applied to all types of matter at all scales of the universe. Near galactic cores, stars orbit in a solid-like manner [85], whereas when distance from the galactic core increases, stars increasingly move independently from their neighbors. This can be thought of in terms of progressively lower stellar concentrations and lower viscosities as distance from the galactic center increases. As another example, hydrogen is a gas-like solution in interplanetary space but turns into a liquid with viscosity like water below Jupiter's surface.

3.2.14. Transformation boundaries

Here, two types of transformation boundaries are discussed: Event Horizon and Roche Limit. In neomechanics, an event horizon is the distance from the center of a rotating object (vortex) to the radius at which solid-like matter can remain solidified. This differs from the conventional definition of event horizon, which is the boundary marking the limits of a black hole – a boundary at which the escape velocity of matter is postulated to equal the speed of light. Because general relativity states that nothing can travel faster than the speed of light, nothing inside the event horizon can ever cross the boundary and move beyond it. For the neomechanical paradigm, an event horizon applies to all types of rotating matter at all scales (not just to black holes), and the controlling factors are the mass, its torque, distance from the core, and the types of rotating matter (having nothing to do with the speed of light).

Similarly, the Roche Limit is the radius from a primary celestial body within which a second orbiting body will disintegrate from the first body's external high-pressure gravitational gradient. Thus, the Roche Limit is simply another gravitational transformation boundary being equivalent to a galactic event horizon, only operating at a different scale. Once again, this neomechanical definition differs from the conventional view, which postulates the disintegration occurs because the primary's tidal force exceeds the secondary's gravitational self-attraction. In neomechanics, semantics are important, and there are no self-attractions nor self-organizations. Instead, nearby bodies either converge or diverge based on their masses and locations within established gravitational pressure gradients. Furthermore, various types of matter might become organized for an unknown reason, although they do not organize by themselves.

In summary, neomechanical transformation boundaries are assumed to exist at all scales of the universe. A transformation boundary is the radius from a vortex at which $\text{fractal}_{\text{Mi}}$ concentrations become too high to allow sufficient space between them, and thus $\text{fractal}_{\text{Mi}}$ components break into their constituent $\text{fractal}_{\text{M}-1}$ parts (a process generally called decay, fission, or disintegration). Any object can have multiple event horizons. For instance, solidified dark matter ($\text{fractal}_{\text{M}-1}$) exists near the core of a spiral galaxy, and solidified stars are found at radii beyond the solidified dark matter. When this happens in the neomechanical paradigm, the hypothesized $\text{fractal}_{\text{Mi}}$ transformation boundary will lie closest to the core, while the $\text{fractal}_{\text{M}+1}$ and $\text{fractal}_{\text{M}+2}$, … $\text{fractal}_{\text{M}+\infty}$ transformation boundaries will lie progressively further from the core.

3.2.15. Fractal matter history

By treating the Ten Assumptions as a basis for describing how the universe operates, an individual is forced to deduce that matter within the universe operates as an infinite fractal. A fractal is a never-ending pattern in Euclidean space [101]. Fractal patterns are often said to be self-similar. While agreeing with the concept, the “self-” prefix is dropped, and the term “similar” is used alone when referring to fractals, as given in the assumption of relativism. Fractals are infinitely complex patterns that are similar across all scales. Fractals are sometimes thought of as indefinite repetitions of a simple process in a feedback loop. However, one must be cautious about interpreting feedback loops. As an example, a feedback loop is constructed in electronic circuits by routing the outputs back to an input point. This produces a chain of causes and effects within the circuit. Accordingly, the circuit is said to feed back into itself. In this scenario, cause-and-effect must be treated carefully. Within a feedback system, causal reasoning is challenging because one might think of this as the first system influencing the second, and the second system influencing the first. This leads to circular reasoning. In neomechanics, a feedback loop is treated as an infinite regress of systems because with time, each system undergoes continual change. Thus, the first system produces a second system, which feeds into a third system that produces a fourth system, ad infinitum. Additionally, the concept of scale invariance is rejected when applied to nature in the neomechanical paradigm. Scale invariance is an exact form of fractal similarity by which magnification of a smaller part of the pattern is identical to the corresponding larger part. Thus, even though mathematical models can produce exact scale invariant patterns, in nature neomechanical fractals are assumed to be similar but never identical.

Ancient philosophers first conceptualized various forms of an infinitely fractal universe. Greek philosopher Anaximander of Miletos (610–540 BCE) first hypothesized the universe is infinite in both time and space but was silent on the divisibility of matter [102]. Roman philosopher Titus Lucretius Carus (95–55 BCE) hypothesized both space and the amount of matter within it must be infinite but was silent about time [103]. During the Renaissance, the idea of an infinite universe was revived by Italian philosopher Giordano Bruno, English astronomer Thomas Digges, and Nicholas Copernicus [104]. During the 20th Century, the Fournier d'Albe fractal universe model [105] was further developed by Mandelbrot [101]. Later, Pietronero [106] and Oldershaw [107] proposed the universe operates as an infinite fractal. Along those lines, Argyris et al. [108], Calcagni [109], Atangana [110], Abro and Atangana [111], and many others have developed complex mathematical models that simulate fractal processes. In the neomechanical paradigm, fractals are defined as the infinitely divisible and infinitely integrable organizations of matter into patterns with some similarities and some differences. This novel treatment of infinity opens the door for comprehensible interpretations of how the universe operates.

For instance, rather than being an unexplained attraction, the neomechanical interpretation of gravity (at observable scales) is the collective pressure from baryonic matter being offset by the collective pressure from the infinitely invisible forms matter assumed to exist at sub-baryonic scales. For this to happen, the relative abundance of the invisible forms of matter must be greatest in regions where baryonic matter is least abundant. This might be thought of as another dark matter hypothesis, but neomechanical dark matter is not a single type of massless matter [68]; instead, it consists of infinite types of fractal matter – all with increasingly miniscule masses as size decreases. Specifically, $\Sigma\text{fractal}_{\text{M}i-1\ \text{to}\ -\infty}$ concentrations are highest where $\text{fractal}_{\text{M}i}$ concentrations are lowest. The neomechanical conceptualization of non-attractive $\text{fractal}_{\text{M}1}$ being the primary components of atoms and molecules runs counter to the chemical paradigm of attractions between protons and electrons. To keep neomechanical theories consupponible with the Ten Assumptions, these distinctions are essential.

3.2.16. Uniqueness

The uniqueness of all types of matter over all time is inferred from *relativism* (Section 3.1.9). However, this inference is not immediately obvious. Atomic weights serve as an example for discussing uniqueness because atoms of the same class are often considered as identical elements having identical weights. However, in neomechanics, no two bits of matter can be identical, just as no two snowflakes can be identical. For instance, the atomic weight of helium is given as 4.002602 amu, which is an average that reflects the typical ratio of its isotopic abundance found in nature [112]. Since samples of elements found in nature contain mixtures of isotopes of different atomic weights, the International Union of Pure and Applied Chemistry (IUPAC) began publishing atomic weights with uncertainties. In 1951, sulfur became the first element to have uncertainty assigned to its atomic weight. By 2007, 18 elements were assigned uncertainties. Then, in 2009, IUPAC began publishing uncertainty-ranges for the atomic weight of some elements [112]. Coplen et al. [113] give the atomic weight ranges for hydrogen [1.00784, 1.00811], carbon [12.0096, 12.0116], and oxygen [15.99903, 15.99977], and when atomic weights are not given as ranges, they are given as single values with a ± uncertainty, such as: helium [4.002602 ± 0.000002] and potassium [39.0983 ± 0.0001]. The Table of Standard Atomic Weights is continuously improving, such as the addition of a new footnote to emphasize that standard atomic-weight values and their uncertainties are consensus values [113].

Accordingly, in addition to assuming that no two examples of matter are identical, the neomechanical view is that a single piece of matter is never identical from one moment to the next. That is, every object evolves into a slightly different but similar object as time passes. The reason is that all matter is assumed to continually undergo accretion and decay, as well as internal transformations – whether the matter is organic or inorganic. For instance, mammals continually inhale air, exhale CO_2, have beating hearts, circulating blood, dying cells replaced with living cells, etc. While these small transformations of matter are minuscule from one moment to the next, their cumulative effects become noticeable over long intervals. This example further illustrates why all types of matter are assumed to be unique throughout eternity, and why a specific object is never identical from one moment to the next.

3.2.17. Matter, space, and time

Measurements of matter and its motions are primarily made in terms of matter, space, and time. These are the material, spatial, and temporal components of matter and motion. In neomechanics, matter is different from its motion, albeit matter and motion are inseparable (Section 3.1.4). Semantically, matter is a noun and is distinguished from its motion (a verb or adjective). Consider the sentence: Jane walked. Jane is the matter and walked is the motion. To gain a better understanding of how Jane moved, additional phrases are sometimes added. Now consider the sentence: Jane walked from 435 Baker Street to 856 Norton Avenue in 15 min. In addition to the matter (Jane) and her motion (walked), further understanding of the walking is achieved by specifying spatial locations (the path from 435 Baker Street to 856 Norton Avenue) and temporal duration (15 min). In this expanded sentence, motion has two components: a spatial reference and a temporal reference. The spatial component of motion contains coordinates in a 3D Euclidean space, whereas the temporal component of motion involves a convenient frame for measuring time, such as a year (the time it takes Earth to orbit the Sun), a day (the time it takes Earth to rotate once relative to the Sun), or a minute ($^1/_{1440}$ of a day). Measurements of motion can be limited to either spatial movement or temporal duration. However, some measurements of motion contain both, such as meters/second. Mathematical measurements of motion include velocity and acceleration.

These descriptions of motion might seem elementary, and thus, unnecessary. Yet, Einsteinian relativity merges the temporal component of motion with its spatial components and treats the universe as 4-dimensional, which needlessly complicates straightforward concepts of motion. To keep the collective assumptions consupponible and consistent with evidence, the only neomechanical ideas considered are those which treat the universe as being 3-dimensional. Within this 3D space, matter exists, and motion occurs. While being inseparable, matter and motion form two different categories.

3.2.18. Matter-motion terms

In the current hodgepodge of misaligned metaphysical assumptions, some physical concepts are incomprehensible, with no clear consensus on how to clarify them. As a specific case, Borchardt [5,6] refers to matter-motion terms. Rather than being measurements of matter alone or motion alone, matter-motion terms involve both matter and its motion. Such terms include momentum, force, and energy. Confusion arises because these terms are often used as nouns and generally treated as objects, when in fact, they are neither nouns nor verbs. Instead of treating momentum, force, and energy as objects (nouns), they must be thought of as calculations that quantify the behavior of matter, such as one type of matter being transformed into another type of matter.

Matter-motion terms include momentum (SI units of $\text{kg}\cdot\text{m/s}$), force (SI units of $\text{kg}\cdot\text{m/s}^2$), and kinetic energy (SI units of $\text{kg}\cdot\text{m}^2/\text{s}^2$), which are measurements of both mass (kilograms) and motions (meters and seconds). To make neomechanical concepts comprehensible, conventional concepts associated with matter (nouns), motion (verbs), and matter-motion transformations (matter-motion terms) are treated in semantically consistent ways. That is, motion is never treated as a noun, nor matter as a verb, nor a matter-motion calculation as an object.

3.2.19. Probability

The neomechanical concept of probability is the likelihood an event will happen based on the inevitable uncertainty associated with the inability of a measurement to identify the infinite causes of an event. In neomechanics, probabilities are considered as measurements of positive outcomes relative to all outcomes based on observer ignorance of the infinite deterministic causes. Based on the assumption of uncertainty (Section 3.1.3), it is impossible to know everything about anything, but it is always possible to know more about anything. Thus, as scientific research gains insights into how a process operates, a process now considered to be probabilistic or indeterministic might be redefined by removing the probabilistic label and assigning a minimal ± uncertainty to it. In neomechanics, probabilities are considered as incomplete descriptions, with crucial variables missing from an otherwise deterministic process.

3.3. Neomechanical theories

The Ten Assumptions and associated neomechanical definitions serve as the foundation for developing consupponible theories. If inconsistencies among the definitions, assumptions, evidence, and/or theories exist, then, eventually, scientific studies will expose these deficiencies. The components of the neomechanical paradigm presented here should provide enough details to give a means for collectively falsifying the assumptions if they fail to align with the ever-increasing scientific observations being made. To help with future attempts to falsify the neomechanical paradigm, various neomechanical theories are given as alternative explanations for some common phenomena critical to understanding their assumed deterministic causes.

3.3.1. Black hole theory

Do things exist that have not been recognized? To a logical positivist, it is an outrage to suggest there might be things that have never been perceived, but Collingwood [4] considers this question as a valid metaphysical supposition. If unobserved things are postulated to exist, then one might wonder: What are the differences among unseen dark matter, fractal$_{M-1}$, and a ghost? To an indeterminist who views them as immaterial, there is little difference. However, to a determinist, it is assumed that ghosts do not exist because they are defined as immaterial, whereas dark matter is real if it has mass, and fractal$_{M-1}$ is already defined as undetectable matter at a scale immediately below atoms. However, fractal$_{M-1}$ should be detectable as a solid when subjected to high enough pressures. Thus, the neomechanical postulate is that a black hole primarily consists of solidified fractal$_{M-1}$. Some investigators [114–116] have already reached a similar conclusion by linking solidified dark matter to black holes. Kouvaris et al. [115] postulate that dark matter can accumulate in a neutron star and collapse, forming a black hole that transforms the rest of the star into a solar mass black hole.

While agreeing that a black hole consists of invisible matter in the form of a solid-like core of fractal$_{M-1}$, the fractal$_{M-1}$ components are not of a single density and cannot reach a singularity. Instead, the solid-like fractal$_{M-1}$ particles are primarily layered by density (higher densities of fractal$_{M-1}$ near the core), with fractal$_{M-1}$ concentrations decreasing as distance from the core increases. This neomechanical explanation of solid-like layering applies to all natural spheroids, at all scales, subjected to intense rotation.

Conversely, the conventional description of a black hole goes something like this: Because of their enormous, space-bending gravity, everything that falls into a black hole is instantly ripped apart and lost, making a black hole invisible because nothing, not even light, can escape it. However, the neomechanical description differs considerably, with solidified fractal$_{M-1}$ being the primary component of galactic black holes. Light waves are assumed to propagate as typical compression waves, which generally require a gas-like or liquid like medium and do not easily propagate through solids. Accordingly, if gas-like concentrations of Σfractal$_{M-1 \text{ to } -\infty}$ serve as the medium for light waves, the solidification of fractal$_{M-1}$ near galactic cores would explain why black holes fail to emit light. Equally important, the notion that nothing can escape the gravitational influence of a black hole has already been falsified. Specifically, as a black hole accretes a less massive, nearby object, extensive axial flares develop and move away from the black hole (Fig. 3a). The existence of nonrelativistic bipolar axial jets emitted from black holes is a topic of considerable interest among astrophysicists [117–119]. The bipolar axial ejections at velocities approaching the speed of light demonstrate that matter can indeed escape from a black hole.

In addition to the bipolar material flows in the form of axial jets from the extremely high rotation rates of black holes, neutron stars, pulsars, protostars, and nebulae [120,121], dipolar motions often appear from rotations at much slower velocities, such as the low pressure region of hurricanes and tornadoes, the alternating dipolar motions of the Earth's magnetic fields (Fig. 3b, which reverses quasi-periodically >100,000 years), the Sun's 22-year Hale magnetic polarity cycle, and the alternating magnetic field of solenoids. Rather than being immaterial matter, traditionally defined as magnetic fields, it is assumed the observed flows are comprised of minuscule fractal matter. Because rapidly rotating objects exhibit bipolar flows and slowly rotating objects exhibit alternating dipolar flows, it is assumed these motions are primarily a function of angular velocity and indicate how all types of rotating cosmological objects evolve over time.

3.3.2. Material distribution theory

To be consistent with the Ten Assumptions, it is logically impossible for the distributions of all types of matter to be evenly spaced (either as a perfect gas or as a perfect solid) and still have motion. Using Newton's Third Law, motion requires something (an action) to exert pressure against something else (the reaction). In an infinitely fractal universe, it is assumed that gravitation operates from high pressure Σfractal$_{Mi-1 \text{ to } -\infty}$ at distal radii serving as the offsetting pressure to push high-density, large-mass fractal$_{Mi}$ toward the core of an astronomical object, atom, or any other type of matter, occurring at all scales of the fractal universe.

The rationale for postulating that gravitation results from counterbalancing pressures is empirical, being based on observed gravitational layering of matter in terms of mass, density, pressure, concentration, size, state, and relative abundance. Whether the analysis (Supplement 1) involves atoms, asteroids, planets, stars, or galaxies, the consistency in observed gravitational layering supports our assumption that gravitational laws operate similarly at all scales. Even beyond the galactic scale, galaxies and star clusters are disproportionately concentrated around the two largest nearby galaxies, Andromeda and the Milky Way. A concentrated group of galaxies is called a galaxy cluster (fractal$_{M+3}$), with Andromeda and the Milky Way acting as the cores of the nearby galaxy clusters (Fig. 4a). The fractal nature of the universe is also observed beyond the galaxy cluster scale, with galaxy clusters (Fig. 4b) concentrated in superclusters (fractal$_{M+4}$).

This neomechanical description of infinite types of matter continually being rebalanced by offsetting pressures explains why matter and motion are inseparable. Essentially, Newton's 3rd Law of motion, in which every action has an equal and opposite reaction, describes the rebalancing process. In neomechanics, the offsetting pressure is never required to originate from a "single" type matter at a specific scale. Instead, the offsetting pressure is postulated to be a consequence of the "collective pressures" from the infinite types of matter assumed to exist at all scales.

3.3.3. Gravitation and bonding theory

Based on these assumptions, definitions, and observations (refer to Supplement 1, gravitational layering), a gravitation hypothesis is developed based on the consistency of the layering patterns, which are briefly summarized here.

- Spheroids are seldom, if ever, perfectly layered by density. Instead, each gravitational layer of a naturally occurring spheroid contains a mixture of matter with a wide range of densities within the object and extends into its atmospheric layers.
- Even though every layer consists of matter with a range of densities, components that are denser are more heavily concentrated near the core, whereas rarefied components are more heavily concentrated at distal radii.
- Small-mass objects are more abundant than large-mass objects, with the relative abundance following in inverse power law.
- The composite pressure exerted from a particular class of matter at a specified radius is proportional to its relative abundance multiplied by its density (i.e., the collective mass-density). Thus, high mass-density near the core translates into high pressure near the core.
- From the core of a spheroid outward, the components tend to be layered as high viscosity solids, low viscosity solids, liquids and plasmas, and atmospheric gasses.
- The increased densities and pressures are not extrapolated all the way to the core (i.e., a hypothetical singularity) because assumed small-

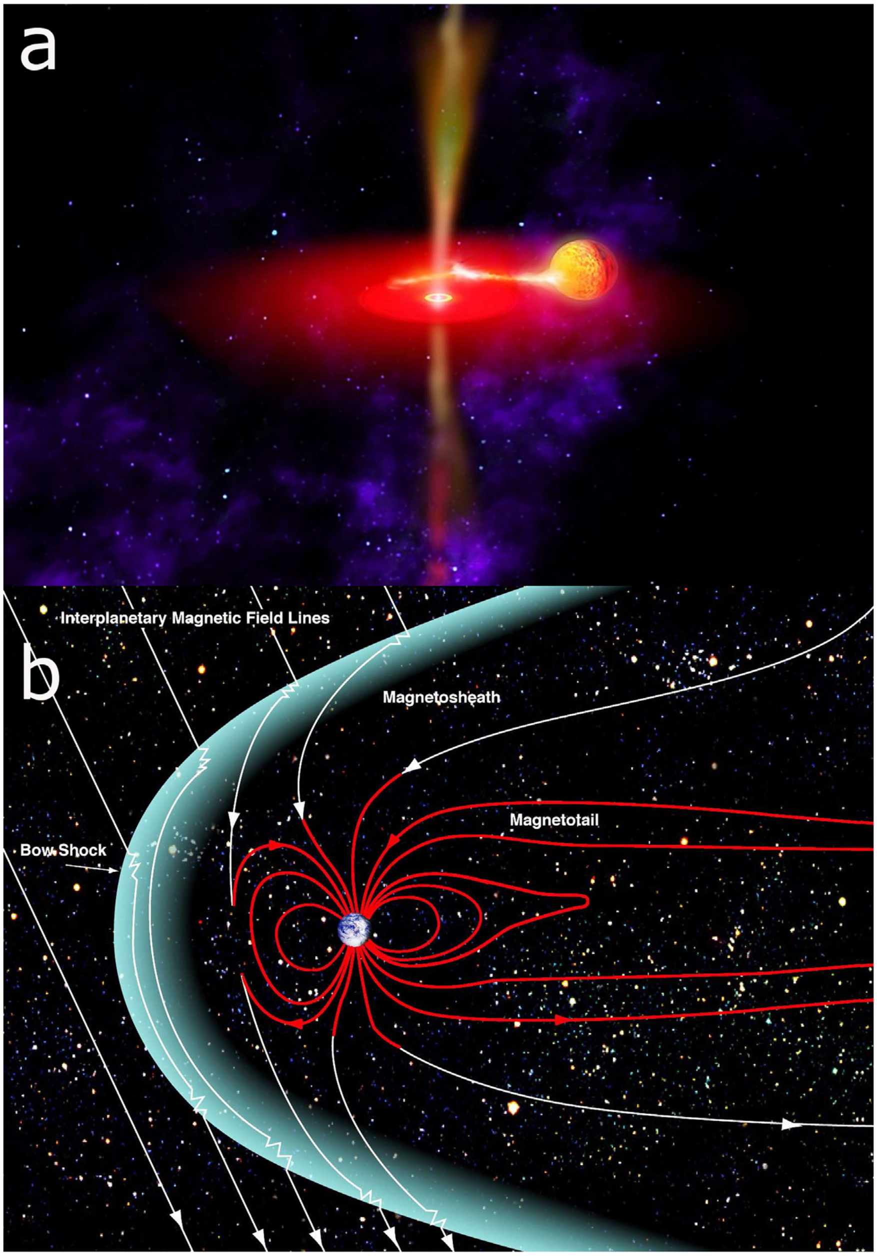

Fig. 3. Postulated flows of fractal matter. Panels: (a) bipolar jets from the flaring black hole GX 339-4, from infrared measurements from NASA's Wide-field Infrared Survey Explorer, catalogued by Jet Propulsion Laboratory of NASA, under Creative Commons photo PIA14730; (b) Earth's dipolar magnetic field Earth's Magnetosphere, NASA/Goddard/Aaron Kaase, https://www.nasa.gov/mission_pages/sunearth/multimedia/magnetosphere.html under Creative Commons photo 470162.

mass material flows develop along a porous axis of rotation, observed as bipolar axial jets in high velocity rotators, as low-pressure systems in hurricanes and tornadoes, and as alternating dipolar magnetic fields in solenoids, Earth, and Sun.

From the observed mixed layering of matter as a function of density and mass (Supplement 1), overlapping log-normal distributions are generated to illustrate gravitation layering as a function of radius for nine types of fractal matter (Fig. 5). This illustration assumes that undetected matter exhibits gravitational layering patterns that correspond to the preceding list of observed baryonic gravitational layering.

Just like conventional gravitational theory, chemical bonding is conventionally described as an attraction between atoms, ions, or molecules that enables compounds to form. Pauling [122] hypothesized that chemical bonding may result from the electrostatic force of attraction between oppositely charged ions as in ionic bonds or through the sharing of electrons as in covalent bonds. However, in the neomechanical paradigm, there are no attractions – only imbalanced pressures from the non-uniform distribution of fractal$_{\mathrm{Mi}}$. Thus, tidal locking of satellites to planets and chemical bonding are considered as analogous gravitational processes, only operating at different scales.

3.3.4. Wave theory

In neomechanics, all waves propagate in repeated sequences of compressions and rarefactions. The type of wave (longitudinal or transverse) depends on factors such as the viscosity of the medium through with the wave propagates and the density of materials that border the medium. As these conditions vary, a longitudinal wave can transform into a transverse wave, and vice versa. Here, the primary interest is with the alternating compressions and rarefactions of waves

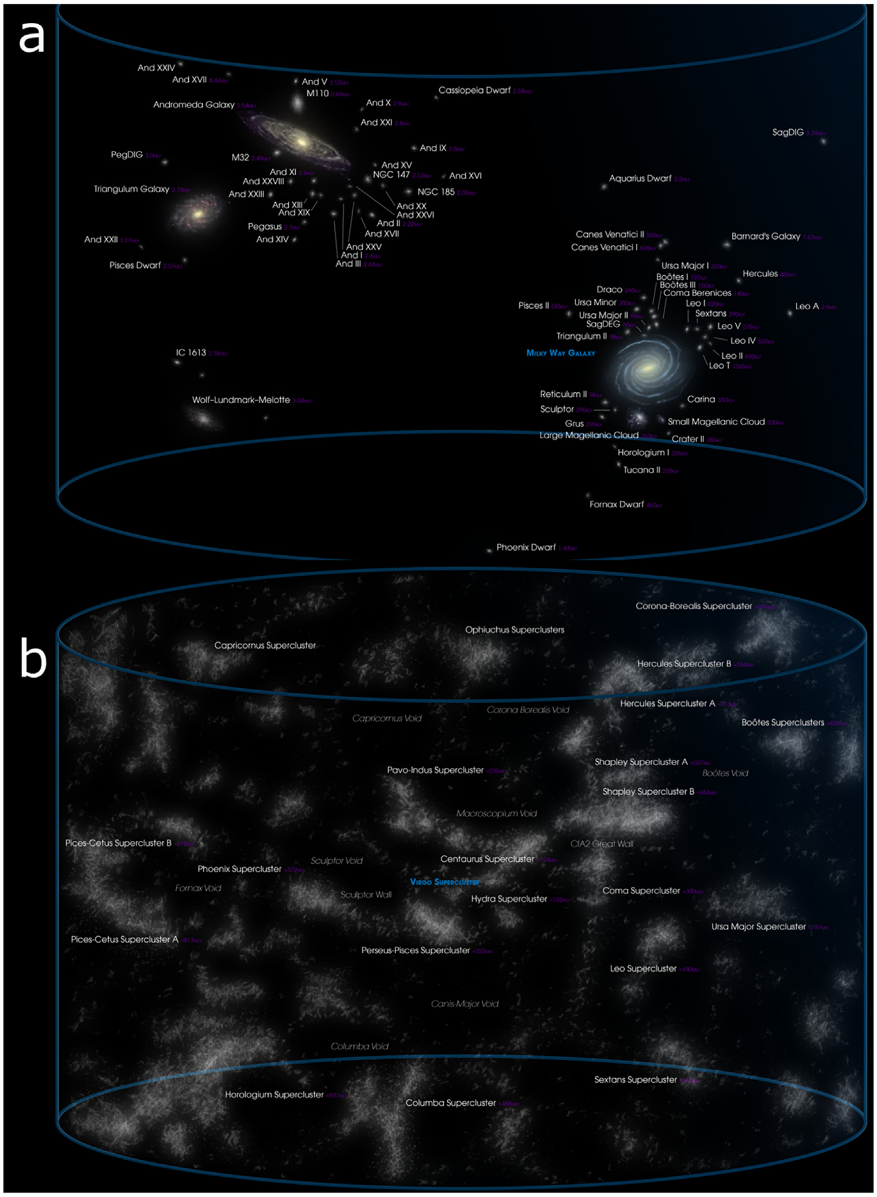

Fig. 4. Largest observed clusters of fractal matter. Panels: (a) local group of galaxies consists of two large clusters, Andromeda galaxy and associated satellite system in the upper left and the Milky Way galaxy and associated satellite system; and (b) Pisces–Cetus Supercluster Complex. Both images from Andrew Colvin, available under Creative Commons license CC-BY-SA-4.0.

rather than the specific type of wave. Thus, the general term "compression wave" is used to include both types.

As illustrated in Fig. 6, waves propagate through water and other liquids with both longitudinal and transverse motions [123]. At the surface, water moves transversely with up-an-down motions, whereas far below the surface water propagates longitudinally. Other waves also exhibit longitudinal and transverse motions. For instance, sound waves always propagate as longitudinal waves in the open air. However, sound waves sometimes transform into transverse waves when passing through solids such as glass at low temperatures [124] and carbon nanotubes [125]. Likewise, seismic waves can be either longitudinal P-waves below the surface or transverse S-waves at the surface [126].

While most terrestrial waves are generally understood quite well, and have both longitudinal and transverse characteristics, the wave-nature of light remains contentious. During the first half of the 20th Century, the prevailing view was that light propagated through empty space, and investigators developed light wave theories accordingly. However, the revolutionary work of Alfvén [41] began changing the view of completely empty space. Today many, if not most, physicists have rejected the idea of completely empty space [127], yet the idea of perpetual photon motion persists. In general, polarization experiments have shown that light has transverse properties [128], and for this reason most researchers consider light as a transverse wave.

Nonetheless, the debate remains open because few consider how a polarizing filter affects light propagation. As with quantum physics, the measurement process itself can affect how an analyst perceives light waves. Just as water waves become transverse when in contact with surface air, does a light wave transform from longitudinal to transverse when contacting a polarizing lens? It might take considerable time and experimentation to answer this question conclusively. Many optics investigators conclude that because the angular momentum of light is aligned with its mean momentum, light primarily propagates as a longitudinal wave when unencumbered in open space [129,130]. In other words, it appears that most (if not all) waves at all scales propagate as longitudinal waves in an unconstrained 3-dimensional medium. The

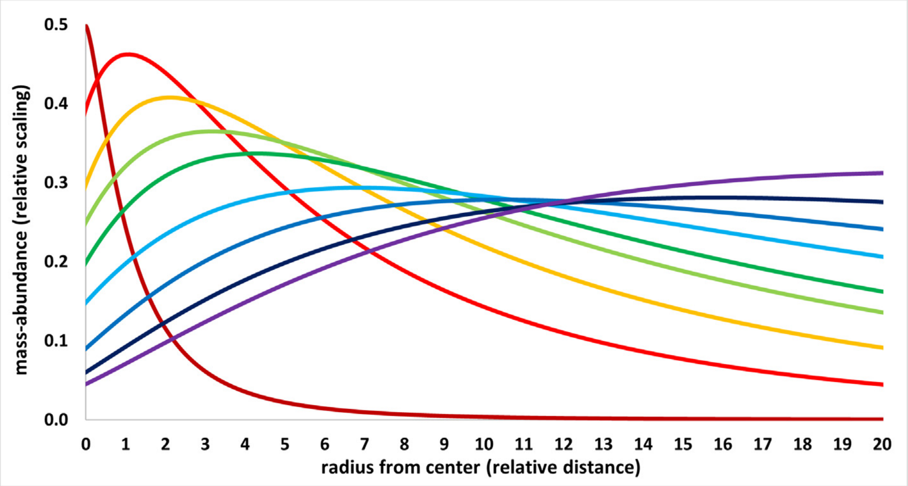

Fig. 5. Log-normal distributions illustrating neomechanical gravitational layering of infinitely fractal matter. The nine curves represent the assumed relative abundance of fractal matter as a function of radial distance from the center of a spheroid. The dark red curve designates large mass, high density forms of matter that progressively transforms to the purple curve that designates small mass, low density forms of matter. Relative abundance is inversely related to mass and density, with a mixture of all types of matter found at all radii. However, large mass, high density forms of matter are most abundant near the core while small mass, low density forms of matter are most abundant at distal radii. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

waves only become transverse after contacting a material boundary with an increased density or after reaching an interfering filter.

Wave diffraction experiments [131] provide another means for comparing how waves respond to obstructions and interference. Four obstructions (Fig. 7) demonstrate how water waves, sound waves, and light waves all respond to interference. True diffraction only occurs when waves pass through a slit equal to one wavelength (Fig. 7a). This happens identically for water, sound, and light. However, for other scenarios (Fig. 7a–c) there are minor differences in how water, sound, and light diffract, but the general pattern is the same. Every time a wave encounters an interference point, it bends around the interference with a radius equal to one wavelength. This provides further evidence that all waves propagate longitudinally, at all scales, when unencumbered in 3-dimensional space, and then respond similarly when an obstruction interferes with the wave transmission.

3.3.5. Vortex theory

Cycles found in nature primarily have one of two sources: waves or vortices. Waves propagate linearly away from a source at repeated spatial intervals (the wavelength), whereas vortices repeat circularly with matter orbiting around a central core at fixed temporal intervals (the period). Even though both processes are cyclic, in neomechanics, vortices are closely aligned with gravitation, whereas waves are not. Neomechanical gravitational theory (Section 3.3.3) explains that imbalances between the concentration of a medium at one scale counteract concentrations of solid-like materials at another scale. However, the theory does not explain how the imbalances initially developed – an explanation that vortex theory provides.

The conventional interpretation is that stars and planets form via the gravitational collapse of a cosmic cloud of gasses. However, the postulated collapse is mysterious because it has no physical cause. The neomechanical explanation differs because gravitation is the last part of the process rather than the first. In neomechanics, two gas clouds must first collide (perhaps sideswiping) to start the spinning that produces a vortex. This typically happens in the spiral arms of galaxies, where gas concentrations are highest. The collective mass of the colliding clouds and the intensity of the collisions determine the torque of the developing vortex. In neomechanics, as soon as the vortex forms, the angular momentum of the smallest particles encounter the least resistance (least collisions) from other types of fractal matter and are ejected from the rotation. Conversely, the more massive particles encounter the greatest resistance from other fractal matter, and thus remain near the

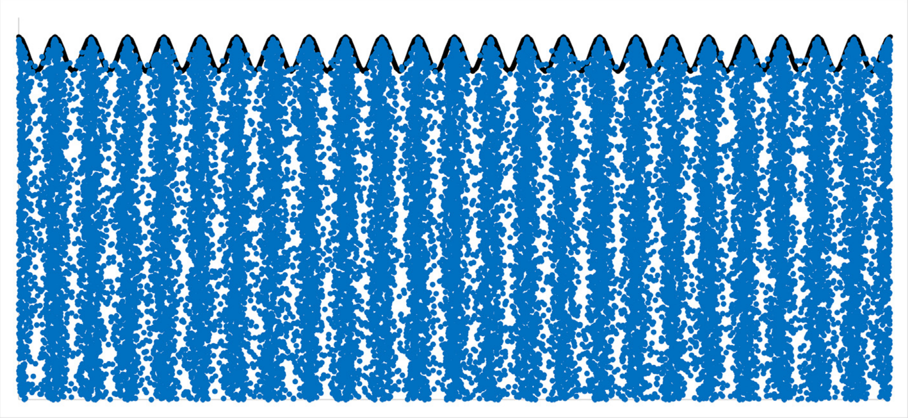

Fig. 6. Alternating wave compressions in a medium of water. Deep within the sea, where the pressure immediately above and below the waves are essentially equal, the wave propagates linearly as a longitudinal wave from repeated sequences of compressions and decompressions. However, near the surface, the air pressure from above is significantly lower than the water pressure below. This pressure imbalance causes the wave to rise when in a compressed state and fall when in a decompressed state. Thus, water propagates as a transverse wave at the surface by rising and falling perpendicular to the direction of the wave movement.

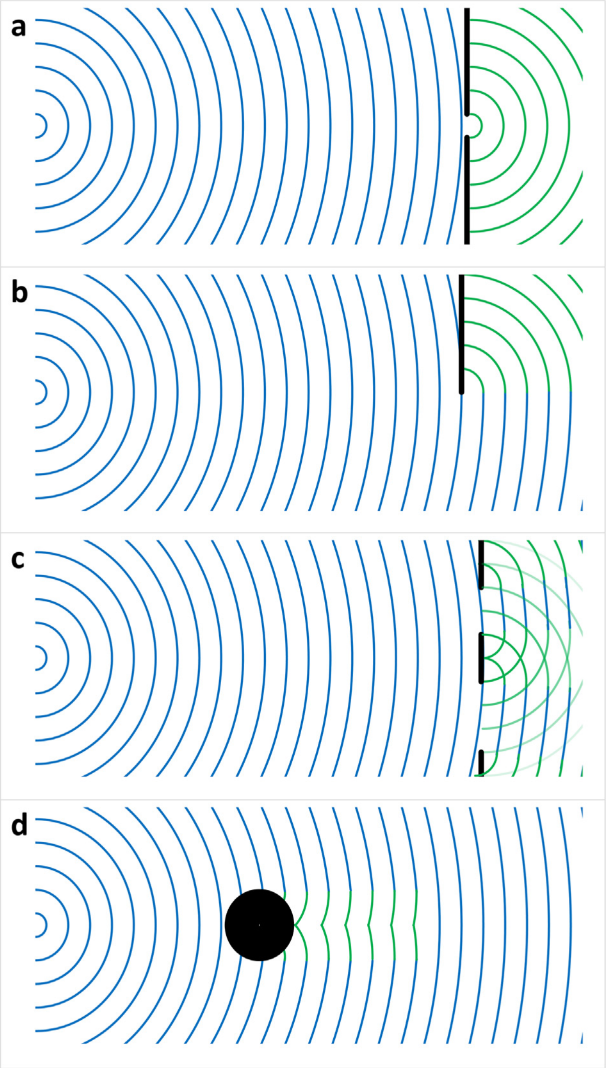

Fig. 7. Four examples of wave diffraction. Blue curves show the original unencumbered wave, and green curves show the diffraction that occurs after reaching an interference point: (a) true diffraction only occurs from two obstructions separated by one-wave-length, (b) one flat obstruction with a single interference point, (c) three flat obstructions with four interference points, and (d) a circular obstruction with interference occurring on opposite sides of the object. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

core. The gravitational gradient then develops proportionally to the pressure imbalance between the external smaller particles and the internal larger particles.

The operation of a household vacuum cleaner provides as an analogy of the basic principles of neomechanical gravitation. After turning on the switch, the motor turns a fan that ejects air from the chamber, causing low pressure within the chamber. The external high pressure pushes air back inside the chamber, carrying some dust along with it. A filter within the chamber allows the small air molecules to easily pass-through it, while the filter blocks larger dust particles from passing through its small openings. In this way, offsetting pressures, along with a filtering system, allows the vacuum cleaner to gradually accrete dust. With enough time and dust, the chamber can accumulate a compact solid-like dust structure. In the neomechanical paradigm, gravitation operates similarly. There are no attractions, only offsetting pressures that originate from some type of filtering system.

For the analogy to hold, a critical question is: What serves as the filter for stellar and planetary formation? The answer: The largest and densest objects. When the vortex first forms, it contains all types of matter with a wide range of densities. In theory, the torque works to eject all matter because the momentum of every component, at any moment, is always perpendicular to the axis of rotation. However, it is impossible for all fractal matter to be ejected because some matter must remain near the center to avoid a complete vacuum – the perfectly empty space prohibited by the Ten Assumptions. Consequently, in the neomechanical paradigm, larger, denser materials remain near the core because their massive surfaces and cores collide with numerous other large and small materials, which inhibits their outward movement. Conversely, the smaller, rarefied materials encounter the least resistance (the fewest collisions) and easily move through and around the larger, denser materials. Thus, the unencumbered smaller bits of fractal matter continue their trajectory perpendicular to the rotational axis – just as it should according to conventional (non-gravitational) physics. In this way, a natural vortex acts as the fan in a vacuum cleaner, with the accumulated larger, denser materials acting as the filter, and the smaller, rarefied materials being ejected thorough this natural filter. This process is hypothesized to produce the large external concentrations of rarefied, undetectable, matter that accumulates as a distal gravitational gradient. In this way, as the torque of the vortex continues its high-speed rotation, small bits of matter are continually ejected, larger materials are continually accreted, the core accumulates more fractal_{Mi} mass, and external $\Sigma\text{fractal}_{Mi-1 \text{ to } -\infty}$ concentrations become increasingly larger. This process of rotation, accretion, and solidification of fractal_{Mi} with counterbalanced ejections of $\Sigma\text{fractal}_{Mi-1 \text{ to } -\infty}$ continues non-stop until the rotation slows to the point that the external pressure prevents further net $\Sigma\text{fractal}_{Mi-1 \text{ to } -\infty}$ ejections. At that point, the object stops accreting matter, and it gradually begins decaying as its rotation slows.

Stars and galaxies are well known to have specific shapes, colors, and rotational periods linked to their ages. Of these properties, the oblateness of the object possibly provides the best clue of its age. Factors such as proximity to another cosmological object, mass, and location within a vortex can invalidate these signs of age, but the general tendencies are briefly summarized in Fig. 8. New-born stars are very elongated (oblate), emit blue light, and rotate very rapidly. As the rotation slows, the object becomes less oblate, and its color turns from light blue, to white, and then yellow. As the rotation slows to a crawl and then stops, the object becomes completely spherical, while turning from yellow, to orange, and then red. Large red stars explode as supernovae (ejecting their outer hydrogen and helium layers) soon after their rotation stops. In neomechanics, the explosion occurs because the rotation stops, which allows previously ejected $\Sigma\text{fractal}_{Mi-1 \text{ to } -\infty}$ to penetrate back into the stellar interior. This intrusion of small fractal matter initially causes the volume of a star to expand, and eventually causes the star to explode. In other words, the collective mass of the small intruding matter eventually pushes a non-rotating star apart. Thus, in neomechanics, supernovae explosions have nothing to do with runaway nuclear fusion. Accordingly, vortices, accretion, gravitation, solidification, axial spin-down times, and decay all happen via related processes at all scales.

3.4. Incompatible theories

In addition to providing guidance on how to interpret causes, the fundamental assumptions of a paradigm also prohibit certain things. Popper [15] frowned upon vague, safe theories and instead favored prohibitive theories – equating increased prohibitions to increased testability, increased falsifiability, and thus increasingly scientific. A specific paradigm prohibits certain theories, while favoring others. A brief discussion follows for some conventional concepts and theories that are incompatible with the Ten Assumptions, and thus cannot be part of the neomechanical framework without introducing contradictions.

In neomechanics, there are no massless particles. The mass of a certain particle might be minuscule, but it cannot be zero because all material objects are assumed to contain other material objects, ad infinitum. Also, energy is neither matter nor motion, but a calculation that idealistically combines both. Thus, momentum, force, and energy are matter-

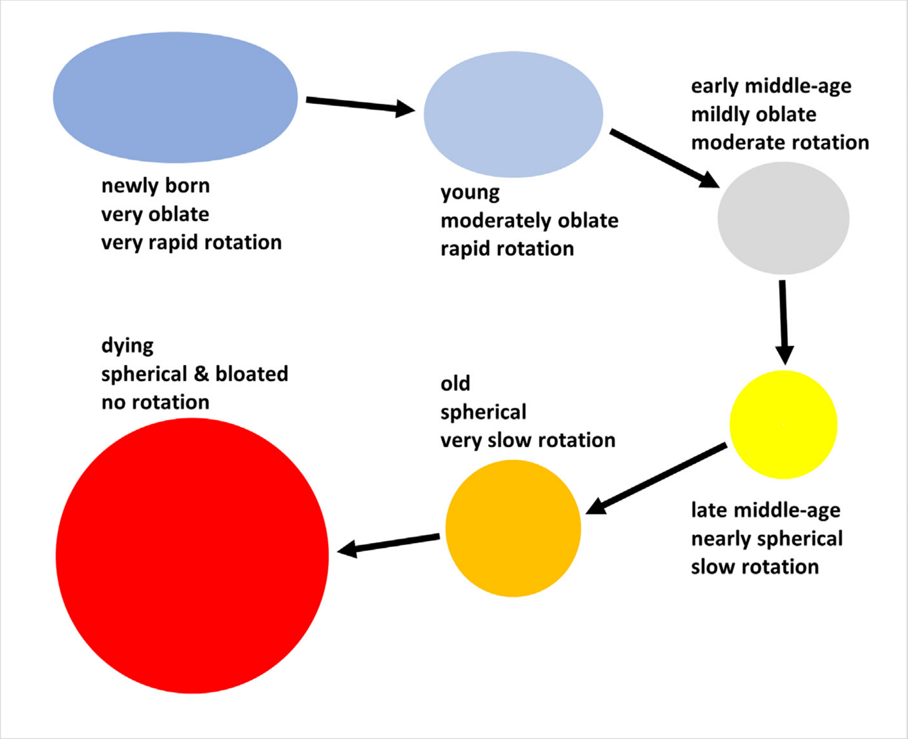

Fig. 8. Six stages of stellar evolution of main sequence stars in terms of vortex torques, spheroidal shapes, and relative ages.

motion terms [6] that quantify the degree to which one type of matter transforms into another type of matter. Furthermore, even though modern astrophysicists treat the dark energy hypothesis as a given, the concept of dark energy is incompatible with neomechanics. The motion described by energy must always be associated with matter, per the assumption of *inseparability*. The necessity of dark matter rests solely on the fundament assumptions one chooses – again demonstrating how a person's fundamental assumptions dictate hypotheses. In the conventional Big Bang worldview, dark energy is a required ad hoc that is essential to prevent falsification of the Big Bang Theory. However, in the neomechanical paradigm the universe is assumed to be infinite, and thus, it cannot expand further. Likewise, in neomechanics, dark energy is a useless concept. The dark energy hypothesis is essentially unrelated to any type of observation (such as cosmological redshift), and instead is heavily dependent on the fundamental assumption that the Universe is finite and expanding. Conversely, in the neomechanical paradigm, because vortices and gravitation are postulated to operate at all scales, the observed cosmological redshift might be best explained by the slowing rotation and expansion of an old, solid-like fractal_{M+5} super massive object.

Because the universe is assumed to be infinite in time, the Big Bang Theory is incompatible with the neomechanical paradigm. In addition to eliminating the need for dark energy, the alternative hypothesis of a slowing rotation of an old, solid-like fractal_{M+5} object explains cosmological redshift without requiring a Big Bang. In this scenario, the cosmological redshift is linked to divergence from the increased density of $\Sigma\text{fractal}_{M-1 \text{ to } -\infty}$ over time, which is counterbalanced by the decreased density of baryonic matter, with both being consequences of a slower rotation of the fractal_{M+5} object. The speed of light slows when traversing a concentrated medium, such as water. Conversely, if the interstellar medium becomes less concentrated with finer, more rarefied $\Sigma\text{fractal}_{M-1 \text{ to } -\infty}$ over time, indeterminists might misinterpret these as a greater speed of light and/or accelerated universal expansion in the distal past. Criticisms of the Big Bang Theory persist to this day [132], yet critics often disagree on an alternative explanation for the cosmological redshift. Recent studies of the observed portions of the universe indicate periodicity in the formation of extragalactic objects, galaxies, and quasi-stellar objects [133–135]. This type of periodicity is indicative of a wave (rather than periodicity from a vortex). Thus, another alternative hypothesis for the observed redshift might be linked to large-scale waves propagating through the observable regions of the universe.

The hypothesis of cosmological inflation is also incompatible with neomechanics. Cosmological inflation refers to a brief period hypothesized to have occurred immediately after the hypothetical Big Bang, being a period during which all physical laws were suspended, and space expanded exponentially [28]. Because the universe is assumed to be infinite and because the laws of nature are assumed to have always operated the same throughout time, these neomechanical constraints prohibit the cosmological inflation ad hoc, which was proposed only after distal galaxies revealed cosmological redshifts that implied recessions greater than the speed of light.

4. General discussion

A metaphysical framework, such as the neomechanical paradigm presented here, enhances understanding by clearly stating up front what is believed to be true (but cannot prove). Because researchers, either knowingly or unknowingly, make decisions based on different fundamental assumptions, the groundwork is laid for contentious resistance when a new paradigm challenges an old paradigm riddled with ad hoc hypotheses. This is because, once embraced, most individuals tenaciously hold on to their fundamental assumptions regardless of new non-supportive evidence [4,11]. This explains why Kuhn [11] wrote the morbid description of failing paradigms gradually dying one proponent at a time, while the emerging paradigm primarily gains favor from new entrants into the field. Because majority worldviews continue to inhibit publication of valid emergent opposing worldviews (e.g., Alfvén, [41], Shechtman [44], Wegener [46], Bell [54]), criteria are suggested for establishing a more open scientific framework. A scientific framework includes clear statements of (a) the paradigm, which consists of fundamental assumptions and associated theories,

(b) the empirical framework that includes observations, evidence, and mathematical models to simulate natural process, and (c) the peer review process generally established and enforced from established paradigms, but always subjected to changing worldviews.

Popperian empirical falsifiability [15] paved the way for a more rigorous structure for testing the coherency of mathematical models with empirical evidence. However, to this point, only Borchardt [6] has applied consupponibility [4] as a means for falsifying a metaphysical paradigm. With this approach, an entire collection of fundamental assumptions is falsified if a single contradiction is found among them and the associated theories. To improve the peer review process, which can often be a dogmatic regime of intolerance toward opposing views, the ideas espoused by Collingwood [4], Popper [15], Kuhn [11], Lakatos [32], and Borchardt [6] into an enhanced approach for evaluating novel scientific research.

A conventional component for evaluating novel research is believability. Ideas thought to be unbelievable are often immediately rejected without considering the associated logic or evidence. However, believability is generally in the eye of the beholder. For instance, a proponent of the Big Bang Theory interprets the cosmological redshift as credible evidence of universal expansion; however, an opponent who doubts that might consider the idea of the universe exploding from nothing is quite unbelievable. Likewise, a Big Bang proponent might easily believe in cosmic inflation because it prevents the theory from being falsified; however, an opponent will likely consider cosmic inflation as unbelievable because it is unimaginable that the laws of nature were briefly suspended. Because believability is biased by individual assumptions, Popper [15] excludes it from criteria for falsifying a hypothesis. Instead, Popper suggests using testability as the standard for developing a scientific theory. A theory could be either true or false and still be scientific. A theory is scientific only if stated in such a way that it can be disproven if it is false. Thus, a potentially valid theory is considered unscientific if it is stated in such vague terms that it cannot be tested.

Popperian falsifiability [15] applies to the empirical framework, whereas another type of falsifiability, consupponibility [4–6] applies to the metaphysical framework. This is important because, while many still hypothesize causes for empirical models, the hypothesis might contain multiple contradictions when considered as a whole, which includes both the relevant paradigm and its associated empirical framework. For these reasons, physicists and astrophysicists sometimes dismiss conjectures of cause as metaphysical garbage. But discarding metaphysics for this reason is unjustified if non-consupponibility is treated as grounds for falsifying a paradigm. A metaphysical hypothesis cannot be disproven empirically because of infinite regress. However, a metaphysical conjecture can be logically disproven if one part of the hypothesis contradicts an associated hypothesis or if it contradicts an associated fundamental assumption. Thus, it is advisable to add consupponibility as a criterion for falsifying a set of metaphysical assumptions and theories. It is further suggested to employ an infinitely fractal universe model, as defined within this work, as an alternative to the logically flawed, ad hoc riddled, Big Bang Theory.

5. Conclusion

A framework for conducting scientific research consists of three major components: (a) the paradigmatic framework consists of fundamental assumptions and associated theories; (b) the empirical framework consists of observations, evidence, and mathematical models; and (c) the peer review framework which is naturally dominated by prominent proponents of the prevailing paradigm. Because individual beliefs and schools of thought often diverge significantly, especially among disciplines, a statement of the postulated paradigm will help readers and reviewers better understand associated deductions and interpretations. Importantly, for any scientific framework, an opposing view is an invalid reason for rejection. Instead, research should be evaluated solely on the internal merits of its fundamental assumptions, theories, observations, and mathematical models. After applying a criterion of consupponibility to each paradigmatic framework, causes and empirical models become susceptible to collective falsification. Also, the degree to which fundamental assumptions force researchers into postulating certain types of theories cannot be overemphasized. Using the same measurements and observations, different assumptions can lead to drastically different theories. The ultimate success of the neomechanical infinite universe paradigm will be judged by its ability to produce discoveries and theories that would not be possible from hypotheses developed from finite universe assumptions. Time and intense study will eventually determine the fate of hypotheses developed from these opposing fundamental assumptions.

CRediT authorship contribution statement

Other than revisions from suggestions specified in the Acknowledgements, the sole author conceptualized the research, and is solely responsible for methodology, analyses, techniques, investigations, writing, and editing the manuscript.

Declaration of competing interest

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Acknowledgements

The author thanks Glenn Borchardt, Kent Condie, and Luciano Pietronero for suggestions from earlier versions of the manuscript, and editor Abdon Atangana is thanked for guidance leading to further post-submission improvements.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.chaos.2022.112065.

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