

Deus sive substantia constans infinitis attributis quorum unumquodque
æternam et infinitam essentiam exprimit, necessario existit.

Ethica Ordine Geometrico Demonstrata, Propositio XI

Go out at night, away from the city and its artificial lights, to as remote a place as possible, and look up at the sky. What do you see?

Do you see the billion stars light up the firmament? The universe is so vast it takes their light eons to reach your eyes, so that, like a reversed prophet, your gaze peers back in time and sees things past. You witness the entire history of the cosmos, from its inception to this very moment, and you know its perfect dance is set by unbreakable laws.

Do you see a black canvas on which a supremely talented artist has painted their supernatural motifs? What is their significance? Some kind of hidden message, perhaps, written in a language you don't understand, or an inarticulate display of glory, meant to inspire, or strike fear into people's hearts? The great artwork, seemingly eternal, makes you ponder your own mortality, and your relationship to the whole. You marvel at the sublime beauty of the cosmos and are at the same time unsettled by it.

Do you see God? If you stare at the heavens long enough, you believe you can touch the truth: the diversity of the world is an illusion, and everything is one. The sky, the stars, this earth, you ... are all the same, different emanations of an infinite and timeless reality. You feel at home, and are no longer scared.

The Language of Nature

It is often claimed that mathematics is the language of Nature. Galileo himself, the father of modern science, said so in an often-quoted passage of *Il Saggiatore* (1623). I will not break with tradition:

La filosofia è scritta in questo grandissimo libro che continuamente ci sta aperto innanzi a gli occhi (io dico l'universo), ma non si può intendere se prima non s'impara a intender la lingua, e conoscer i caratteri, ne' quali è scritto. Egli è scritto in lingua matematica, e i caratteri son triangoli, cerchi, ed altre figure geometriche, senza i quali mezzi è impossibile a intenderne umanamente parola; senza questi è un aggirarsi vanamente per un oscuro laberinto.

Galileo compares the universe to a book written in mathematical symbols, from which it follows, he says, that understanding the world without first learning mathematics is like reading a book without first learning the language it's written in, an impossible task that

Galileo equates, in a remarkably poetic phrase, to that of someone “wandering aimlessly through a dark labyrinth”.

This has become the standard view among scientists: that the universe, in a sense, *speaks in mathematics*, and so any other way of understanding it is at best misguided, and at worst, hopelessly wrong.

In this essay, I would like to consider the possibility that this view of science and philosophy is reductive, and founded on the presumption that the universe has only one aspect, or, in Galileo’s analogy, that it speaks only one language, when in reality it could very well be multilingual.

By that, I don’t mean that we could find another language that can shed light on the surprising regularities of Nature as well as mathematics can. I find that unlikely. What I mean is that the world consists of many attributes or qualities, most of which cannot be captured, even in principle, by the tools of mathematics.

Arguably, the biggest unsolved problem in science and philosophy at present is the *hard problem of consciousness* [1]. This is the problem of explaining qualia, or phenomenal experiences: why and how is it that some physical systems in the universe display individual subjective experiences? The reason why this is such a hard problem is that we are currently operating within a scientific framework that is purely *objective*. What I mean by that is that the laws of Nature we have discovered so far, formulated in mathematical terms, are inherently *functional*: they can describe how a system functions and how its constituent parts relate to each other in space and time, but are inherently incapable of incorporating subjective states, or any other *essential* property of the system. The laws of physics and biology, for example, can explain how photons hitting the retina activate photoreceptor cells that send electro-chemical signals to the brain, which then elaborates the visual data to produce the functional property of sight, but they cannot explain what it *feels like* to see the sun set, or why these type of processes should be accompanied by perception at all.

The nature of matter is no less mysterious [2]. Given that the laws of physics are merely relational, all the properties of matter we call physical, like mass, charge, momentum, etc. only make sense *in relation to* other physical objects. Mass describes the gravitational attraction between two or more objects, charge describes the electromagnetic interaction (attraction or repulsion) between two or more objects, momentum is only defined after choosing a reference frame, etc. In quantum mechanics, which provides the most comprehensive description of the physical universe, events themselves are only defined in relation to an observer. None of these properties would have any meaning in a universe populated by a single particle or physical entity. The question is then: What is physical matter in and of itself, beyond the structure described by physics?

This is known as the *hard problem of matter*, and is a reformulation of Kant’s concept of *noumenon*, or thing-in-itself. Physics describes the mathematical relations between

things, but what are those things intrinsically? Kant argued we can't get access to the noumenon, as our experience of any object is defined by the particular structure of our minds, so we see the world in terms of colors, shapes, sounds, etc. but none of those things can really be found outside our heads, and they certainly do not represent what matter is like at the fundamental level. What we are presented with is a highly biased interpretation of reality that necessarily conforms to the particular configuration of our biology: we can only see phenomena.

Before Kant, in his *Monadology* (1714), Leibniz famously proposed that things in themselves (what he called monads) are immaterial atoms of conscious experience, and so identified matter-in-itself with mind. A more recent proposal, inspired by Pythagoras and Plato, is to identify matter with mathematics [3], and suggests that not only the physical world is an abstract mathematical structure (with no "essence"), but that every single mathematical structure, even the ones that do not describe our own universe, is physically realized somewhere in an ultimate ensemble of possible universes. If one is not ready to take either of these two leaps, matter, or to use a computer science analogy, the hardware on which the software of the laws of physics runs, has to be considered as a fundamental aspect of the universe, together with mathematics and mind.

If this is true, in order to have a complete picture of the universe, at least from the human perspective, it is not sufficient to look at physical laws alone. These laws, formulated in mathematical terms, elucidate the relational structure of the universe, but miss out on its essential properties, like consciousness and matter¹. An omnipotent disembodied mathematician with infinite computing power could in principle derive all the possible histories of the universe from these laws, and map out its mathematical structure in exquisite details, and still know nothing about pain, fear, and love; or, more generally, what the underlying substance whose structure they're describing even is. Assuming matter is fundamental and irreducible to mathematics, we must then also assume that mental phenomena are a fundamental feature of reality [4], quite separate from but complementary with its physical and mathematical properties. Conscious experience does not emerge from the behavior of matter, but is a separate and possibly ubiquitous natural phenomenon that happens alongside it.

In other words, we must assume that the world has at least three aspects [5]: the mental, the physical, and the mathematical. One cannot be said to be more fundamental than the other: they are different ways of looking at the same Thing. This "Thing", which I, following Spinoza, interchangeably call Nature, God, Truth, World, or Universe, is the fundamental substance that exists; this substance has many, potentially infinite, attributes, of which matter (what ancient philosophers called *extension*), mathematical structure and mind are examples. In Galileo's analogy, these *attributes* are the *languages* that Nature

¹Indeed, the designation "physical laws" is a misnomer, given that these laws do not describe matter, but only its interaction.

speaks, which can be quite different, but ultimately convey the same message².

Indeed, I believe that events in the universe can be understood using different epistemological “frames of reference”, with the underlying reality being the same. So, for example, we could understand the act of thinking by looking at the actions it produces, or we could explore the internal subjective states of the thinking agent, or we could study the complicated chemical reactions that happen in the brain when thinking is involved, and so on. None of these reference frames is more fundamental than the others, and none is sufficient alone to fully explain what happens when an organism thinks. They all give a partial depiction of the truth, and only by combining them can we hope to arrive at the full complexity and richness of the event.

The Full Picture

Science as currently practiced, then, although invaluable, gives us a very partial understanding of the world, and emphatically not the “full picture”. But is this full picture even attainable by humans (or any other finite organism, really)? I find that implausible.

First of all, even considering only the three properties of the world we have some grasp on, their depths are likely to be unfathomable. We might not be able to discover or even comprehend all abstract mathematical structures, the nature of the noumenon (the things in themselves) might forever escape us, and it is almost certain that not all conscious experiences are accessible to us [6].

Second, there might be other properties of the universe outside these three that are completely out of reach of our cognitive abilities. The human brain is arranged in a particular way and has evolved in a particular fashion in order to solve efficiently some problems and not others. It is conceivable that the process of evolution has selected some features of the world as important and discarded others, so that modern humans have attained the capacity for math, physics, and poetry, and use those faculties as windows into the world, but all the others are forever closed to them.

In this context, It is important to distinguish between “problems” and “mysteries” [7]. Problems are questions that we can tackle, and are, at least in principle, solvable. Mysteries, on the other hand, are problems that we can formulate, but lie outside our cognitive reach, and are therefore insoluble. We can wonder about the nature of things, or the existence of the universe, but we will likely never be able to find a definitive solution to these questions. Traditionally, problems have been the domain of science, while mysteries

²Let me emphasize again that the metaphysical polyglotism of Nature I’m describing does not entail different incommunicable realities. On the contrary, I believe that the truth is one, and by looking at its different properties we explore its content from different perspectives, gaining different insights on its fundamental nature.

the domain of philosophy or religion³.

To these two categories, I would add a third: *ineffables*, i.e. questions that we cannot even formulate because we lack the relevant cognitive categories. We can ask about the nature of things (though the question might be unanswerable or even meaningless), because we possess the cognitive categories of “nature” and “things”, but any inquiry which relies on categories outside our own cannot even be thought, let alone expressed. We might conceivably be able to discriminate between problems and mysteries, but we cannot even begin to enumerate the ineffables.

For all these reasons, I believe that what is accessible to us is a tiny fraction of the whole, and it's possible other intelligent beings in the universe, who have completely different cognitive architectures, have access to completely different sets of problems - mysteries - ineffables. Some of them might overlap with ours, most probably won't.

It is often argued that we might be able to communicate with aliens using the “universal” language of mathematics. I don't find that argument convincing. Other intelligent species with a different evolutionary history and possibly different chemistry will almost certainly have different minds, and therefore different ways to understand the world and use it to their advantage.

We cannot even begin to imagine what those ways might be.

An Infinite Kaleidoscope

If the world has different attributes, there must be different but complementary ways of looking at the truth. These fundamental “modes of understanding” of the world give rise to the many disciplines we have developed as a species: science, philosophy, religion, art, etc. Each of these disciplines looks at the world through the lens of one of its attributes. So for example physics explores the mathematical structure of the world, philosophy and religion our relation to the fundamental nature of reality, and art the nature of human consciousness and what it means to be human.

These different disciplines are not interchangeable in the sense that one cannot hope to study the evolution of the universe, say, by writing a poem, and in the same way one cannot hope to gain insight on the fundamental nature of reality by writing down a mathematical formula. Each discipline has its own *domain*; domains can sometimes slightly overlap, but are by and large separate.

³Science works within a conceptual and mathematical framework. Given the assumptions, or axioms, of a scientific theory, one can more or less easily derive by logical deduction its consequences (predictions) and test them against observation. The empirical questions one can answer by this process can be classified as “problems”. The assumptions themselves about the nature of reality that science makes in order to start the deductive process are (examples of) “mysteries”, as no amount of empirical evidence can ever prove the axioms true.

The science we practice today gives us an indispensable window into the *functional* aspect of the universe, but has nothing to say about its essential or experiential aspects. Science cannot hope to illuminate the essence of things, nor the depths of the human soul. For that, we require other disciplines, that are based on other features of the world.

Consider the sunset. There are at least two ways of understanding a sunset. The *objective* way, employing the tools of science, will tell you that the sunset is the apparent disappearance of the Sun below the horizon due to Earth's rotation, and its distinct colors are due to the fact that at sunset the Sun's rays have to travel longer through the atmosphere, so the higher frequencies, that scatter more strongly, are removed almost completely, leaving only the longer wavelength orange and red hues. The *subjective* way will tell you what the sunset *feels like* to a human being, and the emotions it evokes, and will not do that with a formula or an essay, but rather a poem, or perhaps a song. The objective and subjective "modes of understanding" are not reducible to each other: they are equally fundamental and independent.

Science and art may be antithetical in the tools they use, but they are after the same thing: the truth⁴. In one case, it is the objective truth, in the other the subjective truth (truth as it relates to conscious beings), but neither of these is more fundamental than the other, nor sufficient all by itself. A complete human understanding of the world ought to integrate the two into a higher form of comprehension and appreciation of the multifaceted nature of the world.

We, as a species, need to rethink science as the sole depositary of the truth. I do not say this because I want to back to an unenlightened era of ignorance and superstition, but because it's time we recognize the limits of science, put it in its proper context, and acknowledge the usefulness of the other human disciplines in understanding the world around us, and our place in it. Art can, exactly like science, expand our knowledge of the world by investigating the content of our feelings and our thoughts, which, like particles and fields, are also part of the universe, but, unlike them, do not "speak" the language of mathematics, but rather the language of emotion and first-person experience.

Acknowledging this basic fact about the universe (its multiplicity) is a small but necessary step towards a "unified theory" of the human experience of the world. This theory would incorporate and make use of the different human disciplines in order to offer a holistic description of the world as seen from the point of view of a human being; it would be able to explain not only the sunset as a physical phenomenon, but the sunset as a conscious experience, perhaps combining the tools of mathematics and poetic language⁵. I

⁴That these disciplines are *after* the truth doesn't mean they ever reach it. Both science and art, I believe, develop progressively better (or in some cases just different) approximations of (one aspect of) the truth. What I don't doubt is the existence of such a thing as the truth.

⁵Note that I'm not talking about a mere juxtaposition of mathematical and poetic insights to investigate the world from different angles, although that will be needed at first. I'm talking about a fully fledged theory whose formalism would unify the different languages we have developed as a species to "talk" to the universe.

don't know if such a theory is possible, but we ought to give it a try if we want to have a chance to understand the world at a deeper level.

If the reconciliation of the human disciplines is even possible, it has to rest on the assumption that the fundamental reality is one, as that is the only way to ground our understanding of the world on similar criteria of validity: a scientific theory is useful if it is predictive, a mathematical structure is interesting if it is consistent, a poem is beautiful if it speaks to us. What all these examples have in common is that in all three cases the human creation (the theory, the mathematical structure, the poem) *conforms to the truth*. In other words, it says something true and genuine about the world. Thus, the ultimate goal of all the different disciplines can be recast in the same form as a “search for the truth”, be this physical, metaphysical, mathematical, emotional, or other.

I like to think of the world as an infinite kaleidoscope, that appears to change pattern and color by changing perspective, but is fundamentally always showing the same thing. The hypothetical theory I am describing would allow us to seamlessly “move around” the kaleidoscope, and experience it from every facet.

Depth and Beauty in Diversity

Since the beginning of modern science five centuries ago, our body of knowledge has increased tremendously. As marvelous as this rapid expansion of empirical knowledge has been, something else was lost in the process: our ability to see the big picture, and to frame our intellectual achievements in the wider context of our humanity and our relationship to the universe. We have now entered an era of technology, in which every decision made is on account of criteria of productivity and efficiency, and we have gradually lost sight of the other critical ingredients that are necessary to make a human life worth living: beauty, meaning, a sense of purpose, among others.

The civilizations of the past, while infinitely less knowledgeable than ours, did have a comprehensive cultural and ideological framework that tried to understand the world in all of its aspects: the scientific, the philosophical, the religious, and so on. The monuments they built often did not serve any “efficient” purpose other than reinforcing their belief structure, and control their existential fears. We do not have that.

Stepping out of the science bubble, with its emphasis on objective phenomena and a functional understanding of reality (but without abandoning critical thinking and rational inquiry) will be needed in order to reconnect us with a deeper sense of meaning, and allow us to really feel “at home in the universe” [8].

Science can tell us *how* the world operates, and that fills me, and a lot of other people, with a great deal of joy and wonder, but it cannot tell us *why* it operates the way it does, or *what* the world even is. We have been taught to avoid these questions as meaningless,

or even foolish, but every society that has ever existed (and likely every human that has ever existed) has been very preoccupied with questions of this kind, and for good reasons: they define who we are, where we are going, and what we value. They give meaning to our lives.

I say this knowing full well that the *why* and *what* questions, contrary to the *how*, may be beyond our ability to answer; but I don't think we should stop trying. The contemplation of the mysteries of the universe is an endless source of meaning and purpose, more so than if we knew all the answers: our spirituality depends on our ignorance of the whole. A world where we had access to the full truth would be a very stale place: debate would be pointless, as well as research and, one might argue, art. The best of all possible worlds, at least as far as the pursuit of knowledge is concerned, is one in which some truths are accessible and some not, and the ones that are not are only partially concealed from us, in a way that can elicit speculation. Besides, humans seem to be wired in a way that makes it nearly impossible not to be concerned with these metaphysical questions, therefore to forgo them is tantamount to repudiating our nature.

Let me reiterate that I hold Science as one of the greatest intellectual achievements of our species, and an essential window into the miracle of existence; not to mention the marvelous technological advancements it produced, that have made life easier for millions of people. We should celebrate Science and rejoice at all the gifts it bestowed upon us, but we should also recognize that its jurisdiction is limited. Just as we wouldn't want to pray for the sick without giving them medicine, so we shouldn't expect science to give us the answers about who we are or the meaning of our lives.

These answers will only be found, if they are to be found at all, in an unprejudiced and fruitful conversation between the disciplines, with the ultimate goal of reaching a holistic understanding of reality and its many facets. Trying to understand the world by focusing on only one of its aspects is akin to watching a movie and focus only on the words being spoken, or the music, or the pictures. The *meaning* of the movie, the message it wants to convey, will inevitably be lost, as it can only be found in the combination of all the different modes of expression.

The process of integrating different disciplines into a coherent whole will require immense creativity and eclecticism. Science, on the other hand, is becoming more and more specialized and conformist [9]. Disruptive thinking is discouraged in favor of safe incremental steps, and the few people who try to engage in original transdisciplinary research with potentially far-reaching consequences are weeded out in the race to a permanent academic position. This is one of the reasons why the science environment is still so uniform, elitist, and unimaginative.

Specialization in particular has become a serious issue. The growing compartmentalization of the scientific disciplines makes the much needed synthesis of the immense knowledge humanity has gathered so far increasingly unlikely. Among other things, such

a synthesis is needed to reconnect us with Nature, and not feel, like we do today, as a cancerous outgrowth whose sole aspiration is to control it. This outlook is a direct consequence of our current understanding of Nature in purely functional terms.

Apart from boundless creativity and a deepened connection with the world around us, the synthetic process I'm envisioning will likely foster inclusion and diversity, as people from all backgrounds will come together and collaborate on highly interdisciplinary projects, each one bringing a unique perspective on the problem, each one looking at the truth from their own idiosyncratic angle. By doing this, we will gain immensely in both our understanding of reality and ourselves, and make way for a more just and equitable society.

The kaleidoscope of reality will finally be reflected in the kaleidoscope of mankind's interests and perspectives.

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