Proportional Philosophers

By

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"Since the ancients (as we are told by Pappus), made great account of the science of mechanics in the investigation of natural things; and the moderns, laying aside substantial forms and occult qualities, have endeavoured to subject the phaenomena of nature to the laws of mathematics, I have in this treatise cultivated mathematics so far as it regards philosophy."

- Isaac Newton, *The Principia: The Mathematical Principles of Natural Philosophy*

When man first looked up at the stars with leisure, observing the ever-regular motions of the heavens, the entirety of his wonder, in this initial curiosity, found itself manifested in efforts to produce an account of this order, of this κόσμος. Over time, these efforts continuously compounded and detected their own errors to produce a proportionality of astronomical accounts. Even Newton acknowledges his gratitude to those coming before him in a letter to fellow natural philosopher Robert Hooke early in 1676, "If I have seen further, it is by standing on the shoulders of giants[1]." In these astronomical accounts, natural philosophy first found itself systematized in respect of certain, accepted premises. Ptolemy, for example, accepted a circular motion for the heavens[2], and from this, he interpreted the phenomena of nature through a geometric lens, using the philosophic principle of circular motion to support the mathematical principles of geometric motions that he derived. Similarly, Copernicus, Brahe, Kepler, and other astronomical investigators begin their inquiries from certain philosophical principles that served as the foundation for developing mathematical principles in respect of natural phenomena.

Without a correspondence to natural phenomena, a strict english transliteration of the Ancient Greek participle φαινόμενα, meaning "the appearing things", any theory of natural philosophy simply cannot hold weight. Kepler realized this necessity when an eight minute discrepancy from his circular model forced him, in the spirit of Truth, towards a complete reformation of astronomy. Whereas in dialectical concerns we can establish premises as principles to follow and readjust as contradictions arise, in matters of nature it is not so simple to proceed solely in a dialectically deduced manner. As Lord Chancellor Francis Bacon gently reminds us in the *New Organon,* "The subtlety of nature is greater many times over than the

[1] Newton *The Correspondence of Isaac Newton. Volume II.*
[2] Ptolemy *The Almagest* 38

subtlety of the senses and understanding[3]." So then to lay Nature bare, how must we tease out her answers?

In response, this paper's purpose will serve a reflection on the principles set forth by Plato and Newton for the investigation of natural philosophy, as well as an inquiry into the seemingly geometrical foundation of the Cosmos. To pursue this purpose, we will take a close look at Plato's *Timaeus* while also keeping Newton's *Principia* in mind as a way to further reflect on the advancement of natural philosophy. Newton does not advance alone from first principles, but he uses a method of general induction from natural phenomena to induce mathematical principles of motion. Only after accepting six particular phenomena as given, can he deduce the geometric System of the World from the induced principles with the aid of his Rules of Reasoning. Similarly, Plato proposed his own "ratio-rule" of philosophy and identified philosophical principles of natural philosophy that express an intrinsic necessity of proportion, commensurability, order, systematization, beauty, and also, an imprint upon this reality from an intellectually rationalizing Being.

Our close look at *Timaeus* will make use of the Ancient Greek text as I will provide my own translations and interpretations for the purpose of engaging Plato in the most direct manner possible. I will supply the original text, as well as a left to right Greek rearrangement. This method of rearrangement, taught and created by Mrs. Rali Christo, rearranges the primary text in a subject-verb-direct object arrangement[4], and maintains identical punctuation with the

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[3] Francis Bacon *The New Organon*

[4] In Greek, we could see the sentence, "Near Orion's belt, that star, which shines most brilliantly, I saw." But we can rearrange this into a clear grammatical order, "I saw that star, which shines most brilliantly, near Orion's belt." Rearrangements can vary with additional grammatical clauses, but most fundamentally, a rearrangement serves to show the grammatical force of the ideas in the text.

translation, so that a reader with a basic understanding of the language can engage the text and also closely examine the evidence of my claims.

So while maintaining a consideration of how Newton cultivated mathematics, I want to examine how, in his own way, Plato cultivated philosophy. I believe there exists a great benefit in using the knowledge gained through time to reflect on the very process by which that knowledge became known. Keeping Newton in one hand, and Plato in the other, I propose three questions that will serve as the movements of this essay: How does Timaeus the character serve as a device for Plato to express his philosophical principles of nature? What regulating rules do Timaeus and Newton hold as they investigate nature? Does Timaeus' final recapitulation about The All, τὸ πᾶν, provide philosophic principles commensurable with Newton's own geometric system of the Cosmos?

Like an architect, Plato carefully constructs his dialogues with no word written in vain, leaving us, the readers, with the task to maintain a keen eye on how Plato's message develops through the dialogue. For this very reason, the first movement will focus on Timaeus' identity, his initial premises between 28A and 29D, and how the Cosmos' function as a imprint (εἰκών) and model (παραδείγμα) necessitates a combination of both reasoning and intellect to produce an account of it. From these premises, and initial analysis of the dialogue's purposeful structure, we will become able to better trace certain words and themes that present themselves within the subsequent movements.

After establishing these starting points, or any starting points really, it will be necessary to consider how to advance upon these beginnings so as to truly develop a consistent and accurate account. To guide his investigation, Timaeus identifies criteria for developing different

accounts, and proposes a ratio as an analogy to keep in mind as he progresses: “as Being is to Becoming, so Truth is to Belief[5]." This second movement will focus on analysing these criteria, along with other passages, in relation to Newton’s four rules of philosophy. Though Plato did not have the luxuries of data and theories that Newton received from the intellectual “giants”, Plato’s identification of limitations in our scope of natural investigation displays a shared understanding with Newton by needing the Rules of Reasoning to properly use our reasoning faculty.

With an understanding of how each natural philosopher regulated their reasoning with their own criteria, we can then better appreciate the gravity of the resulting conclusions. The first part of this last movement will begin with a translation and analysis of Timaeus’ last recapitulation. This dense section contains the philosophic principles that I want to trace back through the dialogue for the purpose of seeing their commensurability with Newton’s mathematical principles of nature. The second part of the movement will then express how Newton uses six φαινόμενα, with his rules of philosophy, to establish propositions that account for all natural motion by the very governance of his mathematical principles. In having a side-by-side comparison of both accounts, I will then be able to most clearly identify the Platonic philosophical principles that I believe underlie the Newtonian mathematical principles in respect of an intrinsically geometrical natural reality.

At the end of this essay, I want to reflect on the implications of mathematical accounts about The All, and with a brief word about the fundamental ideas of Einstein’s General Theory of Relativity, leave the reader thinking about what it really means for an account of natural phenomena to be “true." With these ideas in mind, we can ponder on the necessary and sufficient

[5] O: ὅ τί περ πρὸς γένεσιν οὐσία, τοῦτο πρὸς πίστιν ἀλήθεια. 29C
R: ὅ τί περ οὐσία πρὸς γένεσιν, τοῦτο ἀλήθεια πρὸς πίστιν. 29C

conditions for producing an account of such a κόσμος. But at this moment, perhaps it is necessary to actually set this essay in motion, and observe how the ink on this paper appears to our eyes.

A Platonic Device For A Platonic Message

The importance of examining Timaeus as Plato's device lies in distinguishing the message from the messenger. After all, why does Plato present this character to deliver the message? What are Timaeus' credentials? The first description of Timaeus comes by way of Socrates, when he tells Critias and Hermocrates,

> For this Timaeus, he being of the best well-lawed city, Locris in Italy, and being second to none of those men there, by either property or lineage, actively has handled the greatest authorities and honors from those men in the city, but moreover, he has come upon the highest point of *quite all philosophy*, according to my opinion[6].

Right before this praise, Socrates had bewailed the fact that there exists no class of men to describe the ideal city in its utmost functions as a city, that is, until he points to Timaeus. I tend to hold a certain amount of skepticism to any compliment Socrates gives to his interlocutors, but in this case, I think we do encounter a genuine compliment from Socrates, and a simultaneously purposeful description from Plato. As the proposed perfect mix between a statesman and philosopher, Timaeus serves as an example for maintaining a proper ratio between an active and a contemplative life.

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[6] O: Τίμαειός τε γὰρ ὅδε, εὐνομωτάτης ὢν πολεως τῆς ἐν Ἰταλιᾳ Λοκρίδος, οὐσίᾳ καὶ γένει οὐδενὸς ὕστερον ὢν τῶν εκεῖ, τὰς μεγίστας μὲν ἀρχάς τε καὶ τιμὰς τῶν εν τῇ πόλει μετακεχείρισται, φιλοσοφίας δ' αὖ κατ' ἐμὴν δόξαν ἐπ' ἄκρον ἁπάσης ἐλήλυθε. 20A

R: τε γὰρ ὅδε Τίμαειός, ὢν εὐνομωτάτης πολεως, τῆς Λοκρίδος ἐν Ἰταλιᾳ, ὢν ὕστερον οὐδενὸς τῶν εκεῖ, οὐσίᾳ καὶ γένει, μὲν μετακεχείρισται τὰς μεγίστας ἀρχάς τε καὶ τιμὰς τῶν εν τῇ πόλει, δ' αὖ, ἐλήλυθε ἐπ' ἄκρον ἁπάσης φιλοσοφίας, κατ' ἐμὴν δόξαν. 20A

The next purposeful description comes by way of Critias' last words to Socrates when he cedes the floor for Timaeus to begin the trio of speeches that the interlocutors, in the spirit of hospitality, owe Socrates for the gift of hearing his own speech the day before. We know that speech as *The Republic.* At this point, Critias describes Timaeus as "the *most astronomically skilled* of us, he even having made it his work *to know, most exceedingly,* about the nature of The All[7]." Within this rich section lies not only Timaeus' overall goal, but also hints from Plato on how to go about such a goal ourselves.

Both Timaeus' superlative description as "most astronomically skilled" (ἀστρονομικώτατον) and his superlative effort "to know, most exceedingly" (εἰδέναι μάλιστα) display Plato's subtlety in crafting a fictional character with the necessary attributes of the highest degree to deliver this particular Platonic message. Here, Timaeus' astronomical attribute denotes the need for serious investigation into astronomical matters while his superlative effort to know, most exceedingly, denotes a need for sensational and conceptual insight. This perfect infinitive, εἰδέναι, possesses the double meaning of "seeing that thing with my eyes", quite literally as an eyewitness, and of "seeing that thing with my mind's eye." Both of these purposeful superlative characteristics will be required for an investigation of τὸ πᾶν, which, instead of translating as Universe or Reality, I will translate more literally as The All. I prefer this translation as I believe it preserves the sense that Timaeus seeks to know both the sensational and conceptual characteristics of all existing things. With these ideas of Timaeus in mind, I want to look at his first distinctions and premises that he will build upon.

[7] O: ἀστρονομικώτατον ἡμῶν καὶ περὶ φύσεως τοῦ πάντος εἰδέναι μάλιστα ἔργον πεποιημένον. 27A
R: [ἐστὶν] ἀστρονομικώτατον ἡμῶν, καὶ πεποιημένον ἔργον εἰδέναι, μάλιστα, περὶ φύσεως τοῦ πάντος. 27A

Timaeus first distinguishes between Eternal Being (τὸ ἀεὶ ὂν), which does not possess a generative origin, and Eternal Becoming (τὸ ἀεὶ γιγνόμενον), which never possesses ever-regular Being. He goes on in further detail, explaining that "the former is embraceable certainly by conceptual contemplation with reasoning, always existing with respect to the same parameters, but the latter, moreover, is conjectural by opinion with unreasoning sensation, since it comes to be and perishes, and never truly *is*[8]." This distinction points to a necessarily intrinsic stability of the natural world, The All, that allows for systematic understanding through a rationalization of concepts. Without this stability, this accordance to the same (κατὰ ταὐτὰ), those who maintain the doctrine "All is in Flux" would be correct[9], as no object of sensation or thought would comprehensible in its ever-becoming nature.

In addition to this previous distinction, Timaeus lays down another aiding premise, that "moreover, every becoming thing comes to be by some cause, out of necessity. For it is impossible for anything to acquire a genesis without a cause[10]." The strength of this phrase, out of necessity (ἐξ ἀνάγκης), cannot be emphasized enough. Of the three Greek words for necessity (δεῖ, χρὴ, and ἀναγκὴ), only ἀναγκὴ denotes an inescapable necessity akin to natural functions for mortals, valid conclusions from consistently developed dialectics, and concepts of logical necessity, which is the case here. In another Platonic dialogue, *The Sophist*, Theaetetus

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[8] O: τὸ μὲν δὴ νοήσει μετὰ λόγου περιληπτὸν ἀεὶ κατὰ ταὐτὰ ὄν, τὸ δ' αὖ δόξῃ μετ' αἰσθήσεως ἀλόγου δοξαστὸν γιγνόμενον καὶ ἀπολλύμενον, ὄντως δὲ οὐδέποτε ὄν. 28A
R: τὸ μὲν [ἐστὶν] περιληπτὸν δὴ νοήσει μετὰ λόγου, ἀεὶ ὄν κατὰ ταὐτὰ, δὲ τὸ, αὖ, [ἐστὶν] δοξαστὸν δόξῃ μετ' ἀλόγου αἰσθήσεως, γιγνόμενον καὶ ἀπολλύμενον, δὲ οὐδέποτε ὄντως ὄν. 28A

[9] Plato *Theaetetus:* 181C and following.

[10] O: πᾶν δὲ αὖ τὸ γιγνόμενον ὑπ' αἰτίου τινὸς ἐξ ἀνάγκης γίγνεσθαι. παντὶ γὰρ ἀδύνατον χωρὶς αἰτίου γένεσιν σχεῖν. 28A
R: δὲ αὖ, πᾶν τὸ γιγνόμενον γίγνεσθαι ὑπὸ τινὸς αἰτίου, ἐξ ἀνάγκης. γὰρ [ἐστὶν] ἀδύνατον παντὶ σχεῖν γένεσιν χωρὶς αἰτίου. 28A

acknowledges this same degree of necessity in his weary agreement to the Stranger's dichotomic conclusions, "It is necessary. For there is the need to follow with the reasoning[11]." Timaeus will continue to use this force of necessity in his subsequent reasonings, so the concentrated force of this word should not be diluted in its many appearances.

Timaeus lays down one last premise to combine with the prior two before embarking on the primary question on the nature of The All. Since by the second premise every becoming thing comes to be by some cause, Timaeus decides to label the cause of The All as the Craftsman (ὁ δημιουργὸς[12]) and then provides the last premise:

> So when the Craftsman, always gazing towards that which holds according to the same things, and making use of some model such like this, works out its look and power, in this way, everything brought to completion is beautiful, out of necessity. But if he gazes towards the becoming thing, making use of a begotten model, the created thing is not beautiful[13].

This last premise uses parts of both prior premises to establish a relationship between beauty and the uniformity, the accordance to the same things, of any created object. The force of necessity here denotes an intrinsic quality of beauty that exists within the very idea and creation of uniformity. In this way, the very identification of beauty will indicate the presence of some underlying uniformity, and thus beauty will act as a necessary predicate for any manifestly created order.

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[11] O: Ἀναγκὴ. τῷ γὰρ λόγῳ δεῖ συνακολουθεῖν. *Sophist* 224E
R: [ἐστὶν] Ἀναγκὴ. γὰρ δεῖ συνακολουθεῖν τῷ λόγῳ. *Sophist* 224E

[12] Literally 'The Public-Worker" from δῆμος (people) + ἔργον (work).

[13] O: ὅτου μὲν οὖν ἂν ὁ δημιουργὸς πρὸς τὸ κατὰ ταὐτὰ ἔχον βλέπων ἀεί, τοιούτῳ τινὶ προσχρώμενος παραδείγματι, τὴν ἰδέαν καὶ δύναμιν αὐτοῦ ἀπεργάζηται, καλὸν ἐξ ἀνάγκης οὕτως ἀποτελεῖσθαι πᾶν. οὗ δ' ἂν εἰς τὸ γεγονός, γεννητῷ παραδείγματι προσχρώμενος, οὐ καλόν. 28B

R: ὅτου μὲν οὖν ἂν ὁ δημιουργὸς, ἀεί βλέπων πρὸς τὸ ἔχον κατὰ ταὐτὰ, προσχρώμενος τινὶ παραδείγματι τοιούτῳ, ἀπεργάζηται τὴν ἰδέαν καὶ δύναμιν αὐτοῦ, οὕτως, πᾶν ἀποτελεῖσθαι [εἶναι] καλὸν, ἐξ ἀνάγκης. δ' οὗ ἂν εἰς τὸ γεγονός, προσχρώμενος γεννητῷ παραδείγματι, [ἐστὶν] οὐ καλόν. 28B

Armed with these three premises, Timaeus takes up the question whether this Cosmos, this All, has come into existence, and possesses a genesis, or, always having existed, it does not. By the first premise, the Cosmos must have come into existence since it is experienced, fundamentally, through our passive, unreasoning sensation. This does not condemn the Cosmos to lack the capability of being grasped by conceptual contemplation with reasoning (νοήσει μετὰ λόγου), but rather the Cosmos cannot be apprehended in a more primary way than by our sensations. By the second premise, the Cosmos must have a cause as required by its coming to be, though identifying the need, and assigning a name of the cause does not denote a systemic understanding of that cause. Timaeus makes this point clear as he does not wish to overstep his bounds, "So to discover the maker and father of this All is a labour, and even having found him, to declare him to all men is an impossibility[14]." This restraint from Timaeus displays an understanding of his own limitations in his scope of investigation. Timaeus knows what he does not know, and thus proceeds accordingly.

With the aid of the third premise, Timaeus must next consider what kind of model the Craftsman held in mind as he created the Cosmos. Now by this last premise, if we judge the Cosmos as a beautiful thing, predicating beauty of it, then the creator of such a beauty thing, the Craftsman, must have kept his gaze in relation to an everlasting model of uniformity. Timaeus' emphatic response considers it a case of common knowledge, "It is certainly clear to everyone that He gazes towards the everlasting. Because the Cosmos is the most beautiful of things that

[14] O: τὸν μὲν οὖν ποιητὴν καὶ πατέρα τοῦδε τοῦ παντὸς εὑρεῖν τε ἔργον καὶ εὑρόντα εἰς πάντας ἀδύνατον λέγειν. 29A
R: μὲν οὖν εὑρεῖν τὸν ποιητὴν καὶ πατέρα τοῦδε τοῦ παντὸς [ἐστὶν] ἔργον, τε καὶ εὑρόντα, λέγειν εἰς πάντας [ἐστὶν] ἀδύνατον. 29A

come to be, and the Craftsman is the best of causes[15]." At least to me it seems that this raises the question, what is it about the Cosmos that makes its superlative beauty certainly clear to everyone? Perhaps it is better to ask, can anyone look up at the stars, watch the turning of the constellations, and not consider its overall unity as a beautiful thing?

The phrase "in relation to" here comes from the preposition πρὸς, which generally has a meaning of motion towards or against, but it can also describe a proportional relationship. Euclid uses this word throughout his *Elements*, and more specifically, in Definition 5 of Book 5: "Magnitudes are said to have a ratio *to* one another, which are capable, when multiplied, to exceed one another[16]." Timaeus will continue to use such mathematical language as he describes the Cosmos, and his proportion in the next movement. However, in this passage, it is clear that Timaeus argues for a proportional creation from the Craftsman which keeps the everlasting Being in an everlasting relationship to the created Cosmos.

Timaeus then continues on his response, building upon the seemingly common knowledge, "So having come to be in this way, the Cosmos has been crafted in relation to that thing embraceable by a reasonable account and by pragmatism, and holding with respect to the same parameters[17]." So if we understand the Cosmos to be in proportion to the thing embraceable by a reasonable account and pragmatism, it bearing a strong resemblance to the Being which

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[15] O: παντὶ δὴ σαφὲς ὅτι πρὸς τὸ ἀίδιον. ὁ μὲν γὰρ κάλλιστος τῶν γεγονότων, ὁ δ' ἄριστος τῶν αἰτιων. 29A
R: δὴ [ἐστὶν] σαφὲς παντὶ ὅτι πρὸς τὸ ἀίδιον. μὲν γὰρ [ἐστὶν] ὁ κάλλιστος τῶν γεγονότων, δ' [ἐστὶν] ὁ ἄριστος τῶν αἰτιων. 29A

[16] Euclid *Elements:* Book 5 Definition 5
O: λόγον ἔχειν ἄλληλα μεγέθη λέγεται, ἃ δύναται πολλαπλασιαζόμενα ἀλλήλων ὑπερέχειν.
R: μεγέθη λέγεται ἔχειν λόγον ἄλληλα, ἃ δύναται, πολλαπλασιαζόμενα, ὑπερέχειν ἀλλήλων.

[17] O: οὕτω δὴ γεγενημένος πρὸς τὸ λόγῳ καὶ φρονήσει περιληπτὸν καὶ κατὰ ταὐτὰ ἔχον δεδημιούργηται. 29A
R: δὴ γεγενημένος οὕτω, [ὁ κόσμος] δεδημιούργηται πρὸς τὸ περιληπτὸν λόγῳ καὶ φρονήσει, καὶ ἔχον κατὰ ταὐτὰ. 29A

maintains itself with respect to the same parameters and is apprehensible by conceptual contemplation with reasoning, then the Cosmos, through its proportional relationship, will likewise be embraceable by reasoning and pragmatism and hold according to the same things. The All will then possess an inherent intelligibility, an receptiveness to practical investigation, and an unchanging structural reality.

Now that we've examined Timaeus' premises, and begun his investigation of the Cosmos in respect of these premises, we finally arrive at his necessary conclusion that will govern the way we think about the structure of the Cosmos: "And moreover from these starting-points, it is entirely necessary for this Cosmos to be an imprint of something[18]." Once again, we encounter the absolute force of necessity as Timaeus proceeds in his investigation. In this case, necessity dictates, from the acceptance of the prior premises, that this Cosmos' very existence, this All that came to be, correlates to an intrinsically ordered Being. This correlation bears its weight from the word εἰκόνα, which I will translate, for the most part, as 'imprint'. Whereas other past translators have translated this word, and its derivatives, solely as 'likely' in order to describe the likening of an object, the modern use of 'likely' to me gives an air of probability, and instead, I prefer to offer an attempt to transmit the original conception of representation that arises from this word.

Compared to another Greek word of representation, μίμησις, which works as an indirect representation, or imitation, of an object, εἰκών denotes an idea of a direct likening, as much as possible, of an object. In this sense, εἰκών can mean 'a likeness' or 'an image', but its first meaning developed from the process by which wax receives the very imprint from a stamp[19]. The Greeks described this imprint, the exact likeness or mirror image of the stamp, upon the wax

[18] O: τούτων δὲ ὑπαρχόντων αὖ πᾶσα ἀνάγκη τόνδε τὸν κόσμον εἰκόνα τινὸς εἶναι. 29B
R: δὲ αὖ τούτων ὑπαρχόντων, [ἐστὶν] πᾶσα ἀνάγκη τόνδε τὸν κόσμον εἶναι εἰκόνα τινὸς. 29B
[19] Per The Lectures of Rali Christo. Volume ?

as εἰκών. In addition to ‘imprint’ as a translation, I will also use ‘likeness’ and ‘image’ where it seems necessary to transmit both the conception and the rhetorical force of certain passages. The etymology presented here serves the purpose to make known the richness of a word that cannot be fully expressed in a single word. Such a description of the Cosmos as a imprint then ought not to be taken lightly but calls for serious reflection of the All. If the stamp of Intellectual Order impresses itself upon our generated reality, then such a reality will possess strong resemblances of that very stamp. Identification and analysis of this intellectually ordered impression upon our Cosmos will then provide a proportional basis for identifying and analysing the Intellectual Order itself.

So once we have identified the impression, the ever-present beauty of the All rotating around us, then we can begin the process of providing an unifying account for the natural phenomena that appear before our eyes. We must proceed to ask ourselves, how must we necessarily regulate our reasoning so as to develop an accurate account of the natural world that matches the stamp of Intellectual Order?

The Second Movement: Reasoning Rationally About Nature

In the making of accounts, it becomes necessary to consider the object being accounted for, and how that relationship dictates the kind of account that will need to develop. An account of phenomena will have different requirements, by virtue of investigating phenomena, than an account of a philosophical idea. Whereas investigations of phenomena, of natural philosophy, gather their evidences from the sensational world around us, accounts of philosophic ideas do not have the convenience of tangible evidence to investigate. That does not mean philosophic ideas

cannot be investigated, as we still engage in dialectical pursuits, but simply that we must use a different means for such a pursuit. Though, it would be quite the convenience to perform tangible experiments to identify Virtue. This second movement will take up these ideas of accounting, of producing a λόγος, in respect of Timaeus' argument from 29B-D and Newton's Rules of Reasoning. Timaeus' exhortation to distinguish between accounts of the imprint and its model provides a philosophical commensurability with Newton's own ideas that will reciprocally develop a richer reflection on both natural philosophers.

To begin the second movement and follow Timaeus' argument, let us turn to how he suggests to begin this very matter: "It is certainly most important to begin everything at a beginning according to nature[20]." The combination of the emphatic particle (δὴ) and superlative adjective (μέγιστον[21]) immediately catches my attention in its relation to what an accordance to nature, or a birth could mean. This phrase κατὰ φύσιν indeed can mean in accordance with its nature, but it can also mean, by taking the more literal and original meaning of φύσιν, in accordance with its birth. Nevertheless, it is imperative to keep Timaeus' superlative exhortation, and its governing condition, κατὰ φύσιν, in mind as he begins to produce an account of the Cosmos. There exists no doubt in my mind that Plato penned this ambiguity for a double purpose, though the purposes themselves evade me. In such moments of Platonic aporia we must continue on with our confusion in hand, not losing sight of it, so that as we continue talking with Plato, previously muddied ideas may become clearer and more defined.

[20] O: μέγιστον δὴ παντὸς ἄρξασθαι κατὰ φύσιν ἀρχήν. 29B
R: [ἐστὶν] δὴ μέγιστον ἄρξασθαι παντὸς ἀρχήν κατὰ φύσιν. 29B

[21] Literally, "the greatest (in size) or heaviest."

Continuing his argument, Timaeus next proceeds with a distinguishing exhortation, stating, “So in this wise we must distinguish the accounts about an imprint and about model of such an imprinted likeness, and that they are same-blooded with these things themselves, of which the accounts are interpretations[22].” The word for ‘interpretations’ here, ἐξηγηταί, actually is interpreted from the literally Greek meaning, “someone who leads another out, whether from a problem or location." In this way, we can describe accounts of nature as things which lead mankind out from the problem of not *knowing* Nature. Timaeus here also identifies the necessity for different accounts, different λόγους, in respect of the object, and that these accounts must, quite literally, relate to the object themselves. The descriptor ξυγγενεῖς, which I translate as same-blooded, also literally means ‘kinsmen’ and ‘relatives’, so its use as a connector between an account and the object catches my eye. In this sense, the accounts must function as proportional in blood with the object itself, and as a result, possess an inherited look for itself.

These two descriptors place parameters around our understanding of how our accounts must be created in relation to the object being accounted. By virtue of being a λόγος , an account must stand removed from the object but still maintain itself in a proper ratio to the object’s likeness, or imprint, if you will.

In addition to possessing such descriptions, Timaeus’ accounts will possess different requirements in relation to explaining a likeness, and a structural model of such a likeness. Timaeus here does not directly speak about the Cosmos and its model, but rather identifies the

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[22] O:ὧδε οὖν περί τε εἰκόνος καὶ περὶ τοῦ παραδείγματος αὐτῆς διοριστέον, ὡς ἄρα τοὺς λόγους, ὧνπερ εἰσιν ἐξηγηταί, τούτων αὐτῶν καὶ ξυγγενεῖς ὄντας. 29B

R: οὖν ὧδε διοριστέον ὡς ἄρα τοὺς λόγους περί τε εἰκόνος καὶ περὶ τοῦ παραδείγματος αὐτῆς, καὶ ὄντας ξυγγενεῖς τούτων αὐτῶν, ὧνπερ εἰσιν ἐξηγηταί. 29B

criteria by which accounts of likenesses and models in themselves must also adhere. This distinction must be made clear before advancing as it bears the weight of the proceeding argument. Timaeus does not yet proceed to discuss the Cosmos as a likeness but will do as after he makes known the parameters of his account.

He first begins with the requirements for an account about a model, stating that "it is necessary for accounts of The Unitary and Stable to fall short in no way from this, that they are unitary and unshakeable, as well as with clarity, as much as possible and however it may be fitting for accounts to be irrefutable and unconquerable[23]." This model, which Timaeus calls The Unitary and Stable, bears a strong resemblance, to my mind, of the geometric systems that astronomers have logically contrived in respect of phenomena. These accounts, whether Ptolemy's geocentric epicycles, Copernicus' heliocentric model, or the other models from the philosophic astronomers, all possess a unitary wholeness to their moving parts as well as an unshakeable tenet of regularity. In addition, these models possess a logical clarity that only becomes apparent through systematically understanding the geometry of the model's interconnected parts. All these considerations find themselves made through the universal language of geometry, whose truth allow such accounts to become, as Timaeus hopes, irrefutable and unconquerable in respect of the model. That does not mean that any self-contained modular system represents an absolute truth, but only that the account and its explanational means possess a self-consistency, and thus validity, in respect of the phenomena, i.e the imprint being modeled.

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[23] O: τοῦ μὲν οὖν μονίμου καὶ βεβαίου καὶ μετὰ τοῦ καταφανοῦς μονίμους καὶ ἀμεταπτώτους, καθ' ὅσον οἷόν τε ἀνελέγκτοις προσήκει λόγοις εἶναι καὶἀνικήτοις, τούτου δεῖ μηδὲν ἐλλείπειν. 29C

R: μὲν οὖν δεῖ [τοὺς λόγους] τοῦ μονίμου καὶ βεβαίου ἐλλείπειν μηδὲν τούτου, [ὅτ' εἰσὶν] μονίμους καὶ ἀμεταπτώτους, καὶ μετὰ τοῦ καταφανοῦς, καθ' ὅσον τε οἷόν προσήκει λόγοις εἶναι ἀνελέγκτοις καὶ ἀνικήτοις. 29C

If the account fails to match such an intrinsic model, even to the slightest degree as Kepler discovered, then there must be a reformation of the account to fit the form of the model.

In the case of describing a model, Timaeus lays down strict requirements for the development of such exact accounts, but for describing an imprint, he suggests we develop a more proportional response. He continues with the argument, stating, “the accounts of the thing being imprinted in respect of that model, and that thing being a likeness, it is necessary for such accounts also to be likenesses through a ratio with those former accounts. So that as Being is to Becoming, so is Truth to Belief[24]." His argument, which one might call a rhetorical one, focuses on the fact that the object being accounted is itself a likeness, and thus same-blooded accounts must also be likenesses, though by a proportionally lesser degree. I mention this sounds rhetorical because Timaeus essentially allows himself creative license to develop an account as a likeness of the likeness of object, or in another light, to create a painting of a painting of an object. Perhaps this proportional image-making allows for our speaker to retain a sense of consistency and validity within the entirety of his account as a likeness.

In this passage, I would also like to consider that the thing being imprinted, τοῦ ἀπεικασθέντος, refers to the Cosmos as a likeness in itself, so that, in maintaining a same-bloodedness with its object, this account must itself also be a likeness, and not an exact representation as with the model. Our accounts pertain in ratio to the true phenomena, but that very same phenomena, as a totality of Becoming, pertains in ratio to the Intellectual Order. The Cosmos in this way works a middle term between the accounts and the Intellectual Order that

[24] O: τοὺς δὲ τοῦ πρὸς μὲν ἐκεῖνο ἀπεικασθέντος, ὄντος δὲ εἰκόνος εἰκότας ἀνὰ λόγον τε ἐκείνων ὄντας. ὅ τί περ πρὸς γένεσιν οὐσία, τοῦτο πρὸς πίστιν ἀλήθεια. 29C

R: δὲ μὲν τοὺς [λόγους] τοῦ ἀπεικασθέντος πρὸς ἐκεῖνο, δὲ ὄντος εἰκόνος, τε [δεῖ τοὺς λόγους] ὄντας εἰκότας ἀνὰ λόγον ἐκείνων. ὅ τί περ οὐσία πρὸς γένεσιν, τοῦτο ἀλήθεια πρὸς πίστιν. 29C

made the imprint. So then as accounts are to the Cosmos, the Cosmos is to the Intellectual Order. This line of reasoning explains my extrapolated interpretation of Timaeus' proposed ratio that as Belief is to Truth, so is Becoming to Being. I would to think that as accounts of natural philosophy progress upon each other, so does this proportion, and our efforts as humans, ultimately converge towards a ratio of equality.

With his distinction and criteria set forth, Timaeus takes one last step before journeying on his likened account, and essentially asks Socrates to cut him some slack, as one human to another.

> So therefore, Socrates, as many people have said many things about many subjects, about the gods and the generation of The All, if we become unable to give accounts that are, in all ways and altogether, consistent with themselves and precisely accurate, do not be amazed! But if we provide likened accounts inferior to none, then you should be happy, remembering that I the speaker and you the judges possess human natures, so that as a result, in accepting the likened[25] story about these things, it is befitting to search for nothing still beyond this.[26]

Interestingly, Timaeus does not use the word λόγον here, but instead uses μῦθον, which can mean a story, myth, metaphor, or more fundamentally, an idea, in its whole, communicated piecemeal by a shared understanding of language. Only when Timaeus begins his uninterrupted

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[25] The Greek here can read as a pun, i.e "the likely story", with an air of probability due to their human natures. I kept 'likened' to emphasis the relation of the account to its object, a likeness.

[26] O: ἐὰν οὖν, ὦ Σώκρατες, πολλὰ πολλῶν εἰπόντων πέρι, θεῶν καὶ τῆς τοῦ παντὸς γενέσεως μὴ δυνατοὶ γιγνώμεθα πάντη ππάντως αὐτοὺς αὑτοῖς ὁμολογουμένους λόγους καὶ ἀπηκριβωμένους ἀποδοῦναι, μὴ θαυμάσῃς, ἀλλ' ἐὰν ἄρα μηδενὸς ἧττον παρεχώμεθα εἰκότας, ἀγαπᾷν χρή, μεμνημένους ὡς ὁ λέγων ἐγὼ ὑμεῖς τε οἱ κριταὶ φύσιν ἀνθρωπίνην ἔχομεν, ὥστε περὶ τούτων τὸν εἰκότα μῦθον ἀποδεχομένους πρέπει τούτου μηδὲν ἔτι πέρα ζητεῖν. 29D

R: οὖν, ὦ Σώκρατες, εἰπόντων πολλὰ πέρι πολλῶν, θεῶν καὶ τῆς γενέσεως τοῦ παντὸς, ἐὰν γιγνώμεθα μὴ δυνατοὶ ἀποδοῦναι λόγους, πάντη πάντως, ὁμολογουμένους αὐτοὺς αὑτοῖς καὶ ἀπηκριβωμένους, μὴ θαυμάσῃς! ἀλλ' ἐὰν ἄρα παρεχώμεθα εἰκότας ἧττον μηδενὸς, χρή ἀγαπᾷν, μεμνημένους ὡς ἐγὼ ὁ λέγων τε ὑμεῖς οἱ κριταὶ ἔχομεν ἀνθρωπίνην φύσιν, ὥστε ἀποδεχομένους τὸν εἰκότα μῦθον περὶ τούτων, πρέπει ζητεῖν μηδὲν ἔτι πέρα τούτου. 29D

monologue for the rest of the dialogue does he use the phrase, τὸν εἰκότα λόγον, the likened account. λόγος in itself possesses a multitude of meanings that range from speech, explanation, and account, to relation, ratio and reason. For the purposes of attempted consistency and clearness when λόγος is used, I will translate it as 'account' or 'ratio', unless otherwise noted. Whereas μῦθος uses reason as supplementary in expressing the totality of some idea, a λόγος functions more in the form of a strictly reasoned, and direct, communication or relation between the thinking subject and the object of thought. We may recall Socrates giving a μῦθος at the end of the *Phaedo*, when he describes the Earth with its running waters and interconnected functions. A μῦθος, as a story or metaphor, then does not deserve to simply be thrown away on the basis of a lack of perfect reasonability, but rather, the story must be chewed on and digested, with its reasoning in mind, so as to fully engage with the idea being communicated.

It also appears to me that Timaeus' acknowledgement of his inability to deliver a perfect account, and the human nature shared by him and his audience, functions as one last reminder in this section that we humans innately possess limitations in our efforts to account for the natural world. If anything, limited accounts must continually be developed as "inferior to none" so that, little by little, more accurate accounts evolve from prior inaccuracies. It would be a shame to not build any accounts simply because of self-acknowledged limitations. Copernicus would not have progressed upon Ptolemy, nor Kepler upon Copernicus, nor Newton upon Kepler, nor Einstein upon Newton. Though imperfect, each account produced by these natural philosophers stands upon another's shoulder to see further into Nature, and in time, their genealogy gives birth to a more perfect idea about Nature's functions.

Now keeping Timaeus' criterial exhortations in mind, and continuing with the purpose of reflecting on the proportional relationship between Plato's philosophical principles and Newton's mathematical principles, I want to examine each of Newton's Rules of Reasoning, both to explain their merit in regulating accounts, and to identify other areas of the dialogue that share parallel ideas with these rules.

Newton's first rule of reasoning states: "*We are to admit no more causes of natural things than such as are both true and sufficient to explain their appearances*[27]." For the natural philosopher, appearances of nature constitute the only available data that theories must correlate to. But what makes the better theory? For Newton, that comes down to accuracy and simplicity in respect of natural phenomena. Although the complexity of Ptolemy's geocentric model of epicycles upon epicycles does afford a great pleasure in their understanding, and his motions do seem more realistic, Copernicus' heliocentric model provided more accuracy with fewer motions, and in this way, brings mankind closer to the Truth of these matters. Well the Church at the time did not think so, but thank the Demiurge we do not blindly hold dogma that prohibits intellectual curiosity. Newton continues with a few words about the rule, "To this purpose the philosophers say that Nature does nothing in vain, and more is in vain when less will serve; for Nature is pleased with simplicity, and affects not the pomp of superfluous causes[28]." Even with his mathematics and reasoning guiding him, Newton gives us a bit of a rhetorical μῦθος as he anthropomorphizes Nature for the purpose of communicating the idea underlying his rule. Surely Nature does not find itself *pleased with simplicity*, nor affects the pomp of *superfluous causes*, but rather, in the spirit of Occam, Newton wants to proceed with as few, and necessary,

[27] Newton: *Principia* 320
[28] Newton Ibid.

assumptions as possible, razoring away the fat from the insufficient and complex so as to identify the sufficiently simple. In this vein, I wonder if Newton would consider a superlatively sufficient and true account of phenomena to be directly proportional with an idea of superlative Beauty, together ultimately converging towards a ratio of equality.

Paralleling these ideas of Nature's pleasure with simplicity and disdain of superfluous causes, Timaeus discusses how the God, i.e the Demiurge, arranged all visible appearances in a purposefully ordered and beautiful manner, which I consider commensurable with Newton's first rule. Timaeus begins,

> For the God, having willed for all things to be good things, and for nothing to be trivial as far as its nature permits, so in this very way, having undertaken *all as much was visible*, though not maintaining rest but it being moved out of tune and disorderly, he brought it all into order out from disorder, deeming the former to be, in all ways, better than the latter. And it neither was, nor is, divinely right for the best cause to accomplish anything except *the most beautiful thing*[29].

Within this passage, we see that all visible appearances, by the will of the Demiurge, find themselves systematized in a manner quite opposed to superfluousness. For Nature to have its arrangement as it exists, there lies a necessity for some sort of purposeful ordering since happenstance circumstances through geological time cannot allow for the development of perpetually uniform circumstances for the remainder of such geological time. A state of disorder simply cannot transform itself into a state of order without an impetus.

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[29] O: βουληθεὶς γὰρ ὁ θεὸς ἀγαθὰ μὲν πάντα, φλαῦρον δὲ μηδὲν εἶναι κατὰ δύναμιν, οὕτω δὴ πᾶν ὅσον ἦν ὁρατὸν παραλαβὼν οὐχ ἡσυχίαν ἄγον ἀλλὰ κινούμενον πλημμελῶς καὶ ἀτάκτως, εἰς τάξιν αὐτὸ ἤγαγεν ἐκ τῆς ἀταξίας, ἡγησάμενος ἐκεῖνο τούτου πάντως ἄμεινον. θέμις δὲ οὔτ' ἦν οὔτ' ἔστι τῷ ἀρίστῳ δρᾷν ἄλλο πλὴν τὸ κάλλιστον. 30A

R: γὰρ ὁ θεὸς, μὲν βουληθεὶς πάντα [εἶναι] ἀγαθὰ, δὲ μηδὲν εἶναι φλαῦρον κατὰ δύναμιν, οὕτω δὴ, παραλαβὼν πᾶν ὅσον ἦν ὁρατὸν, ἄγον οὐχ ἡσυχίαν ἀλλὰ κινούμενον πλημμελῶς καὶ ἀτάκτως, ἤγαγεν αὐτὸ εἰς τάξιν ἐκ τῆς ἀταξίας, ἡγησάμενος ἐκεῖνο [εἶναι], πάντως, ἄμεινον τούτου. δὲ οὔτ' ἦν, οὔτ' ἔστι, θέμις τῷ ἀρίστῳ δρᾷν ἄλλο πλὴν τὸ κάλλιστον. 30A

In respect of this necessary ordering, Timaeus uses the most emphatic word of authority to establish that the cause of such ordering can produce nothing but superlative beauty. This word, θέμις, which I translate as divinely right, quite literally means "the thing laid down", coming from the root verb τίθημι "to lay down", but its idiomatic meaning possess the force of "the thing laid down *by the gods*", and its personification as Θέμις correlates to the god of divine order and law. The strength of this relationship between θέμις, orderly cause, and superlative beauty cannot be underemphasized. Timaeus' assertion here that divine law dictates a resulting superlative beauty from orderly cause then functions as one of Plato's philosophical principles of nature. We could consider that as Divine Law is pleased with superlative beauty, so is Nature pleased with sufficient simplicity, and together, they wholeheartedly disdain the vain splendor of superfluousness that could attach itself to beautiful causes.

Following the reasoning from the first rule, Newton states his second rule of reasoning: "*Therefore to the same natural effects, we must, as far as possible, assign the same causes*[30]." If we adhere to criteria of phenomenal truth and theoretical simplicity, it would seem absurd to deviate from such criteria and suggest that identical appearances do not possess identical causes. Though this may not in all ways and altogether be the case, hence Newton's qualifier "as far as possible", this rule finds its utility in simplifying the manner by which we account for nature. Like the first rule, Newton gives a few clarifying words about this second rule, "As to respiration in a man and in a beast; the descent of stones in Europe and in America; the light of our culinary fire and of the Sun; the reflection of light in the earth and in the planets[31]." Now it would seem truly absurd to say that stones falling on different parts of the Earth would have different causes

[30] Newton Ibid.
[31] Newton Ibid.

for their downward attraction, but could the light of my miniscule kitchen fire have the same cause as the light of the perpetually burning Sun? Well, in the limited matters of phenomenal appearances, we find ourselves restricted by the sufficient simplicity required to develop an account about Nature's functions. So to answer my own question, yes, they do indeed possess the same cause for the light of a fire, even though those fires differ by orders of magnitude.

Let us consider this also, that if we were to reduce these two physical events down to their chemical composition and chemical activity, although the burning objects differ, the fires in themselves behave as any fire would, producing heat and producing light. In the same manner, though the two animals differ in species, respiration for both a man and a beast functions from the inhalation and exhalation of air within through the lungs. Even William Harvey's cardiac experiments[32] can serve here as evidence in virtue of his identification of identical circulatory causation for the identical effect of a body's blood recycling across animal species. With these considerations in mind, the attribution of identical causes to identical phenomena prompts me to reflect upon the elemental foundations of identical phenomena.

In the spirit of such elemental foundations for identical phenomena, I want to turn towards a rich sentence in the middle of Timaeus' explanation about the various interconnections and outcomes between the four universal, and geometrically interrelated, elements of fire, water, earth, and air. The wonder of their proposed geometric interrelations will await us in the third movement, but at this moment, the focus lies in how these four elements behave as universal causes for all perceivable effects of Nature, at least per Timaeus' likened account. In the midst of his elemental discourse, after identifying the unique effects from each unique elemental cause,

[32] Harvey *The Anatomical Exercises*.

he states, “So as many are the unmixed and primary bodies, they have come to be through such causes[33].” Now, with Doctor Mendeleev’s periodic table in hand, such a Timaean statement may seem too simplistic, but since his statement functions as a likened story, and an imprinted account, our philosophical focus should look through the rhetorical details to see the underlying idea.

The word for ‘causes’ here, αἰτιῶν, originally developed as a legal term for guiltiness and responsibility. If these four elements bear responsibility for the generation of any and all perceivable bodies, then all perceptible effects of such bodies will arise from these four elemental causes. However, Timaeus does specify that these are only auxiliary causes in respect of the primary, Intelligible cause. After introducing these elements at 53C, Timaeus will, for the remainder of the “dialogue”, rely on their combined elemental responsibility to account for their respective phenomena of heat, cold, pain, pleasure, hardness, softness, smoothness, roughness, taste, hearing, sight, smell, digestion, respiration, and disease, just to name a few of Timaeus’ objects of inquiry. Journeying within this section of the dialogue for the first time can leave one overwhelmed with all these strange explanations. Timaeus even acknowledges at the start of 53C that he will discuss these matters with an “unusual account[34].” However, if we take a step back, and consider what Plato communicates through Timaeus, I think Plato proposes the philosophic principle that all perceivable phenomena arise through physical actions of a set of universal elements.

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[33] O: ὅσα μὲν οὖν ἄκρατα καὶ πρῶτα σώματα, διὰ τοιούτων αἰτιῶν γέγονε. 57D
R: μὲν οὖν ὅσα [ἐστὶν] ἄκρατα καὶ πρῶτα σώματα, γέγονε διὰ τοιούτων αἰτιῶν. 57D

[34] “ἀήθει λόγῳ” 57C

Continuing with the importance, and limitations, of appearances in his first two Rules of Reasoning, Newton next addresses the function of experimental induction in respect of these perceivable appearances. The third rule states: "*The qualities of bodies, which admit neither intension nor remission of degrees, and which are found to belong to all bodies within the reach of our experiments, are to be esteemed the universal qualities of all bodies whatsoever*[35]." This third rule emphasizes how the particular appearances of an object that result from experiments must act as the basis for understanding the universal qualities of all similar objects. Experiments then hold paramount importance in the investigation of any and all natural phenomena. Newton goes on further to emphasize this importance,

> We are certainly not to relinquish the evidence of experiments for the sake of dreams and vain fictions of our own devising; nor are we to recede from the analogy of Nature, which uses to be simple, and always consonant to itself....The extension, hardness, impenetrability, mobility, and vis inertiae of the whole, result from the extension, hardness, impenetrability, mobility, and vis inertiae of the parts; and thence we conclude the least particles of all bodies to be also extended, and hard and impenetrable, and moveable, and endowed with their proper vis inertiae. And this is the foundation of all philosophy[36].

In addition to providing a conclusive consistency with prior notions of such true appearances, the experiment provides us with the phenomenal facts that must lead our investigation of natural philosophy. If a resulting appearance from an experiment contradicts the prior notions, then those notions should be abandoned or modified, and not the experimental result. Newton gives the example of experimentally dividing something previously thought to be indivisible. With this rule, such a division would lead one to conclude that other things once thought indivisible could actually be divisible. Anything that humans can know from Nature comes through the medium of appearances, so it seems natural to recognize the experiment's power to confirm or contradict

[35] Newton Ibid.
[36] Newton Ibid.

explanatory theories about Nature's appearances, and more importantly, the experiments' role to as the sole guide in determining qualities of physical bodies.

Whereas the other three rules only have an extra sentence of explanation, Newton devotes two full paragraphs to further explain the implications and force of this third rule. He concludes this section with a very thought-provoking notion of universal gravitation,

> Lastly, if it universally appears, by experiments and astronomical observations, that all bodies about the earth gravitate towards the earth, and that in proportion to the quantity of matter which they severally contain; that the moon likewise, according to the quantity of its matter, gravitates toward the earth; that, on the other hand, our sea gravitates towards the moon; and all planets mutually one towards another; and the comets in like manner towards the Sun; we must, in consequence of this rule, universally allow that all bodies whatsoever are endowed with a principle of mutual gravitation.[37]

The force of this argument lies in that every time we drop a coffee mug, watch a planet move through the night sky, or perceive any other gravitating body, we measure a gravitational force in the reciprocal ratio of the square of an object's distance to the matter to which it gravitates[38]. And since these bodies which we experience all gravitate towards each other, we can conclude this as a universal characteristic common to all objects. If the force of gravity simply depends on the quantity of matter, then there will always exist some force of gravity no matter the size of the object, whether it be a coffee mug, a human, or a celestial body. Of course, we feel the Earth's gravity far more than the coffee mug's, or the person next to us, but with Newton's third rule of reasoning, we can more appropriately reason about these particular objects, and all others, so as to develop a universally true and sufficient account about Nature.

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[37] Newton Ibid.
[38] Newton *Principia*: Book 1 Proposition 6 Theorem 6

The next proportional passage that I now want to correlate to Newton's third rule emphasises the importance and benefit of our sight in experiencing the natural world, through our various experiences, in order to create an account. Timaeus praises vision above all, stating:

> Sight, according to my account, certainly has become the cause of the greatest benefit for us, because none of the accounts now being spoken about The All would ever have been uttered if men saw neither the stars nor the Sun nor the heavens. And now, since the day and night, months and the revolutions of varied years, have been seen, together they have contrived number, and they gave a conception of time and an investigative means about the nature of The All. From these things, we brought through a genus of philosophy, a good greater than which ever came nor ever will arrive, as something bestowed from the gods, for the mortal race[39].

The emphasis in this passage lies in how the act of perceiving Nature's orderly phenomena provides the very basis for developing an account of such phenomena. In a manner I think similar to Dedekind's explanation of arithmetic's origin, that is, through the successive abstraction of physical objects[40], Timaeus here points to the observation of regular phenomena as what allows for the contrivance of number and time by their shared quality of succession. This regularity of the celestial motions then first allows us, the thinking animals, to conceive an idea of sequential order through their phenomenal experiences.

I wanted to transliterate γένος in this passage because I take genus in its logical sense here to indicate itself as a branch of philosophy that bears its fruit through the observation of the

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[39] O: ὄψις δὴ κατὰ τὸν ἐμὸν λόγον αἰτία τῆς μεγίστης ὠφελείας γέγονεν ἡμῖν, ὁτι τῶν νῦν λόγων περὶ τοῦ παντὸς λεγομένων οὐδεὶς ἂν ποτε ἐρρήθη μήτε ἄστρα μήτε ἥλιον μήτ' οὐρανὸν ἰδόντων. νῦν δ' ἡμέρα τε καὶ νὺξ ὀφθεῖσαι μῆνές τε καὶ ἐνιαυτῶν περίοδοι μεμηχάνηνται μὲν αριθμόν, χρόνου δὲ ἔννοιαν περί τε τῆς τοῦ παντὸς φύσεως ζήτησιν ἔδοσαν. ἐξ ὧν ἐπορισάμεθα φιλοσοφίας γένος οὗ μεῖζον ἀγαθὸν οὔτ' ἦλθεν οὔθ' ἥξει ποτὲ τῷ θνητῷ γένει δωρηθὲν ἐκ θεῶν. 47B

R: ὄψις, κατὰ τὸν ἐμὸν λόγον, δὴ γέγονεν αἰτία τῆς μεγίστης ὠφελείας ἡμῖν, ὁτι οὐδεὶς τῶν νῦν λόγων λεγομένων περὶ τοῦ παντὸς ἂν ποτε ἐρρήθη ἰδόντων μήτε ἄστρα μήτε ἥλιον μήτ' οὐρανὸν. δ' νῦν, ἡμέρα τε καὶ νὺξ, τε μῆνές καὶ περίοδοι ἐνιαυτῶν ὀφθεῖσαι, μεμηχάνηνται μὲν αριθμόν, δὲ ἔδοσαν ἔννοιαν χρόνου τε ζήτησιν περί τῆς φύσεως τοῦ παντὸς. ἐξ ὧν, ἐπορισάμεθα γένος φιλοσοφίας, ἀγαθὸν μεῖζον οὗ οὔτ' ἦλθεν οὔθ' ποτὲ ἥξει, δωρηθὲν ἐκ θεῶν, τῷ θνητῷ γένει. 47B

[40] Dedekind *Essay on the Theory of Numbers:* 4.

phenomenal appearances from the celestial bodies, and more extendedly, from all physical bodies. Species of this genus would include chemistry, biology, electrodynamics, physics, and all other sorts of other experimental sciences of natural phenomena. Imagine the difficulty of taking such sciences to the point of their advancement now without the aid of sight! Of course, certain sciences will require the use of other senses, as the ear with music and the tongue with the culinary craft. But above all, as Timaeus appreciates, our eyesight allows for an unparalleled amount of observing and reporting in our investigation of The All. Like Newton, at least to a proportional degree, Plato understands the intrinsically necessary starting point of experiencing Nature through our senses so as to develop an account about Nature.

Now, since Newton's third rule of reasoning lays down the importance of the experiment in producing analyzable appearances, his fourth and last rule of reasoning will offer a method for unifying such experimental appearances. The fourth rule of reasoning states:

> *In experimental philosophy we are to look upon propositions collected by general induction from phenomena as accurately or very nearly true, notwithstanding any contrary hypothesis that may be imagined, till such time as other phenomena occur, by which they may either be made more accurate, or liable to exceptions.*

This method of general induction from phenomena requires the compiling of persistent observations over a multitude of similar phenomena in order to abstract a formal proposition, and not a heuristic proof, about the shared experimental appearances from such phenomena. As opposed to general deduction, where a set of accepted principles logically birth out from themselves a systematically derived totality, general induction of nature necessitates the use of as many phenomena as possible to affirm an unifying hypothesis. If any phenomena then arise contrary to the induced theories, their appearance must call the theories to attention. And no amount of imagination can shake the induced theories, provided the imagination does not use

experimental phenomena as parameters for developing a more accurate account, as will be the case for Einstein's fresh perspective on measuring a physical event. However, regardless the natural philosopher, the experimental phenomena must always act as the most important standard, and ultimate judicial power, in the investigative means of natural philosophy.

I once heard from a Brother that the popularity of billiards during Newton's day afforded him the luxury of experiencing countless collisions of uniformly dense bodies, each promoting a reaction to their forceful action. Perhaps billiards didn't exactly drop the apple on his head, but the Brother's point remains: Newton induced the three laws of motion, and its six accompanying corollaries, through the meticulous observations of experimental phenomena. With the additional eleven geometric lemmas about the proportional ratios and angles of moving figures, which Newton proposes "to avoid the tediousness of deducing perplexed demonstrations ad absurdum, according to the method of ancient geometers[41]", and only at this point of having these mathematical propositions in hand, Newton embarks on the mathematically wonderful journey of general deduction from these induced principles.

So in the same manner as Euclid geometrically deduced the thirteen books of logical figures from the partless point, and as Apollonius geometrically deduced the parabola[42], hyperbola, and ellipse from the abstract cone, so does also Newton geometrically deduce a whole range of mathematical principles from the laws, corollaries, and lemmas. However, Newton sets himself apart by inducing, from phenomena, "principles of philosophy, principles not philosophical but mathematical; such to wit, as we may build our reasonings upon in philosophical inquiries. These principles are the laws and conditions of certain motions, and

[41] Newton 38.
[42] Apollonius *Conics*: Book 1 Proposition 11

power or forces, which chiefly have respect to philosophy[43]." Through the movement of general induction and then deduction, Newton begins at natural phenomena and ends at mathematically unifying principles of such natural functions. If there exists a pleasure in reading and understanding the logical clarity of Euclid and Apollonius, then there exists an exponential exhilaration in progressing through Newton's own geometric propositions.

To bring Plato back into the flux, I have a proportional passage that sheds light on this idea of logical consistency. Essentially, Timaeus suggests to lay aside Being, and take up accounts of Becoming, in order to an account about The All. In the midst of developing a consistent account about his geometric elements, Timaeus gives us this relevant tangent at 59D,

> And for the others of such things, there exists, in no way, a complexity for the person investigating the very idea of likened stories to reason it through further, and which idea, when someone, for the sake of recreation, having put aside accounts of eternal Beings, and looks through likened accounts concerning Becoming, such a person acquires it as an unrepentant pleasure, and he would produce for himself a measured and practical entertainment within his life. And so giving these current things free rein for this very entertainment, we will go through, in their respective order, the likened things of these same ones, one after another, in this way[44].

I take this so called lack of complexity for Timaeus as a rhetoric device by Plato due to the fact that the subsequent explanations from his geometric elements seem to be, at their face value, absurdly complex. However, in looking through the totality of this rhetoric, and closely at the

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[43] Newton 319.

[44] O: τἆλλα δὲ τῶν τοιούτῶν οὐδὲν ποικίλον ἔτι διαλογίσασθαι τὴν τῶν εἰκότων μύθων μεταδιώκοντα ἰδέαν, ἣν ὅταν τις ἀναπαύσεως ἕνεκα τοὺς περὶ τῶν ὄντων ἀεὶ καταθέμενος λόγους, τοὺς γενέσεως πέρι διαθεώμενος εἰκότας ἀμεταμέλητον ἡδονὴν κτᾶται, μέτριον ἂν ἐν τῷ βίῳ παιδιὰν καὶ φρόνιμον ποιοῖτο. ταύτῃ δὴ καὶ τὰ νῦν ἀφέντες τὸ μετὰ τοῦτο τῶν αὐτῶν πέρι τὰ ἑξῆς εἰκότα δίιμεν τῇδε. 59C

R: δὲ τἆλλα τῶν τοιούτῶν, [ἐστὶ], οὐδὲν, ποικίλον μεταδιώκοντα τὴν ἰδέαν τῶν εἰκότων μύθων διαλογίσασθαι ἔτι, ἣν, ὅταν τις, ἕνεκα ἀναπαύσεως, καταθέμενος τοὺς λόγους περὶ τῶν ἀεὶ ὄντων, διαθεώμενος τοὺς εἰκότας πέρι γενέσεως, κτᾶται ἀμεταμέλητον ἡδονὴν, ἂν ποιοῖτο μέτριον καὶ φρόνιμον παιδιὰν ἐν τῷ βίῳ. καὶ ἀφέντες τὰ νῦν δὴ ταύτῃ, δίιμεν, ἑξῆς, τὰ εἰκότα πέρι τῶν αὐτῶν, τὸ μετὰ τοῦτο, τῇδε. 59C

language here, an idea arises of logical and progressive consistency in respect of priorly reasoned notions when taking up accounts of the physically likened things within our natural reality.

The use of the infinitive διαλογίσασθαι, from the verb διαλογίζομαι, fundamentally meaning "I reason through, distinguish, or calculate", combined with Timaeus' ironic notion of non-existent complexity in progressing through his likened account, communicates this idea of logically progressing through a set of principles, whether philosophical or mathematical, in a valid and consistent manner. By taking up Becoming and all such existing objects, Timaeus works in a method proportional to Newton by using phenomenal appearances as the first step in accounting for The All. Though he does not cultivate this idea as Newton does with his propositions from general inductions, Plato does plant a seed here for engaging in natural philosophy through a logically consistent and, as far as possible, a phenomenally true criteria.

Before moving on towards the third movement, I want to stop this current motion with the force of Socrates' last words in the dialogue by offering a dual translation and interpretation that I take as a purposeful ambiguity by Plato. After Timaeus gives his regulating criteria, and pleas Socrates for a compassionate human ear, Socrates enthusiastically responds, "Most excellent, Timaeus! We must accept it in all ways just as you are commanding. We wonderfully accept your prelude, and so indeed, accomplish the law for us in its order[45]!" This translation takes both νόμον and πέραινε in their more common meaning of law and accomplishing, respectively. However, this last part of Socrates' statement can also be taken idiomatically as,

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[45] O: ἄριστα, ὦ Τίμαιε, παντάπασί τε ὡς κελεύεις ἀποδεκτέον. τὸ μὲν οὖν προοίμιον θαυμασίως ἀπεδεξάμεθά σου, τὸν δὲ δὴ νόμον ἡμῖν ἐφεξῆς πέραινε. 29E

R: ἄριστα, ὦ Τίμαιε, ἀποδεκτέον παντάπασί τε ὡς κελεύεις. μὲν οὖν ἀπεδεξάμεθά θαυμασίως τὸ προοίμιον σου, δὲ δὴ, πέραινε ἐφεξῆς τὸν νόμον ἡμῖν. 29E

"and so indeed, sing the song for us in its order!" Idiomatically the verb περαίνω can also mean 'I sing' or 'I recite' with a musical direct object, in this case νόμον, which idiomatically means a 'song' or 'melody'. To give an idea of this ambiguity, translators R.G Bury[46] and Donald Zeyl[47] take Socrates' last statement as akin to my first translation above, while Peter Kalkavage[48] takes it akin to the second. To reconcile these possible interpretations, I propose the idea that Plato intends for both meanings to impress themselves upon the reader simultaneously. On one hand, Socrates implores Timaeus to sing the harmonious song that constitutes his likened story, and thus communicate his rhetorically tuned ideas about The All. But on the other hand, Socrates implores Timaeus to cultivate the governing law of Nature to its end, and thus establish a logically systematic account of The All.

However, I do not think Timaeus, and by extension Plato, capable of cultivating the law to its end, in the way Newton does, because Plato stands on a much shorter stack of giants than Newton. Who knows if Plato could have done what Newton did, or vice versa, but over time, the abundance of experimental results from giant astronomers such as Brahe, Kepler, and Galileo, as well as their unifying theories from induction in respect of these phenomena, together they provided Newton the necessary resources for him to synthesize all that came before. In this same manner of synthesis, I believe Plato uses Timaeus to unite and review the leading mathematical theories of the ancient world at his time. Even Timaeus' astronomical account concerning revolutions of Same and Other, and eight planetary orbits, starting at 37B strongly bears a resemblance to Ptolemy's astronomical model nearly 400 years later. My concern now lies not in detailing these underlying ancient accounts, but in identifying a similar action of theoretical

[46] *Timaeus.* Trans. Bury. Loeb Classical Library
[47] *Timaeus.* Trans. Zeyl. Hackett Publishing
[48] *Plato's Timaeus.* Trans. Kalkavage. Focus Philosophical Library

synthesis on the part of Plato and Newton. At this point now, each unique synthesis will come into examination by first hearing the song from Plato's lyre, and then, with Plato's melodies in mind, we will heed the law from Newton's phenomenal motions.

The Last Movement: Nature Laid Bare

In order to give a concise, but detailed, summation of Timaeus' likened account, I want to turn to 69C-D in which he recapitulates the main themes and ideas for the third and final time with haste. He possesses such promptness in his eager attempt "to add to the story, at this time, both a completion and a head that harmonize with the prior things[49]." Harmony in this sense for the Greeks fundamentally communicated the idea in which all the parts fit snugly to the whole, so much so that the totality of their functioning arrangements maintains itself in a self-sustaining oneness. Coming from the verb ἁρμόζω, ideas of harmony within Ancient Greek literature occur in musings about all sorts of crafts and in the completions of actual deeds. But overall, the idea of a near, if not, perfect fit for the parts to a whole gets across the notion of how harmony develops its meaning. The following passage will find its context in the dialogue by presenting the ideas fresh in mind as a sort of refrain to Plato's song.

Timaeus must now start at the very beginning, in a total state of disorder with flux fluxing fluxingly, and thus he proceeds accordingly:

> And so just as it had been said at the beginning, though these things were disorderly holding their state, the God produced within commensurabilities for each thing itself, both in relation to itself and in relation to each other - as many commensurabilities, and

[49] O: καὶ τελευτὴν ἤδη κεφαλήν τε τῷ μύθῳ πειρώμεθα ἁρμόττουσαν ἐπιθεῖναι τοῖς πρόσθεν. 69B
R: πειρώμεθα ἐπιθεῖναι τῷ μύθῳ, ἤδη, καὶ τελευτὴν τε κεφαλὴν ἁρμόττουσαν τοῖς πρόσθεν. 69B

> in whatever way, as it was possible for these things to be proportional and commensurable[50].

Through such poetic production, Timaeus' God, the Demiurge, essentially changes the very being of each and every fluxing object through the addition of our plural direct object here, the commensurabilities, αἱ συμμετρίαι. These commensurabilities, by relating all objects both to themselves and any other possible object, thus interrelate The All by an Aristotelian actuality of shared measurement. As a whole, this inner production finds its purpose by making all the previously fluxing flux both proportional and commensurable.

Reading this passage for the first time can seem very fanciful and rhetorical, and I think Plato intends this due to the structure of the dialogue as a near monologue. However, in thinking through these rhetorical details, and considering the philosophical merit of such ideas, I believe much more rises to the surface just as Plato intended.

Coming from the combination of the preposition 'with' (σὺν) and the noun ' a measure' (μέτρον), commensurability works as one of the few useful Latin transliterations of Greek words in that it maintains the clear notion of an object sharing some measure with another object. In ancient mathematics, commensurability between two numbers or lines meant that they shared a common measure, even if a most miniscule one. The Pythagorean discovery of incommensurability in numbers and lines then shook the understanding of mathematics, but also progressed that very understanding. Such shock occurred because geometrical logic

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[50] O: ὥσπερ οὖν καὶ κατ᾽ ἀρχὰς ἐλέχθη, ταῦτα ἀτάκτως ἔχοντα ὁ θεὸς ἐν ἑκάστῳ τε αὐτῳ πρὸς αὐτὸ καὶ πρὸς ἄλληλα συμμετρίας ἐνεποίησεν, ὅσας τε καὶ ὅπῃ δυνατὸν ἦν ἀνάλογα καὶ σύμμετρα εἶναι. 69B

R; καὶ οὖν ὥσπερ ἐλέχθη κατ᾽ ἀρχὰς, ταῦτα ἀτάκτως ἔχοντα, ὁ θεὸς ἐνεποίησεν συμμετρίας ἐν ἑκάστῳ αὐτῳ τε πρὸς αὐτὸ καὶ πρὸς ἄλληλα, ὅσας [συμμετρίας], τε καὶ ὅπῃ, ἦν δυνατὸν [ταῦτα] εἶναι ἀνάλογα καὶ σύμμετρα. 69B

demonstrates that the diagonal of a square does not share any measure with the sides. We could build a perfect square, with sides precisely built 1000 feet long, each meeting at perfect right angle, and not even a hair could act as an exhaustible, common measure between the diagonal and the sides of our stone tribute to Pythagoras!

Proportion does not exactly have the same etymological ease, but we do know its cognate, analogy. Etymologically, the word develops from the combination of the preposition 'up' (ἀνὰ) and the heavy noun λόγος. Quite literally, an ἀναλογία can mean "a reasoning up", in that a sequenced chain of thoughts, maintaining links of justifiable conclusions, progress up into higher genuses of thought when thinking about things. So proportions are analogies, and analogies are proportions. Analogies often help in clarifying ideas, and relating a known concept to a currently unknown one, by facilitating the judgement in discovering a common likeness. I've always felt that the clarity from a good analogy gives a sense of overview for the ideas in hand, and a richer appreciation for both ideas.

When I reflect on this philosophical analogy, that the most fundamental parts of The All intrinsically exist as proportional and commensurable units of matter, I find myself thinking back on the harmonious fit between chemical reactions and their elements that possess various degrees and qualities of commensurability with each other. After all, what would it really mean for every particle of matter to possess such geometric aspects of their being? If nothing else, the establishment of proportionality and commensurability in the very being of existing objects provides an intelligible basis for a systematic rationalization of The All. Only at this point can our minds can possess their own commensurability, their own συμμετρία, with an object.

As Timaeus continues his recapitulation of everything he previously mentioned, he addresses the state of The All prior to the poetic production: "For at that time, nothing was partaking of these things, except by chance, nor was there a worth, in any way, to name anything altogether with the names now in use, such as fire, water, and anything of the others"[51]. For me, this immediately brings to mind the universe moments in its total existence moments after the big bang. At that point in geological time, existence was constituted the countless motions and collisions of the chunky primordial soup. For Timaeus, the Demiurge let the constituents of this primordial soup sit for just a few moments, before placing within its very being an innate proportionality in respect of all things.

I want to diverge a moment to highlight one aspect of this proportionality that Timaeus brings up much earlier in the dialogue. In discussing the four elements, Timaeus eventually offers his idea that the four elements of earth, air, water, and fire are formed, using elemental isosceles and equilateral triangles, in the shape of geometrically "subatomic" constructions as a cube, octahedron, icosahedron, and tetrahedron, respectively. These shapes constitute four of the five famed Platonic solids, and Timaeus uses the fifth, the dodecahedron, for the shape for The All as whole due to its closeness to a perfect sphere. What is it about the Platonic solids that deems that fit to represent the structure of the Cosmos? I leave this question for the reader's own thought. And if these individual elements were not geometrical enough, Timaeus places them in a proportion with two middle terms, as is necessary for a Euclid proportion between two three-dimensional objects. He describes this necessity of a middle term in general, stating that,

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[51]O: τότε γὰρ οὔτε τούτων ὅσον μὴ τύχῃ τι μετεχεν, οὔτε τὸ παράπαν ὀνομάσαι τῶν νῦν ὀνομαζομένων ἀξιόλογον ἦν οὐδέν, οἷον πῦρ καὶ ὕδωρ καὶ εἴ τι τῶν ἄλλων. 69B
R51: ἀρ τότε μὴ τι οὔτε μετεχεν τούτων, ὅσον τύχῃ, οὔτε ἦν ἀξιόλογον, οὐδέν, ὀνομάσαι τὸ παράπαν τῶν νῦν ὀνομαζομένων, οἷον πῦρ, καὶ ὕδωρ, καὶ εἴ τι τῶν ἄλλων. 69C

> It is impossible for two things alone to be beautifully united together without a third thing. For some bond must arise in the middle as a union for both. And the most beautiful of the bonds is that which would, as far as possible, render itself and the things being bound together, into a oneness. And to complete this, proportion naturally arises as the most beautiful[52].

Within this passage, Timaeus attributes a superlative beauty to proportion because of its function in producing a harmonious oneness between the parts and the whole of a relation. At least in the realm of geometry and mathematics, that is exactly what a proportion does. And in compounding proportions, whilst maintaining their own logical unity of parts, further implicit proportions arise. Euclid, Apollonius, and Newton each find a utility in manipulating proportions by the Euclidean definitions of proportions, and in doing so, they progressed and demonstrated further propositions.

Timaeus' use of the verb πέφυκεν also grabs my focus due to its force in conveying an idea of a wholly natural production or event. I think it quite a claim, though not an absurd one, to say that proportion *naturally* presents itself as the best method of interrelating things. Maybe more simply, everything in Nature acts and reacts in each thing's own proper proportion. A plant needs its proportionate amount of water to grow, and not drown, blood needs a proportionate amount of white and red cells to remain vital, water needs a proportionate amount of hydrogen and oxygen to maintain its existence, even our lungs need the proportionate amount of nitrogen, oxygen, and carbon dioxide to maintain our existence. All these natural functions must then

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[52] O: δύο δὲ μόνω καλῶς ξυνίστασθαι τρίτου χωρὶς οὐ δυνατόν. δεσμὸν γὰρ ἐν μέσῳ δεῖ τινὰ ἀμφοῖν ξυναγωγὸν γίγνεσθαι. δεσμῶν δὲ κάλλιστος ὃς ἂν αὑτὸν καὶ τὰ ξυνδούμενα ὅ τι μάλιστα ἓν ποιῇ. τοῦτο δὲ πέφυκεν ἀναλογία κάλλιστα ἀποτελεῖν. 31B

R: δὲ [ἐστὶν] οὐ δυνατόν δύο μόνω καλῶς ξυνίστασθαι χωρὶς τρίτου. γὰρ δεῖ τινὰ δεσμὸν γίγνεσθαι ἐν μέσῳ ξυναγωγὸν ἀμφοῖν. δὲ κάλλιστος δεσμῶν [ἐστὶν] ὃς ἂν, ὅ τι μάλιστα, ποιῇ αὑτὸν καὶ τὰ ξυνδούμενα, ἓν. δὲ ἀποτελεῖν τοῦτὸ, ἀναλογία πέφυκεν κάλλιστα. 31B

maintain a proper ratio for the continuation of such natural functions. In the spirit of Pythagoras, I would want to say, “All is Ratio!”

But in this matter of a geometrically elemental proportion, Timaeus finally lays down the proportion that as Fire to Air, then Air to Water, and as Air to Water, then Water to Earth, or in a Euclidean manner, Fire**:**Air**::**Air**:**Water**::**Air**:**Water**::**Water**:**Earth. Timaeus’ geometrically appropriate use of proportion in relating three dimensional objects, these geometric elements, reminds me of the fact that Euclid, for the most part, gathered and systematized geometry as an art instead of independently developing the logical ideas of each and every proposition. Pythagoras would frown down upon me if I forgot about the contributions of the ancient mathematicians, all the way back to Thales. I can almost imagine Socrates at this point salivating at the mathematical richness of Timaeus’ rhetorical monologue. In a way, Plato now seems to me to have crafted a piece of mathematical fiction, with the nature of Nature as his resonating theme.

The last portion of Timaeus’ recapitulation of The All that I now want to offer also easily reads as wonderful mathematical fiction, but also, and more importantly, as two philosophical assertions: “But first, he thoroughly ordered all these things, and thereupon, he *systematized*[53], out from these things, This All, as one living creature holding within itself all living beings, both mortal and immortal[54]." The Demiurge’s first action here comes by way of the verb διακοσμέω, whose noun, κόσμος, order, we have encountered throughout. The preposition διὰ, fundamentally meaning ‘through’, adds a dimension of thoroughness and completion to the Demiurge’s ordering action. Earlier on, the adverb ἀτάκτως, which I translated as ‘disorderly’,

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[53] Added emphasis.

[54] O: ἀλλὰ πάντα ταῦτα πρῶτον διεκόσμησεν, ἔπειτ' ἐκ τούτων πᾶν τόδε συνεστήσατο, ζῷον ἓν ζῶα ἔχον τὰ πάντα ἐν ἑαυτῷ θνητὰ ἀθάνατά τε. 69C

R: ἀλλὰ πρῶτον, διεκόμησεν πάντα ταῦτα, ἔπειτ', συνεστήσατο, ἐκ τούτων, τόδε πᾶν, ἓν ζῷον ἔχον τὰ πάντα ζῶα ἐν ἑαυτῷ, θνητὰ τε ἀθάνατά. 69C

described the fluxing state of the flux, but this descriptor more literally communicates the idea of an army not in its battle formation. So when the Demiurge thoroughly orders the disorderly elemental battalion, he essentially places each previously fluxing particle in its proper position and proper arrangement in respect of every other particle. Whereas before the Demiurge's touch The All was All with no part distinguishable from the next, but through the totality of this proper ordering, each and every part that constitutes The All found itself distinguished as a particular part in a certain relation to every other part, and in a certain relation to the whole. At this point, the troops are ready for the Demiurge's next command, the systematization of The All.

This second action, which I translate as 'systematize', comes from the combination of σὺν and the verb ἵστημι, meaning "to make stand, set up, establish", to form the verb συνίστημι. This compound verb develops to communicate the idea of action that combines, organizes, and places things together into a united set-up. I choose to use the word 'systematize' here for two reasons.

Firstly, an action of systematization appears to me to communicate an idea of ordering already ordered things into a totality of order. Even the word system implies a notion of distinctly interdependent parts forming an integrated whole. With this in mind, and the Demiurge's first action of orderly battle formation, systemization seemed appropriate to richly communicate the Demiurge's second action.

Secondly, Newton calls his third book of the *Principia*, "The System of the World." In it he first states the phenomena that, with the geometric propositions of Book 1, will serve as evidence for the mathematical propositions of Nature within this third book. He uses here the Latin word systema, which itself comes from the Ancient Greek verb συνίστημι. And in the same

way that the Demiurge's agency sets up the system, Newton also attests in the General Scholium, at the very end of the *Principia*, that, "All that diversity of natural things which we find suited to different times and places could arise from nothing but the ideas and will of a Being necessarily existing[55]." So by translating συνίστημι as "systematizing", I hoped to offer a translation that makes clear the proportional relationship of Plato and Newton's ideas of natural philosophy with the support of this etymological connection.

The Demiurge's resulting systematization of The All as a single living creature initially appears, at least to me, as rhetorically beautiful, but after considering the necessarily proper proportions for the functioning of any natural act, and that perhaps "All is Ratio!", it philosophically makes sense for the The All to exist as a functioning natural thing, or in other words, a living thing.

By walking step by step with Timaeus in his last recapitulation, and the first two movements, I hope to have brought to light the ideas proportionality, commensurability, order, systematization, a necessary Craftsman, and maybe the most important, beauty, as philosophical principles of nature that Plato underlies within Timaeus' mathematically rhetorical λόγος. The identification of these philosophic principles must necessarily precede the cultivation of mathematical principles in the same way that the identification of a problem's characteristics precedes the cultivation of an appropriate solution.

Without a doubt, both Plato and Newton wondered at the night sky, beholding its order, and without a doubt, both Plato and Newton attempted to account for that very phenomena. Though the height of their stacked giants differed, the same problem presented itself to these

[55] Newton 442.

philosophers, and to all philosophers, even ourselves. We all experience the same Nature, and view the same night sky experienced by Great Minds from our books, yet today, our stack of giants now reaches the damp dirt of Mars. Such a proportional progression of natural philosophy could not have arisen with a first originating curiosity to know, most exceedingly, about the nature of The All. So by keeping Plato's philosophical principles in the peripherals of our mind's eye, I want to shift the focus from Plato, the Ancestor, to Newton, the Descendant, in order to recognize the inherited philosophical principles that underlie Newton's mathematical principles.

Before Newton proceeds into his three main books, he begins *The Principia* with an author's preface where he states his purpose as a "design not respecting arts, but philosophy, and our subject not manual but natural powers....and therefore we offer this work as the mathematical principles of philosophy[56]." Such mathematical principles will possess a capability of demonstration and further deduction, and in fundamentally being gathered from a general induction from phenomena, these principles will describe the forces of nature in a geometric form. In the end, for the whole third and final book, Newton intends to "deduce the motions of the planets, the comets, the moon, and the sea;...[and to] derive the rest of the phenomena of nature by the same kind of reasoning from mechanical principles[57]." All the mathematical principles in Books 1 and 2, deduced in a logically geometric manner, will serve as necessary evidence to attribute a functioning geometric form to the powers of Nature.

Following the author's preface, Newton begins Book 1 with the section "*Definitions*", and states eight definitions that establish matter, density, force, and centripetal force as terms with distinct explanations and methods of measurement. Each particular definition results from

[56] Newton 4.
[57] Newton Ibid.

the induction of particular phenomena, some of which Newton mentions. For centripetal force, which tends toward a center point in orbit, he gives the example of a stone being swung around in a sling and of the planets tending towards the Sun. In addition to these defined terms, Newton ends this section with an explanatory Scholium in which he also distinguishes time, space, and motion, as "absolute and relative, true and apparent, mathematical and common[58]." By distinguishing these terms as such, and focusing solely on the absolute, true, and mathematical, Newton intends to consider "those forces not physically, but mathematically[59]." In doing so, he can demonstrate the powers of natural forces with the exact precision of geometric analysis, and thus examine the forces in themselves.

After the establishment of these necessary definitions, Newton presents the next section, "*Axioms, or Laws of Motion*." This section contains his famous three laws of motion and six corollaries, all together which establish governing axioms of motion wholly generated by the general induction from phenomena. In the Scholium of this axiomatic section, Newton simply states that he has "laid down such principles as have been received by mathematicians, and are confirmed by abundance of experiments[60]." Newton even gives credit for the first two laws and first two corollaries to Galileo due to his discovery that all bodies, in a near perfect manner, descend at the same rate of acceleration[61], whether a bowling bowl and a marble, and in the motion of a parabola, the very same curve that Apollonius deduces in his *Conics*. I mention this near perfect manner because Galileo observed that the resistance of air prohibited exact measurements of such a descending acceleration and parabolic motion. He reasoned that if

[58] Newton 13.
[59] Newton Ibid.
[60] Newton 25.
[61] Galileo *A Dialogue Concerning Two Sciences.*

bodies fell in a vacuum, with no medium providing resistance, they would all fall in a perfectly equal and uniform rate of acceleration, and in the perfect motion of Apollonius' parabola. Most importantly, phenomena appeared to Galileo, and he produced a mathematical account with experimental confirmation so as to discover the geometrical form by which bodies descend within The All. By such experimental confirmation, the theory matches the phenomena, and so Newton's nine total axioms of motion carry a true and sufficient weight in governing all natural forces.

Having laid down his definitions and axioms, Newton now demonstrates a new method of geometric analysis for the purpose of developing the subsequent propositions in next two books. This section, titled "*Of the method of first and last ratios of quantities, by the help whereof we demonstrate the propositions that follows"*, contains within it eleven lemmas that allow for a geometric analysis of curved lines through the "first and last sums of nascent and evanescent quantities, that is, to the limits of those sums and ratios[62]." This method demonstrates a proportionality between the subtended angle of a curved line and its sides at all respective points. If a curved line were to shift closer and closer to its subtending angle, nearing its point of disappearance into a point, Newton's method would treat the point right before disappearance, at the ultimate ratio of evanescent qualities. He intends this ultimate ratio "to be understood the ratio of quantities not before they vanish, nor afterwards, but with which they vanish[63]." Near the end of this section, Newton stresses the necessity and utility of these lemmas, stating, "the force of such demonstration always depends on the method laid down in the foregoing Lemmas[64]." With this geometric method of analysis for curved lines in hand, Newton can now demonstrate

[62] Newton 38.
[63] Newton Ibid.
[64] Newton Ibid.

and deduce, *a priori*, the mathematical principles of Book 1 and 2 from the induced laws, corollaries, and lemmas.

In the second section of Book 1, "*On the Invention of Centripetal Force,*" Newton deduces the first of 150 total mathematical propositions to follow in these two books. Newton uses 'invention' here in its more etymological sense as 'a finding' or 'discovery', so in reality, his first progressions in Book 1 quickly establish new knowledge about Nature. Within the first four propositions, Newton demonstrates the geometric principles of a centripetal force that draws bodies off from their rectilinear motions and into a revolving orbit. When such revolving bodies describe areas proportional to their times about a point, one can then assign a centripetal force as its cause. In the Scholium after proposition four, Newton emphasizes the utility of the completed proposition, "by means of the Proposition and its Corollaries we may discover the proportion of a centripetal force to any other known force, such as that of gravity[65]." This proportional means of investigation will then allow for the discovery of unknown forces in a strict mathematical manner.

Once he concludes proposition four[66], Newton lists its nine accompanying corollaries, the sixth of which states, "If the periodic times are in the sesquiplicate ratio of the radii, and therefore the velocities reciprocally in the subduplicate ratio of the radii, the centripetal forces will be in the duplicate ratio of the radii inversely; and the contrary[67]." This ratio of a revolving body's radial distance squared to its periodic time cubed finds itself observed in the various, revolving celestial bodies, "as Sir Christopher Wren, Dr. Hooke, and Dr. Halley have severally

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[65] Newton 45.
[66] Proposition 4 Theorem 4: *The centripetal forces of bodies, which by equable motions describe different circles, tend to the centres of the same circles; and are on to the other as the squares of the arcs described in equal times applied to the radii of the circles*. Newton 43.
[67] Newton 44.

observed[68].” The observed maintenance of this harmonious ratio for a revolving body around a planet will then serve as evidence for justifiably assigning a centripetal force to the attractive planet. As a result, this corollary to the fourth proposition, in addition to the first four propositions and the six phenomena immediately to follow, will serve as an integral part of the necessary and sufficient evidence for Newton to begin the demonstrations of the System of the World.

Following the first 10 propositions, Newton begins the third section of Book 1, “*Of the motion of bodies in eccentric conic sections,”* the last section in the book which I will comment on. Within this phenomenal section, Newton geometrically lays down the law of a centripetal force that towards a focus point for each conic section, the very same conics[69] which Apollonius deduced from his set of defined axioms. Only with Apollonius’ geometry of conics section could Newton even begin this third section, and in doing so, he establishes the three motions of natural bodies when affected by a centripetal force. The most common one we know of comes by Galileo, that all bodies fall in the motion of a parabola by the same rate of natural acceleration. These three motions also possesses natural and mathematical interrelations to morph into each other:

> If the ellipsis, by having its centre removed to an infinite distance, degenerates into a parabola, the body will move in this parabola; and the force, now tending to a centre infinitely remote, will become equable. Which is *Galileo’s* theorem. And if the parabolic section of the cone (by changing the inclination of the cutting plane to the cone) degenerates into an hyperbola, the body will move in the perimeter of this hyperbola, having its centripetal force changed into a centrifugal force[70].

[68] Newton Ibid.
[69] Apollonius *Conics*: Book 1 Propositions 11-13
[70] Newton 51.

The intermorphing nature of these natural conic motions by the simple movement of the focal point boggles my mind. Let alone the incredible geometry of the matter, the fact that natural motions obey such geometry puts to question the very nature of geometry. This form of mathematics finds itself elevated by the touch of Newton. So just as Apollonius progressed upon Euclid, and now with a little motion of his own, Newton can build geometry further upon the shoulders of these two ancient, geometrical giants.

With the most fundamental ideas of Book 1 now in hand, I want to leave Book 2 off to the side for the purposes of this essay and move within Book 3. However it bears note that similarly to Book 1, Book 2 progresses upon the compounding deductions first demonstrated in Book 1. Whereas Book 1 has 14 sections and 97 propositions, Book 2 contains 9 sections with 53 propositions, mostly about bodies moving through mediums of resistance, essentially fluid dynamics. At this point, necessity dictates that Newton's six phenomena make themselves known.

When Newton progresses with the propositions of the System of World, these six phenomena will serve as the necessary and sufficient observed evidence for this final development of Newton's account of The All. So then simply, why these phenomena? What experienced appearances from these six particular phenomena can allow the progression of the mathematical principles?

Following the "*Rules of Reasoning*" to begin Book 3, the first two phenomena of the next section, "*Phenomena, or Appearances,*" focus on the revolutions of the circumjovial and cirumsaturanal 'planets' around the centers of Jupiter and Saturn, respectively. With the use of telescopes ranging up to lengths of 123 feet, astronomers at and before Newton's time measured

that both the moons around Jupiter, and the moons around Saturn, "*describe areas proportional to the times of description; and that their periodic times, the fixed stars being at rest, are in the sesquiplicate proportion of their distances from its centre*[71]." Johannes Kepler first discovered and measured this ratio in his his own efforts to produce an account about The All, and such, the ratio has come to be called "Kepler's Third Law of Motion[72]." The student of the astronomical giant, Tycho Brahe, Kepler inherited his teacher's vast tomes of celestial observations, begun his own work constructing his own λόγος about the celestial motions, and then hit the existential roadblock of eight missing minutes in his constructed theory. With an instinct in searching for mathematical patterns, Kepler decided to put in ratio the square of the radial distance of an orbiting body to the cube of the periodic time for that body. At once, Kepler saw that all revolving bodies, in their measured areas, distances, and periodic times, within the tomes of Tycho, obeyed this natural law of proportionality in their motions as ellipses. With this law in hand, any celestial observation of a body revolving in this sesquiplicate proportion of radial distance to periodic time can justify the claim that such a body revolves in an elliptical motion, and tends towards some focal point.

The third and fourth of Newton's six phenomena state that Mercury, Venus, Mars, Jupiter, and Saturn not only encompass the Sun as Copernicus so thought, but that, "*the fixed stars being at rest, the periodic times of the five primary planets, and (whether of the Sun about the earth or) of the earth about the Sun, are in the sesquiplicate proportion of their mean distances from the Sun*[73]." Interestingly, the measurements from the relative position of the earth or Sun still give the same ratio of periodic time to radial distance for the revolution of the other.

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[71] Newton 322.
[72] Newton 328.
[73] Newton 224.

Whether we take a reference frame of measurement from earth or the Sun, it does not matter, the laws of nature holds in all frames of reference. However, more importantly at this moment, this united phenomena of the five primary planets obeying Kepler's Third Law of Motion, the same law which the circumjovial and circumsaturnal planets obey, identify the physical fact of proportionality in the very function of our Sun's heliocentric, and natural, centripetal force. As Newton states in his explanation of fourth phenomena, "This proportion, first observed by Kepler, is now received by all astronomers… And as to the measure of the periodic times, all astronomers are agreed about them[74]." As we can see, Newton's six phenomena are supported by the countless observations from countless of keen eyed astronomers. These appearances have been experienced over and over, to that point that no astronomer worth his salt would ever dispute such phenomenal facts of The All.

For the last two phenomena, Newton's first states that the five primary planets do not, in any way, describes areas proportional to their times if radii are drawn to the earth, and that such a proportional description occurs only with radii drawn to the Sun. As such, the five primary planets do not revolve around the earth, but around the Sun in their perpetual proportion. However, Newton next states that something does in fact orbit the earth, the moon. This little wanderer, the moon, "*by a radius drawn to the earth's centre, describes an area proportional to the time of description*[75]." It too moves proportionally around our earth, but does our moon maintain the sesquiplicate proportion as do the first four phenomena? Our answers now lie in Newton's next section, "*Propositions."*

[74] Newton 324.
[75] Newton 325.

Armed with his Rules of Reasoning to guide and regulate his investigation, the six phenomenal facts of proportional motion, and deduced mathematical principles from induced axioms, Newton can now lay down, within the first five Propositions, mathematical accounts for the operating forces of Nature. These forces at work, for Jupiter and Saturn to retain their respective moons, for the Sun to retain its five primary planets, and for earth to retain its moon, all these forces function by the same inverse-square law in a reciprocal ratio of the square of distance to the gravitating matter[76]. To answer the question above, the moon does in fact describe the sesquiplicate proportion due to Proposition 4 Corollary 6, as it is retained by the earth in the duplicate ratio of the radii inversely. By the end of the fourth Proposition, Newton pens another Scholium where he states:

> There since both these forces, that is, the gravity of heavy bodies, and the centripetal forces of the moons, respect the centre of the earth, and are similar and equal between themselves, they will (Rule I and II) have one and the same cause. And therefore the force which retains the moon in its orbit is that very force which we commonly call gravity[77].

With the aid of the Rules of Reasoning, we can justifiably state that the force which caused my coffee mug earlier to drop is in fact the very same force which will bring the moon around tonight. We commonly know this force by its more weighty name, gravity, which comes from the Latin word gravitas as ‘weight’ or ‘heaviness’. Having set down these individual relationships between planets and their respective moons, Newton demonstrates Proposition 5, which in its conclusion, establishes the mathematical principle of systematized universal gravitation.

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[76] Force = 1 / Distance^2

[77] Newton 329.

The fifth proposition states, "*That the circumjovial planets gravitate towards Jupiter; the circumsaturnal towards Saturn; the circumsolar towards the Sun; and by the forces of their gravity are drawn off from rectilinear motions, and retained in curvilinear orbits*[78]*."* Because each of these individual relationships maintain the same measured force of gravity, and the same appearances of the sesquiplicate ratio, these appearances "therefore, by Rule II, must be owing to the same sort of causes[79]." If each and every one of these individual relationships between a planet and its respective moons keep the same law, then there in fact exists only one law, that of the inverse-square[80]. With this laid down, three corollaries accompany the proposition to fully establish the weight of Newton's conclusion.

The first corollary acknowledges the possession of a common force of gravity, "There is, therefore, a power of gravity tending to all the planets[81]." Any planet that then retains objects in an orbit does so by the power and force of gravity. And this gravitational force, by the second corollary, "is reciprocally as the square of the distance of places from that planet's centre[82]." So then the law, by which all planets retain their moons, expresses itself in the absolute, precise, and communicable language of mathematics. Through the efforts the giant geometers, Euclid and Apollonius, and the giant astronomers, Ptolemy, Brahe, Galileo, Kepler, and the many others, Newton stood high enough to systematize their natural accounts through both the irrefutable and unconquerable art of geometry and the observations of proportionality among the celestial motions. The truth afforded by Newton's geometric analysis will extend wonderfully far beyond our tangible limitations and, with a pencil and paper, Nature can be unlocked.

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[78] Newton Ibid.
[79] Newton Ibid.
[80] I offer it up for anyone to think how to construct this statute next to Pythagoras'.
[81] Newton Ibid.
[82] Newton Ibid.

To first mold the key, we must understand the third corollary, "All the planets do mutually gravitate towards one another, by Cor. 1 and Cor. 2[83]." Every planet, and everything, at all moments, pulls and is pulled by a universal gravitation that tends towards the bulked density of matter. Each planet feels the others' gravitation, even as the Sun pulls them all around in their united proportion. Our oceans not only feel the great gravitational effects from the moon, but also the smaller effects from the Sun, Jupiter, Saturn, and all other planets within the solar system, within our galaxy, and within our universe. Of course, those forces out beyond are marginally, by orders of magnitude, felt by the sea, but in fact their effects are mathematically doubtless.

Due to this mutual gravitation, Newton states in the seventh proposition, "gravity tending towards all the planets is proportional to the matter which they contain[84]." In its simplicity, this means that mutual gravitation dictates a mutual proportionality of all objects within the gravitational field, and thus extends geometric analysis of gravitational forces to all existing bodies within The All. Proposition 8 makes the utility and wonder of this extension clear, "*In two spheres mutually gravitating each towards the other, if the matter in places on all sides round about and equi-distant from the centres is similar, the weight of either sphere towards the other will be reciprocally as the square of the distance between the centres*[85]." The effects of mutual gravitation will allow for a proportional analysis of gravitational forces between planets simply by use of their differing distance. Essentially the measurement of the tautness of the gravitational string between planets allows for a mathematical account of that planet's proportional force, and consequently, density and matter. To me, the wonder of this essay's concluding idea has always

[83] Newton Ibid.
[84] Newton 333.
[85] Newton 334.

come in the basic nature of this question: How can a thinking animal on our giant rock revolving through space, by the force of its thought, observation, and reasoning, tell me the exact speed, distance, and density of another revolving rock in space millions of miles away, with only a pencil, paper, and compass?

To answer my question, Newton would simply point towards *The Principia*, berating me, "Read!" But if instead of asking how he engages in natural philosophy, and I ask, "Why does gravity work in the way it does?", Newton would not chide me as quickly. He would humbly admit, in his intellectual honesty,

> I have not been able to discover the cause of those properties of gravity from phenomena, and I frame no hypotheses; for whatever is not deduced from phenomena is to be called an hypothesis; and hypotheses, whether metaphysical or physical, whether of occult qualities or mechanical, have no place in experimental philosophy… And to us it is enough that gravity really does exist, and act according to the laws which we have explained, and abundantly serves to account for all the motions of the celestial bodies, and of our sea[86].

Simply because Newton cannot answer the ultimate reducible question, "Why?", does not invalidate or contradict his proposed account of The All, with its universally encompassing mathematical principles. However, Newton does answer the question, "How?", in its fullest and most intelligible form through the power of geometric and the phenomenal proportions of the celestial motions.

Looking back on Plato's philosophical principles of proportionality, commensurability, order, systematization, a necessary Craftsman, and beauty, we can see each of these principles underlying the phenomena that Newton accounts by aid of his mathematical principles. Every celestial body, in maintaining Kepler's Law of Motion and a universal gravitation, participates in

[86] Newton 442.

a universal proportionality and commensurability in respect of every other bulk of matter throughout The All. The totality of these ordered relationships between each planet and their respective moons then constitutes the systematization of all such celestial bodies in Newton's System of the World. And in the General Scholium at the end of *The Principia*, Newton puts himself in ratio with these last two of the proposed Platonic principles, "This most beautiful system of the sun, planets, and comets, could only proceed from the counsel and dominion of an intelligent and powerful Being[87]." These potential philosophic principles, which I believe Plato's layers within *The Timaeus,* find their actuality in Newton's cultivation of geometric and mathematical principles of the System of the World in *The Principia*. By the human reasonings of these proportional philosophers, Plato tells us that Nature can be laid bare, and Newton shows us how.

The Last Stop, Relatively

As we pull head towards our last stop, imagine you're sitting in the carriage of a uniformly moving train, and you lean out the window to drop a basketball. Why? No one knows, but you do it anyway. To you, on your uniformly moving reference frame, the basketball falls in a measured straight line. But to the confused onlookers who watch the train go by, standing on the rigid reference frame of the earth, the dropped basketball falls in a measured parabolic curve. Which measurement is "true"? Does the basketball, in its reality as a physical event, move in a straight line or in a parabolic curve?

[87] Newton 440.

Einstein begins his famed work, *Relativity: The Special and the General Theory*, with this simple example to establish that no independent references frame exists for each particular moving body, as Newton thinks through the distinction of absolute space, time, and motion. Instead, Einstein states that each measurement of a motion is relative to the system of coordinates for the measurer's particular body of reference. In his own words, "The [basketball] traverses a straight line relative to a system of coordinates rigidly attached to the carriage, but relative to a system of coordinates rigidly attached to the ground (embankment) it describes a parabola[88]." In addition to the relative measurement of a body's position in space, there correlatively also exists a relative measurement of a body's position in time. So if motion is subjected to relativity, so are its units, space and time. The relative data for the space and time coordinates of a body's motion will then differ across reference frames, but one thing remains the same, the Laws of Nature.

The constant speed light, through all reference frames, catalyzed the acceptance and growth of Einstein's General Theory of Relativity as it imposed a parameter of equality for Nature's Laws through every reference frame. At the end of his work, Einstein emphasizes this very parameter:

> The general principle of relativity requires that all these molluscs can be used as reference-bodies with equal right and equal success in the formulation of the general laws of nature; the laws themselves must be quite independent of the choice of mollusc. The greater power possessed by the general principle of relativity lies in the comprehensive limitation which is imposed on the laws of nature in consequence of what we have seen above[89].

The molluscs Einstein mentions here function as reference frames of much higher dimensions than our 4 dimensional space-time continuum. These become conceivable, and calculable,

[88] Einstein *Relativity* 11.
[89] Einstein 111.

through Einstein's and other mathematicians' efforts, specifically Gauss' development of a 2-D algebraic coordinate system that can be applied to continua of any and all dimensions[90]. With such progression in mathematics, our species further develops the necessary tool to interpret The All. It is only through this cultivation of mathematics that we can begin to hear the harmony of Nature's whispers.

I want to end on one last etymological word, mathematics. Coming from the Ancient Greek neuter noun, μάθημα, "a lesson", and verb μανθάνω, "I learn," mathematics literally means "the art of the learnable things." What can serve as more learnable than the geometric abstractions that we employ in our mind, beginning with the partless point, and advancing towards the pointed cone? Geometry does not exist as a physical tool, but rather as a systematized logical body of thought expressed through the symbology of lines and ink. One can feel the very force of geometry in resultant absolute clarity when looking upon a proposition, and subsequently *understanding* the logic in each of the proposition's progressive parts. Though geometry exists in an abstract realm of mind, we should not forget its humble origin in its own literal meaning, "the earth-measuring art[91]." In this way, by sheer practicality, geometry comes to be out from Nature just as how, by sheer will, it comes to be out from our minds, and in doing so, geometry provides an investigative means into the very being of both our minds and Nature.

[90] Einstein 97
[91] Earth (γῆ) + measure (μέτρον)

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