# FROM GALILEO TO HUBBLE: THE COPERNICAN PRINCIPLE AS A PHILOSOPHICAL DOGMA DEFINING MODERN ASTRONOMY

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**ABSTRACT**

*For centuries the case of Galileo Galilei has been the cornerstone of every major argument against the church and its supposedly unscientific dogmatism. The church seems to have condemned Galileo for his heresies, just because it couldn't and wouldn't handle the truth. Galileo was a hero of science wrongfully accused and now – at last – everyone knows that. But is that true? This paper tries to examine the case from the point of modern physics and the conclusions drawn are startling. It seems that contemporary church was too haste into condemning itself. The evidence provided by Galileo to support the heliocentric system do not even pass simple scrutiny, while modern physics has ruled for a long time now against both heliocentric and geocentric models as depictions of the "truth". As Einstein eloquently said, the debate about which system is chosen is void of any meaning from a physics' point of view. At the end, the selection of the center is more a matter of choice rather than a matter of 'truth' of any kind. And this choice is driven by specific philosophical axioms penetrating astronomy for hundreds of years now. From Galileo to Hubble, the Copernican principle has been slowly transformed to a dogma followed by all mainstream astronomers. It is time to challenge our dogmatic adherence to the anti-humanism idea that we are insignificant in the cosmos and start making true honest science again, as Copernicus once postulated.*

**Keywords:** astronomy; dogmatism; scientific dogmatism; Galileo Galilei; church; principles; Hubble; Copernican principle; religion and science


*Figure 1: Tycho Brahe[1], prominent astronomer and calculator. Opposed to the model proposed by Galileo.*

[1] Source: Wikipedia Commons, https://en.wikipedia.org/wiki/Tycho_Brahe#/media/File:Tycho_Brahe.JPG

## INTRODUCTION

This paper will examine one of the most important principles in modern astronomy and how this principle has turned into a dogma defining the way cosmology moves forward today. To do that, the case of Galileo will be first examined. Even though most people know the case of Galileo as a case of religion dogmatism against scientific free thinking, the truth is exactly the opposite. To cut the long story short: Galileo was wrong. Not only philosophically (this is related to the abovementioned principle), but mainly scientifically. We will examine the later first. And then we will examine in more depth the philosophical dogmas hidden in this case and how these still determine cosmology today. Detecting the hidden philosophical assumptions (a.k.a. principles, axioms) which lie under today's theories is important so as not to let them turn into dogmas. Unfortunately, many arbitrarily chosen assumptions are considered as self-evident by most people today, thus paving the way to claustrophobic thinking which is inherently unable to grasp the true meaning of the cosmos. Questioning these assumptions is the only way towards a more honest and humane science; a science which will rediscover that it is perfectly compatible with religion. For thousands of years humans were looking for God into the stars. It turns out they might be looking in the wrong place after all.

### What this article does NOT

This article does not attempt to "prove" or "disprove" any hypothesis about the cosmological systems used by astronomy (scientifically this is something impossible anyway, as Gödel showed). Its goal is to show that there is no single objective criterion to use when choosing the center of the solar system[2] and present the philosophy behind this selection. In essence, choosing a Coordinate System (CS) is open to discussion and no single model holds any kind of self-evident correctness, scientifically speaking. As it will be analyzed in more detail later on, science today accepts that changing a reference system does not mean anything as far as the scientific validity of the model is concerned. The goal is not to show that a specific point is more valid as a center than others, but to show the hidden philosophical axioms affecting the selection of that center. Again, the purpose is not to prove or disprove any of the axioms used by modern astronomy (something which is by definition impossible), but to describe how these axioms were crucial in some of the most famous cases in science history and how they still define astronomy. Not recognizing their existence makes us prone to dogmatism. And this is what we should avoid at all costs if true science is to be produced.

## 1. THE GALILEO CASE

The infamous case of Galileo set the terms of the war between religion and science. And this war is raging ever since. Who doesn't know about the great astronomer who supported the idea of the heliocentric model despite the great opposition from the church. At the end, the church managed to suppress the ideas of Galileo but even though they had won a battle, a bigger war has just begun. At the end, church's dogmatism would lose to the scientific rationale and hundreds of years later the Pope would be asking for an apology. A great story. Too bad not even a word of the above story is correct. Putting things straight

[2] The selection of the Earth or the Sun as the center of the solar system is not necessarily fully equivalent to what we know as 'geocentric' or 'heliocentric' systems. For example, the geocentric model calls not only for Earth at the center of the solar system, but for a stationary unmovable Earth at the center of the solar system (and the cosmos). The details however of the various cosmological models are not of importance in achieving the goal of this paper, which is to demonstrate how science can sometimes be driven by our philosophy.

from scientific and philosophical point of view is very crucial if someone is to understand the true issues behind this case and, subsequently, the true cause of subsequent clashes between religion and science.

> To begin with, what is important to understand is that the proofs proposed by Galileo were not without a scientific opposition. Many astronomers at the time, were reluctant to accept the new thesis based on the evidence provided. Tycho Brahe was one of the great critics of the heliocentric model; and his authority as an astronomer and an extremely scrupulous calculator conferred special credibility on this criticism [2].

The main arguments used by Galileo were sufficient to challenge the philosophy of the time regarding the cosmos, but not adequate enough to prove the heliocentric model against the geocentric one. The surface of the moon, the sunspots, the tides, the satellites of Jupiter or the phases of Venus, all proposed by Galileo as 'proofs' of a heliocentric cosmos, indeed demonstrated that certain principles of the Aristotelian model of the world (which called for a stable 'perfect' universe built around a stationary Earth) could not be upheld. However, they were not enough to change the mind of the scientific authorities of the time regarding the center of the solar system. No, the tides do not prove that the Earth is moving around the Sun. There were other explanations for the tides back then. (we now know that these tides are caused by the Moon's gravitational pull and are not at all related to the Earth moving around the Sun). No, the phases of Venus do not prove anything regarding the Earth moving around the Sun. They are just related to Venus moving around the Sun (or the other way around, as we will see in the next section of this paper). These are surely arguments against the stable cosmos envisioned by the Aristotelian model, but not an argument in favor of the heliocentric model per se.

Some discoveries which could have helped Galileo in his reasoning, where not yet part of the scientific knowledge of the time. One should not forget that the gravitational theory of Newton was not yet formulated. Any discussion regarding the movement of planets around other planets was conducted without the theory of Newton regarding the laws of planetary motion. It is also true that the star parallax would be used to support an Earth moving around the Sun (or the other way around, as we will see later on). But Galileo was not able to detect any star parallax back then. Strictly speaking and from a purely scientific point of view, the non-detection of star parallax back then should actually be a point *against* the heliocentric model and not for it[3].

In 1651 the Italian astronomer Giovanni Battista Riccioli published within his Almagestum Novum, a massive 1500-page treatise on astronomy, a discussion of 126 arguments for and against the Copernican hypothesis (49 for, 77 against). Seen through Riccioli's 126 arguments, the debate over the Copernican hypothesis appears dynamic and indeed similar to more modern scientific debates. Both sides present good arguments as point and counter-point. Religious arguments play a minor role in the debate; careful, reproducible experiments a major role. To Riccioli, the anti-Copernican arguments carry the greater weight, arguments against which the Copernicans have no good response. These include arguments based on telescopic observations of stars, and on the apparent absence of what today would be called "Coriolis Effect" phenomena; both have been overlooked by the historical record. Riccioli's work sheds light on a fascinating piece of the history of astronomy and highlights the competence of scientists of his time [4].

[3] The parallax was only measured in 1838 by Bessel.

One has also to take into account that the geocentric and heliocentric models were not the only possible models participating in the debate. Galileo never explicitly addressed the question of the third 'chief world-system', that of Tycho Brahe, one of the major adversaries against the heliocentric system [25]. Formulated in the 1580s, it retained the Earth at the center but had the Sun revolve around the Earth, carrying with it the planets. Observationally, the Tychonic and the Copernican systems were equivalent. Despite that fact and the growing support for the Tychonic system among those who for physical or theological reasons were wary of the Copernican choice, Galileo never seems to have taken this alternative seriously, other than hinting in the Dialogue that a huge solar entourage could not possibly maintain a stable orbit around a relatively tiny Earth [6]. And at this point we must also be careful to understand that the telescope was a new invention and the interpretation of its images was highly problematic[4]. Astronomers in the early 17th century misunderstood the images of stars that they saw in their telescopes. For this reason, the data a skilled observer of that time acquired via telescopic observation appeared to support a geocentric Tychonic (or semi-Tychonic) world system, and not a heliocentric Copernican one [20]. Anti-Copernicans could cite careful measurements of star diameters which showed that, were the Copernican system correct, stars would be enormous. The sun compared to even an average Copernican star would be like the period at the end of this sentence compared to a grapefruit. By contrast, under a geocentric system, the sizes of celestial bodies would all fall into a consistent range. The moon would be the smallest celestial body, the Sun the largest. The stars would be comparable to, but smaller than, the Sun. Copernicans could not argue with that data. They resorted to justifying the absurdly large stars in their system by appealing to Divine Majesty and Omnipotence: an infinitely powerful God could easily make such giant stars [25]. Despite all these and the data he had in hand, Galileo ultimately backed the Copernican system. By contrast, the German astronomer Simon Marius understood that data acquired by telescopic observation supported a Tychonic world system [20].

At the end of the sixteenth century, only a few astronomers accepted the Copernican system, while the majority rejected it. In Italy, we only have to remember the judgements of Clavius and Magini, among the best-known astronomers and mathematicians, who while they stressed the importance of the contributions of *De revolutionibus*, did not consider that they could accept the heliocentric hypothesis which in their opinion had been developed by extremely complex[5] geometric proofs sometimes contradicting each other [2].

There was no 'theology versus science' war. The consultors of the Holy Office in 1616 undoubtedly believed the best natural knowledge (the 'science') of their day to be on their side, since in 1616, natural philosophers more or less unanimously regarded the Copernican innovation as nothing more than a useful calculational device. Their error was to overlook the possibility, so tellingly pointed out by Galileo in his letter to Castelli, that new discoveries can undermine even the most secure seeming certainties, a process already clearly under way in astronomy [6]. If and to what extent the Roman theologians went wrong

[4] Feyerabend in *Against Method* has an elaborate description of the challenges posed by the newly created instrument and the images it produced, images which many times were in contradiction to what people saw with their own naked eyes.

[5] Contrary to what many people believe, Occam's razor could not be a good 'defender' of the heliocentric model back then. One should remember that the epicycles were an element of both the geocentric and the heliocentric model; they were finally removed only after Kepler proposed the elliptical orbits [31].

in their theology as well, is another very important question but completely outside the scope of this paper[6].

From the above it is obvious that from a purely scientific point of view, the church was right not to immediately accept the claims of Galileo. And one should not forget that we are in any case missing to see the elephants in the room: Copernicus postulated the heliocentric ideas before Galileo and neither he nor his disciples were prosecuted for those ideas as Galileo was. In 1616, the church banned Nicholas Copernicus' book "On the Revolutions of the Celestial Spheres," published in 1543, which contained the theory that the Earth revolved around the sun. After a few minor edits, making sure that the sun theory was presented as purely hypothetical, it was allowed again in 1620 with the blessing of the church [5]. Until Galileo forced the issue into the realm of theology, the Church had been a willing ombudsman for the new astronomy. It had encouraged the work of Copernicus and sheltered Kepler against the persecutions of Calvinists. Problems only arose when the debate went beyond the mere question of celestial mechanics [19].

This was not a clash between science and religion. Everyone involved in the case was a Christian. Galileo himself wrote many thousands of words on the theology of biblical interpretation as he sought to make sense of the telescopic observations he was making [7]. This was just a case of a man deceiving the Pope[7] and using not-so-strong scientific arguments to impose a new hypothesis as a 'fact' in an era of theological turmoil. The case did not receive all that much attention back in the day as some want to believe it did. The over-exaggerating importance attached to it today is mostly in the context of the hypothetical so-called 'science vs religion' war which exists only in the minds of some people and is not related to the actual importance of the case as a whole. Had the Catholic Church rushed to endorse Galileo's views – and there were many in the Church who were quite favorable to

[6] The historical context of the case is a crucial element which should not be ignored. What was threatened, what called for defense on the part of the Church, was clearly the integrity of Scripture. In the aftermath of the Counter-Reformation Council of Trent (1545–63) and its strictures concerning Scriptural interpretation, the integrity of Scripture was taken to imply that one should understand it literally unless compelled to interpret it otherwise. Had Galileo published the same book in another point in time, it is very likely that the reaction from the Church could be completely different.

[7] The 'human' details of the case are not be ignored, for they played a crucial role in the final decision. Galileo had the Pope's permission to write about the Copernican topic. But how much latitude had he been given? To be on the safe side, Riccardi instructed Galileo to write an introduction and a closing passage in which it would be made clear that the work was intended only as a 'hypothesis', again the fatally ambiguous term. Eventually, he authorized the Florentine censor to make the final decision. The book appeared finally in February 1632. It arrived in Rome at a most inauspicious time. The Pope was under attack from the Spanish faction in the Curia for supporting France and thus, indirectly, its Protestant ally, Sweden, against the Catholic Hapsburgs. He was also being accused of nepotism and of worldly aggrandisement. He was thus in no mood for a further perceived slight. Not only was the Copernican claim being presented as much more, in his eyes, than the 'hypothesis' that had been agreed upon, but also the Pope's own theological reservation about the possibility of demonstrating that claim had been implicitly called into question. Worse still, it had been reduced to an inadequate closing comment from Simplicio, elsewhere in the Dialogue almost invariably the spokesman for the losing side. In September, the Tuscan ambassador, Francesco Niccolini, tried to intercede with the Pope on Galileo's behalf but was met (as he later described it) with an 'outburst of rage' against Galileo who had 'deceived' him and 'had dared to enter into the most serious and dangerous subjects that could be stirred up at this time'. To make matters worse, a record was found in the Holy Office files of Segizzi's having delivered the personal injunction to Galileo in 1616 forbidding him 'to hold, teach, or defend' the Copernican view 'in any way whatsoever, verbally or in writing'. Since he had not let the censors of the Dialogue manuscript know of this, it would immediately be argued that this invalidated the imprimatur given him for the book. At this point, the Holy Office took over and he was ordered to appear before it [6].

them – the Church would have embraced what modern science has disproved [8], as we will see in more detail in the next sections of the paper. Most scientists refused to accept this theory for many decades; even after Galileo made his epochal observations with his telescope [26].

The Victorian biologist Thomas Henry Huxley, who had no brief for Catholicism, once examined the case and concluded that "the Church had the best of it". Prone as we are to what C. S. Lewis called "chronological snobbery", we must try to understand the prevailing attitude toward science when Galileo began his work back at the era of Galileo. Since the time of the Greeks, the purpose of astronomy was to "save the appearances" of celestial phenomena. To the Greek and medieval mind, science was a kind of formalism, a means of coordinating data, which had no bearing on the ultimate reality of things (as Galileo tried to impose). Different mathematical devices – such as the Ptolemaic cycles – could be advanced to predict the movements of the planets, and it was of no concern to the medieval astronomer whether such devices touched on the actual physical truth[8]. The point was to give order to complicated data, and all that mattered was which hypothesis (a key word in the Galileo affair) was the simplest and most convenient [19]. Not which was more correct or "truer".

Pope John Paul II expressed in 1979 the wish that the Pontifical Academy of Sciences conduct an in-depth study of the celebrated case. A commission of scholars was convened, and they presented their report to the Pope on October 31, 1992. Contrary to reports in The New York Times and other conduits of misinformation about the Church, the Holy See was not on this occasion finally throwing in the towel and admitting that the Earth revolves around the Sun. That particular debate, so far as the Church was concerned, had been closed since at least 1741 when Benedict XIV bid the Holy Office grant an imprimatur to the first edition of the Complete Works of Galileo.

What John Paul II wanted was a better understanding of the whole affair by both scientists and theologians. It has been said that while politicians think in terms of weeks and statesmen in years, the Pope thinks in centuries. The Holy Father was trying to heal the tragic split between faith and science which occurred in the 17th century and from which Western culture has not recovered (mostly because it does not want to, but that is another discussion). Following the guidelines of the Second Vatican Council, he wished to make clear that science has a legitimate freedom in its own sphere and that this freedom was unduly violated by Church authorities in the case of Galileo.

However, at the same time – and here the secular media tuned out – the Holy Father pointed out that "the Galileo case has been a sort of 'myth,' in which the image fabricated out of the events was quite far removed from the reality. In this perspective, the Galileo case was the symbol of the Church's supposed rejection of scientific progress". Galileo's run-in with the Church, according to the Pope, involved a "tragic mutual incomprehension" in which both sides were at fault. It was a conflict that ought never to have occurred, because faith and science, properly understood, can never be at odds [19]. And that is the message one should take from this case as a whole.

[8] In any case the "truth" is not a matter of science, but it is what philosophy searches for (without being able to conclude on itafter thousands of years of research). Science (especially from the case of Galileo and onwards) tried to create physical models to describe the cosmos we observe. Whether those models are close to the 'reality' or not is of no concern as long as the model 'works', i.e. produces predictions.

## 1.1 Church and Science

At this point, it is important to make a short parenthesis regarding the infamous "science vs religion" war. That "war" is not something which the church wanted, but something the proponents of scientism have promoted during the last centuries and especially after the French Revolution and onwards. Today, science and religion have a very clear distinction of scope; science is for the research of the physical phenomena while religion deals with questions related to the meaning of life and ethics [22]. That was not always the case. Science and religion were not separated before Galileo [1]; they were both considered two sides of the same coin concerning the search for the truth regarding human existence [21]. And rightfully so, since they share many common attributes. Religion is based on logic and evidence in the same way science is; while on the other hand faith plays an equally important role in both of these realms of human knowledge [21]. But this is not remotely relevant to the case at hand.

In the case of Galileo, the church did not propose any new model for the description of the physical systems we observe. It simply asked for more scrutiny on what the "experts" say; especially when their arguments claimed the "reality" of the cosmos [1]. The church determined the invalidity of the heliocentric system based on the science (philosophy) of the time and not based on the prevailing theological doctrines[9].

And if one wonders why the church had any place in the debate, then he must understand the way the 16th society (and the medieval society before that) worked in general and realize that the church was an integral part of society's educational system.

The monasteries back then used to be the place were people went to learn about not only theology but also the science of the time (including astronomy). The modern university system has roots in the European medieval university, which was created in Italy and evolved from Catholic Cathedral schools for the clergy during the High Middle Ages [23]. During the 11th century, developments in philosophy and theology led to increased intellectual activity. There was debate between the realists and the nominalists over the concept of "universals". Philosophical discourse was stimulated by the rediscovery of Aristotle and his emphasis on empiricism and rationalism. Scholars such as Peter Abelard and Peter Lombard introduced Aristotelian logic into theology. In the late 11th and early 12th centuries cathedral schools spread throughout Western Europe, signaling the shift of learning from monasteries to cathedrals and towns. Cathedral schools were in turn replaced by the universities established in major European cities [24]. Even one of the greatest adversaries of religion today, Dawkins, is member of a university called "College of St. Mary". The important role of the church in the formulation of education systems as we know them today is not something one can ignore.

[9] Christopher M. Graney performed a very interesting analysis of the actual punctuation used in the decision issued against Galileo [25]. The original text read "*Omnes dixerunt dictam propositionem esse stultam et absurdam in Philosophia; et formaliter haereticam, quatenus contradicit expresse sententiis sacrae scripturae in multis locis, secundum proprietatem verborum, et secundum communem expositionem, et sensum, Sanctorum Patrum et Theologorum doctorum*" (En. "All have said the stated proposition to be foolish and absurd in Philosophy; and formally heretical, since it expressly contradicts the sense of sacred scripture in many places, according to the quality of the words, and according to the common exposition, and understanding, of the Holy Fathers and the learned Theologians") The semicolon after the "absurdam in Philosophia" is an important punctuation mark existing in the original text, which was omitted afterwards. The consultants of the Holy Office did not conclude that Galileo's model was absurd *because* of the contradiction to the formal theology; it was absurd because it was not properly justified by the *science* of the day. The theological problems were also part of the case, but they were not the justification of the scientific assessment of the consultants.

## 2 MODERN SCIENCE VS GALILEO

The antilogos against the thesis of Galileo is not limited to the era of his trial. In fact, modern knowledge seems to reach to a conclusion that either the heliocentric nor the geocentric models are essentially any different. From Einstein and onwards we now know that one can change the reference system in any model and still produce equally "correct" (valid) physics. The "center" of the solar system is something one can arbitrarily choose and still the description of the system will be valid as far as physics is concerned.

*The struggle, so violent in the early days of science,*
*between the views of Ptolemy and Copernicus would then be quite meaningless.*
*Either CS [Coordinate System] could be used with equal justification.*
*The two sentences, 'the sun is at rest and the earth moves,' or 'the sun moves and the earth is at rest,' would simply mean two different conventions concerning two different CS.*

Albert Einstein[10]

### 2.1 Einstein and changing system of reference

Before analyzing how philosophy could play a role in choosing a center for our solar system, the science behind changing reference system must be clarified first. In order to completely understand the situation, one needs to refer to and understand the details behind choosing a point of reference and the potential impact of this choice from a physics point of view. Most people are reluctant in taking a stance regarding the case of Galileo exactly because they know nothing about the science behind the matter; one always fears what he does not know. A high-level analysis of the matter will show that there are no solid rules regulating the selection of a reference system in a physical system and that there is no way to say whether any point has a privileged position over any other as the 'center' of any system. Any dispute regarding what is the center of the solar system can now be answered by any 8th grade student, for even he should know that changing the reference system in a physical system does not affect the validity of the physics describing it.

***Frames of reference***

Physics uses coordinate systems as reference when studying systems. A frame of reference in physics, may refer to a coordinate system or set of axes within which to measure the position, orientation, and other properties of objects in it, or it may refer to an observational reference frame tied to the state of motion of an observer. The need to distinguish between the various meanings of "frame of reference" has led to a variety of terms. For example, sometimes the type of coordinate system is attached as a modifier, as in Cartesian frame of reference. Sometimes the state of motion is emphasized, as in rotating frame of reference [13].

[10] Einstein and Infeld, The Evolution of Physics, The Scientific Book Club and Company Ltd, p.224. The full text reads "*Can we formulate physical laws so that they are valid for all CS [coordinate systems], not only those moving uniformly, but also those moving quite arbitrarily, relative to each other? If this can be done, our troubles will be over. We shall then be able to apply the laws of nature to any CS. The struggle, so violent in the early days of science, between the views of Ptolemy and Copernicus would then be quite meaningless. Either CS could be used with equal justification. The two sentences, "the Sun is at rest and the Earth moves," or "the Sun moves and the Earth is at rest," would simply mean two different conventions concerning two different CS . . . Could we build a real relativistic physics valid in all CS; a physics in which there would be no place for absolute, but only for relative motion? This is indeed possible! . . . Our new idea is simple: to build a physics valid for all CS*". This phrase supports the idea that any reference system can be used for building valid physics, with various implications as it will be shown in the paper.

***A Simple example of changing Coordinate Systems***

For the needs of presenting a simple example of changing “center” or systems of reference (coordinate systems) I will use a simple example of two cars running in a road, as shown in the figure below [14]. These two cars are moving at different but constant velocities and are observed from the stationary inertial frame S attached to the road and the moving inertial frame S' attached to the first car.

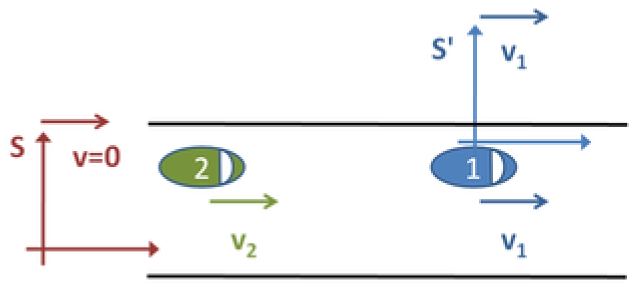


*Figure 2: A simple example of changing reference system. Here two cars 1 and 2 are shown running on the road, with different speeds v1 and v2 respectively*[11]

At some particular moment, the cars are separated by 200 meters. The car in front is traveling at 22 meters per second and the car behind is traveling at 30 meters per second. If we want to find out *how long it will take the second car to catch up with the first*, there are three obvious “frames of reference” that we could choose.

First, we could observe the two cars from the side of the road. We define our frame of reference S as follows. We stand on the side of the road and start a stop-clock at the exact moment that the second car passes us, which happens to be when they are a distance d = 200 m apart. Since neither of the cars are accelerating, we can determine their positions by the following formulas, where $x_1(t)$ is the position in meters of Car 1 after time t seconds and $x_2(t)$ is the position of Car 2 after time t.

$$x_1(t) = d + u_1 * t = 200 + 22 * t$$

$$x_2(t) = u_2 * t = 30t$$

Notice that these formulas predict at t = 0 sec the first car is 200 m down the road and the second car is right beside us, as expected. We want to find the time at which both cars will be at the same point, thus $x_1 = x_2$.

Therefore, we set $x_1 = x_2$ and solve for t, that is:

$$\begin{aligned} &200 + 22t = 30t \\ &\Rightarrow 8t = 200 \\ &\Rightarrow t = 25\ sec \end{aligned}$$

[11] Source: Wikimedia Commons. [https://commons.wikimedia.org/wiki/File:Two_reference_frames.PNG]

Alternatively, we could choose a frame of reference S' situated in the first car. In this case, the first car is stationary (see how a **simple change in the frame of reference** makes one **'moving'** object to seem **'still'** and correlate this to the Galileo case and the geocentric vs heliocentric model debate), and the second car is approaching from behind at a speed of $v_2 - v_1$ = 8 m / s (the difference between the two speeds). In order to catch up to the first car, it will take a time of $\frac{d}{v_2 - v_1} = \frac{200}{8}$ sec, that is, **25 seconds, as before**. Note how much easier the problem becomes by choosing a suitable frame of reference.

The third possible frame of reference would be attached to the second car. That example resembles the frame of reference just discussed, except the second car is stationary and the first car moves backward towards it at 8 m/s (again, note the seemingly incredible **change in the nature of the motion** of the cars when changing system of reference, while we are still discussing about the **same physical system**). The result would still be the same. It would have been also possible to choose a rotating, accelerating frame of reference, but this would have served to complicate the problem unnecessarily.

In any case and regardless of the frame of reference chosen, the result regarding how much time the second car needs to catch up with the first will always be 25 seconds. If we want to expand the implications of this in the solar system center debate, we could say that "Regardless of the chosen center of the solar system, Sun eclipses happen at the same day". And how could they not? Had this not be the case then the ancient Greeks (who used a geocentric model) would not be able to make any predictions of planetary motions.

After this brief analysis it is evident that the frame of reference does not have any impact at all to the physics of the system. Regardless of the frame of reference selected the conclusions we draw regarding the evolution of that system remain exactly the same. Additionally, if the relationship between the different frames of reference is properly defined there is no issue with people communicating results to each other. It is like you are wearing a watch which is set five minutes earlier compared to the local standard time. If you know that this is the case, when somebody asks you what time it is, you are able to deduct five minutes from the time displayed on your watch in order to obtain the 'correct' time. You might say that the bus arrived at five past three, but the other person will still know that according to local standard time it arrived at three. As long as we know the differences between two reference systems, there is no problem in the communication between people using them.

As a conclusion, even though we do need to choose a coordinate system (frame of reference) to use when analyzing a system (since we do need a frame of reference to formulate our equations), this choice does not affect the validity of the scientific analysis of that system. We can choose any frame of reference and still be able to formulate physical laws and make correct predictions. That is why centuries before the Copernican model came to be, ancient Greeks were able to predict with such precision solar eclipses decades or even centuries before they happened.

## 3. CRITERIA FOR CHOOSING FRAME OF REFERENCE

After it was made clear that changing a reference system does not essentially makes any difference regarding physics, we must nonetheless answer the question we avoid: How do we select a reference system after all? Because at the end and even though Einstein has settled the debate, we will have to choose one in order to describe the physical system we investigate. What is important to show and understand is that science is not the major factor affecting that choice. Philosophy is. In order for us to understand why and how philosophy determined not only the stance of Galileo and the church, but also still affects the stance of modern astronomy, we will first briefly review the scientific reasoning behind this selection. After this reasoning is demystified it will be evident to any honest reader that the only reason to choose between one model and the other would be a philosophical one. The implications of using a specific philosophical criterion and how this can feed dogmatism within modern astronomy is then analyzed.

### 3.1 Scientific criteria

There are many different reasons invoked for the selection of the Sun as the center of the solar system. I will concentrate my efforts on the most important ones, by giving a short description of them and then I will try to explain why every single one of them is inherently flawed.

***The "elegance" criterion***

In the Ptolemaic system of astronomy, the epicycle (literally: "on the circle" in Greek) was a geometric model used to explain the variations in speed and direction of the apparent motion of the Moon, Sun, and the planets. It was designed by Apollonius of Perga at the end of the 3$^{rd}$ century BC. In particular it explained the retrograde motion of the five planets known at the time. Secondarily, it also explained changes in the apparent distances of the planets from Earth.

Many people advocate that the heliocentric model is more valid because it is more elegant than the geocentric one, since the latter has to make use of epicycles to fully describe the planetary motions. That is simply wrong. The model of Copernicus faced many issues and also used epicycles.

When Copernicus transformed Earth-based observations to heliocentric coordinates[18], he was confronted with some entirely new problems. The Sun-centered positions displayed a cyclical motion with respect to time but without retrograde loops in the case of the outer planets. In principle, the heliocentric motion seemed simpler but included some new subtleties due to the yet-to-be-discovered elliptical shape of the orbits. Another problem that Copernicus never solved was related to correctly accounting for the motion of the Earth in the coordinate transformation. In keeping with past practice, Copernicus used the deferent/ epicycle model in his theory, but his epicycles were small and were called "epicyclets" [18]. In essence, the epicycles were 'transferred' from the other planets to Earth in the same way the center was 'transferred' from Earth to the Sun. The simple cars example mentioned above regarding the change of reference system and its implications on how we perceive motion, is starting to seem alarmingly familiar.

In the Ptolemaic system the models for each of the planets were different and that was the case with Copernicus' initial planetary models. As he worked through the mathematics, however, Copernicus discovered that his models could be combined in a unified system. Furthermore, if they were scaled so that Earth's orbit was the same in all of them, the ordering of the planets we recognize today literally fell out of the math. Mercury orbited closest to the Sun and the rest of the planets fell into place in order outward, arranged in distance by their periods of revolution.

Whether or not Copernicus' models were simpler than Ptolemy's is moot. Copernicus eliminated Ptolemy's somewhat-maligned equant but at a cost of additional epicycles. Various 16th-century books based on Ptolemy and Copernicus models use about equal numbers of epicycles. The idea that Copernicus used only 34 circles in his system comes from his own statement in a preliminary unpublished sketch called the *Commentariolus*. By the time he published *De revolutionibus orbium coelestium*, he had added more circles. Counting the total number is difficult, but estimates[12] show that he created a system just as complicated than the Ptolemaic one, or even more so [18].

***The "accuracy" criterion***

Some people claim that the heliocentric model is more accurate (and, thus, able to produce better predictions) than the geocentric one, but again this is not true. As hinted already, ancient Chinese and Greeks were able to predict celestial events with great accuracy well before the advance of the Copernican model [27]. Copernicus' theory was at least as accurate as Ptolemy's but never achieved the stature and recognition of Ptolemy's theory. Not to mention that in scarcely more than a hundred years, Copernicus would be overcome by events set in motion by Johannes Kepler.

The first planetary model without any epicycles was that of Ibn Bajjah (Avempace) in 12th century Andalusian Spain. The epicycles were not eliminated in Europe until the 17th century, when Johannes Kepler's model of elliptical orbits gradually replaced Copernicus' model based on perfect circles. So essentially the elimination of the epicycles was not something which took place because of the change from the geocentric to the heliocentric model, but because of the change of the orbits from perfects circles to ellipses [18]. After that, it was the Newtonian or Classical Mechanics which eliminated the need for deferent/ epicycle methods altogether and produced theories many times more powerful. By treating the Sun and planets as point masses and using Newton's law of universal gravitation, equations of motion were derived that could be solved by various means to compute predictions of planetary orbital velocities and positions. The power of Newtonian mechanics to solve problems in orbital mechanics was illustrated by the discovery of Neptune. Analysis of observed perturbations in the orbit of Uranus produced estimates of the suspected planet's position within a degree of where it was found. This could not have been accomplished with either the geocentric or the heliocentric models before Newton [28].

What is interesting to note is that the geocentric (Ptolemaic) model of the solar system is still of interest to planetarium makers, as, for technical reasons, a Ptolemaic-type motion has some advantages over a Copernican-type motion [44]. The celestial sphere, still used for teaching purposes and sometimes for navigation, is also based on a geocentric system [45] [46]. When you want to find where a satellite is in relation to Earth, then you certainly do not try to figure out where it is in relation to the… Sun. Of course Earth becomes more and more irrelevant when it comes to deep space navigation, where other points of reference need to be used. This is almost tautological in nature and rather irrelevant to the discussion for the center of the solar system, however it is important to mention from time to time so as to remind us the obvious when we analyze a physical system: that most of the times (with the exception of the discussion regarding the solar system) we just select as the center… us. Sounds simple? Yes, it does. And it could be the most scientific criterion you will ever need to use to decide on the 'center' of anything. I will come back to that in the next section, where I will analyze the philosophical criteria which are important with regards to the selection of the center of a physical system being studied.

***The "center of mass" criterion***

Another criterion cited by many is that the Sun makes a so much obvious choice for the center, because the Sun is the center of mass (and gravity) in the solar system. This is not

[12] The popular total of about 80 circles for the Ptolemaic system seems to have appeared in 1898. It may have been inspired by the non-Ptolemaic system of Girolamo Fracastoro, who used either 77 or 79 orbs in his system inspired by Eudoxus of Cnidus [18].

a bad choice indeed and the most scientific of all the criteria we have seen so far (if by 'scientific' we mean adherence to hard cold numbers, which is wrong for many reasons outside the scope of this paper). If we look at the solar system as a whole, then the center of its mass is close to the Sun, so it would be logical to use the Sun as the center. Most navigation systems for space use the Sun or other major celestial objects[13] as the main points of reference since it is those objects' gravity which plays the most important role when it comes to deep space exploration[14]. For people involved in celestial navigation it really makes no sense to use the Earth as a point of reference when the spaceship is intended to navigate through space to reach a comet in the outer area of the solar system. But again, this seems more of a tautology than an argument for or against the use of a specific point as the center of the solar system: It is obvious that the preferred reference system differs per case depending on the needs. For a satellite orbiting Earth, Earth can be the preferred point of reference [46]. For Voyager spaceships which have left the boundaries of the solar system, Earth as a point of reference is just irrelevant. For the famous Cassini spacecraft, after its probe entered Saturn orbit, the moons of the giant planet became important gravitational bodies. Their locations had to be determined to an accuracy of a few kilometers relative to Saturn, since for the specific spaceship these bodies were important for its navigation [47]. So it seems that indeed the major gravitational bodies in a physical system do qualify as useful reference points, at least from a practical point of view (navigation).

After this short tour to the universe and coming back to the question at hand, one can say that using the Sun as the center for the whole solar system is something which can be justified on the basis of the Sun's mass. However, even for this criterion which sounds solid, we should ask ourselves the hard question science keeps avoiding: What does this actually mean in terms of reality? Why would that choice be more correct from any perspective? From a modern astronomer's point of view, there is nothing in the universe except matter and lifeless particles. And in a cosmos full of particles, it makes all the sense in the world to select as the 'center' the point with the greatest concentration of those particles. Especially if this selection has important practical implications, like making the navigation easier. Could there be any argument against such a selection? In order to find out, we should turn to philosophy. But before doing so, we should try to discover the true nature of the problem we are trying to solve.

[13] For example, the Station Explorer for X-ray Timing and Navigation Technology, or SEXTANT (named after an 18th century nautical navigation instrument), uses X-ray technology to see millisecond pulsars, using them much like a GPS uses satellites. [https://www.sciencealert.com/x-ray-pulsar-space-navigation-nasa-world-first-success]

[14] One of the most known navigation systems, the JPL Solar System Ephemeris specifies the past and future positions of the Sun, moon and eight planets in three-dimensional space so that they can be used in celestial navigation. [https://scienceandtechnology.jpl.nasa.gov/research/research-topics-list/communications-computing-software/deep-space-navigation]

*Figure 3: Retrograde motion: We observe it, but we do not 'accept' it exists, based on the theory.*

### 3.2 Science and Philosophy: An invisible bond

Even though many people mistake modern science for philosophy this is simply not the case. Science today is not a way to search for the truth. All it does is trying to model what we perceive through our senses and then builds theories to make predictions. It could not care less about what is "true" and what is not. Scientific models work perfectly well no matter how close they are to "reality" or not.

What is the center of the solar system? The answer lies in the question, as Aristotle postulated. In that sense, it is important to formulate the question properly in order to get the answer. Because once we carefully read the question we will realize that it is incomplete; there are more than one way to read it. Modern science reads that question as a practical issue which needs solving, always in the context of the shallowness of today's era. When we ask about the center in the solar system we always ask that question with practical issues in our mind: What is the center of the solar system that would serve our calculations best? What is the center of the solar system that would be more useful in navigation? What is the center of the solar system that would better match our theories?

And here lies the great misconception. Because we are not trying to discover which solution could be the most practical one. We try to find the truth regarding the reality for the matter at hand. Remember, Galileo did not claim that "The Sun is at the center because the celestial navigation would be easier this way". Galileo claimed that the "Sun *is* at the center" as an absolute truth which everybody should know, despite the plea from the church to clarify that his proposal was merely another theory and nothing more. If scientists find it useful to have the Sun as a center for practical reasons, they can surely do so. But this selection has nothing to do with anything else than those practical reasons. And this was surely not the question in the first place; the question we try to answer is whether the Sun *is* the center of the solar system and not whether choosing the Sun as the center makes our life practically easier. Science is always focused on the practical implications and the true problem here is not a scientific one. It is a problem of science trying to disguise itself as philosophy but without the proper tools to do it. The final selection regarding the true nature of the center can only be made based on philosophical criteria (i.e. the belief that we are insignificant) even though even the scientists using them do not realize it. Only philosophical criteria can claim anything with regards to "reality" in the first place; the only thing science has proved in this case is that it cannot prove anything (since any point of reference could be equally valid).

That is why in order to answer to our initial question we should try to explore the validity of the philosophy which stands behind the selection of the Sun as the center, leaving aside the scientific practical implications. Unless of course anyone believes that the truth would be in any way related to our easiness in performing orbital calculations. The next section will check if the philosophical analysis of the problem at hand can have any impact on the above-mentioned criteria and undermine their importance. Do the scientific criteria mentioned hold against the slightest scrutiny by philosophy? Or do they fall apart like a castle built on sand when the tide rises?

### 3.3 Philosophical criteria

As already mentioned, from the scientific criteria analyzed above, only one holds some kind of validity; the "center of mass" criterion. However, this criterion is more about the practicality of the problem than the actual essence of the question. And this essence can only be addressed by philosophy. One must remember that science is not an independent field of knowledge and certainly not the only one. And even though many people like to think it is the king of human's endeavors towards discovering the always elusive notion of "truth", its true place is far away from that. Science is nothing more than one of the many children of philosophy. It has been born out of philosophy and was grown inside its bosom. And as any kid which needs to seek approval from its parents for its new great adventures, science has to turn to philosophy once more in order to conduct the final approval test on its conclusions. To do this examination we must first analyze on which philosophical propositions the above-mentioned criterion is based upon. Then, all we need to do is offer alternatives and see it those are equally (or more) valid.

The criterion for choosing the Sun, as mentioned above, is based on the fact that Sun has more matter than any other object in the solar system. This makes it a perfect candidate for the "center", since it is logical for anyone to envision the "biggest" (and, thus, most important) thing of a set of things at the center of that set. But is that logic correct? For economy of the analysis reasons, I leave out of the discussion any questions regarding the prejudiced notion that the "biggest" is the "most important" part (a notion which would make Confucius turn into his grave) and I also leave out of the picture any practical implications regarding the effects of that selection in celestial navigation (since I consider these practicalities as a peripheral issue to the main question, which is related to the true nature of what is the 'center'). Instead, I focus on the argument as a whole. An argument which makes use of the notion of "matter" and uses the comparison between different sets of matter (Earth and the Sun) to make the choice. For this choice there are two important comments to be made.

First, the notion of "everything is matter" is a pure philosophical dogma known as "materialism" in its shortest typical form. Materialism is a thesis which modern scientists like to think as obvious and self-evident and that is why it is of crucial importance to always remind ourselves that it is not. The current observational data could fit with equal ease in a world which is not materialistic. The existence of spirit or a soul in the cosmos does not make the planets move differently. And yet, they may create an interesting factor we should weight in the problem at hand.

For a long time, humans have been trying to find their place in the cosmos. For most of the time until the days of Galileo, the answer to that question was obvious: we are important. And thus, we sit at the center of everything. The selection of Earth as the center was never questioned simply because the place of man in the cosmos was never questioned either. And why should it be?

In a cosmos full of inanimate matter, humans were the only ones with the ability to ponder on their own existence, to look at the sky and question why everything is the way it is. Science, even before it was even called science, was based on the premise that we could understand the mind of God who rules the cosmos[15]. Even Galileo himself admitted that "Holy Scripture and nature, are both emanations from the divine word: the former dictated by the Holy Spirit, the latter the observant executrix of God's commands." Thus, "…no truth discovered in Nature could contradict the deep truth of the Holy Writ" [30]. As the sons of God, created in His image, it was more than logical to accept our place at the center of the solar system – it was natural and scientific.

Of course, there can be many objections to what was described above. And these objections would be based on the premise that humans are not important. Why should we consider ourselves special? As it is logical for a theist to believe[16] that he is important, it is also logical for an atheist to believe otherwise. Even though I have serious arguments in favor of the former, I will for the moment accept the latter as an equally valid stance of life. For the goal of this paper is not to argue in favor or against a specific cosmotheory, but to argue on the (philosophical) dogmatism pertaining current astronomy; while proposing ways to get past that dogmatism in the future. The starting point for fighting dogmatism is to recognize that there are alternatives to your way of thinking.

What we need to keep from this discussion is that the view which has the Sun as the center because of its greater mass is not the only one and should not be accepted without scrutiny. Yes, the Sun has the greatest mass, but one could easily counter-argue that the Earth is much more valid as a 'center' since it is the only place in the solar system hosting conscious beings pondering on what that center should be. A set of inanimate particles – no matter how big - is certainly less important than even a single human being with a soul and spirit. (at least for someone who accepts the existence of a soul and spirit)

To sum up, regarding philosophy the selection of the center is arbitrary and inherently related to the place your cosmotheory holds for humans. This is neither good nor bad. It is what it is. All we can do, all we ought to do if we are to formulate a theory, is make a selection and be honest enough to admit the philosophical background supporting that selection. How modern astronomy makes that selection and whether it admits the philosophical foundations supporting it, is something that will be analyzed in the next section of this paper.

### 3.4 The common-sense criterion

In all great problems, there is a closely guarded secret that neither scientists nor philosophers would ever like to admit its existence: Besides the high-end science, beyond over-analytical and sometime obscure philosophy, there lies the common mind. And even though what we call 'common sense' may well be related to some of the biggest misconceptions, in some cases the same common sense proves incredibly wise within its

[15] "This Being governs all things, not as the soul of the world, but as Lord over all: And on account of his dominion he is wont to be called Lord God παντοκράτωρ or Universal Ruler" [Newton, The Mathematical Principles of Natural Philosophy, 1729]

[16] Here I use the word 'believe' with the sense of adhering to a position based on someone's logic and the data available; I am not referring to blind dogmatic faith.

simplistic ignorance. It is this common mind which sometimes reveals a simple yet often overlooked aspect of the whole issue under analysis and provide the solution, by simply overriding all the obstacles put into our path by our adherence to over-analysis of things. In our case, the solution on what is the center of a system might be much simpler than we thought. (and as we will see, anyone driving a car could attest to that)

The solution goes like this: Why not choose the point of the observer as the center of the system he is observing? Why are we trying to find out what is the center of the solar system while we are sitting here watching it? What is more natural than saying that the center of an observed system is where the observer stands?

As most simple answers do, this argument is deeper that it initially looks. The whole question under analysis was raised by men who sit at night observing the sky. Would there be any logical reason for them to choose as center for that system any different place than the place from which they are watching it in the first place? The immediate answer is a simple "No". Why would there be such a reason? Think of yourself driving your car. You observe the other cars, their velocities, their direction. What do you say when looking at them? Which point of reference do you use when describing their motion? Do you describe the situation in the road as if the center of the whole "road and cars" system is somewhere outside your own car? Or do you simply describe everything as if you are the center of everything in the road? Do you care how fast a car is travelling in relation to another third car? Or do you care about how fast it travels as compared to you?

When we think of the above situation the answer that comes to our mind is obvious: We are the center of the system we are analyzing. Not the (potentially bigger) truck next to us. So why don't we apply the same logic to the situation where we observe planets moving around? Or when we observe the Sun moving in the sky? The answer to these simple (thus, hard) questions lies in a centuries-old dogma penetrating astronomy from the days of Galileo.

## 4. HIDDEN DOGMAS: THE COPERNICAN PRINCIPLE

Cosmology, as any other field of science, has created models based on many unproven assumptions (also known as 'axioms' in other fields). Those axioms/ assumptions are the principles with the help of which the observations of astronomy are analyzed and based on that analysis specific scientific models are developed. If we took alternate assumptions, then those same observations would support wholly different models. Two major assumptions which lie in the foundations of astronomy are the isotropy (the universe looks the same in any direction and from any place) and homogeneity (the make-up of the universe is more or less the same everywhere) of the cosmos.

These two points taken together are called the Cosmological Principle [34]. Since it is a "principle", this means that pretty much all cosmologists and astronomers will make this assumption. In an over-simplification, it can be said that the Cosmological Principle supports the idea that "on a large scale the universe is pretty much the same everywhere" [33]. What does mainstream astronomy call on for support? Observed isotropy of the cosmic microwave background radiation (CMB), combined with the Copernican principle: If you observe the universe being isotropic then, taking for granted that the Copernican principle is true, you can infer the conclusion that the universe is homogeneous.

But what is the Copernican principle?

In physical cosmology, the Copernican principle states that humans are not privileged observers of the universe. Named for Copernican heliocentrism, it is a working assumption that arises from a modified cosmological extension of Copernicus's argument of a moving Earth. It is a principle with very important implications to science [9] [12] [17]. It essentially states that we are in no special place in the cosmos. Just a random planet moving along in a random galaxy. And that is why if we assume this principle is valid, then the fact that we observe the universe to be isotropic from a totally random point, then it should be logical to say that it is in general homogeneous. In some sense, the Copernican principle is equivalent to the mediocrity principle.

The mediocrity principle is the philosophical notion that "if an item is drawn at random from one of several sets or categories, it's likelier to come from the most numerous categories, than from any one of the less numerous ones". The principle has been taken to suggest that there is nothing very unusual about the evolution of the Solar System, Earth's history, the evolution of biological complexity, human evolution, or any one nation. It is a philosophical statement about the place of humanity. The idea is to assume mediocrity, rather than starting with the assumption that a phenomenon is special, privileged, exceptional, or even superior than others [10] [11].

Given the physics described in the previous section, it is not difficult to see that these principles (axioms) are the basis for the belief that Earth is not at the center of the solar system; sometimes despite contradicting empirical data as in the case of Galileo or Hubble (which will be analyzed in the next section). And even though it is necessary for science to start from somewhere its quest for exegesis, it is important to at least understand what this starting point is. Astronomy has been adhering to the above-mentioned principles for too long that it has almost forgotten that these principles can change as easily as they were chosen in the first place. Galileo was an early example on how personal beliefs can drive scientific conclusions, but certainly not the last. The scientific community should learn from the example of geometry, where it took us almost 2,000 years to question an axiom. And when we did, a whole new world and two new geometries came to surface. What should be clear is that the Copernican principle is what it is: a principle. And what is important is that not only it can be questioned, but it should be. If not, that principle will soon become a dogma. And from that, no good science was ever born.

## 5. DOGMATISM INTO SCIENCE: FROM HUBBLE AND BEYOND

Most modern scientists (like Hawking or Neil de Grasse Tyson) don't miss a chance to claim that philosophy is dead. And yet, it is their philosophy which defines their science. The example of Galileo is not the last case of scientists letting their own philosophical beliefs get in the way of the science they produce. This is not something bad per se. There is nothing wrong with having philosophy influencing your stance in the matter under analysis. Philosophy is and will always be the basis of not only our science, but our life itself. What is wrong (and potentially scientifically dangerous) is not to acknowledge that this influence exists. Because then is when science gradually regresses into dogmatism. The case of Hubble can illustrate how this can happen.

The famous astronomer Edwin Hubble published on 1937 a study on the cosmological model of the universe, under the title "*The Observational Approach to Cosmology*". In the data published in that study it was evident that Earth appeared like having a *unique* (sic) position in the cosmos, i.e. that it was in the center or very close to it. However, Hubble chose not to accept that unique position based on philosophical propositions (principles) that be believed in. (and against all the observational data)

In particular, even though the nebula distribution showed that Earth should be in a center position, he discarded that idea based on the “principle” (axiom) that we are not unique. Based on that principle it would be illogical to say that we are in a privileged position (in the center of the Universe) and in order to accommodate that belief (axiom) he added some corrective factors to his equations! As simple as that! No hard data, no scientific analysis - a plain philosophical choice was the basis of the choice for what is valid and what is not.

One of the parts of Hubble's research where he makes those philosophical choices is cited below [17] (emphasis added by me):

[Beginning of excerpt from “The Observational Approach to Cosmology”][17]

*“The departures from uniformity are positive; the numbers of nebulae increase faster than the volume of space through which they are scattered. Thus the density of the nebular distribution increases outwards, symmetrically in all directions,* ***leaving the observer in a unique position****.* ***Such a favoured position, of course, is intolerable****; moreover, it* ***represents a discrepancy with the theory, because the theory postulates homogeneity****. Therefore, in order to restore homogeneity,* ***and to escape the horror of a unique position****, the departures from uniformity, which are introduced by the recession factors, must be compensated by the second term representing effects of spatial curvature.*

*There seems to be no other escape. Observations demonstrate that*

$$\log_{10} N = 0.6 m_c + \text{constant}$$

*Relativistic cosmology requires that*

$$\log_{10} N = 0.6(m_c - d\lambda/\lambda + C_v) + \text{constant.}$$

*Therefore,*

$$C_v = d\lambda/\lambda.$$

*The curvature of space is demonstrated and measured by the postulated recession of the nebulae. To the observer the procedure seems artificial. He has counted the nebulae to various limits, applied only the corrections that are necessarily required (energy-corrections), and derived the quite plausible result of uniform distribution. Now, in testing the relativistic theory, he introduces a new postulate, namely, recession of the nebulae, and it leads to discrepancies. Therefore, he adds still another postulate, namely, spatial curvature, in order to compensate the discrepancies introduced by the first. The accumulation of assumptions is uneconomical, and the justification must be sought in the general background of knowledge. The outstanding argument is the fact that velocity-shifts remain the only permissible interpretation of red-shifts that is known at the present time.”*

[End of excerpt from "The Observational Approach to Cosmology"]

[17] Retrieved from http://ned.ipac.caltech.edu/level5/Sept04/Hubble/Hubble3_6.html on 2018-09-06. The full text of the abovementioned research paper by Hubble can be found online at The Observational Approach to Cosmology archived at the respective site of the NASA/ IPAC Extragalactic Database (NED), which is operated by the Jet Propulsion Laboratory (JPL), California Institute of Technology (CalTech), under contract with the National Aeronautics and Space Administration (NASA).

If anyone wondered, that is the true face of modern dogmatism. Crude and raw. Scientists (and all other people in general, this is not only a science issue) have the tendency to adhere to things they already 'know', thus destroying the possibility to learn anything new. (or remember things we already knew, if we get more philosophical) The worst enemy of knowledge is sometimes knowledge itself.

Note that I am not trying to make any claim regarding the validity of the research of Hubble, or the correctness of his conclusions. The comment raised here relates only to the blatant use of axiomatic principles in the formulation of those conclusions, thus leading to the exclusion of other possible conclusions. It could be said that it was honest of him to admit the use of specific principles; and that would be true up to a point. However, one would expect a little bit more of an analysis of why such principles are selected when it comes to conclusions related not to just a minor detail but to the very nature of our cosmos (i.e. static or expanding universe). A proper examination of the observational data would at least entail a short presentation of the alternative options; discarding one of those options simply on the premise of "this is intolerable" is not only shallow and crude but deeply unscientific as well. And if one wanders how this was acceptable, the answer is simple. Science uses axioms to formulate theories for thousands of years. Once an axiom is formulated and accepted, then a whole set of theorems are based on that axiom and whole worlds (theories) are built upon them. It is not so easy to discard all this just in order to present the other potential options. It takes courage to do that (and a lot of time, the scarcest resource for modern scientists, who are always under pressure to publish their next new original research as soon as possible). It took the world more than 2,000 years to discard the belief that only one parallel line exists for any given straight line. Discarding the notion that we are unimportant will take much more; especially by people who do believe that they are not important in the first place.

The abovementioned cases are not the only ones in the history of science. Anti-humanity dogmatism runs deep into astronomy, as in modern science in general. During the last centuries there has been a systematic promotion of the idea of humans being unimportant. The (scientifically valid) biological theory of evolution was wrongly used by many in philosophy (where it doesn't belong) to promote the unimportance of the human species in the context of nature. Carl Sagan watched the stars and postulated that we are nothing more than a speck of dust in the vast space. Hawking also said "We are just an advanced breed of monkeys on a minor planet of a very average star". In the modern era of scientism, there is no place for theories which hint of humans being more important than the scientific models per se. And yet, if we do believe into our insignificance we cancel our own selves and the science we produce. Which speck of dust wanders about its own existence? What kind of "minor planet" is full of conscious beings observing the cosmos in awe and postulating on the meaning of life? How many unimportant beings have you met which ponder about all the important questions of existence? How valid could anyway be the science produced by a random set of particles which just happens to be called human?

The need for a new kind of astronomy, closer to humans, which will be compatible with the importance of our very existence is more evident than ever.

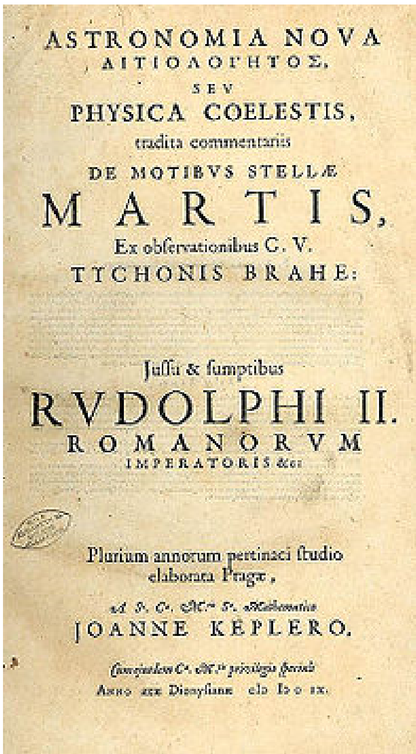
ASTRONOMIA NOVA
ΑΙΤΙΟΛΟΓΗΤΟΣ,
SEV
PHYSICA COELESTIS,
tradita commentariis
DE MOTIBVS STELLÆ
MARTIS,
Ex obſervationibus G. V.
TYCHONIS BRAHE:
Juſſu & ſumptibus
RVDOLPHI II.
ROMANORVM
IMPERATORIS &c:
Plurium annorum pertinaci ſtudio
elaborata Pragæ,
A S. C. M.tis S.tis Mathematico
JOANNE KEPLERO,
Cum ejusdem C. M.tis privilegio ſpeciali
ANNO æræ Dionyſianæ CIƆ IƆ C IX.

*Figure 4: Kepler's Astronomia Nova[18] is the cornerstone of modern astronomy, denoting a major paradigm shift from the circular orbits [31]. Our era seems to need again a paradigm shift towards a more humane astronomy.*

## 6. TOWARDS ASTRONOMIA HOMINUM

Astronomy is not the only field of science governed by our adherence to anti-humanism dogmas. Since Descartes and certainly after enlightenment, almost every field of modern research endeavor is dominated by a materialistic and mechanistic view of the cosmos; a view discarding any human from the universe we are investigating[19]. Incredible as it may sound, scientists today analyze the cosmos as if we are not around. From biology and genetics to psychology and physics, we examine a cosmos void of anything by matter. It is our genes which dictate what we do. It is our brain which makes us act. We are just a set of particles moving around along with other sets of particles. And surely, we cannot claim to be the center of anything since we can hardly claim that we exist anyway (at least not as humans with a soul).

This path – as any other path flirting with dogmatism – has led to many problems. Despite the latest scientific and technological breakthroughs, modern astronomy cannot in any case claim definite 'progress' in our understanding of the movements of celestial objects. Recent discoveries have led us to a weird path of adding more and more variables (dark matter, dark energy) to the equations in order to account for what we see. And yet, some of the problems we now face could be potentially solved had we used different principles in the first place. What we see as 'problematic' motion in a homogeneous universe

[18] Source: Wikipedia Commons, https://en.wikipedia.org/wiki/Astronomia_nova#/media/File:Astronomia_Nova.jpg

[19] Another good example of materialism setting the path in modern research is the field of neuroscience and the search for consciousness. Check out Spyridon Kakos, "Consciousness and the End of Materialism: Seeking identity and harmony in a dark era", International Journal of Theology, Philosophy and Science, Vol 2, No 2 (2018) for more details on that.

(something we accept as an axiom) could be normal in a inhomogeneous cosmos. Today, the homogeneity of the universe is greatly at dispute [38] [39] [43]. Studies show that, given a particular choice of measure, universe is inhomogeneous, and this inhomogeneity actually is a probable outcome of inflationary theory with us being located near the center! [36] One cannot dismiss such models out of hand for probability reasons [37].

Some astronomers have proposed models where Earth is at the center of the universe, so as to solve the problems modern astronomy has with the explanation of the movement of the galaxies (problems which have led to the introduction of the dark matter notion for example). George Ellis[20] has proposed that we live on a planet that is near one of the two centers the universe has and - according to his calculations - that 'semi-geocentric' model removes the need to invent terms like "dark energy" or "dark matter" to explain how galaxies move. He claims that his model gives almost as good a description of the real universe as the conventional models. In an article in Nature journal, Ellis proposes that the universe is like a cylinder-shaped universe with two centers, with the Earth is located on one side and a naked singularity on the other [35].

Note again that the point here is not to question the current consensus of modern astronomy (which indeed accepts the existence of dark matter and supports the opinion that the universe is homogeneous), but to illustrate what an important role the principles we use play in the formulation of our conclusions. And to show that under specific models the notion of us being in the center is not so implausible after all. Even astronomers which do not adhere to the above theories, accept that it is plausible to say that we are at the center of the cosmos, along with all other objects of the universe, since we all started our journey into existence from the same single point with the Big Bang. As the universe expands, all points in the universe see all other points getting further and further away from them, as if they are in the center of the universe.

All in all, Ellis explains that scientific exploration can tell us much about the universe but not about its ultimate nature, or even much about some of its major geometrical and physical characteristics. Some of this uncertainty may be resolved, but much will remain. Cosmological theory should acknowledge this uncertainty [41]. Taking into account all of the above, we must be very careful when we speak as scientists. When formulating a theory, we must clearly state what are the pre-assumptions that we make and the axioms or propositions that we use [42]. And we must most certainly be clear about the limitations of science, the goal of which is mainly to formulate scientific models to describe and predict and not to reach the truth regarding reality as philosophy defines it.

At the end, as is was made clear from the above analysis, science alone can never reach to a solid conclusion on the matter without philosophy. And it is unfortunate that science has lost any connection with philosophy during the last centuries. We tend to look at the stars when studying the universe and yet, the strongest argument for seeing humans at the center of everything is not hiding in the stars, but back here on Earth. On a small planet where conscious beings share their love for the dark sky. Science must regain its connection with philosophy and must find its way towards humans again. It is imperative that our models for the cosmos are compatible not only with the observation data (which anyway

[20] George F. R. Ellis is the Distinguished Professor of Complex Systems in the Department of Mathematics and Applied Mathematics at the University of Cape Town in South Africa. He co-authored The Large Scale Structure of Space-Time with University of Cambridge physicist Stephen Hawking, published in 1973, and is considered one of the world's leading theorists in cosmology. From 1989 to 1992 he served as President of the International Society on General Relativity and Gravitation [40].

could lead towards to us having a more important place in the cosmos than thought before) but also to the very soul of the universe we observe. And that soul is not the Sun nor the Earth. The soul of the cosmos is us. Shestov said it a long time ago, but few people recognized the importance of his claims: astronomy is the child of astrology and as most children in today's world, it is a spoiled one [31]. Modern astronomy is void of any meaning: it just looks for ways to analyze the cosmos which is seen not as a living one, but as an empty shell devoid of any meaning. Astronomers today measure and log data. They do not search for the Logos inside creation. But it was Logos which made creation possible in the first place. And to regain connection with that, we must perhaps start analyzing the cosmos without any principles or axioms holding us back.

## CONCLUSION

Even though a scientific ending could seem appropriate, I felt that since philosophy was the source of the problems in the first place it is also the only one able to offer a closure to the issue at hand. Albert Einstein stated, "Once it was recognized that the Earth was not the center of the world, but only one of the smaller planets, the illusion of the central significance of man himself became untenable. Hence, Nicolaus Copernicus, through his work and the greatness of his personality, taught man to be honest"[21]. In a sense, he was right. Despite the disagreements and the debate, this honesty is indeed something we all need to uphold. Beyond the fallacies, the controversies and the mistakes, we are all human. And we should all stay humble in front of the cosmos. A cosmos which is meaningful only if there is someone in it. Like Galileo and Copernicus, one day we will all die. One day, even the Sun will fade away along with all the stars in the universe and our cosmos will eventually fade into oblivion. Some might argue that during our time we were just tiny specks of dust wandering around meaninglessly, but this could not be further away from the truth. We are not just watching the stars. We are deciding on their fate. We are not just the interpreters of their motions, but the ones breathing Logos into the cosmos itself. There is no point in being honest in a cosmos void of any meaning, but it is of cosmic significance to be honest in a world governed by divine wisdom. We used to be kids. We used to have this wisdom, but we chose to grow up and acquire 'knowledge'. And we chose to sacrifice that wisdom in the belief of our insignificance. We used to have everything, yet our lust for more has led us to nothing. The path from Athens back to Jerusalem will be hard, but it is a path we need to tread so as to rediscover the center not of the solar system but of our very existence. We are important. Our words are not just meaningless noise but have the power to make the Sun stop. And we must just open our eyes to make it move again. Our beliefs do not only shape the conclusions of science about the universe but can also shape the universe itself. We are not tiny specks of dust. We are part of God. And even though we look at the night sky without remembering what message it conveys, we do feel that it has a message to convey. Close your eyes. Look carefully and rejoice. For it is not us looking up at the stars, it is them staring back at us in awe…

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