Modelling and Thought Experimenting: The Case of Galileo on Falling Bodies*

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Introduction

In my book *Thought Experiments, Models and Scientific Explanation,* (Karadimas 2026) I made the case that thought experiments are basically indistinguishable from models and that both can be conceptualized as mingled representations, i.e. as representations that entail content that is at once hypothetical and empirical. I moreover argued that this representational schema is capable of giving scientific explanations for it carries scientific information that can be explanatorily relevant in context. In order to evaluate explanations, we can use a lexicographic structure whereby the representation with the most relevant piece of information can be ordered higher in the ranking. The book excerpt below applies this framework to Galileo's famous thought experiments on falling objects. Galileo offered a hypothetical scenario on falling bodies which, even though is taken to be central to modern physics, it has never been considered as an explanation (at least in the field of philosophy of science).

Galileo's mingled representations—typically taken to be a "thought experiment" in the relevant literature—are therefore examined and presented anew here. It is shown that Galileo's account can offer explanations under several contexts once its representational strategies are considered. The explanations it provides are compared with other competing theories, and mainly with Aristotle's theory and a lexicographic ordering is offered in each case. Moreover, philosophical approaches that explicitly

preclude the possibility of Galileo's thought experiment to explain are addressed and it is argued that the opposite conclusion is to be drawn.

Galileo's Case Study

Two concerns should be tackled when we examine case studies in science: first, why do we need case studies by and large, and second, why do we need the case study in question. As for the first, it seems obvious that case studies can make a philosophical stance specific, so we need them for illustration purposes. Indeed, a case study serves as an exemplar and shows how a philosophical theory finds a detailed application and they are thus often necessary. This is important for philosophers of science, for the branch cannot simply discuss philosophical concepts without exploring whether they bear resemblance to science.[1] As for the second though, the answer should be given on a case-by-case basis, for it cannot be said in advance which accounts should be used for illustration and which have to be excluded from the discussion. Widely discussed scientific examples that seem to have reached a standoff, may lead to unexpected conclusions when examined in a new framework. The converse also holds: Neglected projects or accounts not considered at all may either trigger philosophical and scientific insights or may provide proving ground for clarification or for application of theories, of concepts and of philosophical ideas.

I would like here to discuss the well-known Galileo's account on falling bodies which is typically considered a "thought experiment" while sometimes many call it a "model" too. But since it is "well-known" and hence widely discussed, one may doubt the need to examine it further. Indeed, the characterization "widely discussed" is an understatement for this construction since scholars have elaborated on it[2] and it is actually the first thought experiment that springs to mind whenever we come to discuss thought experiments in science.

As indisputable as it is that many philosophers have used it in defense of their own philosophical accounts, no one, at least to the best of my knowledge, has examined it in view of its representational strategies and of the possibility to offer explanations through them. In fact, quite the contrary has happened: Lipton for example argues that Galileo's thought experiment does not provide explanation but only understanding. I obviously take issue with this view and a case study on this thought experiment is the best way to show first and foremost how Galileo's thought experiment can provide explanations and also to oppose Lipton's view.

Galileo's representational mingling can explain events in the sense that it can address why-questions under certain contexts. But Galileo's mingled representations cannot be examined on their own right. Galileo questioned Aristotle's theory on

[1] At the same time, caution is required for, as scholars have argued, it is not a foregone conclusion that by discussing case studies, all philosophical or scientific uncertainties are resolved (Scholl & Sauer 2016).

[2] Koyre (1943; 1968) should be credited as the first who stressed Galileo's inclination to thought experiments by describing him as a Platonist shcolar. For discussion on Galileo's thought experiment on falling bodies see (Atkinson and Peijnenberg 2004; Brown 1991; 2000; 2004; Camilleri 2015; Gendler 1998; McAllister 1996; Norton 1991; 1996; Oh 2014; 2016; Palmerino 2018; Palmieri 2005; 2018).

falling objects, so Aristotle's theory and its consequences will inevitably be part of this case study. I will start with a presentation of the main aspects of Aristotle's cosmology and more especially with his views on falling bodies. I will then present Galileo's thought experiment in terms of its representations and of how they can be used as an explanatory relevance relation. Eventually I will challenge Lipton's view on Galileo's account.

Aristotle's Theory

Aristotle famously constructed the geocentric model according to which the earth is stable and the planets, as well as the sun, rotate around it. Aristotle discriminated conceptually between the Earth as an astronomical object that stands motionless at the center of the universe and the earth as an element (γῆ). Four elements have a special role in Aristotle's cosmology: the Earth (γῆ), the Water, the Air and the Fire. In fact, Aristotle regarded all bodies of the universe as a mixture of these four elements in different proportions. So a stone contained mostly the element of earth (γῆ) and in lesser quantities the other three elements.

All these elements have moreover a tendency to reach their natural place: Since Earth (as an object) already resides at the center of the universe, then a stone reaches the bottom of it and similarly does water. The Air and the Fire on the contrary, are moving away from the center. Thus the heavier elements, such as the Earth (γῆ) and the Water move downwards and the lighter ones move upwards. Corollary to this is that that the objects consisted mostly of Earth (γῆ) and Water must seek to reach their natural place at the center of the universe i.e. the center of the Earth (the object).

Aristotle held that heavy objects fall faster than lighter ones. For example a heavy stone falls faster than a lighter one and this is to be put down to the greater proportions of the element of Earth (γῆ) that the heavy ball is consisted of. This part of Aristotle's physics is mainly presented in the work *On the Heavens* where he declares that a given weight moves a given distance in a given time; a weight which is as great and more, moves the same distance in a less time, the times being in inverse proportion to the weights. For instance, if one weight is twice another, it will take half as long over a given movement (Aristotle, 1908, 10).

But apart from the weight of an object he regarded the resistance of the medium through which it falls as a factor determining its speed. For example, a stone should fall faster in the air than in the water. Thus the speed of a falling object has been directly proportional to its weight and inversely proportional to the falling medium i.e. the resisting force. As Holton and Brush put it, one can think of the weight of the object and the resistance provided by the medium as two opposing forces. There is motion only if the weight exceeds the resistance and the greater the weight in proportion to its resistance, the greater the speed.

Aristotle's theory leaves no room for the existence of vacuum. In fact it seems that the existence of vacuum is inconceivable. This is not an arbitrary assessment but it was based on the following rationale: if the density of the medium vanishes, then according to the postulate that the speed is inversely proportional to the resisting force, then a heavy object would have to fall in vacuum with infinite velocity which does not happen and so vacuum is not even a possibility. From a modern perspective,

this may seem absurd, though according to Aristotelians it was exactly that anomaly that consolidated their view that vacuum simply cannot exist (Holton and Brush 2005, 78-79).

This is a brief overview of Aristotle's physics with special attention given to his theory of falling bodies. Aristotle offers a well-grounded empirical theory which unsurprisingly prevailed for centuries. However, several limitations have been pinpointed over the centuries and most emphatically by Galileo.

Galileo's Representational Mingling

Galileo was not the only scientist who criticized Aristotle's theory and he was not even the first one,[3] though admittedly is the most prominent among the critics. The best part of his criticism is developed through his mingled representations on falling objects. In this construction, Galileo not only debunks Aristotle but also proposes his own theory on falling objects.

Galileo presented his thought experiment in his *Two New Sciences* (Galileo 1638/1952) through a dialogue. This is a linguistic representational tool and is the unique one since both the *–of* representation and the *–as* representation are represented almost exclusively by it, with the exception of some numbers that occasionally split in the text.[4] He portrays three fictitious persons and two of them *as* representing the theses *of* real-world persons. The third one is an imaginary figure who, as it has happened with Darwin's demon and Maxwell's demon, it has certain features attributed to it by Galileo. There are three interlocutors which are: Salviati, who presents Galileo's opinion, Simplicio who is an Aristotelian and Sagredo who is neutral and has been attributed the feature of being a philomath. The disagreement between Salviati and Simplicio reflects Galileo's opposition to Aristotle.

We saw that Aristotle predicts that heavier bodies fall faster than lighter ones and that their falling speed is directly proportional to their weight and inversely proportional to the resisting force i.e. the medium. Galileo's spokesman, Salviati, calls us to imagine a heavy body, say a heavy stone, to fall in the air with 8 degrees of speed and a lighter stone to fall through the same medium with 4 degrees of speed. If we join them together we have an even heavier stone which is expected to fall with more than 8 degrees of speed in the air. But the lighter stone will partly retard the speed of the heavier and the heavier will partly speed up the lighter. Therefore this bigger stone moves slower than the first heavy ball. So, from the initial postulate that heavy balls fall faster than lighter ones we conclude that heavy bodies fall slower than lighter ones.

[3] Philoponus for example, in his commentaries on Aristotle's physics, conceived as problematic the Aristotelian postulate that the speed of fall is proportional to its weight (Philoponus 1887). For further discussion on Philoponus see (Cohen and Drabkin 1948).

[4] See for example (Galileo 1638/1952, 74, 97). I follow Crew's and de Salvio's translation which has not amended the original representations, as they were first presented in Galileo (1638).

It seems therefore that Aristotle's main prediction "the speed of fall is proportional to its weight" leads to a situation according to which the mass of a body is independent of its falling speed (Galileo 1638/1952, 63), which is incompatible with Aristotle's physics. The representation *of* how bodies behave is expressed by a fictitious person i.e. Salviati. So, Salviati presents the observational results according to which bodies of different weights fall at *almost* the same time through the same medium[5] or even do not fall at all, as it happens for example when a piece of wood, say a plank, is placed in the water. It does not sink even though it falls rapidly through the air (Galileo 1638/1952, 64-65, 69). These results, as presented by Galileo's representational mingling, provide a serious challenge to Aristotle's view that the speed of a falling body is proportional to its weight and inversely proportional to the resisting force.

Salviati then asked what would happen if we eliminate the effects of the resisting force. He argues that in such a scenario all bodies would *all fall at the same speed regardless of their weight*. Galileo's *–as* representation therefore involves as well a hypothetical condition in which no medium intervenes. Other forces that act upon bodies, such as air friction, are to be imaginary and no more taken into account. To gain a better grip on the counterfactual rejection of an intervening medium we should consider this to be Galileo's response to the slight differences in the speed of falling bodies, as those were observed in nature. [6]

Koertge wittily conceptualizes Galileo's attitude towards the resisting force, by claiming that the differences in the speed of falling bodies were in fact "accidents" (and hence not trustworthy data). Friction or resistance for example, hinder and impede the motion of falling bodies and if we are to attain knowledge about falling bodies such accidents should be abstracted away from our picture (Koertge 1977, 392). These accidents therefore were due to the resistant medium. And as Galileo observed, the less dense the medium is, the slightest the difference in speed turns out to be. Thus in the air heavier bodies fall faster than lighter ones but only in the narrowest of margins and not proportionately to their weights. Notwithstanding these vexing minor differences in the speed of falling bodies, Galileo seems to have been convinced that we are led inexorably to think how bodies would move should they be

[5] See Galileo who criticizes Aristotle by offering several empirical representations. According to Galileo (masked up as Salviati), an iron ball of ten hundred pounds falling from a height of one hundred cubits reaches the ground before a one-pound ball has fallen a single cubit. Salviati says that they arrive at the same time. You find, on making the experiment, that the larger outstrips the smaller by two finger-breadths, that is, when the larger has reached the ground, the other is short of it by two finger-breadths; hence we need not hide behind these two fingers the ninety-nine cubits of Aristotle and miss the general conclusion according to which Aristotle was mistaken (Galileo 1638/1952, 64-65).

[6] McAllister when discussing Galileo's commitment to thought experiments makes an interesting point by mentioning that if the phenomenon is so subtle that no concrete occurrence can be produced in which the phenomenon can be produced in accident-free form, the phenomenon may be displayed only in an abstract occurrence: that produced in a hypothetical representation, as part of a thought experiment. This view explains why Galileo, in the case of some phenomena, withdrew from the sphere of sense data (McAllister 2004, 1168).

free of all resisting forces.[7] Such a state of affairs that was excluded formally from Aristotelian physics and so had been the conclusion that all bodies fall at equal speed.

A Woodwardian Pathway

One way to view Galileo's account is through James Woodward's theory of counterfactual causality (Woodward 2021). That is, it can be used to explore possible causal connections in the world. As we just saw, Galileo's bashing of Aristotle's physics hinges on the paradoxical conclusion that Aristotle's premises lead us to.

The core of Aristotle's theory can be translated in Woodwardian terms of variables. So, let:

- Variable *W* be Aristotle's statement: "The speed of a falling body is proportional to its weight"
- Variable *M* be Aristotle's statement: "The speed of a falling body is inversely proportional to the resisting force provided by the medium"
- Variable *H* be Aristotle's conclusion that "Heavier bodies fall faster"

Thus we have

- $W+M \rightarrow H$

Recall now that the best part of Woodward's theory of explanation demands that we should be looking for invariant relationships between variables. A variable is invariant if it remains stable when other variables are altered. Galileo first altered *W*. In fact, he denied *W* based on the Aristotelian paradox that it is not always the case that heavy bodies fall faster than lighter ones. He then changed the value of *M* by counterfactually assuming that *no medium interferes* and hence there is no resisting force to check the speed of the falling body.

Galileo's conclusions can be presented in terms of variables:

- *S*: "The speed of falling objects is not proportional to their weight"
- *V*: "Bodies fall in vacuum and thus there is no resisting force"

We are in a state in which Galileo altered both the Aristotelian variables *W* and *M* and replaced them with *S* and *V* respectively. The question is: Do the variables *S*+*V*

[7] Galileo describes in some detail the impact the falling medium has in each case on falling objects and to make his counterfactual case without any intervening media. He claims that when we are trying to investigate what would happen to movables very diverse in weight in a medium quite devoid of resistance, so that the whole difference of speed existing between these movables would have to be referred to inequality of weight alone. Hence just one space entirely devoid of air-and of every other body, however thin and yielding-would be suitable for showing us sensibly that which we seek. Since we lack such a space, we better observe what happens in the thinnest and least resistant media, comparing with what happens in less thin and more resistant.

If , Galileo' argument goes, we find in fact that movables of different weight differ less and less in speed as they are situated in more and more yielding media, and that, finally, despite extreme difference of weight, their diversity of speed in the most tenuous medium of all, though not a perfect vacuum, is found to be very small and almost inappreciable, then we are justified in believing it highly probable that in a vacuum all speeds would be entirely equal (Galileo 1638/1952, 64-65, 69, 72).

lead to *H*? Galileo says no. Since bodies fall in vacuum, then there is obviously no resisting force and thus the resisting force no more determines the speed of the objects. Thus the relation *W+M* no longer leads to *H* and hence *H* is not an invariant variable.

Galileo's thought experiment therefore replaces *H* too. If *S+V* hold, nothing impedes free fall and we are led to variable *S'*:"all bodies fall at the same speed regardless of their weight".

In brief we have:

1) *W+M→H*
2) *S* instead of *W*
3) *V* instead of *M*
4) *H* no more stands
5) If *S* and *V* is the case, then *S'* holds.

We see therefore that this thought experiment can be treated as demonstrating whether causal relationships in the world are to be established or disputed. While this is a useful philosophical tool to approach Galileo's account, it does not show how really an explanation is achieved, because it does not answer a why-question that is related to a context, it simply showcases that the variable that "heavier bodies fall faster than lighter ones" does not remain stable if we alter the premises upon which it was based, which, on its own, does not suggest that we have an explanation. To see precisely how Galileo's thought experiment explains, we need to pick up on its representations and how the information they carry could be relevant to diverse contexts.

Falling Bodies and Why-Questions

The first task is to present Galileo's mingled representations in propositional form and to describe the piece of information that the mingled propositions bear and then to bring examples of why-questions that they may answer. We have already seen that Galileo's representational tools are not abundant since his *of/as* representations take place almost solely through linguistic representational tools. However, his representational mingling (*RM*) is informationally rich. It involves the following set of linguistic representations:

$Rm_i=\{m_a,\ldots,m_n\}$, $Rm_{ii}=\{m_a',\ldots,m_n'\}$, $Rm_{iii}=\{m_a'',\ldots,m_n''\}$, $Rm_{iv}=\{m_a''',\ldots m_n'''\}$ whereby their content is:

$Rm_i=\{m_a,\ldots,m_n\}$: The weight of a body is irrelevant to its acceleration.
$Rm_{ii}=\{m_a',\ldots,m_n'\}$: The thinnest the resistant medium is, the less it impedes the speed of falling objects.
$Rm_{iii}=\{m_a'',\ldots,m_n''\}$: Bodies in vacuum, have no resisting force to obstruct their motion.
$Rm_{iv}=\{m_a''',\ldots m_n'''\}$: Bodies falling in vacuum, being free of any resistant force, will fall exactly at equal speed.

These seem to be the most scientifically interesting linguistic representations of this representational mingling. Of course, one may find other mingled representations in

Galileo's dialogues which can as well explain events. But I shall restrict my attention to these four. We can take some examples of why-questions to see the extent to which these representations bear relevant information. In what follows, I will treat these mingled representations as competing answers that all strive to explain the same explanandum and add Aristotle's theory as a competing explanation, to see under what contexts Galileo's representations are more sound than Aristotle's theory and vice versa.

One example entails another theory on falling objects, the one offered by Rabinowitz, in a context whereby it is lighter bodies that fall faster. A lexicographic ordering will be structured to represent the hierarchy in each context. All of Galileo's representations can in principle answer why-questions depending on the information each one of them bears. In other words, they are in principle explanatory and in principle relevant when why-question on falling objects are raised. Whether they are moreover explanatory relevant is determined by the context.

Rabinowitz shows that there are settings in which lighter bodies fall faster than heavier ones. To visualize the context, consider three spheres of masses $M>m_2>m_1$ and let the central force interaction act upon them. Let the three masses be in a straight line with M (the earth) an equal distance between m_2 and m_1 (this would be like dropping m_2 and m_l simultaneously from equal heights at opposite poles of a spherical earth.) When let go, the three bodies accelerate toward their common center of mass (CM). Since the CM of the system is between the centers of M and m_2, m_2 will have a shorter distance to fall toward the CM. Since M moves towards m_2, M moves away from m_l. Thus m_l will have a longer distance to fall than m_2 to reach M or the CM.

Therefore, relative to M, one might be tempted to think that the heavier mass m_2 will fall faster than m_1. However, all three bodies must reach the CM at the same instant or the CM would move, which is not allowed. Since the lightest mass m_l has to go the farthest distance to reach the CM, it must go the fastest relative to the CM. Thus relative to a point fixed in space (the CM) for 3 bodies, the lighter body falls faster that the heavy body for bodies falling concurrently from opposite ends of the earth.

As Rabinowitz states, the fact that lighter bodies fall faster in such a context does not suggest that Einstein's equivalence principle is violated for gravitational and inertial masses are equal and the lightest mass m_l goes the fastest in the center of mass three-body system because it is acted by both M and m_2, whereas m_2 is acted on by both M and m_l. The case remains even if the three bodies are not collinear (Rabinowitz 1990, 34-38).

Say now that we ask the question: "Why do lighter bodies fall faster than heavier ones?", under such a context. This question is raised in a context where the measurements of the speed of each body happen not relative to one of the other bodies, but relative to a point fixed in space, the center-of-mass of the system (Rabinowitz 1990, 34-38). Clearly, the representational mingling bears information that is not explanatory relevant to the topic and hence it fails to explain this and so does Aristotle's theory. Thus under such a context none of these explanations becomes explanatory relevant despite the fact that they are both in principle relevant and in principle explanatory.

Fischbach et. al. (1986) reanalyzed the results of Eōtvōs experiment and they observed some data anomalies that led them to the assumption that there must be some fifth force that causes some lighter objects to fall faster than some heavier ones. Their analysis seems to be closer than any other explanation proposed so far and even though it does not fully explain, it needs to be ranked higher in the ordering than the other two. However, since their assumption that there is a fifth force remains undocumented (at least as far as I am concerned), it appears that we cannot claim that the purported fifth force provides an explanation of the fact that under some contexts lighter objects can fall faster and it is I think appropriate to search for an explanation whose information is compatible with the explanatory indexicals of the context.

Such an explanation is offered by Rabinowitz himself who puts the issue down to the fact that "the lightest mass m_1 goes the fastest in the center of mass three-body system because it is acted by both M and m_2". Let the scientific context to bear propositions in principle explanatory and in principle relevant to our explanatory context which are represented by a collection of sets:

- *S* that includes: Galileo's account (*A*), Aristotle's theory (*B*), Fischbach's et.al. reconstruction of Eotvos experiment (C) and Rabinovitz discussion of the issue (D), and explanatory indexicals
- I_k { I_{k1}, I_{k2}, I_{k3},… I_{kn})

We have made Rabinovitz's account as explanatory relevant which leaves the other possible explanations as in principle relevant. Second in the ordering comes Fischbach's hypothesis on the fifth force,[8] third Galileo's mingled representations and fourth Aristotle's theory. Galileo's construction is ranked higher in the ordering because in this context the equivalence principle is presumed, a postulate which is not within Aristotle's cosmology. So, we have I_{k1} : $D>C>A>B$.

Suppose now that we ask: "Why do heavier bodies fall faster than lighter ones?". The topic of this question is that heavier objects do fall faster. This question makes sense only under a context of resistant media i.e. under the context of the common atmospheric conditions, as known in earth. This question has two in principle relevant answers. The one is Aristotle's i.e. heavier bodies fall faster since their speed of fall is proportional to their weight and inversely proportional to the resisting force.

For example, Rovelli (2015) praises Aristotle's physics and claims that when new theories arrive, we should not necessarily see them as rejecting altogether the old ones, but as building upon them while restricting their scope of applicability at the same time. He holds that Aristotle's theory has advantages and disadvantages as Newton's and Einstein's theories have.

That is, Aristotle is still right in certain respects in the same way Newton and Einstein have been right and conversely he is wrong in the way Newton and Einstein can be found wrong. He thus concludes that his theory is by no means irrelevant to the later developments in physics and that we can speak of an old theory in modern terms.

[8] In case a fifth force becomes a credible scientific proposition the ordering can be altered since the indexicals perhaps would no longer support the one presented here.

Thus when it comes to explanation and we are working under a context of intervening media, Aristotle is right, in the sense that heavier objects do fall faster, even though the speed is not proportional to its weight and inversely proportional to the resisting force. At face value Aristotle's theory is explanatory relevant and Galileo's account in principle relevant.

My takeaway is that this is the case if we take Galileo's representations as *–of* ones and not as mingled ones i.e. if we treat it, as modern physicists do, as an empirical theory. In that case, as Rovelli mentions, Aristotle's theory is more relevant than Galileo's and, as I say here, it is placed higher in the ordering.

However, if we analyze the representational strategies of Galileo's thought experiment and the information these mingled representations bear, we may end up with a different lexicographic ordering because we will see that a second almost equally strong answer is offered. The one that is given from Galileo's $Rm_{ii}=\{m_a', \ldots, m_n'\}$ representation i.e. that heavier bodies fall faster but their speed is not proportional to their weight it is just impeded by the resistant medium and the less dense the medium is the less it impedes the motion. Thus heavier bodies fall only slightly faster than lighter ones. Therefore, the explanatory indexicals (such as facts about terrestrial conditions) make Rm_{ii} explanatory relevant while Aristotle's theory is ranked second and remains in principle relevant. $I_{k1} : Rm_{ii} > B$

The conflict between Galileo's and Aristotle's approaches appears when one asks "Why does a stone weighting 5kg fall with greater speed in the air than in the water?" under a context in which these media impede the motion of objects. Again, Aristotle is in principle relevant since his theory predicts that the same body falls faster in the air than in water. Galileo's mingling puts forward one more time $Rm_{ii}=\{m_a', \ldots, m_n'\}$ which is also in principle relevant. The explanatory indexicals here make Rm_{ii} explanatory relevant because it is a fact that air is thinner than water and so it is more relevant to say that water impedes much more the motion than the air. So again we have $I_{k1} : Rm_{ii} > B$.

Consider now the question "Why is the motion of bodies not obstructed?" The context of this question cannot be that of the terrestrial environment. This question would be raised under context of no resistant force or under a context in which only gravity acts upon them i.e. presumably in the laboratory during an experiment. Here $Rm_{iii}=\{m_a'', \ldots, m_n''\}$ seems to fit and to explain the topic by stating that bodies in vacuum have no resistant force. Thus vacuum explains the absence of impediments to the motion of objects. $Rm_{iv}=\{m_a''', \ldots m_n'''\}$ is also a possible candidate since it bears information relevant to vacuum and to falling bodies.

However, some pedantry is needed here in order to distinguish between Rm_{iii} and Rm_{iv}. Even though Rm_{iv} does bear information relevant to vacuum and to falling bodies, we are by no means interested in falling bodies when we ask: "Why is the motion of bodies not obstructed?". We are simply interested to know the reason that enables bodies to move free of any resistance and Rm_{iii} proposes vacuum as an explanation without any irrelevant reference to falling objects. Thus it is the explanatory indexicals i.e. the fact that vacuum exists in that context that makes Rm_{iii} explanatory relevant and Rm_{iv} in principle relevant. The ordering in that context goes as follows: $I_{k1} : Rm_{ii} > Rm_{iv} > B$.

Now assume that we ask "Why do bodies fall at exactly the same speed?" Of course this question makes sense in a context where bodies fall in vacuum, such as in experimental settings. Then $Rm_{iv}=\{m_a''', \ldots m_n'''\}$ seems to be a preferable explanation since it gives special information relevant to vacuum and to its effect on falling bodies. Thus $I_{k1} : Rm_{iv} > Rm_{iii} > B$.

Hopefully these examples show how Galileo's mingled representations and the linguistic representations they offer bear sets of information which can be used to explain particular events i.e. to answer why-questions and how it performs when competing explanations appear, such as, among others, Aristotle's theory. The context under which a why-question emerges makes clear which is the task at hand i.e. for what kind of information we are looking for and which representation bears information that better satisfies it. Thus a proposition that explains very well another proposition under one context may fail to explain it under another. Galileo's thought experiment (as well as Aristotle's theory which appears as a competing explanation) gives representations whose information can be used in diverse contexts and can be favored against other in-principle explanatory and in-principle relevant propositions but they can also fail to explain and thus remain in principle relevant under other contexts.

Conclusions

Galileo's thought experiment manifests itself through mingled representations which can be treated as explanations that answers why-questions. The mingled representations Galileo uses bear information able to offer answers to why-questions under certain contexts. Different contexts require different piece of information and thus the representations Galileo offers can give answers only relevant to particular contexts. In some cases they do explain very well, whereas in other some of them may be only in principle relevant or even explanatorily irrelevant. No matter how successful the explanations may turn out to be, it can barely be denied that it is in principle able to offer explanations since its representations carry scientific information and appear to perform fairly well under several contexts.

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