

(Penultimate Version)

**Cartesian Certainty, Realism and Scientific Inference**  
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In the *Principles of Philosophy*, Descartes explains several observable phenomena showing that they are caused by special arrangements of unobservable microparticles. Despite these microparticles being unobservable, many passages suggest that he was very confident that these explanations were correct. In other passages, however, Descartes points out that these explanations merely hold the status of “suppositions” or “conjectures” that could be wrong. My main goal in this chapter is to clarify this apparent conflict. I argue first that for Descartes it was indeed possible to have knowledge of unobservable particles and structures, and that the possibility of natural explanations being wrong should be understood as these explanations not being absolutely certain, but only morally certain. I use the debate in contemporary philosophy of science between scientific realism and antirealism as a framework to understand how Cartesian explanations work. Specifically, I argue that Cartesian explanations rely on what Ernan McMullin calls *retroduction*, which is a mode of inference that justifies beliefs in concrete unobservable entities and processes, based on considerations such as simplicity, coherence, etc. This kind of justification is of common use among scientific realists. Thus, another goal of this chapter is to highlight the relevance of Descartes’ ideas about explanation in the contemporary debate on scientific realism.

**§1 Cartesian Explanations and Unobservable Particles**

In contemporary philosophy of science, *antirealism* is the view that the aim of science is empirical adequacy. Scientific theories are supposed to account only for observable phenomena (e.g., to facilitate predictions about observable phenomena), and the epistemic attitude toward claims regarding unobservable entities and processes should be agnosticism (e.g. van Fraassen 1980). *Scientific realism*, on the other hand, holds that the aim of science is truth. On this view, beliefs in the existence of the objects and processes posited by our best scientific theories are to some extent warranted, regardless of whether these objects and processes are currently observable by humans (e.g. Maxwell 1962). Most versions of scientific realism restrict their commitments to the entities and processes posited by the best scientific explanations, classifying explanations using the so-called theoretical virtues. There is, of course, wide disagreement concerning what exactly these virtues may be, but it is generally believed that good explanations subsume their *explananda* under more general regularities (generality), while at the same time positing the fewest explanatory entities or processes (unificatory power), arranged in the simplest possible way (simplicity). In turn, if an explanation gives rise to further developments of the theory, it is said to be fruitful (fertility) (e.g. Lipton 2004 and McMullin 1992). This framework will help illuminate an

interpretative debate concerning the nature of Cartesian explanations. I will argue that Descartes did endorse the use of retrodution, and so in a sense he was a scientific realist.

In Part 4 of the *Principles*, Descartes provides a long list of explanations of several *observable* phenomena, showing that these phenomena are effects of interactions, by physical contact, of *unobservable* micro particles (for example, he explains attraction between magnets in terms of the pulling of strings composed of screw-shaped micro particles). Appealing to these particles is not a return to medieval “occult” qualities, and they make sense within the Cartesian metaphysics of science. After our pure reason grasps the essential properties of matter as an extended substance, we only need to accept that matter is indefinitely divisible to conclude that there can be very small particles with exactly the same properties as concrete, observable objects, namely size, shape, and motion as described by the laws of movement outlined earlier in the *Principles* (AT VIII-1 324). The reason why these particles are unobservable by humans is simply that “[the] nerves, which must be set in motion by objects in order to produce a sensation, are not themselves very minute... hence they cannot be set in motion by very minute bodies”. Here Descartes relies on two notions, only one of which, I think, has survived the scrutiny of time. First, there is nothing ontologically significant in distinguishing between observable and unobservable particles. The distinction is based on a contingent feature of human biology (this anticipates an argument made by Grover Maxwell 1962). However, Descartes also endorses a view called *scale invariance*, which holds that what is true for middle-sized objects is also true for very small and very large objects. Nowadays, many philosophers of science believe that physics has shown us that this is not the case (see Humphreys 2013 for a discussion).

Now, having established the existence of these particles, Descartes explicates how their usefulness in explanations justifies claims regarding the way these particles are structured.

[S]ome people may be led to ask how I know what these particles are like. My reply is this.... I took the simplest and best known principles, knowledge of which is naturally implanted in our minds; and working from these I considered, in general terms, firstly, what are the principal differences which can exist between the sizes, shapes and positions of bodies which are imperceptible by the senses merely because of their small size, and, secondly, what observable effects would result from their various interactions. Later on, when I observed just such effects in objects that can be perceived by the senses, I judged that they in fact arose from just such an interaction of bodies that cannot be perceived -especially since it seemed impossible to think up any other explanation for them.... Men who are experienced in dealing with machinery can take a particular machine whose function they know and, by looking at some of its parts, easily form a conjecture about the design of the other parts, which they cannot see. In the same way I have attempted to consider the observable effects and parts of natural bodies and track down the imperceptible causes and particles which produce them. (AT VIII-1 326).

The method consists in inferring, from observable phenomena taken as effects, the causes that better account for them. Here we can see that although the unobservable causal structures responsible for observable phenomena are posited as suppositions or conjectures, Descartes appears to be confident of the correctness of these conjectures, to the point that it seems hardly possible to him to be mistaken about them. However, this confidence is apparently undermined by the remarks he makes in the section right after the one I just cited, where he says that “although

this method may enable us to understand how all the things in nature could have arisen, it should not therefore be inferred that they were in fact made in this way. Just as the same craftsman could make two clocks which tell the time equally well and look completely alike from the outside but have completely different assemblies of wheels inside, so the supreme craftsman of the real world could have produced all that we see in several different ways. I am very happy to admit this...” (AT VIII-1 327). This passage appears in §204, entitled: “With regard to the things which cannot be perceived by the senses, it is enough to explain their possible nature, even though their actual nature may be different.”

So, on the one hand, Descartes says that it seems impossible for these causal explanations to be wrong, and on the other, he says that one must not infer that things in fact occur in that way. How are we to understand the seemed impossibility that warrants Descartes’s confidence in the correctness of the explanations against his admission that it is possible that these explanations are wrong? In what follows I argue that, contrary to some antirealist readings, the possibility of these explanations being wrong should be understood merely in a metaphysical sense (from the perspective of God, it is possible for these explanations to be wrong), but this in no way warrants antirealist readings that advocate for skepticism towards unobservable structures. By making reference to God’s power, Descartes is drawing a distinction between the metaphysical or absolute certainty we can achieve in some domains, namely, the existence of God, humans being thinking things, and matter being an extended substance (what he calls *Scientia*), and the weaker certainty that is the goal of the natural sciences.

## §2 Descartes as an Antirealist

The remarks in section §204 have led some authors to argue that, for Descartes, whether or not claims about unobservables are true is not important in explanation. For example, according to Daniel Garber:

It simply does not matter if the conjectures [i.e. the explanations] are false, as long as they agree with the phenomena of experiment and observation. What is important for Descartes is now simply that the consequences of his conjectured particular natures agree with experience. For if they do, then whether true or false, they can be used to predict future experience, and in that way serve as reliable guides to life. In this way we can say that for Descartes, experience doesn’t confirm the truth of conjectures about the corpuscular sub-structure, but their reliability as predictors of future experience. (Garber 2001: 127).

On Garber’s view, Descartes’ goal is merely to account for observable phenomena, regardless of whether both the unobservable structures and the causal histories described in the explanations actually exist. Beyond the fundamental properties of matter and the laws of movement, Descartes would be giving up the quest for knowledge about the unobservable physical world.

The antirealist undertones of Garber’s reading are clear. Antirealism is an empiricist view. It gives primacy to the evidence gathered by the senses directly or by systematic organizations of disparate accounts of observable phenomena, over the speculations concerning unobservable reality. Garber attributes this asymmetry to Descartes. He quotes the *Meditations* as evidence that, for Descartes, despite the fact that the senses can deceive us, they can also be truth-conducive: “I

know that in matters regarding the well-being of the body, all my senses report the truth much more frequently than not.” (AT VII 89) But, Garber argues, this is not the case with our speculations regarding the unobservable physical reality: “[W]e can’t even say this about our conjectures about hidden natures; for all we know they may be genuinely false” (Garber 2001: 128). He then concludes that, for Descartes “the hidden mechanism, the corpuscular substructure, the real nature of a body has become a mere calculating device for predicting future phenomena, and lost the status of even being a candidate for knowledge or ignorance; all that really seems to count are the phenomena” (Garber 2001: 128).

A more recent antirealist reading is that of Finnur Dellsén, who argues that “on [Descartes’s] conception there is no conflict at all between appealing to a hypothesis in an explanation and simultaneously recognizing that it is not true” (Dellsén 2017: 316). On Dellsén’s view, Descartes’s goal in the *Principles* is to present plausible mechanical explanations, that is, explanations that align with Cartesian general principles of nature, but these explanations do not necessarily correspond to the way things actually are. In that sense, Dellsén argues, for Descartes “theories can explain even if they are not true” (Dellsén 2017: 315).

Dellsén appeals to a distinction by William Dray (1957) between *how-possibly* and *why-actually* explanations (see also Salmon 1992 and Cuffaro 2015). *How-possibly* explanations show how things could have happened, given some basic principles of nature, but without asserting that they actually happened that way. *Why-actually* explanations, on the other hand, do intend to track down the actual causal history of the phenomenon to be explained. To Dellsén’s mind, Cartesian explanations are better described as *how-possibly* explanations (Dellsén 2017: 318). Dellsén quickly points out that this does not mean that for Descartes “any explanation will do, as long as it is mechanical” (Dellsén 2017: 317). Rather, “an adequate explanation must also be the clearest and most distinct of the available explanations. And of course, the mechanical explanations must also be consistent with the observations they explain and be deducible from the laws of motion. However... the explanantia in such explanations need not be regarded as true” (Dellsén 2017: 317).

On Dellsén’s reading, Descartes didn’t intend to take the extra step of inferring, from the clarity and distinctiveness of his explanations, that they were actually true. In that sense, Dellsén’s is an antirealist reading because, according to it, Descartes’s goal was merely to account for the observed phenomena, regardless of whether both the unobservable structures and the causal histories described in the explanations actually existed. Beyond the principles of movement, “the theories appealed to in Cartesian explanations... do not fall within the scope of Descartes’ requirement of certainty” (Dellsén 2017: 326). Thus, for Dellsén the ultimate epistemic value of Cartesian explanations is to be “indicative of the explanatory power of the first principles” (Dellsén 2017: 321), but these explanations do not justify any commitments to the unobservable structures they describe.

### **§3 Descartes as a Scientific Realist**

Despite these readings, a more comprehensive interpretation shows that the project of the *Principles* goes beyond empirical adequacy, and that there is a further task which consists in finding out which of these possible explanations is the correct one. Granted, the task is hard and may not always prove to be successful, but Descartes takes it to be *the aim of natural inquiry* to engage in this task with the tools of reason. On this reading, Descartes would be closer to scientific

realism, since he relied on the theoretical virtues of his explanations to decide whether or not they correctly describe the structure of the unobservable physical world.

There is plenty of textual evidence for this reading. For example, in Part III of *Principles* Descartes appeals to the virtues of generality and fertility:

in order to come to know the true nature of this visible world, it is not enough to find causes which provide an explanation of what we see far off in the heavens; the selfsame causes must also allow everything which we see right here on earth to be deduced from them. There is, however, no need for us to consider all these terrestrial phenomena in order to determine the causes of more general things. But we shall know that we have determined such causes correctly afterwards, when we notice that they serve to explain not only the effects which we were originally looking at, but all these other phenomena, which we were not thinking of beforehand (AT VIII-1 98-9).

In addition, Descartes appeals to the virtue of simplicity when he says that “[i]f a cause allows all the phenomena to be clearly deduced from it, then it is virtually impossible that it should not be true.... We would seem to be doing God an injustice if we suspected that the causal explanations discovered in this way were false. For this would imply that God had endowed us with such an imperfect nature that even the proper use of our powers of reasoning allowed us to go wrong” (AT VIII-1 99). Similarly, in a letter to Jean-Baptiste Morin, Descartes appeals to the virtue of unificatory power: “while there are indeed many effects to which it is easy to adjust different causes, one to the other, it is not always so easy to adjust one single cause to many effects, if it is not the actual cause from which they proceed. Indeed, there are often effects which are such that to specify one cause from which they can clearly be deduced is sufficient to prove it to be their true cause. And I maintain that all of those of which I have spoken are of this sort” (cited in McMullin 1990: 37).

The paragraph quoted in §1 must also be understood as inferring the correctness of an explanation from its intelligibility: “[I judge that] such effects in objects that can be perceived by the senses... in fact arose from just such an interaction of bodies that cannot be perceived – *especially since it seemed impossible to think up any other explanation for them.*” (AT VIII-1 326, emphasis added). Here we see Descartes justifying his commitments to the correctness of his explanations by appealing to what we now call theoretical virtues, a move very similar to the ones made by contemporary scientific realists. But of course, one may wonder why these virtues are knowledge-conferring. Unfortunately, Descartes does not explicitly address this issue (which is controversial in the contemporary discussion as well!) However, his use of these virtues is certainly not arbitrary. For example, the idea of God as immutable gives a sense of the kind of virtues to be considered in order to understand God’s creation, namely, simplicity, generality, intelligibility, etc. These virtues are also at play when understanding the laws of motion in terms of conservation principles. But in general, it seems that for Descartes it was obvious that these were the features good explanations must have.

#### **§4 Retroduction**

According to Ernan McMullin, Descartes was the first philosopher who explicitly acknowledged the importance of inferring, from plausible explanations of observable phenomena, the causal structures posited by these explanations. Following Charles Peirce, McMullin calls this form of inference *retroduction*: “[A]s a process of inference, [retroduction...] is not rule-governed as deduction is, nor regulated by technique as induction is. Its criteria, like coherence, empirical adequacy, fertility, are of a more oblique sort... It is a complex, continuing, sort of inference, involving deduction, induction, and abduction” (McMullin 1992: 92). Building upon William Whewell and Peirce, McMullin takes retroduction as involving three steps. First, induction is the process of systematizing our observations and generating regularities whose scope covers not only those observations, but other unobserved phenomena of the same kind. These regularities are the phenomena to be explained (the *explanandum*). Next, abduction is the process of formulating verifiable causal hypotheses. Via abduction, a causal hypothesis is posited, which includes entities, processes and relations that would account for the phenomenon to be explained. Finally, deductions are performed that extract the possible consequences of these causal hypotheses. We then return back to induction, which is both the verification of these hypotheses, and the generation of verifiable laws that will in turn require a causal explanation. Induction is an ampliative inference restricted to the observable realm. Abduction is also an ampliative inference because, if successful, it provides a deeper form of understanding, and opens a yet unknown domain.

Understanding Cartesian explanations as relying on retroductive inferences, as defined by McMullin, allows us to see the kind of certainty they confer. Consider the following reconstruction of Descartes’ explanation of the behavior of magnets:

**Step 1. Induction:** By experience we verify that a set of observed magnets attract each other, and by induction we establish that “magnets attract each other”. This regularity is the *explanandum*. Because of our clear and distinct ideas about the nature of the material substance, we know that the explanation of this regularity must be purely mechanical and must appeal only to the size, shape, and motion of particles of matter. What is more, we already have a good argument to establish that there are unobservable microparticles, so there is no problem appealing to them in the explanation.

**Step 2. Abduction:** What else can be inferred from the nature of matter? Not much. Here we must use our imagination and postulate a hypothesis: magnets emanate screw-shaped particles that hook up to one another forming some sort of string. These strings hook up to the strings emanating from the other magnet. Because of the action of vortex forces (which can also be explained mechanically), the strings are pulled back, creating a force that pulls the magnets together.

**Step 3. Deduction:** By appealing only to mechanical forces, this causal story can be used to deduce the observable behavior of magnetic attraction.

Going back again to step 1 (induction), with this in mind, we look for more observations of magnetic attraction that may or may not support the hypothesis. Based on the virtues of this explanation, Descartes justifies his belief that the story in step 2 is correct and, therefore, that those screw-shaped particles do exist and behave as described. But retroduction is a continuing sort of inference, and in that sense this conclusion is not definitive. That is why we need to go back to step 1.

## §5 Natural Explanations and Moral Certainty

We saw in §1 that Descartes himself admitted that his natural explanations, despite having the virtues outlined above, can be false because “the supreme craftsman of the real world could have produced all that we see in several different ways” (AT VIII-1 327). How are we to interpret this possibility? In what follows, I argue that for Descartes these explanations can be false in the same way that we can be misled by our senses: we could be wrong about what our senses inform us, but it is not likely. Similarly, although claims concerning unobservable structures can be false, if they play a role in our best explanations of the observable reality, their falsity is very unlikely.

To see this point more clearly, we should appeal to the distinction between absolute or metaphysical certainty on the one hand, and moral certainty on the other. In the *Principles*, Descartes takes absolute certainty as one that “arises when we believe that it is wholly impossible that something should be otherwise than we judge it to be” (AT VIII-1 328). Moral certainty, on the other hand, is a certainty sufficient “for application to ordinary life, even though [what is morally certain] may be uncertain in relation to the absolute power of God.” (AT VIII-1 327). This distinction was already introduced in the *Discourse*, where Descartes explains that morally certain things are those that we cannot doubt “without being extravagant” (AT VI 37-8), although from the perspective of absolute certainty “we cannot reasonably deny that there are adequate grounds for not being entirely sure about them” (AT VI 38).

There are few things that can be known with absolute certainty, for example, “that God exists”, “that the mind is different from the body” (AT VII 6), “that I am something”, “that in the future it will be true that I have existed”, “that two and three added together are five”, etc. (cf. AT VII 21). Crucially, our knowledge of these things depends on our knowledge of God, “[f]or if [we] do not know this, it seems that [we] can never be quite certain about anything else.” (AT VII 21). If we do not believe in God, all we can hope to achieve is moral certainty. In that sense an atheist, Descartes argues, “will never be free of [doubts...] until he acknowledges that God exists.” (AT VII 141). It is in this context that Descartes writes his famous remarks in the *Replies*: “The fact that an atheist can be ‘clearly aware that the angles of a triangle are equal to two right angles’ is something I do not dispute. But I maintain that this awareness of his is not true knowledge, since no act of awareness that can be rendered doubtful seems fit to be called knowledge” (AT VII 141). This passage should not be interpreted as if Descartes was claiming that only metaphysical certainty is suitable for natural inquiry, with the implication that atheists cannot engage in this kind of inquiry. Rather, as Jorge Secada points out, the idea of this passage is that the atheist clearly apprehends (*clare cognoscere*) some relatively simple geometrical matter, but lacks “true knowledge (*veram scientiam*)”, because her cognitions can be rendered (metaphysically) doubtful (Secada 2009). The key point is that Descartes distinguishes between *scientia*, which is a kind of cognition that is indubitable, evident, and absolutely certain (Pasnau 2017: 23) -something that only him and a handful of other people has ever achieved (see Pasnau 2017: 24)- and the clear cognitions of an atheist, which are not *scientia*.

Now, there are many things about which moral certainty is the best that can be achieved, even if after going through the meditational process outlined in *Meditations* one has become a true believer in God. Among these things are, for example, the existence of the external world, and the existence of the objects of our sensory perceptions. As he puts it in the introduction to *Meditations*:

[In the sixth meditation] there is a presentation of all the arguments which enable the existence of material things to be inferred. The great benefit of these arguments is not, in my view, that they prove what they establish -namely that there really is a world, and that human beings have bodies and so on- since no sane person has ever seriously doubted these things. The point is that in considering these arguments we come to realize that they are not as solid or as transparent as the arguments which lead us to knowledge of our own minds and of God, so that the later are the most certain and evident of all possible objects of knowledge for the human intellect. (AT VII 15-6)

The unobservable causal structures posited by natural explanations also belong to the kind of things that can only be known with moral certainty. Support for this view comes from section 205 of part 4 of the Principles, entitled “*Nevertheless my explanations appear to be at least morally certain*” (AT VIII-1 327), where Descartes provides the following examples that clearly illustrate the *kind* of certainty he sought in his natural explanations:

...those who have never been in Rome have no doubt that it is a town in Italy, even though it could be the case that everyone who has told them this has been deceiving them. Suppose for example that someone wants to read a letter written in Latin but encoded so that the letters of the alphabet do not have their proper value, and he guesses that the letter B should be read whenever A appears, and C when B appears, i.e. that each letter should be replaced by the one immediately following it. If, by using this key, he can make up Latin words from the letters, he will be in no doubt that the true meaning of the letter is contained in these words. It is true that his knowledge is based merely on a conjecture, and it is conceivable that the writer did not replace the original letters with their immediate successors in the alphabet, but with others, thus encoding quite a different message; but this possibility is so unlikely, especially if the message contains many words, that it does not seem morally credible. (AT VIII-1 327-8 and IX-2 323).

The idea of this passage is that, although we may never know with metaphysical or absolute certainty whether we have found the real meaning of the letter, or whether Rome is actually a city in Italy, it would be absurd (it would not be *morally* credible)<sup>1</sup> to think otherwise given that this is the best explanation of the available evidence.

Neither the Rome case nor the letter case are fully analogous to the case of unobservable structures, for in the first two it is in principle possible to verify the truth of our beliefs either by going to Rome or by asking the author of the letter directly, whereas this is not available with respect to our beliefs about unobservables. However, the fact that Descartes uses examples based on unobserved structures to illustrate the moral certainty of natural explanations is significant. It suggests that in some cases hypothesizing about unobserved structures is epistemically analogous to hypothesizing about unobservable structures: as long as we have a good hypothesis (a hypothesis having certain acceptable theoretical virtues), it would be extravagant not to believe in its truth. The explanations must be simple (the hypothesis that all from whom those who've never been in Rome got their information about the city were deceitful or themselves deceived is too complicated), general (the more words the letter has, the more likely the interpretation is the correct

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<sup>1</sup> The qualifier *morally* was not present in the Latin edition of the Principles, but was added in the French edition.



one), etc. In the case of natural explanations, these virtues feature in the highest degree, and for this reason (on Descartes's mind) having these explanatory virtues yields moral certainty about the truth of these hypotheses (this rejection of absolute certainty is an important aspect of the contemporary debate as well, as seen, for example, in Psillos 1999).

Descartes's own explication of natural explanations is somewhat misleading. He claims that they are carried out via *deduction* from the principles of shape, size, position and motion of matter: "there is nothing in the whole of nature (nothing, that is, which should be referred to purely corporeal causes, i.e., those devoid of thought and mind) which is incapable of being *deductively explained* on the basis of these selfsame principles" (AT VIII-1 315, emphasis added). One way of reading this passage is as if Descartes's goal was to know these unobservable structures with absolute certainty, thus extending the ideal of absolute certainty from metaphysics to the natural sciences. After all, if explanations of natural phenomena are *deductions* from the material principles of size, shape, and motion, and if these principles are themselves deduced from absolutely certain beliefs such as that God exists, and those concerning the nature of matter as an extended substance and of humans as thinking things, then our knowledge of the unobservable structures posited by these natural explanations would inherit the epistemic strength of those rational beliefs. In the *Principles*, for example, he suggests that these explanations are not just morally, but absolutely certain: "[P]erhaps even these results of mine will be allowed into the class of absolute certainties, if people consider how they have been deduced in an unbroken chain from the first and simplest principles of human knowledge.... [I]t seems that all the other phenomena, or at least the general features of the universe and the earth which I have described, can hardly be intelligibly explained except in the way I have suggested" (AT VIII-1 328-9). If the explanations are *deductions* from principles we know with absolute certainty, our knowledge of the microstructures they posit should be *metaphysically* certain, and not simply morally certain.

I believe, however, that this passage does not warrant this conclusion. Descartes begins by saying that all other phenomena have been deduced from the principles, but then immediately backs off and narrows the scope of his assertion, focusing only on "the general features of the universe and the earth". Part of the issue is that Descartes mistakenly describes his own method of explanation as purely *deductive*, but this is not quite right. For starters, it is impossible to deduce every phenomenon from a fixed set of principles without taking the initial conditions into account, which can only be apprehended by experience. But more importantly, as we have seen, in his own practice of advancing natural explanations Descartes appeals to retroduction, which is a mode of inference that is not purely deductive. For example, although it may be *in principle* possible to deduce (what Descartes's thought to be) the fact that magnets emanate screw-shaped particles, *in practice* this cannot be done. Rather, the screw-shaped particles explanation can only be hypothesized as the (for him) best plausible explanation of magnetic attraction. It is true that, according to Descartes at least, from this hypothesis magnetic attraction follows deductively, but this does not mean that the shape of those particles was inferred from the principles of size, shape and motion. Carrying out such a deduction is humanly impossible, and as he points out at the end of *Meditations*: "[I]t must be admitted that in this human life we are often liable to make mistakes about particular things, and we must acknowledge the weakness of our nature." (AT VII 90)

Helen Hattab (2009) defends the view that Cartesian explanations sought absolute certainty (see also Hattab's contribution to this volume). Hattab argues that Descartes did seek absolute certainty in his explanations.<sup>1</sup> Hattab interprets the letter to Morin cited in §3 above as evidence for this view (Hattab 2009: 131). For Hattab, the geometrical nature of the extended substance, along with the deductive inferential methods Descartes employs, support this interpretation. One

example she discusses is the nature of salt (Hattab 2009: 126ff). That salt possesses the observable feature of “moving less easily than water” is explained by “salt [being] made up of oblong-shaped particles”, along with the geometrical principle that “oblongs shapes that touch a surface on many points are moved less easily than round ones” (Hattab 2009: 130). On Hattab’s view, the fact that the explanation involves a geometrical principle “guarantees the certainty of the conclusion that is demonstrated” (Hattab 2009: 131). However, as has been pointed out by Dellsén, if this was what Descartes actually thought, “he would have been guilty of the elementary epistemological mistake of attributing certainty to a conclusion of an argument in virtue of the fact that one of its premises is certain.” (Dellsén 2017: 312). For example, the geometrical principle referred to in the salt case is a conditional, not a biconditional: “if a particle has an oblong shape, its movement would be less easy than if the shape was round”. But the inference does not work the other way around: we cannot deductively infer, from the “less easy movement” that the particles are actually oblong. In fact, salt’s observable property of moving less easily than water could also be explained by salt particles being triangular, because, properly arranged, triangles can make up oblong shapes. In that sense, salt’s observable features underdetermine its unobservable geometrical nature, which in turn undermines the claim that Descartes sought absolute certainty in his explanations.

## §6 Conclusion

There is an ongoing debate regarding whether Descartes had at some point in his life hoped that he could extend this ideal of absolute certainty to the natural sciences by actually deducing all natural phenomena from principles concerning God, humans as thinking things, and matter as an extended substance, or whether instead he never thought this to be possible (see Dellsén 2017). My goal in this chapter has been to argue that, at least in the *Principles*, Descartes’s purpose was not to actually deduce all the observable effects from these principles. In that sense, the kind of natural inquiry introduced in the *Principles* is not *scientia*. As Robert Pasnau convincingly argues (Pasnau 2017: 25), if Descartes had thought that only the products of *scientia* are knowledge, he would have been a skeptic, because that view entails that we lack knowledge concerning almost everything, including for example that there is an external world. But Descartes was not such a skeptic. Rather, he thought that we can indeed acquire knowledge of things outside the domain of *scientia*. What I have shown in this chapter can be interpreted under this light: the fact that, from a metaphysical perspective, we could be wrong about natural explanations, does not entail that it is not possible to *know* (or cognize) that the microstructures cited by natural explanations exist. If the conjectures have the right explanatory virtues, then we can be morally certain that the posited microparticles are indeed arranged in the way described. For Descartes, to think otherwise would be like the kind of skepticism of the person who believes that she may be dreaming and so knows little or nothing about the external world (see Douven 2022 for an analysis of the relationship between abduction and Cartesian skepticism of the external world).

Now, in the contemporary debate retrodution is not without challenges. For example, in his response to McMullin, van Fraassen (2013) argues that we should not trust retrodution as a legitimate form of inference because doing so is a form of circular reasoning: “That the contingent conditions for the success of retrodution actually obtain could only be inferred by retroductive inference: an insight that sweeps the rug from under any assurance of epistemic safety to be found here” (2013: 141). Van Fraassen’s idea is that, since retrodution is supposed to give us knowledge

of the unobservable realm, whether or not retrodution is actually successful can only be determined by comparing its results to what we know about the world via retrodution, which is question-begging. For this reason, van Fraassen holds, causal hypotheses can never be truly tested, and therefore our commitments to theories should stop at whatever can be directly verified by the senses. But a realist can reply that the same point about circularity can also be made about our empirical experiences: how can we know that our experiences are reliable if it is not by comparing them to other truths obtained by experience? This would be a skeptical position that most of us would agree ultimately does not undermine the trust we place in our senses. If rejecting commitment to unobservables is the same as rejecting the evidence from the senses, it would be, to put it in Cartesian terms, an extravagant form of skepticism.<sup>2</sup>

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<sup>1</sup> Hattab talks about ‘mathematical’ certainty, but I take it, from the discussion on (2009 p. 208 ff), that this refers to absolute certainty and not just moral certainty.

<sup>2</sup> I thank Jorge Secada, Russell Marcus, and the members of the California State University Sacramento philosophy reading group for helpful comments on earlier drafts of this chapter.