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Towards Descartes' Scientific Method of Doubt: The Rhetoric of *Les Météores*

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Abstract: In this paper, I argue that Descartes' *Les Météores* contains an analytic procedure that is similar to his method of doubt. First, I hold that the method of the *Regulae* is best explained by two examples: one scientific, his proof of the anaclastic curve (1626), and one metaphysical (1628), his question of the essence and scope of human knowledge. Based on this account, I suggest that the form of his early metaphysics (not its content) is similar to the method of doubt of the *Meditationes*. Second, I argue that Descartes' explanation of the cause of parhelia (1629), likewise, contains a formulation of this procedure. I provide a novel reading of *Les Météores*, where, following Descartes' guidance in the *Discours* and *Correspondance*, I interpret his meteorology by reasoning from effects to causes, in this case, from Christopher Scheiner's 1626 observation of parhelia to his meteorological foundation. This backwards orientation to *Les Météores*, I argue, reveals an instance of what I call Descartes' scientific method of doubt.

Key Terms: Descartes, method of doubt, science, metaphysics, *Regulae*, and *Les Météores*

In Descartes' scientific works, he did not begin with a grand scheme to question all of human knowledge through a series of exaggerated thought experiments as he did in the *Meditationes* (1641).[1] There, moreover, is no procedural reduction, no Archimedean point, and no cogito sum, not even a proposal of an apodictic truth or truths that claims to explain the entirety of human knowledge. Rather, Descartes had more modest aims during the 1620s and early 1630s. His *Le Monde* (1632), *L'homme* (1633), *La Dioptrique* (1637), and *Les Météores* (1637) set out to explain a discrete scientific phenomenon in each discourse, and, in this limited endeavor, he

[1] In this paper, I use the following abbreviations: AT = René Descartes, *Oeuvres de Descartes*, ed. by Charles Adam and Paul Tannery, 11 vols, 2nd edition (Paris: Vrin, 1964–1974); CSM = René Descartes, *The Philosophical Writings of Descartes*, trans. J. Cottingham, R. Stoothoff, and D. Murdoch, 3 vols (Cambridge: Cambridge University Press, 1984–1985), vol I and II; CSMK = René Descartes, *The Philosophical Writings of Descartes*, trans. J. Cottingham, R. Stoothoff, D. Murdoch, and Anthony Kenny, 3 vols (Cambridge: Cambridge University Press, 1991), vol III; *Dioptrique* = René Descartes, *Discourse on Method, Optics, Geometry, and Meteorology*, trans. Paul Olscamp (Indianapolis: Hackett, 2001), pp. 65-173; *Les Météores* = *ibid.*, pp. 263-361.

proposed assumptions to make his explanations, not the clear and distinct perceptions,[2] and did not seem to incorporate doubts, much less his method of doubt. Rather, he used experiments and everyday observations to guide his inquiries. From this vantage point, there are two methodical paradigms in Descartes' published writings: one, scientific and hypothetico-deductive, and the other, mathematical, metaphysical and deductive.

This conclusion, however, is a result of treating Descartes' metaphysics and science independent of his *Correspondance* and his methodological works. When we turn to these writings, Descartes suggests that there is methodological continuity; more specifically, he claims there is a single, unified method that was universally applied in his natural philosophy and metaphysics. For instance, he tells in the opening of the *Regulae* (1619-1620, 1626-1628) that the "aim of our studies" should be to "forming true and sound judgments about whatever comes before [the mind],"[3] and such judgments are achieved via his method,[4] which, he told, would ultimately reveal "all the sciences are so closely interconnected [...]."[5] Concerning the *Discours* (1637), he tells that the method "could be used to explain any [...] subject," and this is why he included remarks on "metaphysics, physics, and medicine [...]," to suggest the sciences are unified in a deductive lattice structure.[6] His inclusion of metaphysics, moreover, was no trivial matter. He tells in the Dedicatory Letter to the Sorbonne that his "method for resolving certain

[2]July 13, 1638 to Morin, AT II, 200; CSMK III, 107.
[3] Rule I, AT X, 359; CSM I, 9.
[4] Rule IV, AT X, 371; CSM I, 16.
[5] Rule I, AT X, 361; CSM I, 10.
[6] End of May 1637 to an unknown correspondent, AT I, 370; CSMK III, 58. On the interconnectedness of the sciences, see *Discours*, AT VI, 76; CSM I, 150; April 15, 1630 to Mersenne, AT I, 140-141; CSMK III, 22; February 22, 1638 to Vatier, AT I, 562, 564; CSMK III, 87, 88. For an interpretation of Descartes' *Discours* as presentation of his early philosophical system, see Patrick Brissey, 'Descartes' *Discours* as a Plan for a Universal Science' *Studia UBB. Philosophia* 58 (2013), 37-60. For an alternative, see Gilbert Gadoffre, 'Introduction et remarques de Gilbert Gadoffre Descartes,' in *René Descartes' Discours de la Méthode* (Manchester: Editions de l'Université de Manchester, 1941, 1945, 1949, 1961, 1967, 1974).

difficulties in the sciences" resulted in the *Meditationes*.[7]

We thus have two horns to this dilemma. On the one hand, there seems to be inconsistent methods in Descartes' natural philosophy, metaphysics, and methodological works, which suggest that there are multiple methods in Descartes' corpus. On the other hand, Descartes strongly advocated, or at least strongly claimed to have advocated, a single, unified method that is applicable to any problem capable of human reason.

The goal of a response to this dilemma, of course, is to escape through the horns and avoid being impaled by one horn or the other. Nevertheless, the prominent orthodox interpretations fall prey to the dilemma. For instance, the multiple methods view – most prominently advocated by Edwin Curley, Peter Dear, and Daniel Garber – identifies important differences between, first, Descartes' description and examples of his method and, second, the procedure of his metaphysics.[8] On this reading, the method was a viable option when Descartes was interested in particular scientific and mathematical problems, but, when he became interested in his mature epistemological problem in 1628 and transitioned to a systematic presentation of his science in the early 1630s, the method proved inadequate, and he slowly stopped using and speaking of it, which resulted in him dropping his method.[9]

John Schuster, on the other hand, following the sociological thesis of Gaston Bachelard,

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[7] Dedicatory Letter to the Sorbonne, AT VII, 3; CSM II, 4.

[8] Edwin Curley, *Descartes Against the Skeptics* (Cambridge: Harvard University Press, 1978), chapter 2; Peter Dear, 'Method and the Study of Nature,' in *The Cambridge History of Seventeenth-Century Philosophy*, eds. Daniel Garber and Michael Ayers, vol 1 (Cambridge: Cambridge University Press, 1984); Daniel Garber, "Descartes and Method in 1637," in *Descartes Embodied: Reading Cartesian Philosophy through Cartesian Science* (Cambridge: Cambridge University Press, 2000); Daniel Garber, *Descartes' Metaphysical Physics* (Chicago: University of Chicago Press, 1992); Gary Hatfield, 'Science, Certainty, and Descartes,' in *Proceedings of the Biennial Meeting of the Philosophy of Science Association 1988* , ed. by A. Fine and J. Leplin, vol 2 (East Lansing: Philosophy of Science Association, 1989).

[9] For a succinct explanation of this problem and a plausible response, see Roger Florka, 'Problems with the Garber-Dear Theory of the Disappearance of Method,' *Philosophical Studies* 117 (2004), 131-141.

Alexandre Koyré, Thomas Kuhn, and Paul Feyerabend, argues that there is no such thing as a single, veracious method and, thus, method discourses, in general, are "mythic speech."[10] The role, then, of the historian in the history of science is to debunk method discourses: to explain how scientific discoveries are actually made and how fictional method discourses are created.[11] With this aim, Schuster shows that Descartes did not use his method in his most notable scientific discoveries. On this point, I agree. I take Descartes' method as a normative presentation of his findings, explaining how scientific discoveries ought to be made, not describing how he actually discovered his results. Schuster, however, goes a bit further. He tells that Descartes invented his method and described some of his science in terms of it, well after his discoveries, in order to rhetorically appeal to the scientific community and to popularize his findings.[12] On this reading, one would suspect noticeable inconsistencies in the descriptions and examples of the method, for the method is ultimately a ruse, a ploy to dupe his readers.

The no method and multiple methods views successfully avoid the first horn but fall prey to the second. Although Descartes supposedly dropped his method in the late 1620s, the multiple methods view additionally holds that he continued to refer to the method in the *Correspondance*, *Discours* and *Meditationes*, as if the method was still a guiding light, and this is because he failed to realize that he did not use it in his scientific practices.[13] On this reading, Descartes is depicted as sitting at his desk sometime in 1635 writing his methodological manifesto, not realizing he did not use his method. The principle of charity, I think, requires a better

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[10] John Schuster, *Descartes-Agonistes: Physico-mathematics, Method and Corpuscular-Mechanism* 1618-33 (Sydney: Springer, 2013), chapter 2.
[11] Schuster, *Descartes-Agonistes*, chapter 6.
[12] For instance, Schuster provides a plausible explanation of Descartes' route to the law of refraction. See Schuster, *Descartes-Agonistes*, chapter 4.
[13] Garber, *Descartes' Metaphysical Physics*, p. 49 and Dear, 'Method and the Study of Nature,' p. 159.

explanation. Schuster, on the other hand, provides a more charitable account, but it also falls short. For him, the cunning Descartes falsely told that his universal method resulted in his science solely for the purpose of promoting his natural philosophical program.[14] The problem with this explanation, however, is that it saddles Descartes with malevolence; that is, regardless of one's contemporary view on scientific method, we must imagine almost the entirety of Descartes' writings as purposefully attempting to fool his readers into believing in the veracity of a universal method. Nevertheless, outright denying the second horn of the dilemma does avoid being impaled, for, on this view, there is no horn. However, it seems that such a route is a hard pill to swallow, or, better said, it is not the most plausible interpretation available or so I argue in this paper.

Other commentators affirm the second horn and deny the first, but this strategy too is not without problems.[15] Those that provide a unitary account claim to have identified the definitive Cartesian method and its application in the *Meditationes*. When, however, they turn to his natural philosophy, problems emerge, for the method, with a few exceptions, seems to be largely absent from these texts. Such commentators resort to methodological faith, trusting Descartes' claim to have applied his analytic method although he presents it synthetically in his scientific writings.

In this paper, I propose a heterodox response, one that avoids the two horns. I hold that Descartes advocated a single method that was applicable to any question capable of human reason and that his rhetorical presentation of his science, interpreted in the proper light, presents

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[14] Schuster's characterization of Descartes is akin to that of Richard Watson. See Richard Watson, *Cogito, Ergo Sum: The Life of Descartes* (New Hampshire: Godine Publishing, 2002).

[15] L. J. Beck, *The Method of Descartes: A Study of the Regulae* (Oxford: Oxford University Press, 1952); Florka, 'Problems;' Peter Schouls, *The Imposition of Method: A Study of Locke and Descartes* (Oxford: Oxford University Press, 1980).

this method. I thus adopt a formulation of the unitary thesis but explain how and why one should deny the first horn of the dilemma, using *Les Météores* as a case study. In this light, I argue that Descartes' meteorology is a result of the application of his reductive procedure in the *Regulae*, what I call Descartes' scientific method of doubt. In the first section, I argue that Descartes' method is best exemplified by two notable examples: one scientific, the anaclastic curve in optics, and one metaphysical, his inquiry into the essence and scope of human knowledge. Following the innovative work of Daniel Garber and John Schuster, and further bracketing the developmental interpretations of the *Regulae* and *Discours*,[16] I provide a unitary account of Descartes' method and suggest that the form of his reduction in his "finest example" is the form of his method of doubt in the *Meditationes*. In the second section of the paper, I argue that Descartes' explanation of the cause of parhelia, likewise, contains a formulation of this procedure. I provide a novel reading of *Les Météores*, where, following Descartes' guidance in his *Correspondance* and the *Discours*, I interpret his meteorology by reasoning from effects to causes, in this case, from Christopher Scheiner's 1626 observation of parhelia to his meteorological foundation. This backwards orientation to *Les Météores*, I argue, is an instance of his scientific method of doubt and provides room for the unitary thesis to escape through the horns of the dilemma.

I. Descartes' Method: The Key Questions.

[16] See Jean-Paul Weber, *La constitution du texte des Regulae* (Paris: Société d'édition d'enseignement supérieur, 1964) and Gadoffre, 'Introduction.'

In the *Regulae*, Descartes defined knowledge as indubitable cognition and proposed two faculties to meet this goal.[17] Intuition, he explained, was a conception of a self-evident truth,[18] and deduction, on the other hand, he defined as "an inference of something as following necessarily from some other propositions which are known with certainty [i.e. intuitions]."[19] Following the guidance of the ancient geometers, the constructive portion of his method begins with indubitable axioms and proceeds to necessary deductions. The problem, however, among others, is how one is to discover a self-evident intuition. In this endeavor, Descartes provides a general procedure:

> We shall be following this method exactly if we first reduce complicated obscure propositions step by step to simple ones [intuitions], and then, starting with the intuition of the simplest ones of all, try to ascend through the same steps to a knowledge of all the rest [deductions].[20]

When a Cartesian investigator turns to apply this procedure and attempts to provide a step-by-step reduction of a particular, scientific problem, Descartes' programmatic description seems inadequate, for it does not provide the proper guidance necessary for one to discover an intuition in a particular question, and, further, it does not disclose the proper tools for a historian to understand his use of method in his natural philosophy.[21] We get a better footing, however, if

[17] It is unclear what level of doubt that an "indubitable cognition" must withstand in this case (CSM I, 10; AT X, 362). For an account of Descartes' early approach to skepticism, see Matthew J. Kisner, 'Skepticism and the Early Descartes,' *British Journal of the History of Philosophy* 13 (2005), 207-32.
[18] Rule III, AT X, 368; CSM I, 14; AT X, 407-408; CSM I, 37.
[19] Rule III, AT X, 369; CSM I, 15.
[20] Rule V, AT X, 379; CSM II, 20. See also *Discours*, AT VI, 18-19; CSM I, 120.
[21] Many complained about the lack of method. For instance, see February 27, 1637 letter to Mersenne, AT I, 348-350; CSMK III, 52-53.

we turn to an example of the method. In this regard, Daniel Garber directs us to the anaclastic curve example in Rule VIII, what Garber considers a definitive example of the method.[22]

In the midst of Rule VIII – a rule that directs one to cease an investigation if one is incapable of discovering an intuition – Descartes provides two examples to illustrate his rule: the anaclastic line example and the "finest example of all." In the first, he began with an inquiry question: "What is the shape of a line (lens) that focuses parallel rays of light to the same point?" He proceeds by reducing the question, step-by-step, to further questions, the last of which ends in an intuition. In order to discover the anaclastic, he tells, one must, first, know the cause of the

Table 1: Garber's Reconstruction of Descartes' Anaclastic Line Example[23]

Q1. What is the shape of a line (lens) that focuses parallel rays of light to the same point?

Q2. What is the relation between angle of incidence and angle of refraction (i.e., the law of refraction)?

Q3. How is refraction caused by light passing from one medium into another?

Q4. How does a ray of light penetrate a transparent body?

Q5. What is light?

Q6. What is a natural power?

Intuition: A natural power is. . . .

Construction: The construction consists in traversing the series of questions from Q5 to Q1, deducing the answer to each question from that of the preceding question.

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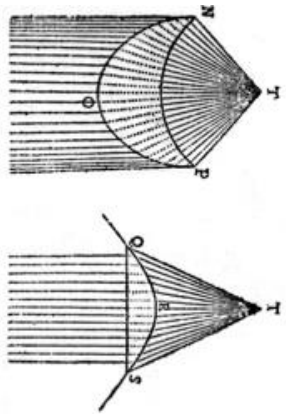
[22] Rule VIII, AT X, 397; CSM I, 31. I argue elsewhere that this example is a definitive example of not the full-fledged method but of Rule VIII. See Patrick Brissey, 'Rule VIII of Descartes' *Regulae ad directionem ingenii*,' *Journal of Early Modern Studies*, 3 (2014), 9-31.

[23] Garber, 'Descartes and Method in 1637,' p. 37 and Daniel Garber, 'Descartes and Experiment in the *Discourse* and *Essays*,' in *Descartes Embodied* (Cambridge: Cambridge University Press, 2000), p. 88. I have discarded Garber's proposal of Descartes' answers to the questions due to my focus on his reductive procedure.

relation of the angle of incidence to the angle of refraction (Snell's law), and, as we go deeper into the problem, we must, second, know the cause of refraction, accounting for how the density of the lens causes the ray to bend. This requires an explanation as to how the light travels through the medium. He, then, concludes the procedure by turning to more sublime issues: the "nature of light" and then what a "natural power is in general," what he considered to be the intuition.[24]

To fully appreciate Descartes' procedure, it is important to see that the reduction stems from the presuppositions implied of the question itself. Better said, Descartes, at the outset of the investigation, assumes the observation of the phenomenon, in this case, a geometrical

Fig. 1: Descartes' Figures for the Elliptical and Hyperbolic Solutions of the Anaclastic[25]



representation,[26] and draws causal questions from the geometrical model or, perhaps, from the various experiments that he conducted on refraction during the 1620s. On this point, Schuster's investigative work in Descartes' early science is helpful.[27] He holds that Descartes' early career

[24] Rule VIII, AT X, 395; CSM I, 29.
[25] AT VI, 194; *Dioptrique*, p. 148.
[26] AT VI, 194 ; *Dioptrique*, p. 144. Descartes was most likely using experiments and other procedures in the discovery phase. See February 2, 1632 to Golius, AT I, 236-240; CSMK III, 34-36.
[27] Schuster, *Descartes-Agonistes*, p. 167-220. See also John A. Schuster, 'Physico-Mathematics and the Search for Causes in Descartes' Optics—1619-37' *Synthese* 185 (2012), 467-499.

began as a physico-mathematician, a natural philosophical program that aimed to answer questions (e.g. Simon Stevin's hydrostatic paradox, the law of fall, and the law of refraction) by constructing a mixed-mathematical solution, and then using the geometrical diagram to "see the causes" of the phenomenon; that is, Descartes thought the cause, in some sense, could be read off of the diagram.[28] Something similar to this, I think, occurs in the anaclastic line example and is an important part of the method itself, for it is the initial observation that results in the parts of the reduction. In terms of Fig. 1, he first noticed the parallel rays emitted from the luminous source have a ratio in the model; that is, he identifies the fact there are rays that enter the refracting medium (the angle of incidence) and are changed when they exit, for they are now bent toward T (the angle of refraction). This relation, he observes, is caused by the density of the lens and how light travels through the medium.[29] The ultimate perception of light, however, is produced by the force of light on the perceptual organ. In this part, Descartes' provides a description of the point where the parallel rays are refracted, the light crashing on the retina of the eye.[30] The final two questions, therefore, are dependent on his physiology of vision described in his *Dioptrique*, which was derived from Johannes Kepler's *Ad Vitellionem Paralipomena*.

Descartes presents a similar procedure when he turns to metaphysics around 1628. In the very next example,[31] Descartes, once again, begins with an inquiry question - "What is human knowledge and what is its scope?" - and proceeds by reflecting on an instance or, rather, the definition of knowledge: what he counted as an indubitable cognition or an intuitive grasp of a

[28] Schuster, *Descartes-Agonistes*, chapter 4.
[29] For an example, see February 2, 1632 to Golius, AT I, 236-240; CSMK III, 34-36.
[30] For a more exhaustive account, see Brissey, 'Rule VIII.'
[31] Descartes provides three separate drafts of the "finest example" in Rule VIII.

self-evident object.[32] As with the anaclastic line example, the presupposition is the source of the reduction. In this light, Descartes announces in Rule III that the question concerning human knowledge should "relate either to us, who have the capacity of knowledge, or to the actual things it is possible to know."[33] It relates to us, human agents, he tells, because we have cognitive faculties or abilities capable of knowledge. In this stratum of the problem, he examines our capacity for knowledge by first enumerating the human faculties and, second, by testing them to determine which is capable of certainty. The general procedure that is conducted in this

Table 2. The Form of Descartes' "Finest Example" of Rule VIII

Q1. What is the essence and scope of human knowledge?

Q2. What is the definition of knowledge?

	Q3. Which human cognitive faculties are capable of knowledge?	Q4. Which objects are known with certainty?
The Procedure of Sufficient Enumeration	Q3.a. Do the corporeal faculties (sensation, imagination, and memory) guarantee knowledge?	Q4.a. Which objects are simple, and which are composite? (Which are spiritual, and which are corporeal?)
	Q3.b. Does the faculty of deduction guarantee knowledge?	Q4.b. Which objects are epistemically dependent on other ideas?
	Q3.c. Does intuition guarantee knowledge?	Q4.c. Which objects are simple and self-evident?

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case is that of sufficient or inductive enumeration. In Rule VII, Descartes proposes that after complete enumeration of all the parts of the problem that must be discussed is complete and translated into questions, an inquirer answers the questions via sufficient enumeration. This procedure is conducted by listing plausible, hypothetical answers to a question and then testing

[32] Rule II, AT X, 362; CSM I, 10 and Rule III, AT X, 369-369; CSM I, 14-15.
[33] Rule VIII, AT X, 398; CSM I, 32.

each by doubt. The reduction to probability during this period is produced by a mitigated version of skepticism: ordinary observations, scientific experiments, or everyday thought experiments. Nevertheless, once a hypothesis is deemed false it is eliminated. This procedure is commenced until an indubitable intuition is discovered.

In the problem proposed by the "finest example," Descartes does not disclose the specifics of his procedure concerning the faculties but only the conclusion: "while it is the intellect alone [intuition and deduction] that is capable of human knowledge, it can be helped or hindered by three other faculties, *viz*. imagination, sense-perception, and memory."[34] Despite this, we see that, similar to the *Meditationes*, Descartes implicitly enumerates the corporeal faculties, shows, in some manner, that they fall short of knowledge and concludes that only the intellect meets his standard. Thus, the eliminative procedure would help the will to understand that only intuitions and deductions are apodictic.

In the "finest example" there also is a corresponding reduction of the objects of knowledge, where Descartes assesses the psychological status of his cognition of the object, ultimately reducing those that are composite and epistemically dependent to simple, self-evident ones. Rule VIII, however, does not provide a specific account of the objects. We do, however, get a concise list of his mature metaphysical propositions in Rule XII, but it is unclear whether these propositions had the same epistemic status as his mature metaphysics.[35] Nevertheless, such an account is not required for our purposes, for the general form of Descartes' reductive procedure is all that is required to gather the methodological tools to examine *Les Météores*. On

[34] Rule VIII, AT X, 398; CSM I, 32.
[35] Jean Luc-Marion provides a plausible depiction of Descartes' position in the late 1620s, drawing largely on the metaphysical examples in Rule XII. See Jean-Luc Marion, 'Cartesian metaphysics and the role of simple natures,' in *The Cambridge Companion to Descartes* (Cambridge: Cambridge University Press, 1992).

this front, Descartes procedurally looks for the most-simple, epistemically-independent object capable of human knowledge, denoted in Q4.a.-Q4.c.

What is noticeable with this example, though do not argue for this claim here, is that the form of Descartes' "finest example," the specific questions and arrangement of them (excluding the content), is the form of his method of doubt in his *Meditationes*; that is, if we bracket his skeptical scenarios, Descartes asks similar questions and conducts similar procedures as those that are proposed in Rule VIII, which suggests formal continuity between the two texts.[36] In summary, the general procedure of Descartes' *Regulae*, the one that we should be looking for in *Les Météores*, is one that (1) poses an inquiry question, (2) reduces the assumptions of the original question into parts, (3) orders the parts based on epistemic dependency, (4) translates them into questions, and (5) insures that the final question results in the discovery of an intuition.

II. The Rhetorical Method of *Les Météores*.

When we turn to Descartes' presentation of his natural philosophy during the late 1620s and early 1630s, he presents a similar reductive strategy. My interest, or rather my case study, is Descartes' 1629 question, "What is the cause of parhelia?" given in the tenth and final discourse of *Les Météores*, the question that ultimately resulted in him drafting his meteorology. As the text stands, Descartes' begins with assumptions and proceeds to tightly-knit explanations, which suggests, at best, a hypothetico-deductive method. Nevertheless, my claim is that this feature of the publication is a prominent secondary one. The main point or the primary aim of the text, however, is to present an early formulation of his method of doubt, a procedure that has been, to

[36] This question of the "finest example" was examined in the *Meditationes*. Descartes described it as a "task which everyone with the slightest love of truth ought to undertake at least once in his life," which was, essentially, the same description that he provided in the First Meditation (AT VII, 17; CSM II, 12).

this point, hidden or masked because of obscurities in the mode of presentation. The reductive method, however, is uncovered if we read the discourses of *Les Météores* as Descartes directed: in reverse order, having a backwards orientation to the interpretation, beginning with the phenomenon (or model) of parhelia in the Tenth Discourse and proceeding backwards to the subsequent discourses, one by one, as he did in his two examples in the late 1620s.

Before we turn to this reading, let's begin with an explanation as to why one should adopt this historiographical strategy. I begin with the traditional interpretation of the text and then provide some evidence for my own interpretation. Many commentators argue that Descartes did not present a reductive procedure in his *Les Météores* but began with hypotheses and proceeded to a loose series of tightly-knit explanations, what Descartes described as deductions.[37] This thesis, on the surface, has obvious support. Descartes openly began *Les Météores* with "suppositions"[38] and provides an explanation or, rather, a brief justification of them in the *Discours*, where he acknowledges that this feature of the text would "shock" his readers.[39] Better yet, he explained in the preamble to the *Discours* that he did not intend to "teach" or "demonstrate" his method, which suggests that the method was not disclosed[40] and, to compound this problem, he explained to Antoine Vatier that he could not "teach the *whole* of [the] method" or "demonstrate" its use because "it prescribes *an order of research* which is quite

[37] Desmond Clarke, *Descartes' Philosophy of Science* (Manchester: Manchester University Press, 1982), pp. 180-185; Peter Dear, 'Method and the Study of Nature,' in *The Cambridge History of Seventeenth-Century Philosophy*, eds. by D. Garber and M. Ayers, vol 1 (Cambridge, Cambridge University Press, 1984), pp. 147-177; Garber, *Descartes' Metaphysical Physics*, chapter 2; Gary Hatfield, 'Science, Certainty, and Descartes,' in the *Proceedings of the Biennial Meeting of the Philosophy of Science Association 1988*. ed. A. Fine and J. Leplin, vol 2, (East Lansing, Philosophy of Science Association, 1984), pp. 147-177. Craig Martin, *Renaissance Meteorology: Poponazzi to Descartes*. (Baltimore: The Johns Hopkins University Press, 2011), pp. 128-132; Paul J. Olscamp, 'Introduction,' in René Descartes' *Discourse on Method, Optics, Geometry, and Meteorology*, trans. by Paul J. Olscamp (Indianapolis: Hackett Publishing Company, 2001), pp. xxx-xxxiv.

[38] *Les Météores* AT VI, 76; CSM I, 150.

[39] *Discours*, AT VI, 76; CSM I, 150.

[40] *Discours*, AT VI, 4; CSM I, 112; End of May 1637 to an Unknown Correspondent, AT I, 370; CSMK III, 58; February 27, 1637 to Mersenne, AT I, 349; CSMK III, 53.

different from the one I thought proper for exposition."[41] To be clear, the "order of research," in this case, was different in two ways. First, he tells Vatier that to fully disclose his method he thought that he must provide a prerequisite demonstration of his "physics" and early "metaphysics" in order to "prove *a priori* the assumptions […] at the beginning of the *Meteorology*."[42] Second, his presentation was different in the *Essais* because he failed to explain how he discovered his meteorological foundation and his overall explanation of parhelia via his analytic method.

In response, it is true that Descartes began with assumptions and did not explicitly disclose his reductive method in the *Discours* and *Essais*. He did, however, provide a brief depiction of his *Le Monde* and *L'homme* in the *Discours*, the physics and physiology that was the foundation of his *Les Météores*, which provides some response to the first point.[43] In terms of the second, he provides a roadmap or directions as to how one should read his *Les Météores*. For instance, in the *Discours*, he explained that those that "have the patience to read the whole book [including the *Dioptrique* and *Les Météores*] attentively […] will be satisfied," for "my reasonings [are] so closely interconnected that just as the last are proved by the first, which are their causes, so the first are proved by the last, which are their effects."[44] In clarification, he added, "[…] the causes from which I deduce them serve not so much to prove them as to explain

[41] February 22, 1638 to Vatier, AT I, 559; CSMK III, 85, emphasis added.
[42] February 22, 1638 to Vatier, AT I, 562-563; CSMK III, 87. See also *Discours*, AT VI, 76; CSMK III, 150; March 9, 1638 to Huygens, AT II, 661-661; CSMK III, 91-92; Letter to Dinet, AT VII, 602-603; CSM II, 397.
[43] For Descartes' claim to have deduced his foundations of *Les Météores*, see Patrick Brissey, 'Descartes and the Meteorology of the *World*,' *Society and Politics* 6 (November 2012), pp. 88-10. For Descartes' suppression of his physics and physiology during the 1630s, see End of November 1633 to Mersenne, AT I 270-272; CSMK III 40-42 and February 1634 to Mersenne, AT I 281-282; CSMK III, 41-42.
[44] Descartes makes this claim in several instances. See *Discours*, AT VI, 76; CSM I, 150; Rule XII, AT X, 428; CSM I, 50; Rule XIII, AT X, 433; CSM I, 53; July 13, 1637 to Morin, AT II, 198; CSMK III, 106-107; October 1637 to Noël, AT I, 455; CSMK III, 75. Most notably, however, he makes this claim in the Second Replies. See AT VII, 155-159. For discussion of this passage, see Gaukroger, Stephen, *Cartesian Logic: An Essay on Descartes's Conception of Inference* (Oxford: Clarendon Press, 1989), chapter 3 and pp. 99-102.

them; indeed, quite to the contrary, *it is the causes which are proved by the effects*."[45] What Descartes had in mind was not for his sagacious readers to begin with the foundations of his meteorology, the causes briefly explained in the First Discourse, but with the "effects," the initial observation of parhelia described in the final discourse and the proceed backwards to the necessary causes, step-by-step, in the early discourses. This backwards or inverted orientation to *Les Météores* suggests that the published text contains a presentation of his method of reduction under the guise of a seemingly hypothetico-deductive method.

This interpretive strategy is additionally confirmed by the genesis of *Les Météores*. Descartes began research on meteorology by first analyzing a specific problem, mainly Scheiner's description and model of parhelia, and then, while searching for causes of this phenomenon, he thought his explanation depended on meteorological causes, and, for this reason, he proposed a full meteorology.[46] In August 1629, Descartes reported that he received a description of the phenomenon of parhelia, most likely from Henricus Reneri, and, by October, he told that he was "investigating the cause of the phenomenon" and that he thought that he "give some explanation of the phenomenon."[47] Presumably, Reneri asked him to compose a small treatise on the matter which he was going to compare to Pierre Gassendi's. Nevertheless, the unveiling of his solution was suspended for a broader project. He explained, "Before I could give [Reneri] my answer I had to *interrupt* my current work in order *to make a systematic study*

[45] *Discours*, AT VI, 76; CSM I, 150; emphasis added. Descartes makes a similar claim in his explanation of his use of experimentation, *Discours*, AT VI, 63-65; CSM I, 143-144.
[46] Descartes also thought his *Les Météores* could serve as a textbook on meteorology. See October 1637 to Noël, AT I, 455; CSMK III, 75; Letter to Father Dinet, AT VII, 573; CSM II, 386. See also Martin, *Renaissance Meteorology*, chapter 6.
[47] October 8, 1629 to Mersenne, AT I, 23; CSMK III, 6. See also Delphine Bellis, 'An Epistoloary Lab: The Case of Parhelia and Halos in Descartes' Corespondence (1629-1630),' in *The Circulation of Science and Technology: Proceedings of the 4th International Conference of the ESHS, Barcelona, 18-20 November 2010*, ed. By A. Rosell, (Barcelona: SCHCT-IEC, ROCA, 2012), pp. 372-377.

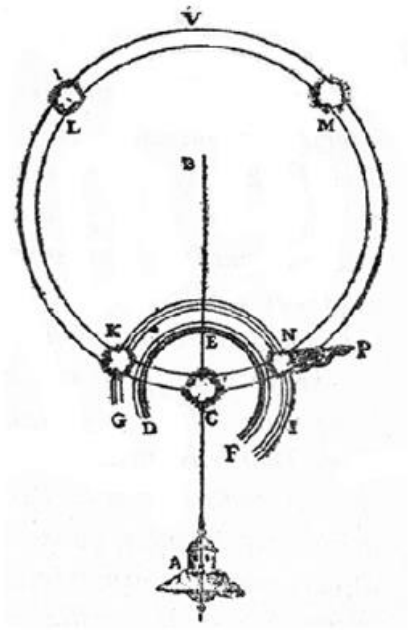
of the whole of meteorology."[48] His explanation of the cause of parhelia thus depended on meteorological causes and would result in the publication of a "little treatise" that would contain, in part, an "explanation of the [causes of the] colours of the rainbow […] and for *all sublunary phenomena* in general."[49] By November 13th, he completed an outline of his proposal,[50] but this project was also temporarily suspended for broader concerns. He wrote, "Rather than explaining just one phenomenon I have decided to *explain all the phenomena of nature*, that is to say, *the whole physics*."[51] Descartes' order of research began with Scheiner's observation and then proceeded to deriving causes, which led him to various explanations of meteorological phenomena. This suggests that a definitive way of reading the text is beginning from the last discourse and proceeding to the first, inferring causes from the effects, as he directed in the *Discours*.

When we apply this interpretive strategy in *Les Météores*, it reveals a reductive procedure, an instance of his scientific method of doubt. Descartes tells in the Tenth Discourse that the observation in Rome consisted of an apparition of five suns and three coronas. Scheiner witnessed an extremely beautiful phenomenon, one that consisted of the actual sun (C in Fig. 2) centered at the bottom of a large, white corona (LCM), along with two parhelia appearing at its left (K) and right (N), both of which were placed within the main corona, like "diamonds […] set into a ring."[52] In addition, there were two secondary, or smaller coronas, concentric with the sun, at the bottom of the main corona, which contained various colors of the rainbow. The first (DEF) was located equidistant to the second (GNI), and the second had two parhelia centered within the

[48] October 8, 1629 to Mersenne, AT I, 23; CSMK III, 6, emphasis added.
[49] October 8, 1629 to Mersenne, AT I, 23; CSMK III, 6.
[50] November 13, 1629 to Mersenne, AT I, 70; CSMK III, 7, emphasis added.
[51] November 13, 1629 to Mersenne, AT I, 70; CSMK III, 7, emphasis added.
[52] AT VI, 323; *Les Météores* p. 354.

outer edges of its perimeter (K and N). Further, at the apex of the main corona, above the three lower parhelia, there were two symmetrical parhelia (L and M), again embedded within the corona, and were observed parallel to the lower parhelia that were on the left and right of the actual sun.

Fig. 2: Christopher Scheiner's 1629 Observation of Parhelia[53]



With Descartes' inquiry question established (Q1 in Table 3), its description, and model, the point of the remaining procedure is to read off, or point out, parts of the observation that need explanation. Scheiner's observation of parhelia, as I have explained, consisted of the apparition of false suns embedded in a large, colored corona. Based on this, Scheiner's description necessitated an explanation of coronas, for it was a major part of the phenomenon and is the visual feature that unifies or holds together the other celestial lights. Thus, Descartes' first step of his reduction is Q2: "What is the cause of coronas?" Moreover, this feature of the observation,

[53] AT VI, 363; *Les Météores* p. 358.

along with some of the outer edges of the false suns, contains, at parts, brilliant and, at other parts, less brilliant presentations of colors, which need explanation, thus Descartes derives Q3: "What is the cause of color?" The perception of colored, meteorological phenomena also necessitates an explanation of light and the visual sensation of heavenly bodies; that is, one must explain how the particles of a luminous source collide with objects in the visual field to produce images in the eye with the aim of differentiating the lights that make up this phenomenon and

Table 3. Descartes' Explanation of Parhelia in *Les Météores*

Q1. What is the cause of parhelia? [Discourse 10]

Q2. What is the cause of coronas? [Discourse 9]

Q3. What is the cause of color? [Discourse 8]

Q4. What is the cause of illuminated objects in the sky? [Discourse 7]

Q5. What is the cause of precipitation? [Discourse 6]

Q6. What is the cause of clouds? [Discourse 5]

Q7. What is the cause of winds? [Discourse 4]

Q8. How minute particles come to populate the sky? [Discourses 2]

Q9. What types of minute particles populate the sky? [Discourses 1 and 3]

Intuitions: The conclusions of *Le Monde* and *L'homme* included in Discourse 1.

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other heavenly lights, thus Q4.[54] Similarly, if we seek the necessary conditions for Scheiner's observation, we will likewise need an explanation of precipitation, mainly the formation of snow and polished ice, the objects that reflect and refracts light to produce coronas (Q5). In addition,

[54] Descartes had much more to say on visual perception in *Le Monde ou Traité de la lumière*, *L'homme*, and *Dioptrique*.

the formation of large lens-like, ice sheets that hover in the sky necessitates an explanation of the frigid clouds that forms and supports them (Q6), and the phenomenon of clouds necessitates an explanation of wind, their cause. Further, it is the cold wind that makes the body of the ice sheet, and the warm wind cuts or sharply melts the edges of the large body into a lens-like shape; thus, Descartes' explanation of parhelia needs a prerequisite explanation of the formations of winds (Q7). This move also makes Descartes proceed to a lower level in his reduction. Wind, he tells, amounts to forces of small particles or transparent corpuscles that travel through the sky, which requires a causal explanation as to how minute objects come to populate the sky (Q8). This story, moreover, suggests an explanation of the types of minute objects – the shapes and sizes that produce sensory qualities – that populate the sky and produce the visual perception of clouds, lightning, and color (Q9).[55] Thus, from a causal perspective, the motion of particles in the sky causes the production of wind, clouds, precipitation, and, in short, the phenomenon of parhelia, that is, under the proper conditions. However, from the perspective of one epistemically attempting to discover the cause of parhelia, one would start with a question and observation of the phenomenon and then proceed piecemeal from the more general to the specific causes, essentially knowing the causes by way of effects or, better put, establishing the necessary conditions for the perception of parhelia.

We oddly end our reduction in *Les Météores* with the shapes and sizes of various particles that make up meteorological phenomena. This, however, did not amount to a simple intuition or intuitions. As Descartes explained to Vatier, his *Essais* depended on a prerequisite demonstration of his physics and physiology; that is, the base of the branch that is his

[55] Descartes thought he could deduce the foundation of his *Les Météores*. See December 20, 1637 to Plempius, AT I, 476; CSMK III, 77. For this reason, his intuition is composite, immediately known but the conclusion of a deduction. See Rule XI, AT X, 407-408; CSM I, 37.

meteorology depends on the trunk of the tree, his *Le Monde* and *L'homme*. Therefore, the foundations of *Les Météores*, what he construed as "assumptions," should be interpreted as a series of composite intuitions, deductions that have been methodically reduced to immediately known, self-evident truths. With the discovery of an intuition, would then proceed up and down the ordered questions to construct a loose deductive answer to the question.[56]

Nevertheless, our aim is to nail down, in broad strokes, Descartes' scientific method of doubt, a method of presentation that is akin to his early metaphysical example in Rule VIII and the form of his *Meditationes*. The much-awaited question is where does doubt play any significant role in Descartes' explanation of parhelia? In response, there are two parts of the method where doubt plays a significant role: one vertical and one horizontal. On the vertical level, Descartes incorporates his procedure of "complete enumeration" where the Cartesian scientist is required, at the outset of the investigation, to list all of the relevant issues or parts of the proof that needed to be explained and then order them in terms of epistemic dependence. If a question or answer is omitted, then the investigator will not be able to cognize all of the necessary links in his deduction and the conclusion will be probable and, for Descartes, not knowledge.

There is, additionally, a horizontal level of investigation where Descartes attempts to answer the questions posed in the vertical stage. This procedure is applied during the reductive stage (Beck's concept of backwards deduction) and during the deductive ascent. In this portion of the method, Descartes incorporates his procedure of "sufficient enumeration;" that is, he lists

[56] On Descartes' deductive presentation in *Les Météores*, See Martin, *Renaissance Meteorology*, pp. 126-132.

the most plausible explanations as hypothetical answers and then tests them with doubt.[57] If the hypothesis cannot withstand doubt, it is eliminated. Moreover, there is no need, in this case, to provide a complete list, for the eliminative procedure, the series of reductio ad absurdums, does not verify the object. Rather, the agent's intuitive grasp of the object provides confirmation. Nevertheless, this procedure is applied at each stage and each question posed in the vertical reduction.

The actual application of these two procedures is complex and a specific depiction is much too broad for our purposes. Nevertheless, Garber provides an excellent reconstruction of Descartes' explanation of the rainbow in Discourse Eight of *Les Météores*. With his reconstruction in mind, we see that at each level Descartes provides a vertical enumeration of the parts of the problem that needs to be solved, orders them, and translates them into questions with the aim of discovering intuitions. He begins with the question of parhelia and derives all of the discourses of *Les Météores*, but, then, within each discourse, he provides a secondary vertical enumeration of the specific meteorological phenomenon. After this task is complete and he is prepared to discover specific causes, he transitions to the horizontal level of investigation: where he enumerates plausible hypothetical answers and tests them with doubt until an intuition is achieved.

III. Conclusion.

The examples in Rule VIII thus indicate that Descartes' reductive procedure posed an inquiry question, derived presuppositions of the question to enumerate the essential parts that need

[57] For an explanation of observation and experimentation used as methodical doubt, see Garber, "Descartes and Experiment."

explanation, translated the parts of the phenomenon into questions, ordered them in terms of epistemic dependency, and concluded the procedure with a series of intuitions. The seemingly hypothetico-deductive method turns out to be an instance of his reductive method, where he inferred causes by way of effects. We thus have sketched the procedure *Les Météores*, which is similar to his early metaphysical method in Rule VIII and to the form of his method of doubt in his *Meditationes*.

What is left outstanding is a response to the dilemma posed in the introduction. On the traditional reading, Descartes presents differing methods in the *Regulae* and *Discours* and inconsistent applications in *Le Monde, L'homme, Dioptrique, Les Météores*, and the *Meditationes*. As we have seen, he also claims that there is a single method applicable to any problem capable of human reason. My path out of this problem is to affirm the second horn, and presume that the methods of the *Regulae* and *Discours* are consistent. I additionally affirm the first horn, at least, partially. I hold that Descartes did not discover his most notable scientific discoveries by way of his method and also grant that he presented his science with a hypothetico-deductive method. However, I cast this feature as an important secondary one, used, in part, to avoid possible condemnation because of his heliocentric thesis in his physics. Nevertheless, I escape through the horns and avoid being impaled by holding that *Les Météores* presents an application of his method of doubt, which is consistent with his examples in the *Regulae* and his reductive method in the *Meditationes*. Moreover, using *Les Météores* as a case study provides a strategy for uncovering Descartes' normative method in his science in general. I thus deny, at least partially, that Descartes had multiple methods in the presentation of his method, metaphysics, and natural philosophy.

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