On the role of experiment in Descartes' Metheorology

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Although the nature and evolution of Cartesian physics has been the subject of many debates, relatively little has been done so far to clarify the details of the way in which Descartes devised, constructed and used experiments. Even if there are significant discussions/studies of the status of hypotheses in Descartes' works (see Blake 1929 and 1960, Garber 2000, Ariew 2011), they pay comparatively little attention to the process of experimentation as such and to the particular way in which experiments act as problem-solving devices. The standard story is that, for Descartes, experiments function as illustration and have, therefore, a mere 'passive role'. My purpose in this paper is to challenge this account. Adopting, in part, the position stating that Descartes was less *aprioristic* about the scientific method as it is usually thought (Galison 1984, Buchwald 2008), I will identify, on particular examples, some of the functions of Cartesian experiments. I will be particularly interested in a number of Cartesian experiments destined to bridge the gap between the visible and the 'invisible' world of particles of matter in motion. I will especially concentrate on Descartes' *Meteorology*.

An interesting example to begin with is Descartes study of the halo which appears in the ninth discourse of *Meteorology*. The discourse begins with an account of how the nature of transparent and opaque bodies depends on light's refraction through thicker or multilayered surfaces. To generalize the findings, Descartes offers a set of observational instances bearing on transparency (water, ice, clear sky) and on opacity (crushed glass, snow, foam, clouds, hazy sky). If pointing out the characteristics of the medium and the nature of light is sufficient to explain observed tokens, there is yet at least another phenomenon that needs explanation: the halos around stars, the sun and the moon. His explanation progresses continuously through a series of observations related to the atmospheric conditions of their appearance. The fact that halos appear mostly in summer and when it is not raining determines Descartes to conclude that the medium has to be composed of "small stars of transparent ice" (Descartes, *Discourse on Method*, 348; AT VI 348). The conclusions drawn in the rainbow study allow Descartes to make an analogy between this studied phenomenon and other similar optical phenomena. Therefore, the question of the angles at which the colour red appears is kept, and he answers it by choosing the maximum 45º diameter of halos, as established in others' observational reports (AT I 148; CSMK 24; AT I 84; CSMK, 13). Further on, Descartes makes intelligible the remarkable appearances of halos with the help of the *application* of experiments (Descartes, *Discourse on Method*, 350; AT VI 351). In this discourse the last optical phenomenon analyzed within the same explanatory structure is the corona formed around the candle or flame. On 18 December 1629, Descartes sent to Mersenne a letter in which he appears to be surprised by Mersenne's experiment of the coronas formed around the candle flame and the fact that Mersenne could rehearse the experiment at will. Hence, in order to test the hypothesis that the liquid of the eye might be the cause, Descartes asked Mersenne for the exact experimental conditions:

> I was astonished to hear that you have often seen a corona around a candle, apparently just as you describe it, and that you have a device which enables you to see it at will. (…) I would like to know at what time you see the coronas: whether it is a night, when your eyes are laden with the vapours of sleep, or after having read for a good while, or whether you have been awake for some time or have gone without food; whether it is during a dry or rainy spell, whether indoors or out in the open air, etc. Having settled that question, I think I could explain the matter. (AT I 83; CSMK 13).

According to Descartes, what distinguishes the halos and coronas is in fact the different order of colours (AT I 83-84; CSMK 13-14). Using the prismatic experiments, the systematized study of the coronas establishes that their cause can be the crystalline humours of the eye which "changes in temper or shape" the presence of an opaque body in the crystalline humours or the internal wrinkles (Descartes, *Discourse on Method*, 351-352; AT VI 353).

The striking part of Descartes' study is the fact that in order to settle the explanation of the phenomena, two methodological strategies are available. One is to manipulate the initial experimental setting in order to reproduce phenomena compatible so far with a mere probable explanation. The other is to use analogical reasoning and, starting from one phenomenal occurrence, to design another, new experiment in order to extend the domain of related phenomena. The modifications produced in the experimental setting enable the connection between apparently dissimilar physical occurrences, as the halo around stars and coronas around the flame, under the same domain of investigation, in order to generate a body of knowledge that shares a common explanation. These are, in the end, the resulting *scientific facts* standing in need of an explanation.

The same structure can be unearthed, I think, in many of Descartes' experiments from the *Meteorology*. It is a structure that demonstrates, I claim, the creative role of experimentation. By modifying the experimental setting and the field covered by the experiment, the process of experimentation plays a more active role in the process of discovery that is usually ascribed in the case of Descartes. Meanwhile, we do not have a hypothetico-deductive structure at work; experiments are not testing predictions. They stand in a much more complex relation with Descartes' physics than usually assumed. Hence, studying the nature, function, structure and application of Descartes' experiments and the associated heuristic of the 'scientific discovery' sheds a new light on Descartes' doctrine, allowing a much less speculative reading of his physics.