Evidence
Lecture 4 (25. May 2022)
Newton's Doctrine, Its Framework and Evidential Structure, and His Disputes with Pardies, Hooke and Huygens

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Contents

This lecture covers:

1. Newton (1672b)
2. Hooke (1672), "Letter to Henry Oldenburg, Secretary of the Royal Society, Containing Hooke's Response to Newton's Investigations on Light"
3. Newton (1672c), "Letter to Henry Oldenburg, Secretary of the Royal Society, Containing Newton's Response to Hooke's Criticism of Newton's Doctrine of Light"
4. Pardies (1672a), "Letter of April 9, 1672, to Henry Oldenburg, Secretary of the Royal Society, Containing Pardies' First Response to Newton's Investigations on Light"

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5. Newton (1672a), "Letter of April 13, 1672, to Henry Oldenburg, Secretary of the Royal Society, Containing Newton's Response to Pardies' First Criticism of Newton's Doctrine of Light"
6. Pardies (1672b), "Letter of May 21, 1672, to Henry Oldenburg, Secretary of the Royal Society, Containing Pardies' Second Response to Newton's Investigations on Light"
7. Newton (1672d), "Letter to Henry Oldenburg, Secretary of the Royal Society, Containing Newton's Response to Pardies' Second Criticism of Newton's Doctrine of Light"
8. Huygens (1673a), "Letter to Henry Oldenburg, Secretary of the Royal Society, Containing Huygens' First Response to Newton's Investigations on Light"
9. Newton (1673a), "Letter of April 3, 1673, to Henry Oldenburg, Secretary of the Royal Society, Containing Newton's Response to Huygens' First Criticism of Newton's Doctrine of Light"
10. Huygens (1673b), "Letter to Henry Oldenburg, Secretary of the Royal Society, Containing Huygens' Second Response to Newton's Investigations on Light"
11. Newton (1673b), "Letter to Henry Oldenburg, Secretary of the Royal Society, Containing Newton's Response to Huygens' Second Criticism of Newton's Doctrine of Light"

1 Admin Crap

1. REMEMBER TO RECORD THE LECTURE!
2. postponement of make-up lecture
3. my travel, some upcoming lectures will be by zoom
4. I still need to update the schedule of lectures and readings to reflect delay caused by the missed lecture
5. remind: invitation to short essay

2 Review of Newton's Doctrine

2.1 Statement of the Doctrine

Newton demonstrated unequivocally:

1. that sunlight consists of an innumerable number of simple light rays differing from each other in their refrangibility relative to a given medium of propagation [positive quantitative existential indicative claim about the present state of the world and positive quantitative modal claim about a general phenomenon in the world];
2. that the refrangibility associated with a particular simple ray for a given medium of propagation is a primitive property of that ray in the sense that no manipulation of the ray Newton could contrive would change it [positive quantitative existential indicative claim about the present state of the world and positive quantitative modal claim about a general phenomenon in the world];

3. that when a simple ray exhibits a particular refrangibility, it also always exhibits a particular correlated colorific character, *viz.*, the appearance to a normal observer under normal conditions of a particular color when the simple ray falls on a white surface, always the same color for a given refrangibility [positive qualitative existential indicative claim about the present state of the world and positive qualitative modal claim about a general phenomenon in the world];

4. that light from all sources he could find to experiment on has the property of being composed of simple rays of fixed refrangibility, if it is not itself in the first place such a simple ray [positive qualitative existential indicative claim about the present state of the world];

5. that simple, homogeneal rays manifest a local quasi-additive structure in their colorific properties: the composition of two rays close in color (as determined by relative position in the spectrum) tends to produce a complex ray whose color is intermediate between the two [positive quasi-quantitative existential indicative claim about the present state of the world and positive qualitative modal claim about a general phenomenon in the world]

2.2 The Framework—or, Metaphysics and Ontology—of Newton's Doctrine

In this context, by 'framework' I mean (at a minimum) a system of:

1. terms;

2. propositions formed from the terms making claims about (*inter alia*) the physical world;

3. mathematical structures;

4. various means of interpreting the terms and propositions as being (in part) about experiments, including at least rules of evidence (what one can have evidence for, what can act as evidence, how it can act as evidence);

5. various means of interpreting the mathematical structures using the terms and propositions and their relations to experiments;

6. all such that one can use the machinery:

    a. to produce descriptions of and predictions about actual physical systems;

    b. to produce characterizations of families of relevantly related systems ("natural kinds");

    c. to characterize the modality structure (possibility and necessity) of the systems (individuals and natural kinds), their properties and their behaviors, treated by the framework

Some of the most important terms and propositions of Newton's framework:

original and connate property a property of a kind of physical system that cannot be altered by any known or achievable manipulation of or intervention on it, nor by any interaction it may have with any other kind of system (as used, *e.g.*, at Newton 1672b, p. 53), given the

time's epistemic state and state of methodological and technological prowess; such properties are definitive of the kind or species of system (Curiel 2017); see Rule III of Newton's "Rules of Reasoning in Philosophy" (Newton 1726a, Bk. III, pp. 398–399); it seems clear that Newton's contemporaries did not understand his usage

ray (of light) the smallest "part" of a given body of light that can be isolated and observed, propagating along a straight line, independent of all other parts of the light; in experimental investigations, what counts as "smallest" may depend on factors such as the acuity of the instruments and the precision allowed by their use; in theoretical investigations, "smallest" may be taken in something like a mereological sense, indicating that any given body of light is to be conceived of as composed of rays aggregated and mixed with each other, unless the body is itself a single ray; when the ray is simple (*q.v.*), then one may think of it as something like the fundamental "ontological unit" of all forms of light

refrangibility the disposition of a ray of light to refract

simple ray a ray (*q.v.*) having a fixed refrangibility (and so a fixed colorificity), thus being an original and connate property (*q.v.*) of the ray

qualification of light a change made by an external agency to the constitution or dynamical behavior or properties of whatever constitutes light (as used, *e.g.*, at Newton 1672b, p. 53); it was universally held at the time that white light (canonically, sun light) is the "natural state" of light, and that different colors are produced by disturbances ("qualifications") of some kind to white light

Perhaps the most important feature of the framework is what we may call its *schematic* character:

1. it is formulated entirely in terms whose meaning can be given by bringing the terms into appropriate relation to observable and manipulable properties and behaviors of light

2. *N.b.*: this is *not* a crude empiricism or verificationism, for no demand is made that the observability and manipulability *exhaust* the meanings

3. in particular, it is formulated in a way independent of any "hypotheses" or "conjectures" concerning the fine details of the mechanical or other constitution of light (*e.g.*, whether light is "really" a wave or a particle), what one may perhaps call "models" of the framework (in something akin to the sense of Tarskian referential semantics or model theory)[1]

1. See the most illuminating remarks of Stein (1989, pp. 58–59):

   > Now light, as we have come to understand it, whether we "represent" it by means of the classical wave theory of Fresnel, the electromagnetic theory of Maxwell, or (now most fundamentally) by the quantum theory of the electro magnetic field, does not have "parts" that are propagated along definite trajectories. One cannot say, of the light that reaches a certain point P at a certain time t, that at an earlier time t' this same bit of light was at a point Q; the notion of *identity of localized parts through time* is simply inapplicable at all to light.
   >
   > Therefore, one either has to say that Newton's term 'ray' fails to "refer" or one has to strain to find some way to associate that term with an "entity" of one of the later and deeper theories – at best a pedantic and unrewarding move. On the other hand, it is an essential task of physical understanding, and a most instructive one, to exhibit the formal relations of the Newtonian theory of rays to the later

4. thus, Newton feels he has evidence for such "schematic" claims as "sunlight consists of an innumerable number of simple light rays differing from each other in their refrangibility"

5. On p. 57, Newton avers, "I shall not mingle conjectures with certainties." Why does he feel he does not have evidence—at all? or just inadequate?—for what he calls 'conjectures'? In this context, it seems clear that the conjectures are the more specific and concrete "ontological models" of light championed by the Mechanical Philosophers, *e.g.*, that lights is a wave or a particle, and, precisely because the Doctrine is neutral between them, nothing in it can be used as evidence for one over the other (or for any other of its concrete ontological models)

6. he articulates this clearly in his reply to Hooke (Newton 1672c, pp. 118–119):

> Had I intended any such *Hypothesis*, I should somewhere have explain'd it. But I knew, that the *Properties*, which I declar'd of *Light*, were in some measure capable of being explicated not only by that, but by many other Mechanical *Hypotheses*. And therefore I chose to decline them all, and to speak of *Light* in *general* terms, considering it abstractly, as something or other propagated every way in streight [*sic*] lines from luminous bodies, without determining, what that Thing is; whether a confused Mixture of difform qualities, or Modes of bodies, or of Bodies themselves, or of any Virtues, Powers, or Beings whatsoever.

2.3 The Evidential Methodology behind the Doctrine

As an example of the methodology, what Newton considers evidence and how he builds it up and applies it, let us consider the immutability of the refrangibility of simple rays. Consider the full statement of the evinced claim, the general evidential warrant and Newton's subsequent litany of particular concrete, specific evidential claims supporting the general warrant (pp. 53–54. item 3):

> 3. The species of colour, and degree of Refrangibility proper to any particular sort of Rays, is not mutable by Refraction, nor by Reflection from natural bodies, nor by any other cause, that I could yet observe. When any one sort of Rays hath been well parted from those of other kinds, it hath afterwards obstinately retained its colour, notwithstanding my utmost endeavours to change it. I have refracted it with Prismes, and reflected it with Bodies, which in Day-light were of other colours; I have intercepted it with the coloured film of Air interceding two compressed plates of glass; transmitted it through coloured Mediums, and through Mediums irradiated with other sorts of Rays, and diversly terminated it; and yet could never produce any new colour out of it. It would by contracting or dilating become more brisk, or faint, and by the loss of many Rays, in some cases vary obscure and dark; but I could never see it changed *in specie*.

theories. One finds, when one does this, that there are several different structural aspects of the later theory, each of which has a significant bearing upon the success of the notion of a ray in serving to represent the optical phenomena dealt with by Newton. Thus the principle of "cutting at the joints" – a motif in recent realism that I heartily applaud – seems to indicate not using referential semantics as the basis of comparison of theories (at least in the case cited; but I offer it as typical).

Analysis:

1. The evinced claim receiving evidential warrant: "The species of colour, and degree of Refrangibility proper to any particular sort of Rays, is not mutable by ... any ... cause, that I could yet observe."

2. The general evidential claim supporting it: "When any one sort of Rays hath been well parted from those of other kinds, it hath afterwards obstinately retained its colour, notwithstanding my utmost endeavours to change it."

3. the particular concrete, specific evidential claims supporting the general evidential claim: he fucked with it in every way he could think of, and nothing he did had any effect on it

4. BUT the evinced claim itself is then immediately used as evidence for a more remarkable, abstract, schematic, one might say metaphysical and ontological, claim (which we will call "the second evinced claim", and the former "the first"): it was the immutability of the refrangibility and colorificity that led Newton, warranted by the Third Rule, to think of these rays as the 'simple' components of the more 'complicated' ray of sunlight, and his denomination of the properties of refrangibility and colorificity of a ray "of a particular sort" as "original and connate" properties of those rays—though strictly speaking he explicitly denominates only colorificity so, but the intended extension to refrangibility is, I think, clear, as mandated by the Third Rule[2]

5. it is important to note that the first evinced claim can be used as warrant for the second *only* in conjunction with the (implicit) claim that refrangibility and colorificity are the only two physical properties of light that can be used to differentiate it into species. (Strictly speaking there is also reflectivity, but that is trivial and so we, and Newton, ignore it.)

6. What is the nature of this second evinced claim? Interpretive? Architectonic? Ontological? Metaphysical? Epistemic? Methodological?

7. In any event, given that it must be presupposed in order even to formulate Newton's Doctrine, and *a fortiori* apply it in research to produce new possible knowledge claims, can or ought one assign it a different evidential weight from that of the framework as a whole? In what sense is there a circularity here, and, if there is indeed one, is it virtuous or vicious?

At the end of the day, perhaps the most important lesson is this:

2. This is Rule III, along with the first paragraph of the attendant scholium on it (Newton 1726b, Bk. III, p. 398–399):

> *The qualities of bodies, which admit neither intensification nor remission of degree, and which are found to belong to all bodies within the reach of our experiments, are to be esteemed the universal qualities of all bodies whatsoever.*
>
> For since the qualities of bodies are only known to us by experiments, we are to hold as universal all such as universally agree with experiments; and such as are not liable to diminution can never be quite taken away. We are certainly not to relinquish the evidence of experiments for the sake of dreams and vain fictions of our own devising; nor are we to recede from the analogy of Nature, which is wont to be simple, and always consonant to itself.

sometimes what one can have evidence for depends, in part, on one's metaphysical, epistemological and methodological commitments

3 The Recieved View of Science

> When science starts to be interpretive
> It is more unscientific even than mysticism.
>
> – D. H. Lawrence
> "Self-Protection"

Coeval, Near-Universal Attitude toward Scientific investigation: Hypothetic-Deductive (HD) Method in conjunction with adherence to the Mechanical Philosophy as underlying metaphysics is dominant, only game in town really:[3]

1. the "Principles" of all scientific investigations must conform to the Mechanical Philosophy, to wit, that the only way that any physical system can act on any other physical system is by forces of direct and contiguous contact (*e.g.*, impact, percussion, pressure, *etc.*)

2. HD mandates that *what it means* to give a scientific account of a phenomenon is to pose a detailed hypothesis (or set of them) describing a specific and concrete kind or family of kinds of matter (*e.g.*, particles, continuum, plenum) with determinate properties that act on each other in a particular way conforming to the Mechanical Philosophy; and then to deduce from them testable consequences; the conformance of appropriate experimental results with the consequences provides evidential support for the hypothetical system

in particular:

1. such systems of hypotheses and their testable consequences constitute the *only possible* kind of scientific knowledge

2. observations that in some sense are in accord with conclusions deductively drawn from those hypotheses constitute the *only possible* kind of evidence for such knowledge

3. Huygens (1690, "Preface", pp. vi–vii) gives a classic statement of the hypothetico-deductive method of science, spelling out as clearly as one could wish its essentials:

> There will be seen in [this work] demonstrations of those kinds which do not produce as great a certitude as those of Geometry, and which even differ much therefrom, since whereas the Geometers prove their Propositions by fixed and incontestable principles, here the Principles are verified by the conclusions to be drawn from them; the nature of these things not allowing of this being done otherwise. It is always possible to attain thereby to a degree of probability which very often is scarcely less than complete proof. To wit, when things which have been demonstrated by the Principles that have been assumed correspond perfectly to the phenomena which experiment has brought under observation; especially when there are a great number of them, and further, principally, when one can imagine and foresee new phenomena which ought to follow from the hypotheses which one employs, and when one finds that therein the fact corresponds to our prevision.

4 Pardies, Hooke and Huygens

As astonishing as Newton's results (in the form of his Doctrine) were in themselves, and as difficult as they were for many of his contemporaries to digest and accept, in the end it was not the concrete results themselves, but rather the abstractness of the architectonic results of the Doctrine and his method of arriving at and of stating them that caused the most confusion.

4.1 Pardies

1. In his second reply to Pardies, Newton (1672d, p. 106) makes his clearest statement describing the essence of this method, which suggests some clues as to why Newton's contemporaries may have greeted his doctrine with uncharacteristic confusion; in the process, he also makes a trenchant, penetrating criticism of HD:

   > ... [T]he doctrine which I explained concerning refraction and colours, consists only in certain properties of light, without regarding any hypotheses, by which these properties might be explained. For the best and safest method of philosophizing seems to be, first to inquire diligently into the properties of things, and establishing those properties by experiments and then to proceed more slowly to hypotheses for the explanation of them. For hypotheses should be subservient only in explaining the properties of things, but not assumed in determining them; unless so far as they may furnish experiments. For if the possibility of hypotheses is to be the test of the truth and reality of things, I see not how certainty can be obtained in any science; since numerous hypotheses may be devised, which shall seem to overcome new difficulties.

2. The manner in which Newton deduced and stated his conclusions about the nature of light was completely independent of hypotheses in the sense that they did not depend on any particular hypothesis one may have had about the physical structure of light rays—whether one postulated that they were waves in some ætherial medium or that they were particles or whether one postulated nothing about their physical microstructure at all, Newton's propositions not only made sense but held true.

3. Newton derived his propositions about the behavior of light based solely on his experimental results, with no thought during that derivation of trying to explain the observed behavior by this or that hypothesis; that maneuver, if performed at all, would be only after the fundamentals of the behavior of light were captured by a series of propositions independent of any particular hypothesis about the microstructure of light.

4. To a scientist schooled in the method of science articulated by Huygens, such a feat was incomprehensible.

5. Speaking broadly, hypotheses were used in Seventeenth Century scientific investigation as the starting point from whence experimental phenomena were to be explicated, with the mechanical hypothesis regnant: a purely mechanistic explanation was the *sine qua non* of scientific endeavor, and no one gave thought but that the world must conform to his *a priori* hankerings.

6. Newton rejected outright any *a priori* demand that the world be any particular way before having actually investigated the phenomena, and this was the truly radical break both with his predecessors and with his contemporaries.

7. Induction from detailed and thorough experiments was to provide a rough sketch of the properties of systems, their behavior and interactions with other systems, and only then could one produce hypotheses, under the constraints of the experimental results with no preconceived prejudices, in an attempt to explain the phenomena.

8. None of these results, moreover, was to have the apodeictic certainty of mathematical demonstration, but they all were always (in principle, at least) open to revision in the future, if experimental evidence demanded it.

9. Such was the best hope Newton saw for understanding in natural philosophy: not to constrain one's investigation of the world with perhaps incorrect preconceptions of the world, but simply to examine the experimental evidence and search for the best explanation.

4.2 Hooke

1. Hooke (1672, p. 111):

   > [W]hatever refracting medium does again reduce it to its primitive simple motion by destrroying the adventitious, does likewise restore it to its primitive whiteness and simplicity.

   But Hooke *has no criterion* for "primitive" and "simple", so he cannot have evidence for this claim.

4.3 Huygens

[*** coming soon ***]

5 Invitation to a Short Essay

I invite you to write me a short discussion (no more than 2 pages, *i.e.*, no more than 1000 words) on any issue discussed in this lecture or any of this week's readings, required or suggested. You can raise further questions, propose answers or interpretations, or whatever seems of most interest to you. If you get it to me by the start of next lecture (1. June), then I will return it to you with my comments the following week.

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