

Glossary for Newton’s Studies on Light and Color

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This is a glossary of terms that appear in Newton’s work on light, color and optics, and in the responses of his contemporaries to that work, that a modern reader may have difficulty with. (The relevant works are, especially: Newton 1672b, 1672c, 1673a, 1673b, 1672a, 1672d, 1730; and Hooke 1672, Huygens 1673a, 1673b, and Pardies 1672a, 1672b.) I also include definitions and discussions of some terms that, while not archaic or otherwise unusual, may not be familiar to those without a passing knowledge of this branch of physics, and yet other terms that may not appear in Newton’s work but which I need in order to define and discuss some of the terms that do. I do not discuss or mention every obscure, archaic or technical term used in those investigations and discussions, as there are in this world such things as dictionaries, and you should make a practice of consulting them whenever you have the slightest doubt about the meaning of a term.

N.b.: the way that Newton uses some of these terms *does not* always accord with the way that several of his contemporaries use the same terms, especially in the works cited in the previous paragraph. It often seems to be the case, moreover, that Newton is aware of the discrepancy in usage whereas his interlocutors are not. I note in their respective entries the terms for which this may hold, and what the differences in usage may be.

angle of incidence *q.v.* ‘incidence’

angle of refraction *q.v.* ‘refraction’

connate *q.v.* ‘original and connate property’

difform as in “Light . . . consists of *difform* rays” (Newton 1672b, p. 53): *q.v.* ‘ray’ and ‘similar’

Experimentum Crucis The term has its origins in the *Novum Organum* of Francis Bacon, where he uses ‘*instantia crucis*’ to mean a determining circumstance that would show that one hypothesis or theory holds true while all rivals do not. I am told (but cannot find the reference) that the term ‘*experimentum crucis*’ was then coined by Robert Hooke, to mean the deliberate construction of a controlled situation whose observed result would provide an *instantia crucis*. But I have also been told the same of Robert Boyle.

homogeneous as in “Light is not . . . homogeneous” (p. 53): *q.v.* ‘similar’

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hypothesis of the proportionality of the sines of incidence and refraction as used, *e.g.*, at Newton (1672b, p. 49), *q.v.* ‘received laws of refraction’

in specie in appearance; thus, beams of light that are the same *in specie* are those disposed to induce the same color sensation in the same circumstances; closely related (almost punning) to the idea of a fundamental “species” or (natural) kind of light (*q.v.* ‘original and connate property’)

incidence the falling of a ray of light (*q.v.*) on a surface, in particular that of the boundary between two translucent media; the angle a ray of light makes with the normal (*i.e.*, line perpendicular) to such a boundary when falling upon it

incident *q.v.* incidence

index of refraction a quantitative measure of the amount a ray of light (*q.v.*) suffers refraction (*q.v.*) when it passes the boundary of two different, contiguous translucent media, depending on the specific media; thus, there is a fixed index of refraction for air and glass, for glass and water, for air and water, and so on

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 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 1726, Bk. III, pp. 398–399); it seems clear that Newton’s contemporaries did not understand his usage

Phænomena of Colours the iridescent display of colors produced when sunlight (or any heterogeneous mixture of light) enters a glass prism and exits, appearing as a rainbow



Figure 1: The Phænomena of Colours, courtesy of Pink Floyd

proof a test of a proposition, to see whether it is false, *not* (as in modern usage) a demonstration of its truth; thus, the maxim (as popularized in modern time by Bacon) “the exception proves the rule” means that a seeming exception to a general rule *serves as a test* of whether the rule

is in fact general (*i.e.*, is in fact a rule)—either it really is an exception, and the putative rule is shown to be no rule at all, or it is to be explained why it is not in fact an exception, with a concomitant gain (one hopes) in understanding of the content and meaning of the rule by clarification of the rule’s scope and of the conditions under which it holds; the modern sense of ‘proof’ is sometimes also used, as in, *e.g.*, the first paragraph of Hooke (1672, p. 110), but context should disambiguate which sense is intended

prove *q.v.* ‘proof’

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

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

received laws of refraction in particular as used at the end of the first paragraph of Newton 1672b means here primarily what we know of as Snell’s Law, a formula that quantitatively describes the relationship between the angle of incidence and the angle of refraction (*q.v.*) of a ray of light (*q.v.*) as it passes the boundary between two different translucent media. According to the understanding of the phenomenon at the time Newton began his investigations, the relevant aspect for Newton’s work, and in particular for the observation that initiated the work described in Newton (1672b), is that all rays of light passing the boundary between two given, different translucent media have always the same ratio of the sine of the angle of incidence to that of refraction. This is what Newton refers to as “the Hypothesis of the proportionality of the Sines of Incidence and Refraction” (p. 49).

In a modern formulation, which exhibits the relevant point, the law is

$$\frac{\sin \theta_{\text{ref}}}{\sin \theta_{\text{inc}}} = \frac{n_1}{n_2}$$

where θ_{inc} is the angle of incidence, θ_{ref} is the angle of refraction, n_1 is the index of refraction (*q.v.*) of the medium the light is leaving, and n_2 is that of the medium the light is entering.

refract the act of refraction (*q.v.*)

refraction the change in the direction of propagation of a ray of light (*q.v.*) when it passes from one medium to another (*e.g.*, passing from air into the glass of a prism, or back out again); sometimes it is meant qualitatively, merely as the general phenomenon of the bending of light

in the circumstance; at other times it is meant quantitatively, as a numerical measure of the bending, usually given as an angle

refrangibility the disposition of a ray of light (*q.v.*) to refract (*q.v.*)

similar as in “Light is not similar” (Newton 1672b, p. 53): consisting entirely of parts all of the same sort; in this case, that light is not (generally) similar means that it (generally) consists of different sorts of simple rays (*q.v.*)

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

specie q.v. ‘in specie’

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