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Errata in various editions of Huygens' *Treatise on Light*

The list below is the result of my reading the 2005 Gutenberg HTML edition [1] of Huygens' *Treatise on Light* (*Traité de la Lumière*), noting any apparent inconsistencies, and checking them against other editions [2–4a]. The same "inconsistencies" appear in the Gutenberg EPUB version [1e], but with different page numbers. Needless to say, it is possible that some "inconsistencies" in [1] escaped my notice.

The 1912 edition [2], translated by Silvanus P. Thompson FRS, was simultaneously published by University of Chicago Press and subsequently republished in Britannica's *Great Books of the Western World*. Any errors in the text of [2] would presumably have propagated to [1] and should therefore appear on the list below. (Two accidents with the diagrams in [2], corrected in [1], are also listed.)

The partial 1900 edition [3] is apparently a more licentious translation. On p.35 of [3], the "plane surface bounding a transparent body extending in a direction between C and N" actually separates two transparent substances "which lie towards C and towards N" [2, p.36]. And on p.39 of [3], the so-called "angle of incidence" should be immediately identified as DAQ.

N.B.: What Huygens calls the "angle of incidence" is the *complement* of the angle that we now call by that name, and to which the "law of sines" is applicable. This point is not spelt out in the annotations to [1–3].

Page numbers in the list below, unless otherwise attributed, are those given in the right-hand margin of [1] and match those in [2]. Some items on the list are merely clarifications. Otherwise a reference number at the end of an erratum indicates that the correction is confirmed by that reference. If [2] is *not* cited, the error has propagated from or through [2]. If [3] is *not* cited, it does not cover the passage in question. Knowing little French vocabulary and no French grammar, I consulted the 1690 edition [4] only if the correction was not confirmed by any of [1–3], and then consulted the 1937 edition [4a] only if the correction was not confirmed by [4]. I can report that the initial publication chain was the source of at least four errors, one of which was corrected in [4a]. I can further report that, contrary to the impression that might be given by Thompson [1] in his "Note by the Translator", there are 12 places where Huygens uses *rayon* in the sense of "radius" and one place where he uses *rayons* in the sense of "radii". But in most places, including two on the list below, *rayon*/*rayons* means *ray*/*rays*.

***P.S.* (July 29, 2016):**

The corrections concerning evolutes and involutes (pp.124–127 on the list below) were made in response to Shapiro [5, pp. 232–236]. The *evolute* of a curve is the locus of its centers of curvature. The curve itself is an *involute* (or *evolvent*) of its evolute, and is traced by a point on a taut string which is unwound from the evolute without sliding along it — the straight portion of the "string"

being always the tangent of the evolute, and the normal (and radius of curvature) of each involute.* Thus the involutes are "*faite par l'evolution*" (made by the unrolling) or "*nées des evolutions*" (born of unrollings), which Thompson has unfortunately translated into (e.g.) "formed as the evolute" or "generated as evolutes", when in fact Huygens means *in*volutes. Furthermore, according to Shapiro [5, pp. 233n, 234n], Huygens' Latin term for the involute was "*descripta ex evolutione*". The French equivalent is apparently "*decrite par l'evolution*", which is used twice in the *Traité* [4, p.120] and is translated by Thompson as "described by [the] evolution" [1, p.124].

As the tangents to the evolute are the normals to the involutes, the evolute is the *envelope* of the normals — and this definition can be extended to surfaces, such as wavefronts. Which brings us to the point: A *caustic* is the envelope of the set of rays defined by a propagating wavefront. The successive wavefronts (or successive positions of the same wavefront), being normal to the rays, are normals to tangents to the caustic; that is, *the caustic is the common evolute of the wavefronts* (and, if the problem is reduced to two dimensions, e.g. by axial symmetry, *the wavefronts are the involutes of the caustic*). This matters because if the wavefronts, rather than the rays, have a physical existence, one must be able to define a caustic in terms of wavefronts and describe what happens to wavefronts where they meet a caustic. A further benefit is that if the wavefronts are the involutes of the caustic, the normal distance traveled by a wavefront gives the length of the associated portion of the caustic.

Errata in Reference [1]

p.23, par.1:	"inclined to AD" should be "inclined to AB" [3].
p.35, par.1:	"cuts the radii" should be "cuts the rays" [3].
p.39, par.1:	"angle BAD" should be "angle EAD" [2,3].
p.44, par.1:	"further from B than the point A" should be "further than B from the point A" [3].
p.49, par.1:	"the real Sun, which will be seen along the line AE" should be "the real Sun, which *would* be seen along the line AE" [4, p.45], i.e. if the atmosphere were not there.
p.54, Art.5:	"this Treatise" means the current chapter (cf. "the treatise on this Crystal" on p.92, par.3).
p.56, par.2:	"parallel to JK" should be "parallel to IK" [2].
p.60, Art.15:	"FR" should be "ER" [4, p.56].
p.62, Art.19:	"this Treatise" means the current chapter.
p.65, Art.24:	"not" should be omitted from "conjugate with respect to diameters which are not in the straight line AB." The point is that the diameters are conjugate *rather than perpendicular*. Neither I nor Google Translate can find a negative in the corresponding clauses in [4, p.61].
p.68:	In the 1912 edition [2], the point *k* at the left of the diagram has been cut off, and the line *Ci* should be extended to *t*.

p.69, bottom: "*rc*" should be "*r*C" [4, p.66].

p.74, par.3: "rectangle *g*DC" should be "rectangle *g*DG", i.e. the product of *g*D and DG [4, p.70].

p.79, par.1: "this Treatise" means the current chapter.

p.84, par.1: According to Huygens' usual terminology, "radius BC" should rather be "ray BC".

Chap. VI: In the original [4, pp.103,104], the first two diagrams appear closer together and later in the text; and they appear *again* on the following double-page spread, because they are referred to over several pages.

p.106: In the 1912 edition [2], the name of the point at the right-hand end of the diagram should be 'H' (but has been mostly cut off, so that it looks like an 'l').

p.108, par.2: The intended meaning, which may be clearer in the original [4, pp.104–5], is that AK is tangential to the curve at K, as confirmed near the bottom of the next page [2, p.109].

p.108, par.3: "passes along AL" should be "passes along AK" [4, p.105].

p.109, par.2: "cuts BD at N" should be "cuts BD at X" [2]. (And obviously "from-the centre" in [1] and "from he centre" in [2] should be "from the centre".)

p.113, par.1: "3 to 2" should be "2 to 3". (This error was introduced in the initial publication chain [4, p.109]. The ratio, which is the reciprocal of the eccentricity of a hyperbola, should be the inverse of the ratio given in the corresponding place on the previous page [4, p.108], which is the reciprocal of the eccentricity of an ellipse.)

p.116, par.1: "excess of BD over DG" should be "excess of BD over BG". (This error also comes from the initial publication chain [4, p.112] and can be confirmed only by following the argument.)

p.122, par.3: "arc BC" should be "arc BP", unless the illegible symbol to the left of 'P' in the diagram [1, p.121; 4, p.118] is a 'C'.

p.124: "curved line formed as the evolute" should be "curved line, the involute"; "others described by the evolution of" means "other involutes of"; and "to have been described by evolution from" means "to be the involute of".

p.125, par.1: "SK or DV" should be "SK or FV", and "wave ED" should be "wave AD". (Again the errors have propagated from the initial publication [4, pp.121–2]. The first is corrected in the 1937 edition [4a, p.536]; the second can be confirmed only by following the argument.)

pp.125–6: The paragraph crossing the page break should read (e.g.): ...from thence they fold back and are composed of two contiguous parts, one being an involute of the curve ENC in one sense, and the other the involute of the same curve in the opposite sense. Thus the wave KE, while advancing toward the meeting place becomes *abc*, whereof the part *ab* is the

involute of *b*C, a portion of the curve ENC, while the end C remains attached; and the part *bc* is the involute of the portion *b*E while the end E remains attached. Consequently the same wave becomes *def*, then *ghk*, and finally CY, from whence it subsequently spreads without any fold, but always along curved lines which are involutes of the curve ENC, extended by some straight line...

p.127, par.2: "generated as evolutes" should be "involutes".

References

[1] Huygens (translated by S.P. Thompson, 1912), *Treatise on Light*, Project Gutenberg, 2005, gutenberg.org/files/14725/14725-h/14725-h.htm.

[1e] Huygens (translated by S.P. Thompson, 1912), *Treatise on Light*, Project Gutenberg, 2005, t.co/dv8JZxuRtu (EPUB).

[2] Huygens (translated by S.P. Thompson), *Treatise on Light*, London: Macmillan, 1912; archive.org/details/treatiseonlight031310mbp.

[3] Huygens (translated by H. Crew?), *Treatise on Light*, Chapters I to III, t.co/NUZWwGjhqA; in H. Crew (ed.), *The Wave Theory of Light: Memoirs by Huygens, Young and Fresnel* [Vol. X in J.S. Ames (ed.), *Scientific Memoirs*], American Book Company, 1900, t.co/daG5eyCAza, pp. 1–41.

[4] Huygens, *Traité de la Lumière*, Leiden: Pieter van der Aa, 1690; archive.org/details/bub_gb_kVxsaYdZaaoC.

[4a] Huygens, *Traité de la Lumière*, in *Oeuvres Complètes de Christiaan Huygens*, The Hague: Nijhoff, 1937, Tome XIX, t.co/ftoxMulcZq, pp. 451–537.

[5] A.E. Shapiro, "Kinematic Optics: A Study of the Wave Theory of Light in the Seventeenth Century", *Archive for History of Exact Sciences*, vol.11, no.2/3 (December 1973), pp.134–266.

* When I read Thompson's translation of the *Treatise*, I was familiar with the term *involute* (as in "involute gears") but not the term *evolute*. Hence I inferred from the context that *evolute* was an alternative term for *involute* — and a more logical one, because the prefix *e* means *out*. But in fact the "more logical" alternative term for *involute* is *evolvent*, which means "unrolling", and the evolute is what it unrolls *from*!

[Last modified September 23, 2019.]

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