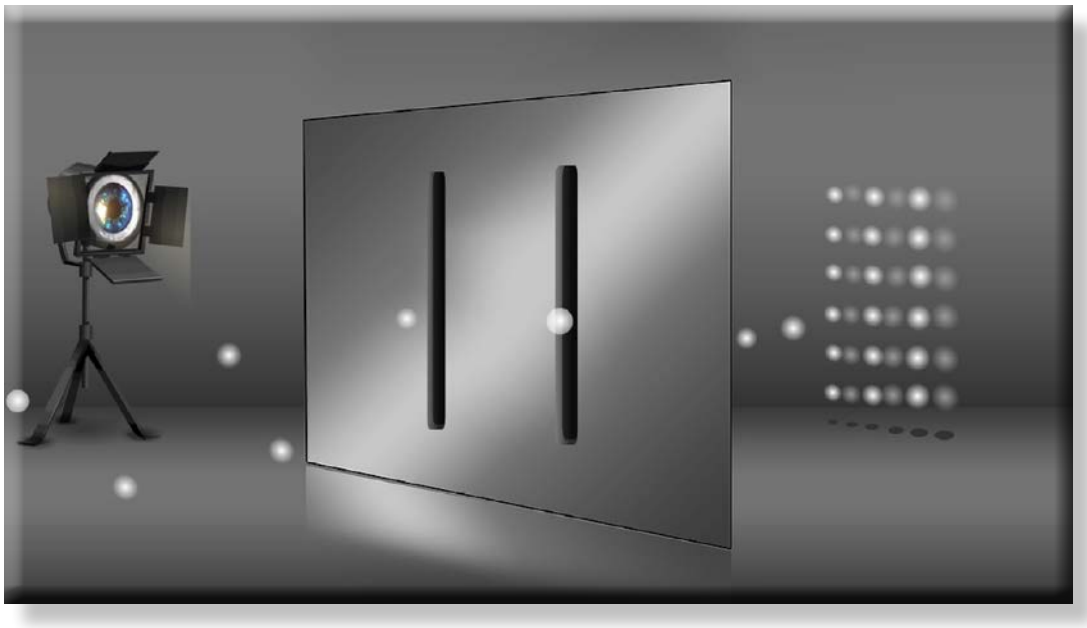
The Double-Slit Experiment

by Robert McKnight, DSPE

***Editor's note*:** Our previous *Telicom* issue sadly announced that our good friend, Robert McKnight, passed away earlier this year. What follows is the last article Robert sent in for *Telicom*, which he specifically stated was to appear in the 4th-quarter 2022 issue. *Telicom* will sorely miss the intellectually stimulating contributions Robert regularly provided for so many years.



In 1801, Thomas Young first performed *the double-slit experiment* in which a beam of light was shone on a wall which had two slits cut in it.[1] When the light reached a screen behind the wall, an interference pattern resulted. This result was taken to mean that light was a wave.

Centuries later, when a detector was placed by the slits to record which slit the light passed through, the interference pattern did not occur. (It was believed that the detector was positioned in such a way as to not affect the result of the experiment.) The absence of the interference pattern was taken to mean that light was a stream of particles.

Given these two seemingly contradictory results, physicists have claimed that light is *both* a wave *and* a particle. Some call it a *wavicle*. This essay attempts to refute that conclusion, claiming, instead, that light must be *neither* a wave *nor* a particle. The argument for this essay's claim depends only upon the rules of *propositional logic* and does not dispute the conduct of the experiments.

In what follows, the first experiment will be called Test 1: the test during which the interference pattern was observed. The latter experiment will be called Test 2: the test during which the interference pattern was not observed.

In Table A, three results are shown. The first row in the table shows the results that occurred when actual light was tested. The second and third rows display the hypothetical results that should occur if first an ideal wave and then an ideal particle were to be tested. These results are just what we would expect; that is, a wave produces an interference pattern, and a particle does not.

In the table, the existence of an interference pattern is indicated as "INT." The absence of an interference is indicated as "~INT."

	Test 1	Test 2
Light	INT	~INT
Ideal Wave	INT	INT
Ideal Particle	~INT	~INT

Table A

The conclusions drawn from Table A by the physicists are as follows.

Conclusion 1:
Light is a wave because it produces an interference pattern in Test 1.

Conclusion 2:
Light is a particle because it produces no interference pattern in Test 2.

These conclusions could be drawn only with the following assumptions.

Assumption 1:
A wave is the only entity that can produce an interference pattern during Test 1. That is, INT implies *wave* in Test 1.

Assumption 2:
A particle is the only entity that does not produce an interference pattern during Test 2. That is, ~INT implies *particle* in Test 2.

As far as I know, neither assumption 1 nor 2 has ever been proven. If proofs of assumptions 1 and 2 were attempted, the analysts could not include the *wavicle* as an entity having the desired attributes, since its existence is what is to be proven.

Two other conclusions exist that can be drawn from Table A.

Conclusion 3:
Light is not a wave because it produces no interference pattern in Test 2.

Conclusion 4:
Light is not a particle because it produces an interference pattern in Test 1.

These conclusions can be drawn if the following assumptions are made.

Assumption 3:
If no interference pattern results in Test 2, then the tested entity is not a wave. That is, ~INT implies a non-wave. But, according to the *axiom of replacement* of propositional logic, called *transportation*, "~INT implies non-wave" is equivalent to "wave implies INT" in Test 2 (and elsewhere).[2]

Assumption 4:
If an interference pattern results in Test 1, then the tested entity is a non-particle. That is, INT implies non-particle. But, again, the *axiom of transportation* states that "INT implies non-particle" is equivalent to "particle implies ~INT" in Test 1 (and elsewhere).

Assumptions 3 and 4 are obviously true and require no proofs—unlike assumptions 1 and 2. Assumptions 1 and 2 would appear to be difficult (or impossible) to prove, since no proofs have been offered. Therefore, the sensical final conclusion is that no proof that light is both a wave and a particle exists. However, there is a proof that light is *neither* a wave *nor* a particle, as demonstrated in this essay.

NOTES

1. Urbasi Sinha, "Quantum Slits Open New Doors," *Scientific American* (January 1, 2020), 56–63, https://www.scientificamerican.com/article/quantum-slits-open-new-doors/.

2. Patrick J. Hurley, *A Concise Introduction to Logic*, 3rd ed (Belmont, CA: Wadsworth Publishing Company, 1988). Ω