## Physics Integration Lesson 23 – Do Opposites Meet?

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Ecclesiastes 3 gained the attention of popular culture in the Byrd's anti-war song, *Turn! Turn! Turn!* "To everything there is a season" is followed by a series of opposites: birth/death, kill/heal, destroy/build, weep/laugh, love/hate and war/peace. This use of opposites is a way to classify and categorize, which is useful from philosophy to physics. In his *Physics I*, Aristotle calls this the principle of the contrary. His first principle defines what exists and then the second principle defines its absence (e.g. Black/White, Hot/Cold and Motion/Stationary).

Contraries show up several ways in this week's lab. After directing a laser through a double-slit slide, a pattern is generated on a screen that consists of regions where laser light is visible separated by regions where it is absent. This observation is explain by the concept of interference. Monochromatic light coming from two or more sources combine in phase (wave crests align) to generate a bright patch of light, which we call constructive interference. If the light is out of phase (wave crest aligns with a trough), no light is seen and we call this destructive interference.

Prior to Young's double-slit interference experiment (1801), light was believed to consist of corpuscles, or particles, as promoted in Newton's *Opticks* (1704). Physical events consist of the movement of material points that have inner qualities of inertia, translation and force. Since points are located at a specific location in space and time, their interaction with other points is through forces that act at a distance with no physicality between them, like the gravitational interaction between the earth and the moon. Contrary to this position is the wave theory of light held by Newton's contemporaries, Hooke and Huygens. If light is a wave, then it extends everywhere through a continuous medium, the exact opposite of a point.

Young's experiment settled the matter that light was a wave. Developments in electromagnetic theory, which culminated in Maxwell's electromagnetic wave equation (1861), provided the theoretical basis for the wave nature of light. However, between 1900 and 1925, this iron-clad evidence was breached by the work of Planck, Bohr, Einstein and Heisenberg, whose contributions established the foundations of quantum mechanics. In this theory, matter and light are simultaneously particles and waves. The contrary principle of Aristotle, which defined observations as being composed of either something or its opposite, had its own opposite, which states that observations are composed of **both** something **and** its opposite.

- 1. Since the word 'edify' is not used in common language, it is often treated as a churchy word. (It is interesting how words come in and out of common usage or shift their meaning.) A form of this word is edifice, which means an imposing building or structure. When light combines in phase, we say it edifies or builds itself up. The result is a patch of light that is more intense than the light coming through each individual opening of the double-slit slide. Where in the Bible is the word edify used? What is its context and would this experiment be an appropriate illustration of this principle? (If your version of scripture doesn't use this word, do a search on the internet. There are some versions that use the word edify.)
- 2. With the development of quantum mechanics, some philosophers began to reject the principle of non-contradiction, which is considered foundational to logic. Ironically, non-contradiction is also introduced by Aristotle in *Metaphysics IV*. Adherents of philosophical contradiction feel

that stating something as either right or wrong (true or false) is too simplistic. Truth and morality must be considered as a continuum between right and wrong. This view is held by forms of Buddhism. How would you respond to someone who disputes the existence of the principle of non-contradiction? What examples would you give them? (If you have difficulty with this question, do a search on Ravi Zacharias, a Christian apologist and evangelist.)