Physics Integration Lesson 5 – Universality of Gravity

S. Gollmer (2020)

Years ago I attended a workshop on "critical thinking" led by a university professor of evolutionary biology. He, as well as others, have studied students' attitudes towards evolutionary theory by giving entrance and exit surveys to students in their biology classes. He was perplexed that, in spite of spending considerable time explaining the scientific evidence and value of evolution, his students were essentially unchanged in their attitudes towards this theory. In the workshop he presented techniques of critical thinking to help students move beyond their preconceived bias against evolutionary theory. One statement he made was particularly troubling to me and I discussed it with him during a break. His statement was: "Evolution is a better proven theory than that of gravity." When confronted about this statement, he responded thus: "Gravity is just an observation and has no need of proof. However, evolution is proven through multiple avenues of reason. Therefore, it is a better proven theory than that of gravity." Is this man correct or is there more to our understanding of gravity?

During the time of Aristotle gravity was known as a falling tendency and that heavy objects fell faster than lighter ones. It was not until ~1590 that Galileo proved in *On Motion* that all objects fall at the same rate. Nearly a century later Isaac Newton proposed that an object orbiting near the earth's surface experiences a centripetal acceleration of 32 ft/s^2 (9.8 m/s²). Comparing this to the centripetal acceleration of the moon as it orbits the earth, he was able to verify that gravity is proportional to the inverse square of the distance between two masses (gravity $\propto 1/r^2$). Although he was troubled that two objects could interact at a distance with no means of conveying the force, he was convinced that gravity existed and that it obeyed the law he proposed. This view of gravity persisted until 1915, when Einstein published his general theory of relativity. This theory was validated four years later when gravitational bending of light was observed near the sun during a solar eclipse. So strong is the confirmation of Newton's law of gravity and Einstein's refinement of it, that astronomers and cosmologists formulate all of their theories based on the assumption that gravity as observed on earth applies universally to the entire cosmos.

- 1. Given the history of our understanding of gravity, do you feel it is just an observed phenomena or is it something that has been proven? How did you come to your conclusion?
- 2. Although evolution defined as biological "change over time" has been observed among organisms on the time scale of days for bacteria and centuries for mammals, Darwin's proposal of all organisms arising from a common ancestor eons ago is the evolutionary concept that all "critically thinking" people should accept. Do you feel this macro theory of evolution is "better proven than gravity?" Why?