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Extended Abstract

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Photodynamics: How massive photons, gravitons, gluons and neutrinos manage to travel at the speed of light

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Our present understanding of how particles travel at the speed of light is all wrong. This is particularly apparent when the experimental facts of neutrino oscillation have to be denied to preserve our present understanding of relativity. Massive neutrinos do travel at the speed of light. The experimental facts are correct. The theory is wrong. The source of the problem is the unjustified application of E=mc2 to particles that travel at the speed of light. We first provide a rigorous proof that E=mc2 and its associated energy momentum theorem do not apply to any particle that travels at the speed of light. This means that relativity; the foundation of modern physics does not and has never possessed a valid relativistic dynamics for such particles. To remedy this shortcoming we derive the laws of photodynamics whose equations are similar to but different from the Einstein equations in important respects. We use photodynamics to resolve three outstanding problems in physics: in relativity, the motion of massive particles at the speed of light; in cosmology, how cooling CMB photons lose energy for 13.8 billion years without slowing down; in neutrino astrophysics, neutrino oscillation at the speed of light. Along the way, we correct historical misconceptions like the "fact" that photons have a zero rest mass and can only travel at the speed of light. The exact opposite is the case. In fact, all particles must have mass in order to exist. We also describe the exciting new property of self-propulsion, akin to rocket propulsion in space, wherein a particle like a photon consumes its internal energy in order to generate an internal force which accelerates it in the direction of flight until all its energy has been consumed and it has attained the speed of light.

As the best known particle in its class, we use photons to develop Photodynamics, but it applies to all particles that travel at the speed of light. The photon is the most abundant and readily available elementary particle we know, and yet it is arguably still the most mysterious and ill understood. We do know that it has a frequency ω0 w0 ,η, an energy either aligned or anti-aligned withηand an angular momentum its direction of motion. On the other hand, there are a number of troubling, unanswered questions, and inconsistencies with our present understanding of the photon. Let us list a few of these. Most particles can travel at different speeds, but the photon cannot. Why? How can a photon go from zero to the speed of light when a flashlight is turned on without going at any speed in between? Using E = mc2 a photon is seen w0 and travels at the speed of light.ηto have a constant mass 2 m c = Why can't atomic particles with the same constant mass go at the speed of light? The energy of most particles depends on their speeds, but the photon's energy does not. Why? A photon can lose energy for 13.8 billion years and keep going at the speed of light (CMBR) [1-3]. Why? What causes the photon to travel at the speed of light, and what is the physical mechanism which prevents the photon from going faster than the speed of w0 . What is revolving at angular frequencyηlight? The photon's energy is w0 ? What determines the direction of flight? Why is the photon's angular momentum either aligned or anti-aligned with its flight axis? If something is indeed revolving, how far is it from the axis of rotation? What is its orbital speed? Why is it revolving at that distance from the axis, and at that speed, rather than at a different distance and speed? In the area of neutrino astrophysics, neutrinos have been shown to undergo flavour oscillation while traveling at the speed of light. Neutrino oscillation cannot happen unless neutrinos have a non-zero rest mass as recently highlighted by the 2015 Nobel Prize in physics. How is this possible using E = mc2 ? The plan of the paper is as follows: We begin with neutrino oscillation and its conflict with relativity, in particular E = mc2 .

This leads us to examine the validity of using E = mc2 for particles, like the neutrino, that travel at the speed of light. We prove that E = mc2 and its associated energy-momentum theorem do not apply to any particle that travels at the speed of light, and that, consequently, relativity is incomplete. As presently formulated, it does not possess valid dynamics for particles that travel at the speed of light. This is an unexpected shortcoming of enormous importance. The Universe is composed of only two types of particles, those that can and those that cannot travel at the speed of light, and we don't know the laws that govern the motion of half these particles by type, and the vast majority numerically! To solve this problem we derive the laws of Photodynamics. These laws not only provide the missing dynamics, but also reveal that particles like the photon possess exciting new properties, one of which is self-propulsion. We use self-propulsion to explain how CMB photons lose energy for 13.8 billion years without slowing down. We then examine the origin of the photon's angular momentum and angular frequency, summarize our findings, and offer concluding remarks

Bottom Note: *This work is partly presented at 4th International Conference on Astrophysics and Particle Physics*, December 03-05, 2018, Chicago, USA