OFFICIAL ABSTRACT and CERTIFICATION

Developing Algorithmic Machinery to Explore the Cosmological Horizon Problem by Numerically Solving Maxwell's Equations in the Kasner Metric

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The Horizon Problem posits the cosmological question: if the early universe was not homogenous to begin with, and information cannot travel faster than the speed of light, how could the Cosmic Microwave Background (CMB) be at such a uniform temperature everywhere? The Mixmaster model of the universe posits that the early universe churned to evenly distribute matter and radiation, exhibiting repeated chaotic, oscillating Kasner epochs alternating between an expanding and contracting universe at different rates in different directions. Unlike prior studies involving the Kasner metric, this study modeled light as a wave rather than rays, allowing it to retain significant physical properties. The purpose of this study was to numerically find electromagnetic wave speed from the physically interesting Kasner case, in order to model early universe light behavior. Algorithms in Wolfram Mathematica were written to numerically solve Maxwell's equations in this metric for propagation speed, as there is no known analytical solution. To test this simulation program, the light-ray expectation of the velocity of the models was compared to results produced by waves, demonstrating successful development of a calculation tool to gain insight into the Horizon Problem. Numerically determined results from a light-wave model matched those of a ray, while algorithms were developed to address improperly orthonormalized functions that present a contaminating standing wave. As expected, results support the hypothesis: numerically determined wave speeds match those produced by ray tracing, suggesting that a calculation tool has been developed in order to explore further Kasner cases in a non-vacuum universe.

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