Longitudinal Energy Waves in the Propagation Mechanism of Electromagnetic Waves

### Introduction

Electromagnetic waves are typically regarded as transverse, propagating without the need for a medium. However, their finite speed of propagation raises a fundamental question: what happens to energy in space during wave propagation? If energy cannot change instantaneously, then at some point in space, an energy gradient must form. If this is true, then it is logical to assume that electromagnetic waves generate not only transverse but also longitudinal energy oscillations.

### Energy Gradient and Its Consequences

When an electromagnetic wave leaves its source, it alters the energy density in the surrounding space. As the wave propagates, the energy at the source returns to its original value, but at a distance R, the energy remains altered. This means that between these two points, an energy gradient exists, which can propagate as a longitudinal wave. Classical physics does not account for such a phenomenon, but that does not mean it does not exist. Instead, its effects might be too subtle to detect directly.

Put differently, space, initially uniform in its energy distribution, becomes non-uniform after a wave passes. If energy redistributes itself, then a process akin to longitudinal oscillations must be taking place.

### Connection to de Broglie’s Hypothesis

De Broglie proposed that particles exhibit wave-like properties but did not specify a mechanism for their formation. If a standing wave indeed forms the basis of an elementary particle, then one must ask: what exactly generates this wave? If electromagnetic waves induce longitudinal energy oscillations, these oscillations might stabilize the standing wave, thereby forming a particle. Thus, a particle may not be just an abstract probability wave but a real structure in space governed by wave processes.

### Conclusion

Electromagnetic waves are traditionally viewed as purely transverse. However, from the perspective of energy density variation, it becomes clear that transverse oscillations cannot exist in isolation. They inevitably induce longitudinal energy redistribution, opening new avenues for understanding physical processes. Longitudinal energy waves may help explain not only wave propagation but also particle structure and some currently unexplained phenomena. This does not require a revision of established physics but offers a fresh perspective on well-known processes.