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Is Faster-Than-c Light Possible?

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ABSTRACT

A gedanken experiment purporting to show that light can travel faster than c is examined. The experiment is shown to entail a violation of the uncertainty principle.

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Scharnhorst has recently claimed that light propagating between cold conducting (Casimir) plates will travel faster than c.[1] Barton subsequently gave another, somewhat more intuitive derivation of the same result.[2] The magnitude of the purported effect is small but its sign is very striking,

$$\frac{\Delta c}{c} = +\xi^{-1}(mL)^{-4}, \tag{1}$$

where m is the electron mass, L is the distance between the plates, $\xi = 8100/(11\pi^2\alpha^2)$ $\sim 10^6$, and $\hbar = c = 1$. The purely QED calculation assumes explicitly that $mL \gg 1$, and that the frequency of the light, ω, is small compared to the electron mass,

$$\omega \ll m. \tag{2}$$

In order to establish that the calculation relates to a real effect, one must show that it is possible, at least in principle, to set up an experiment where this effect can be measured. When formulating such a gedanken experiment it is extremely important to make sure that no relevant physical principles are violated. In the experiment proposed by Scharnhorst, an emitter and an absorber (e.g. atoms) are placed at least a few Compton wavelengths from opposite Casimir plates so that the light never comes in direct contact with the conductors.

Equation (1) applies only to light traveling in the normal (and not the parallel) direction. Thus, the net reduction in travel time from emitter to absorber is always bounded by

$$\Delta t < \xi^{-1}(mL)^{-4}L. \tag{3}$$

The calculation leading to equation (1) makes strong use of quantum mechanics (vacuum fluctuations). The gedanken experiment must therefore not violate any quantum-mechanical principles including, of course, the uncertainty principle. Since the times of emission and adsorbtion must be measured with accuracy greater

than (3), the uncertainty in the frequency of the light is

$$\Delta\omega \gtrsim \xi(mL)^3 m. \tag{4}$$

This violates the explicit assumption (2). The proposed gedanken experiment is therefore inconsistent with the uncertainty principle. It would appear that "faster-than-c light" is an artifact of a particular mathematical description of the Casimir plates and not a real physical effect.

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REFERENCES

1. K. Scharnhorst, *Phys. Lett.* **B236**, 354 (1990).

2. G. Barton, *Phys. Lett.* **B237**, 559 (1990).