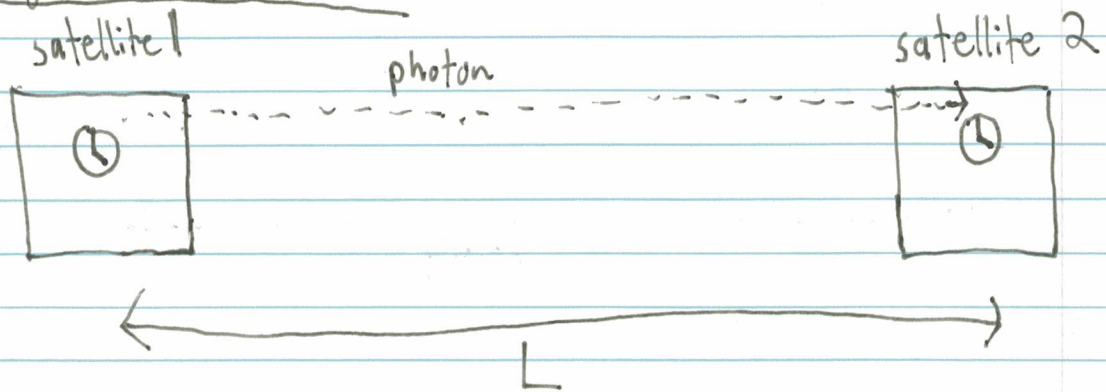


Introduction to EM Wave Propagation in Free Space

Thought experiment



1. Two satellites are in space, separated by a large distance L . We do not know L and would like to measure it.

2. For simplicity, we assume that there is a perfect vacuum.

3. The two satellites carry perfectly synchronized clocks and are both at rest in the same inertial frame.

4. We propose the following scheme to measure L :

A. satellite 1 sends a single photon toward satellite at time t_1 .

B. satellite 2 receives and detects this signal at time t_2 .

C. assuming that these times t_1 and t_2 were measured with perfect accuracy, we can infer:
 c is speed of light $\leftarrow L = c(t_2 - t_1)$

How well does this scheme work?

- There will be some quantum uncertainty in when photon emitted. Let us assume that this is negligibly small.
- The scheme could work extremely well if the photon corresponded to a plane wave.
- Realistically, perfect plane waves cannot be produced.
- The transverse shape of the photon's wave packet results in the photon's longitudinal (along the baseline) speed being a bit less than c .
- We will build up a quantitative understanding of this and other related effects.