Measuring the one-way speed of light

Gabriel-Claudiu Grama

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I. Abstract

In this article, we present a method for measuring the one-way speed of light, for both flat (euclidean) and curved space (non-euclidean), with subtle differences in approach. So far, there is no solution for measuring the one-way speed of light, but there is for the two-way speed of light, where, in essence, only a mirror is used to reflect light back to where the light began it's journey, assuming that the speed of light is equal in all directions (which may not be true, according to Einstein).

II. Keywords

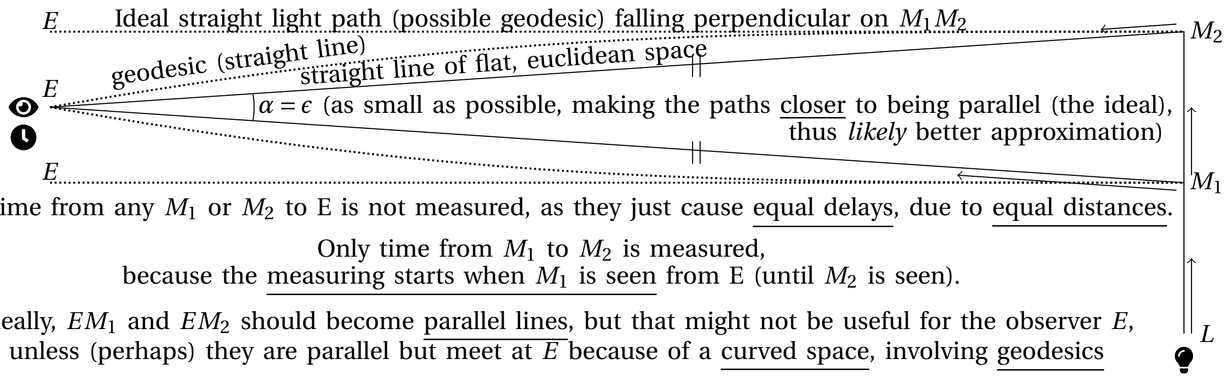
Measure speed light Euclid space geodesic

III. Introduction

So far, only the two-way speed of light, is known how to be measured, relying on Einstein's Synchronisation Convention [1], which assumes that the speed of light is not dependant on direction: in essence, just using a mirror to reflect light back to where the light began it's journey (where also the clock is) is enough to measure the two-way speed of light. This means that the speed of light might change (but we just don't know), the more we change the angle α (continuous change, or sudden, but the continuous version seems more natural). In other words, the function $f_{(\alpha)}$, which outputs the speed of light, may be constant or not. In our article we either assume that the speed of light does not change discontinuously, but continuously, with continuous change of direction, or we assume a curved (non-euclidean) space (where we don't care about α). In this article, we propose a method for measuring the one-way speed of light. If, in reality, $f_{(\alpha)}$ is continuous, then the presented method is measuring the one way speed of light, but if $f_{(\alpha)}$ is not continuous, then it may, at least, detect eventual differences.

IV. Methodology

We propose using two mirrors $M1$ and $M2$, collinear with the departure location of light L, the first mirror $M1$ being a two-way mirror, both mirrors reflecting light to the destination E (the observer), forming an isosceles triangle with a very small angle α at the destination (parallel paths desired). The observer is located on a line that falls perpendicular in the middle of the mirrors. The measurement begins when the light, reflected by the first mirror $M1$, arrives at the observer E, until the light reflected by the second mirror $M1$ arrives at E, thus measuring the time light needed to travel from the first mirror $M1$ to the second mirror $M2$.



In the above figure, we have:

- L - where the light begins it's journey.
- M_1 - the first mirror, which, at least virtually or analogously, is a two-way mirror (or two-way glass), reflecting and letting light pass through
- M_2 - the second mirror (a normal mirror)
- E - destination of the light, where the only clock is.
- distance(E, M_1) = distance(E, M_2)
- α needs to be as small as possible. Ideally, the two lines defining α should, in staid, be parallel (geodesics), and meet at E thanks to a curved space (assuming that the two parallel geodesics, have the same direction).

The speed of light is measured from M_1 to M_2, by observing from E, how much time it takes for light to reach M_2 from M_1 (this means that the time it takes for light to travel from any M_1 or M_2 to E is not measured). If EM_1 and EM_2 are parallel, then they have the exact same direction, thus the exact same properties: no need to worry that the speed of light depends on direction. But if they are almost parallel, forming the angle α, it's a reasonable and better assumption to say that they have almost the same properties as their parallel versions (better than assuming that light has the same speed in all directions). And if the properties are vastly different, then it might be detectable.

Note that L only exists for simplicity. $M1$ and $M2$ can be two things blocking, at command, the light of two different stars (for geodesics: the light can pass the sun, on opposite sides, during an eclipse).

V. Results

We presented a way to measure the one-way speed of light, relying on geodesics, or a lighter assumption (less risk).

References

[1] A. Einstein, "Zur elektrodynamik bewegter körper," *Annalen der Physik*, vol. 322, no. 10, pp. 891–921, 1905. [Online]. Available: https://onlinelibrary.wiley.com/doi/abs/10.1002/andp.19053221004