Differential Geometry (and Relativity) - Summer 2014

Homework 6, Sections II.2, II.4, and II.5

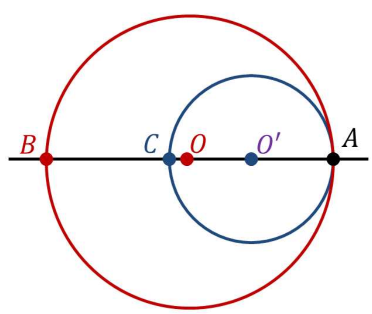
Due Wednesday, June 29 at 11:20

Write in complete sentences!!! *Explain* what you are doing and convince me that you understand what you are doing and why.

II.2.3(a). In the Michelson-Morley experiment, $L_1 = L_2 = 11$ m, and the light used had a wavelength $\lambda \approx 5.8 \times 10^{-7}$ m. The period T of this light, given by $T = \lambda/c$, is approximately 2×10^{-15} sec. Let $N = (\Delta t - \Delta t')/T$, the number of periods contained in the change in time delay. Assuming the Earth's speed through the ether is 3×10^4 m/sec, verify that $N \approx 0.37$ (on the basis of the ether theory), i.e., the interference pattern should shift by 37% of the distance between consecutive bands. HINT: Use Exercise II.2.2, which is worked in the class notes.

II.4.1. Draw the counterparts of Figures II-4 and II.5 for the case in which O' sees the lightening flashes simultaneously.

II.4.4. Suppose observer O' is moving to the right with constant speed v relative to observer O. Let us assume that at the very instant O and O' pass each other, rays of light proceed in all directions from the place where they pass. O will observe a spherical light wave front moving away from him with velocity c. After t seconds, the light will have reached all points at distance ct from him. According to O, at the instant the light has reached point A (see the figure below), it has also reached point B. On the other hand, by Postulate 1, observer O' may consider herself at rest and O as moving. By Postulate 2, she will also observe a spherical wave, distance ct from her t seconds after O passes her. However, as the light travels to A, O' has moved a short distance to the right of O, so that the spherical wave front O' observes is not concentric with the one observed by O. Therefore, in the view of O', at the instant the light has reached A, it has also reached (not B yet, but) C. They cannot both be right, and yet Einstein's postulates imply they are. Resolve this apparent paradox.



II.5.2. As pointed out in this section, when we see an object at a particular moment, light rays reaching our eyes from the most distant parts of the object must have left the object earlier than rays from the nearer parts, since all these rays enter our eyes at the same instant. Suppose the object we are seeing is a very long train approaching us at a substantial fraction of the speed of light. Would its (seen) length appear longer or shorter than if the train were seen at rest? Explain. (By qualitative only.)