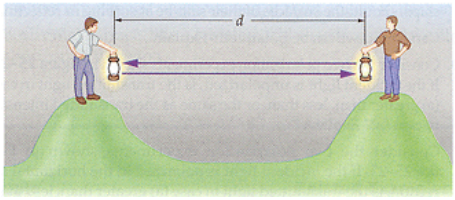
L02 – The Speed of Light

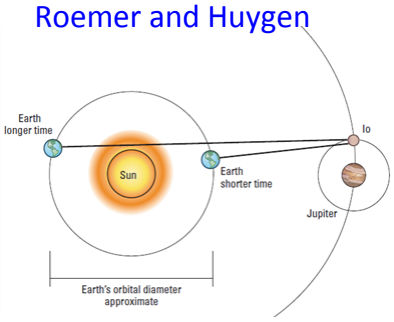
Physics 30 – What is EMR?
Unit: Electromagnetic Radiation
Objective:

- Explain, qualitatively, various methods of measuring the speed of EMR
- Calculate the speed of EMR, given data from a Michelson-type experiment

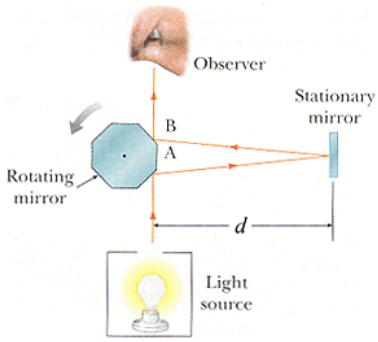
Galileo



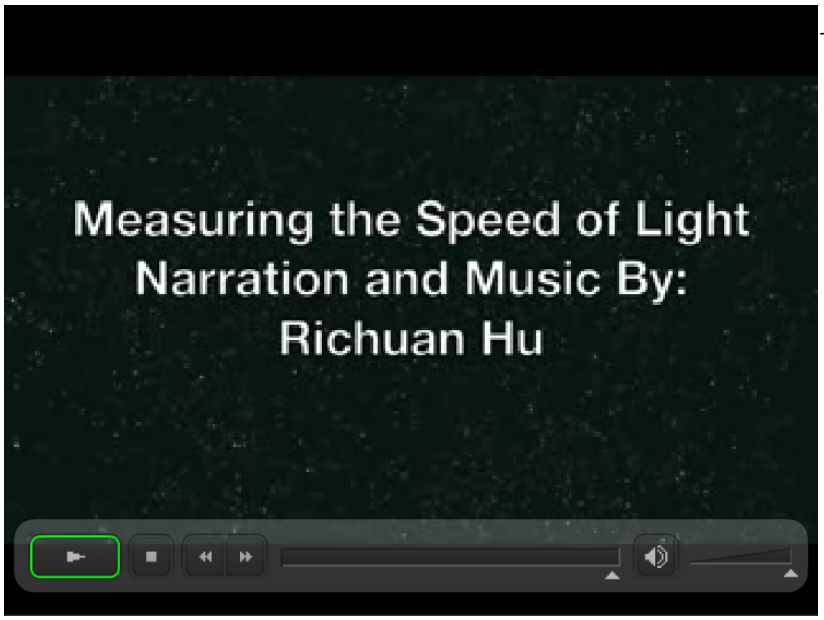
Roemer and Huygen



Michelson



Measuring the Speed of Light in History



Covers...	Does not cover...
Galileo	Michelson
Roemer	
Fizeau	
Foucault	

The Speed of Light - Galileo

Galileo's Experiment:

On the tops of two hills, Galileo would uncover one lamp and then his assistance would uncover another lamp and Galileo would time the event with his pulse.

How long would it take for light to travel 2 km?

$c = 3.0 \times 10^8 \text{ m/s}$

$d = 2000 \text{ m}$

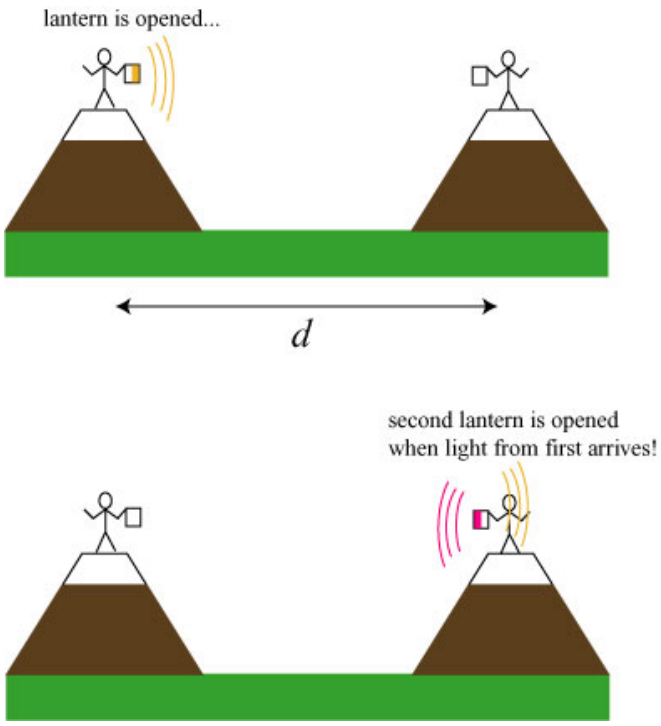
$t = ?$

$v = \frac{d}{t}$

$t = \frac{d}{v} = \frac{2000}{3.0 \times 10^8}$

$t = 6.\bar{6} \times 10^{-6} \text{ s}$

$= 6.\bar{6} \mu\text{s}$

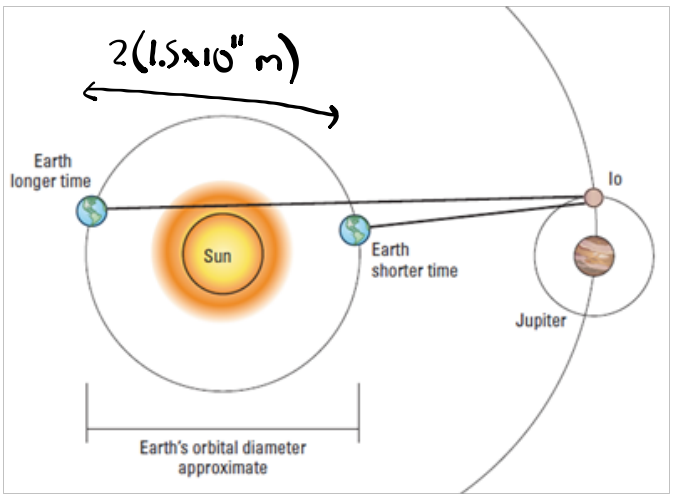


The Speed of Light - Romer and Huygen

Romer and Huygens Experiment:

- Romer knew that Io orbited Jupiter every 42.5 hours.
- Io appeared 22 minutes later when Earth was on the far side of the sun.
- Earth's orbital radius is approximately 1.50 x 10^{11} m.

What is the speed of light?



$d = 3.0 \times 10^{11} \text{ m}$

$t = 1320 \text{ s}$

$v = \frac{d}{t} = \frac{3.0 \times 10^{11}}{1320} = 2.27 \times 10^8 \text{ m/s}$

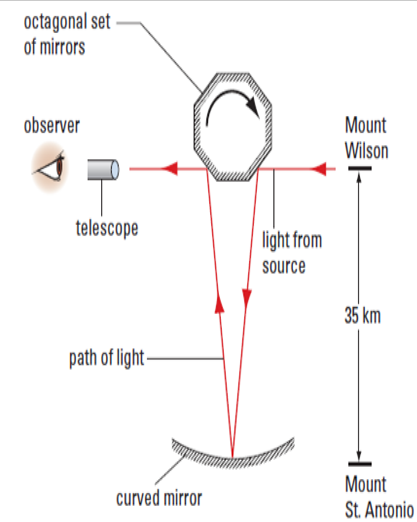
The Speed of Light - Michelson

http://www.crodog.org/animate/fanimate.html

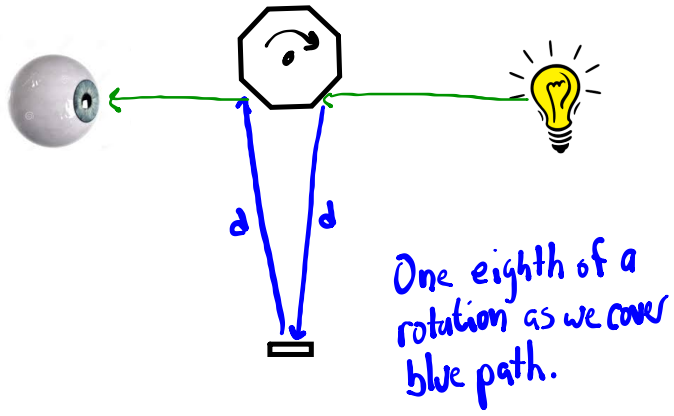
Michelson's Experiment:

- Used rotating mirrors to calculate time incredibly accurately.
- The set of rotating mirrors in Michelson's experiment was rotating at 533 Hz.
- The curved mirror was located 35.0 km away.

Show how Michelson determined the speed of light from these data.



▲ **Figure 13.24** Michelson's experimental apparatus to measure the speed of light



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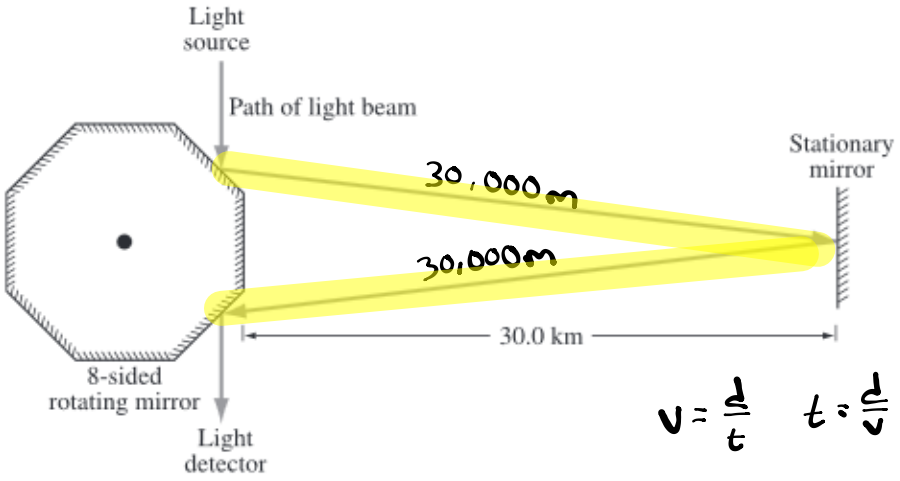
Use the following information to answer the next question.

In a Michelson-type experiment, the path followed by a beam of light when the 8-sided mirror is at rest is as shown below. The detector indicates a maximum signal.

As the 8-sided mirror begins to rotate, the beam of light no longer follows this path, and the detector indicates a decreased signal.



Note: This diagram is **not** drawn to scale.

$v = \frac{d}{t}$ $t = \frac{d}{v} = \frac{60{,}000\ m}{3.0 \times 10^8\ m/s}$

$t = 0.0002\ s$ for 1/8th of a rotation.

23. Once the 8-sided mirror is rotating, the frequency of rotation for which the detector will first indicate a maximum signal is

(A.) 6.25×10^2 revolutions per second
B. 1.25×10^3 revolutions per second
C. 5.00×10^3 revolutions per second
D. 1.00×10^4 revolutions per second

$T = 8(0.0002)$
$T = 0.0016\ s$

$f = \frac{1}{T} = \frac{1}{0.0016} = 625\ Hz$