PHY151 – Practical Session 2
Mini-presentation

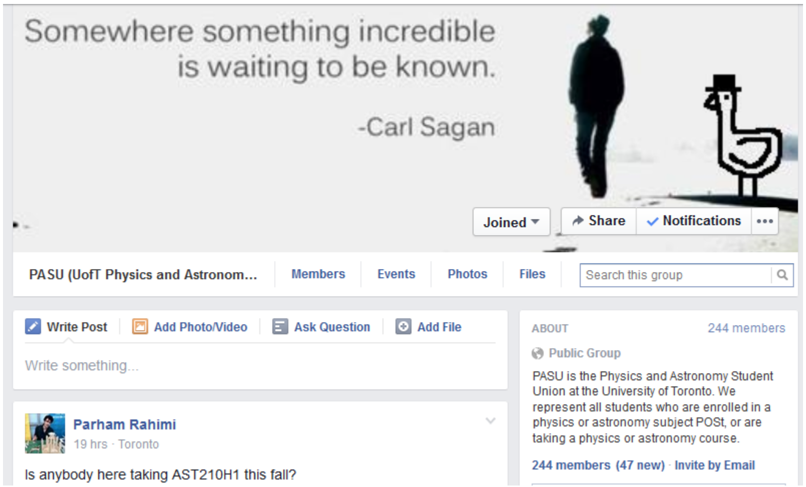
- “Belonging” in Physics, and doing well going forward
- Special Relativity

You were asked…

- Recommendations for a student who has no friends in physics, and who feels lonely and isolated, or excluded.
- Recommendations for a student who did not understand Problem Set 1, or who is having trouble following lecture derivations, etc, feeling overwhelmed.

PASU = Physics and Astronomy Student Union

- PASU is in MP217 – you are **all** welcome!
- There is a facebook page:
- https://www.facebook.com/groups/pasu.physics/



Feeling Excluded: Thoughts from upper-level undergraduates in PASU

- “Physics students are mostly cool people, but they have their own problems too. Sometimes they're shy and don't want to interact with people outside their group of friends, and sometimes they don't have the greatest social skills.”
- “If someone is excluding or disrespecting you, it likely has more to do with them than with you, and they may not realize that they're doing it.”
- “a vague feeling of not belonging” … “is perfectly understandable, as is feeling inadequate. But I would say that if you're interested then you shouldn't let this hold you back. A lot of physics skill comes with time and training.”

Feeling Overwhelmed: Thoughts from upper-level undergraduates in PASU

- “Every single one of us has found the material hard and not followed the derivations at one point or another. Literally every single physics student I know.”
- “As far as I'm concerned the only indicator that you can't do physics is if you don't like physics.”
- “As long as you find the material interesting and "get" most of it eventually, at least for the fields that interest you and that you want to pursue further, you're good. If you decide after you finish a physics undergrad that the field isn't for you, you can enter a huge variety of careers and graduate programs with your physics background.”

Electromagnetic Waves

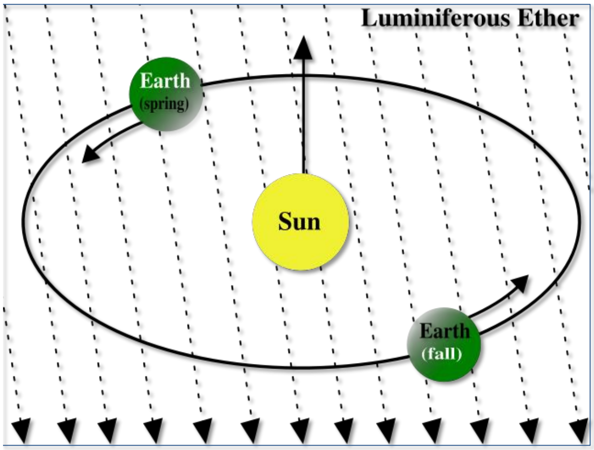
Maxwell, using his equations of the electromagnetic field, was the first to understand that light is an oscillation of the electromagnetic field. Maxwell was able to predict that:

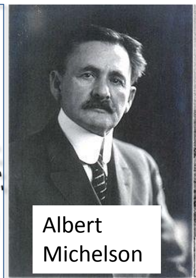
Electromagnetic waves can exist at any frequency, not just at the frequencies of visible light. This prediction was the harbinger of radio waves.

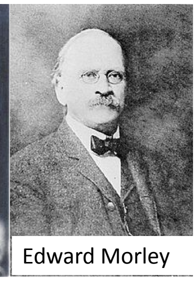
- All electromagnetic waves travel in a vacuum with the same speed, a speed that we now call the *speed of light.*

$$v_{\text{em}} = \frac{1}{\sqrt{\epsilon_0 \mu_0}} = 3.00 \times 10^8 \text{ m/s} = c$$

Michelson-Morley Experiment (1887)







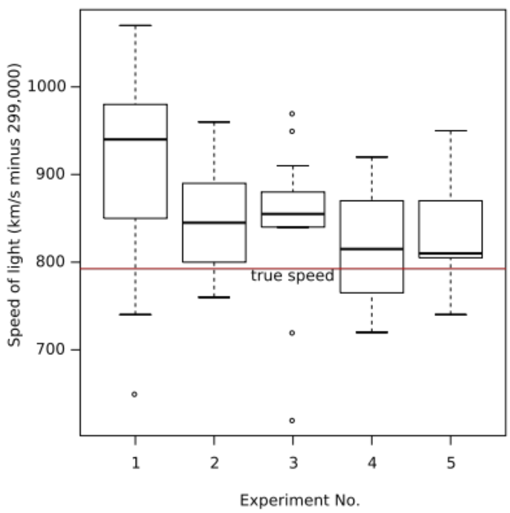
• In the 1800s physicists believed that light must wave in what was called the "Luminiferous Ether".

• Since the Earth is in motion, the speed of light should vary with direction and time of year.

Source: http://en.wikipedia.org/wiki/Michelson-Morley_experiment

Michelson-Morley Experiment (1887)

• **Result:** No variation. The speed of light was always exactly c in any direction at any time of year.



Apparently, there is no "Luminiferous Ether".

Light just always travels at *c* relative to the *observer*, even if the source is moving relative to the observer, or the observer is moving relative to the rest of the universe.

Source: http://en.wikipedia.org/wiki/Michelson-Morley_experiment

Einstein's Principle of Relativity (1905)

Principle of relativity All the laws of physics are the same in all inertial reference frames.

- Maxwell's equations are true in all inertial reference frames.
- Maxwell's equations predict that electromagnetic waves, including light, travel at speed $c = 3.00 \times 10^8$ m/s.
- Therefore, light travels at speed c in all inertial reference frames.

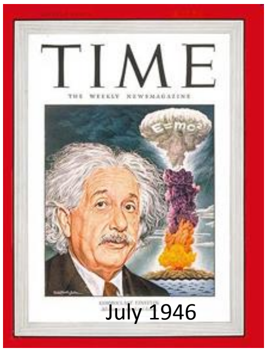
Every experiment to date (circa 2014) has found that light travels at 3.00×10^8 m/s in every inertial reference frame, regardless of how the reference frames are moving with respect to each other.

Einstein's Principle of Relativity (1905)

Principle of relativity All the laws of physics are the same in all inertial reference frames.

All the results of relativity follow from this simple principle, which implies that light travels at 3.00×10^8 m/s in every inertial reference frame. Examples:

- The relativity of time – moving clocks run slow.
- The relativity of space – moving objects are shorter along the direction of motion.
- The relativity of mass – moving objects are more massive.
- c as the speed limit – impossible to accelerate an object to or beyond c.
- $E = m c^2$



July 1946

Today's Schedule

- Hour 1 and 2: Practicals activities in notebooks
- Your notebook will be due at the end of the second hour!
- Hour 3: Practice Problem Set, Student Presentations

Notes on "half-life"

- If there are N_0 muons at time t = 0, then there will be N muons at time, t:

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{t/t_{half}}$$

- Here t_{half} is the half-life.
- t is the "proper time" in the muons' rest frame.
- Taking the logarithm of both sides and solving for t gives:

$$\ln\left(\frac{N}{N_0}\right) = \ln\left[\left(\frac{1}{2}\right)^{t/t_{half}}\right] = \frac{t}{t_{half}}\ln\left(\frac{1}{2}\right)$$

$$t = t_{half}\,\frac{\ln\left(N/N_0\right)}{\ln\left(1/2\right)}$$