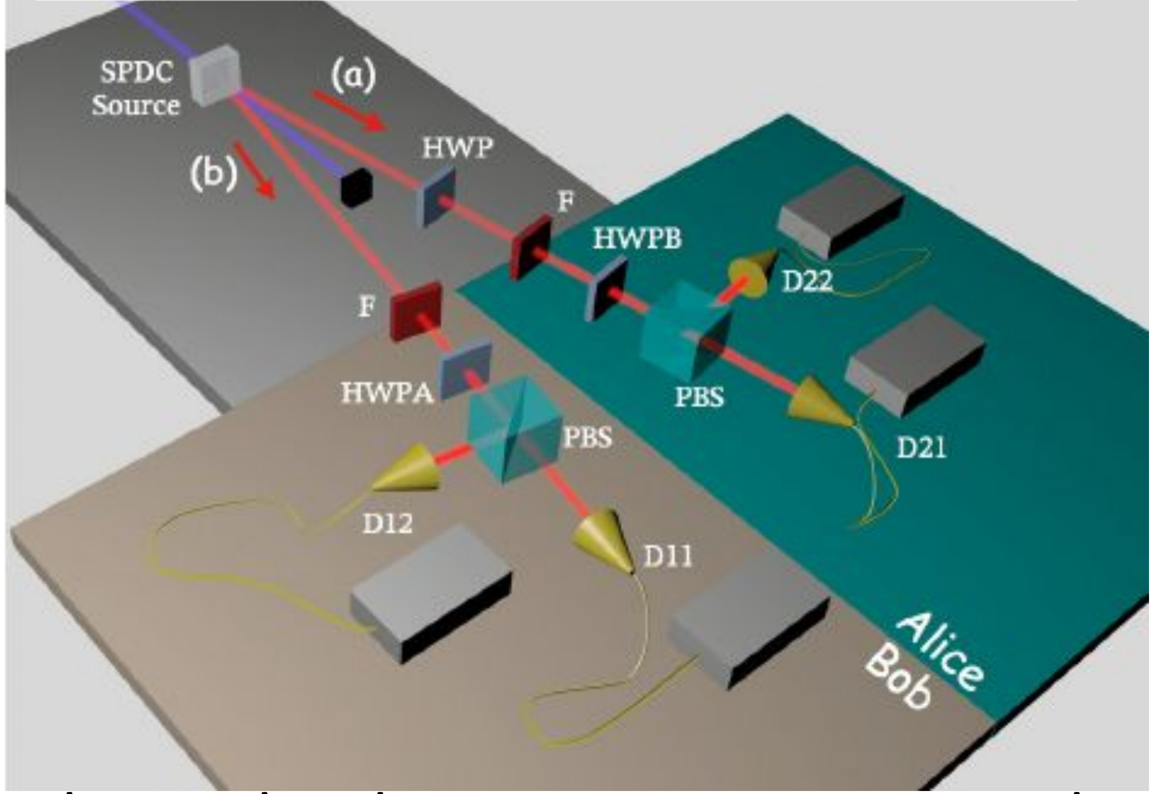
PHY151 Practical 3

The nobel prize in physics went to researchers in quantum information for work on photon entanglement



Above: the classic CHSH experiment that proves Einstein wrong. Right: entangled photons being shot at an iPhone camera.

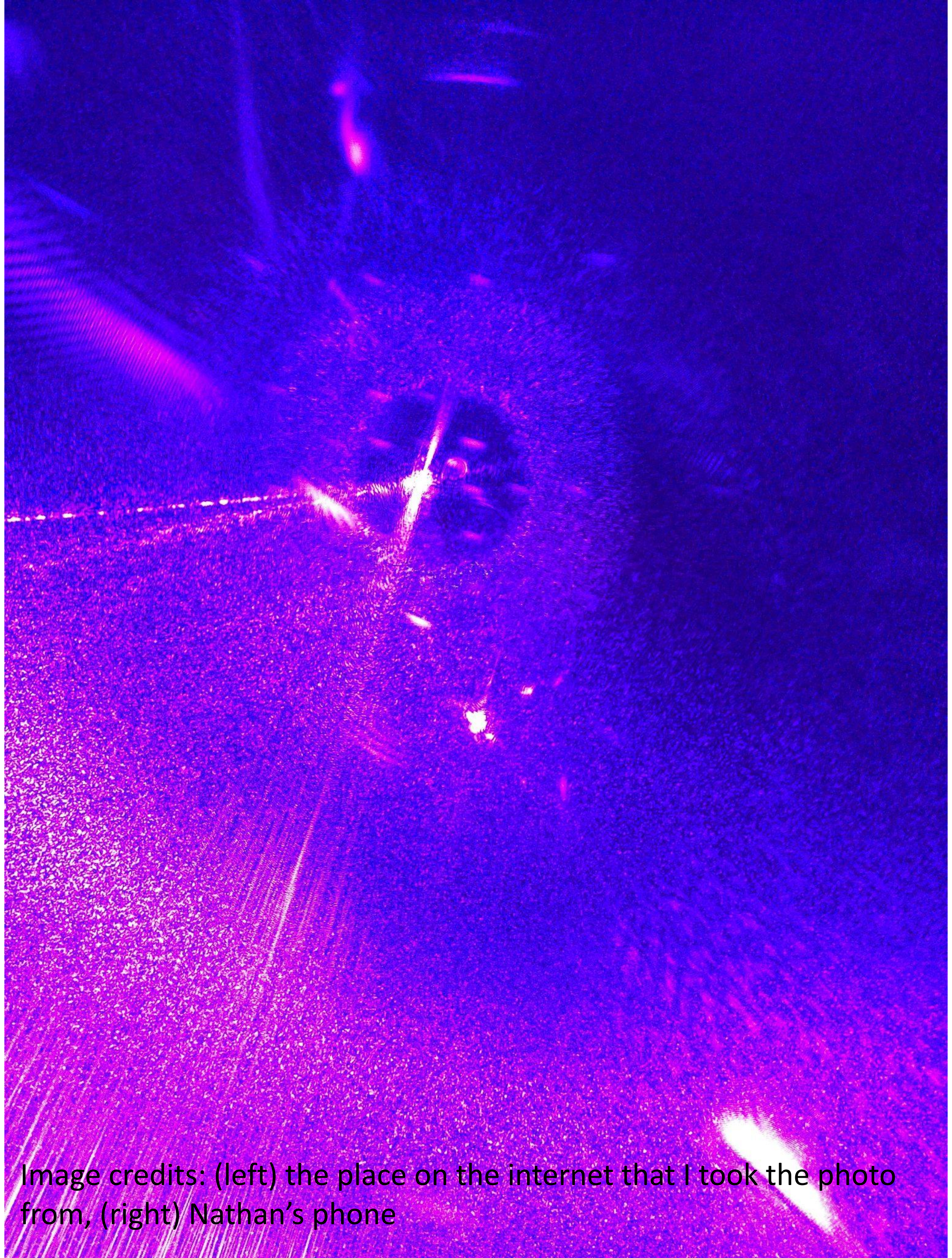


Image credits: (left) the place on the internet that I took the photo from, (right) Nathan's phone

Outline for Today

- First 50 minutes: Practice problems – Prof. Wilson has given us a list of 4 problems he says are similar to ones he may put on Term Test 1. Please work ***together*** on these – ***not for marks!***
- Final 2 hours: working on the Practical Activities of the week. Students complete write-ups in the TERM booklets **for marks**. Mechanics Module 2, Activities 14, 15, and 7 if you have time

For your mid-term:

- **Tutorial problems are the best practice problems**. Previous weeks' tutorial problem solutions are on the practicals page on quercus.
- **There will be 1 differential calculus problem**, but not an extremum problem (the exam likely will have an extremum problem though, so you will have to be able to do them by the end of the year)
- **You're allowed a (non-graphing) calculator and an aid sheet**
- **There will be 2 short answer questions and 1 long answer**. The long answer has a "mulligan" option, meaning if you think you did it wrong, you can submit one page written before midnight on quercus explaining what you think you did wrong to get up to 2 points back out of the total 12 for the question.

Last weeks’ practical

- **Cite lab manual** or write out complete procedure.
- **Save yourself time**: no need to print raw data or write out the questions. You can also submit scrap pieces of paper so you can all be working rather than person B sitting and waiting for person A to finish writing their bit before person B can add theirs
- **REFLECT ON RESULTS**
- **Uncertainties on all measurements** (show them and explain them)

- Fan force when moving is not necessarily the same as fan force when stationary (this was an assumption)
- F=ma not F=ma+F_0

Today's Tutorial Problems

1. the equation for air resistance is $F = \frac{1}{2}C_D\rho A v^2$, balance the forces to solve the problem
2. high school stuff basically, just use vector algebra
3. what forces are acting on a transport truck? One force will probably be considerably larger than others (think about what it feels like to put your hand out a car window when moving at speed). Estimate the size and weight of a loaded truck
4. another minimization problem. Follow the hint in the problem

Today’s Tutorial Problems

1. $mg = \frac{1}{2} C_D \rho A v^2$

   $C_D = 0.5$ for a sphere. Air has a density of $1.2\,\mathrm{kg/m^3}$. The area is πr^2, though we’re given the diameter.

   $m = \frac{1}{2g}(0.5)(1.2)(\pi(0.0325)^2)(26)^2 = 69\,\mathrm{g}$

2. Choose x as positive downhill, and y as positive up and away from the hill.

   $x : mg \sin\theta + T\cos\theta - \mu n = ma$

   $y : n - mg\cos\theta + T\sin\theta = 0$

   Combine to eliminate n:

   $ma = mg\sin\theta + T\cos\theta - \mu(mg\cos\theta - T\sin\theta)$

   $a = -0.22\,\mathrm{m/s^2}$, which is uphill, so slowing down.

Today’s Tutorial Problems

3. $F = F_{drag} = \frac{1}{2} C_D \rho A v^2$

   Guess $C_D = 0.5$ since trucks look worse than cars ($C_D = 0.25$ in the textbook) but better than people ($C_D = 1.2$).

   Assume highway speed is 30 m/s. Assume the truck’s cross-sectional area is a rectangle 2 m wide by 4 m tall.

   $F = (0.5)(0.5)(1.2)(2 \times 4)(30)^2 = 2200\,\text{N}.$

   This is independent of mass, so a loaded truck uses no more gas than an unloaded truck (ignoring the speed up issues).

4. Define θ so it’s zero for a horizontal rope.

   $y : n + T\sin\theta - mg = 0$

   $x : T\cos\theta - \mu n = 0$

   Combining and eliminating n gives

   $T\cos\theta = \mu(mg - T\sin\theta)$

   $T = \frac{\mu mg}{\cos\theta + \mu\sin\theta}$

   $\frac{dT}{d\theta} = 0 = -\frac{mg(-\sin\theta + \mu\cos\theta)}{(\cos\theta + \mu\sin\theta)^2}$

   Therefore the denominator must be zero which means $\tan\theta = \mu$.

Today’s Practical Activities

Today we’re working on **Mechanics Module 3: Activities 9, 11 and 15** (and 16 if you have time).

For the first two parts, think about extreme cases. Bear in mind that acceleration is not always as intuitive a concept as velocity.

Note that he track will bow considerably in the middle when suspended. Since we’re working with the cart in a stationary position, you’ll want to measure the angle very close to the cart. Make sure angle measure is properly zeroed.