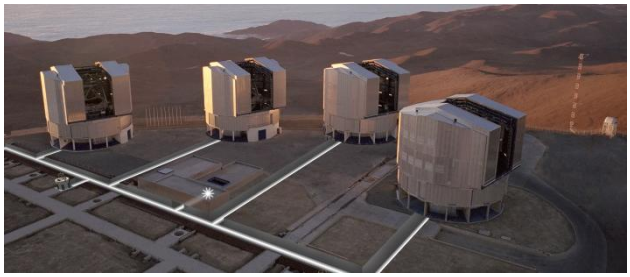
Kate Husband talk – Monday Morning

How galaxy clusters form

Following the safety briefing and a tour of the physics building, we were given our first talk of the experience on astrophysics by Kate Husband. The talk gave various explanations of the reasons why galaxy clusters form. Kate taught us about the detection of galaxies using spectroscopy. Measuring the electromagnetic waves- the way they peaked at various points in the spectrum gave an accurate distance that the wave would have travelled and consequently the position of the galaxy.

Equally informative was a Q and A session at the end. In which she spent most of her time answering questions on why she chose to study astrophysics. Kate also mentioned the interesting time she had doing research in astrophysics, showing us a picture of the impressive VLT, a 'Very Large Telescope' in Chile. The whole group found this talk very informative and interesting, as many of the people in the group hope to study astrophysics in the future.



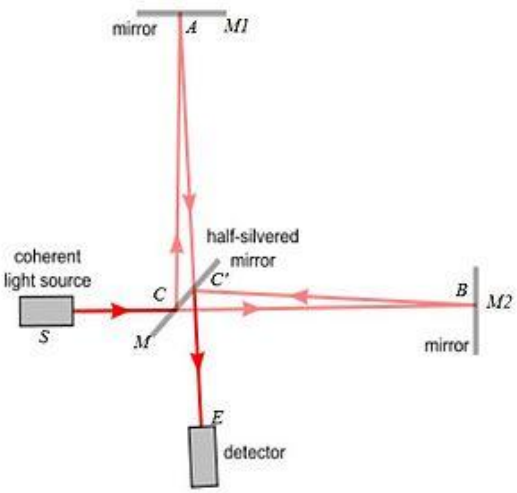
The VLT in Chile http://en.wikipedia.org/wiki/Very_Large_Telescope

Nanoscience Fair – Monday Afternoon

On Monday afternoon, we had the opportunity to judge a Science Fair for the Bristol Centre for Nanoscience (BCFN). The fair consisted of a series of demonstrations, created by pHd students of the department. They were designed to explain various concepts of Nanoscience to year 10 and 11 students. The experiments were very creative and very fun, and they captured the imagination of the young audience. Some of the more innovative experiments included using honeycomb with different fillings to demonstrate how the properties of polymers can be altered with the addition of nanoparticles and using a darkroom and balls designed to fluoresce in order to demonstrate how Nanoscience might be used to tag tumorous cells.

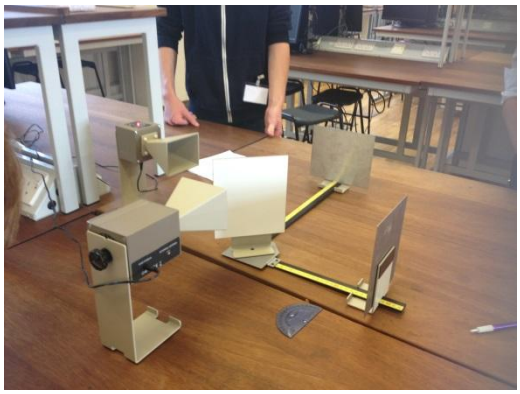
Measuring the Wavelength of Microwaves –Tuesday morning

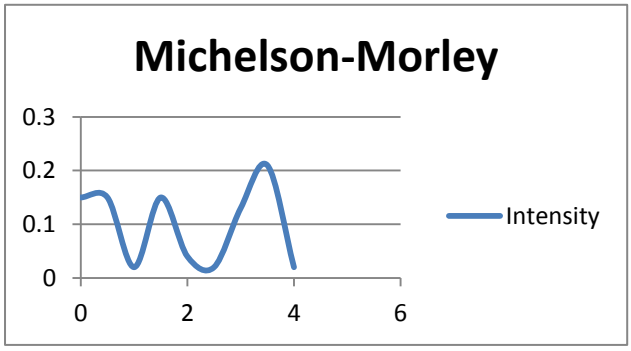
On Tuesday, we were asked to test out a new undergraduate experiment in the lab. We were told first to research the Michelson-Morley and the Fabry–Pérot interferometers, and to come up with two different means of measuring the wavelength of a microwave source based

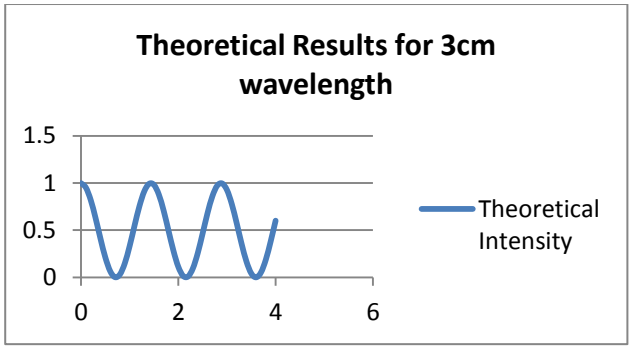


on these methods. We were given a source, a detector, two microwave mirrors and a semi-silvered mirror.

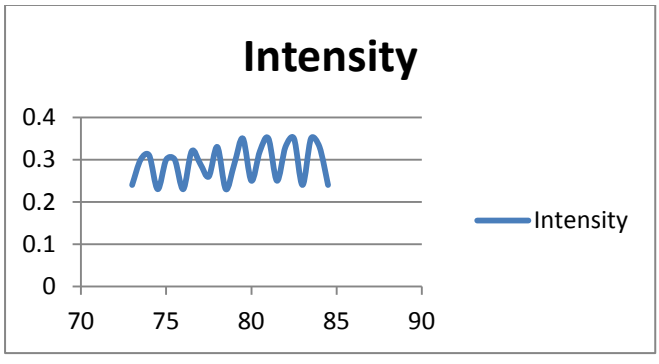
Our first setup was based on the Michelson-Morley experiment which was originally used to disprove the existence of the Aether. The setup is shown below, where a microwave beam is split by a half-silvered mirror and sent in two perpendicular directions. After reflection at the mirrors on the end, they are recombined and sent to a detector. The waves interfere constructively or destructively according to the relative distances of the mirrors. We thought the condition for constructive interference would be: **2(AC – BC) = n λ**. We moved one mirror and plotted the microwave intensity as a function of distance (below left). This predicted a wavelength of about 3cm, which (theoretically) should have looked like the graph on the right.

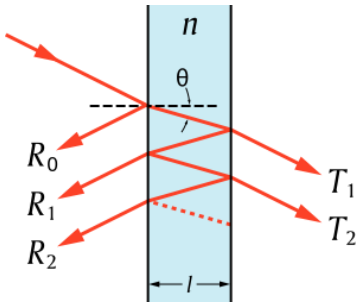






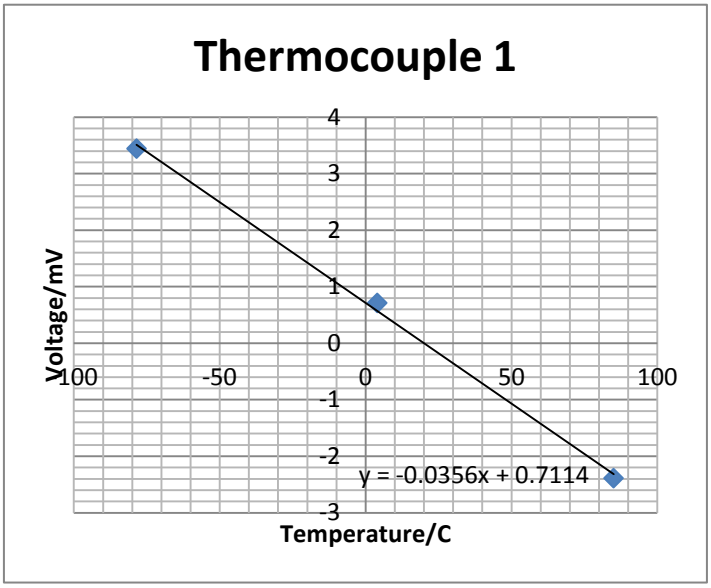
Our second setup was based on the Fabry–Pérot interferometer, in which light is sent into two parallel half-silvered mirrors. Some of the wave leaves the setup on each reflection, and these leaving waves interfere. The resultant amplitude depends on the relative distances of the mirrors, because they only construct fully when: **2d = nλ**, where d is the distance between the mirrors. We found that the intensity varied like:





This gave us the result of 2.9 cm as λ, which apparently was closer to the real value. We found the Fabry–Pérot setup was also much easier to use.

Thermocouple experiment - Gemma Winter - Tuesday Morning



On our second day one of our supervisors, Gemma Winter, asked us to test a new undergraduate experiment. Initially we were told to research Thermocouples; this provided the initial basis for the experiment. After receiving some advice from Gemma, we began to set up our experiment and took multiple measurements. A thermocouple produces a potential difference when the temperature at one end of the circuit differs from the reference temperature. We made our thermocouple by soldering together three wires, two made of the same metal and one from a dissimilar metal. After attaching the wires onto the multi-meter, we dipped the 'Probe' end into ice water, boiling water and dry ice. The different temperatures produce a different voltage, as shown in the graph below. The measurements recorded were then used to plot a graph on excel of voltage against temperature and we were very glad that our measurements generated a straight line graph.

Dan Saunders – Particle Physics – Tuesday Morning

^The alternate USS Enterprise during Warp.
http://en.memory-alpha.org/wiki/Warp_drive

After an interesting morning of testing first year undergraduate experiments, we were treated to an interesting and captivating talk by Dan Saunders. This talk aimed to explain basic concepts using Star Trek. The 4 sections covered in the talk were: Photon Torpedoes, Time Travel, Transportation and Warp Drives. Dan explained how these four things could be made into reality by using physics. This talk was undoubtedly one of the highlights of the week, as it was a very different method of explaining many difficult concepts.

^The USS Enterprise firing a photon torpedo.
http://en.memory-alpha.org/wiki/Photon_torpedo

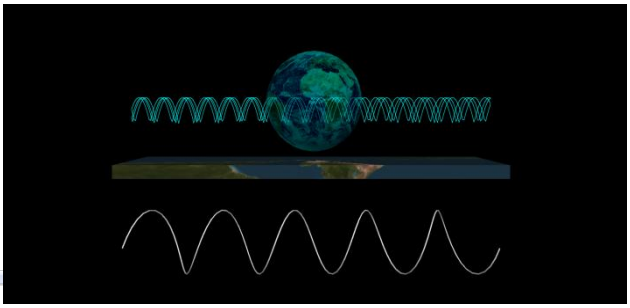
Warp Driving is even being worked on now by NASA. They have the concept design of a spaceship designed for warp travel.
http://sploid.gizmodo.com/holy-crap-nasas-interplanetary-spaceship-concept-is-fr-1589001939/1589277571/+jesusdiaz

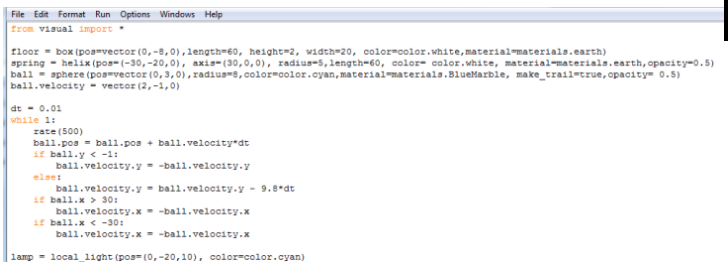
Materials talk by Xander Warren – Tuesday Afternoon

To finish our second day of the experience, Xander Warren gave us a talk on materials. He discussed his work on the structure of steels, and how a new form of microscopy (Magnetic Force Microscopy) could be used to map surfaces with great detail. Previous methods were highly sensitive and difficult to use, requiring very polished surfaces, whereas the new form was much more convenient. This was very interesting, as most of the group did not know much about Materials, this made it a very exciting talk for many of the group.

Computing session-Wednesday Morning

In this session we used software called VPython, which those of all ability could use. VPython had many files already saved which we could open and develop- for example there was a file called 'bounce.py' which displayed a ball bouncing on a block when run. Although this is quite simple we were encouraged to improve and develop it further, resulting in many different variations of the original file. For example we could change the velocity, colour, rate and radius of the ball that was bouncing. But, for those who had a more developed ability of using computers, there were other more challenging problems to solve. Overall the session was very enjoyable, as there was plenty to do for everybody. For those who did not know how to program, it was a very interesting introduction to this vital skill.





```
File  Edit  Format  Run  Options  Windows  Help
from visual import *

floor = box(pos=vector(0,-8,0),length=60, height=2, width=20, color=color.white,material=materials.earth)
spring = helix(pos=(-30,-20,0), axis=(30,0,0), radius=5,length=60, color= color.white, material=materials.earth,opacity=0.5)
ball = sphere(pos=vector(0,3,0),radius=8,color=color.cyan,material=materials.BlueMarble, make_trail=true,opacity= 0.5)
ball.velocity = vector(2,-1,0)

dt = 0.01
while 1:
    rate(500)
    ball.pos = ball.pos + ball.velocity*dt
    if ball.y < -1:
        ball.velocity.y = -ball.velocity.y
    else:
        ball.velocity.y = ball.velocity.y - 9.8*dt
    if ball.x > 30:
        ball.velocity.x = -ball.velocity.x
    if ball.x < -30:
        ball.velocity.x = -ball.velocity.x

lamp = local_light(pos=(0,-20,10), color=color.cyan)
```

Theoretical Physics talk by Felix Flicker- Wednesday Morning

Unlike the other talks, Felix's talk was more focused on our questions rather than what he was studying. Felix Flicker is a PhD student whose area of research is Quantum field theory in condensed matter. In his talk Felix outlined the key differences between a theoretical physicist and an experimental physicist; he also talked about his educational journey, which was useful to those deciding their A levels. His responses to our questions were very helpful to everyone. We came away with a better understanding about pHds and life as a theoretical physicist.

Ice-cream Lecture (Phase Changes) – Wednesday Afternoon

For this part of the day we were in the Tyndall Theatre (one of the lecture halls) while Helen Heath was telling

(Above - Helen Heath during the lecture)

us about different states of matter (solid, liquid, gas, plasma) and what the key components of making Ice-cream are (ice crystals, air etc.). But she also told us about the strange effects certain materials can have when put at very cold temperatures, these materials are called superconductors. Helen also showed us how these new states of matter could be used in the real world, such as to power trains with very little energy. The Lecture ended with Helen Making ice-cream in seconds with liquid nitrogen, a tasty end to a fantastic lecture.

Student Life Session- Wednesday Afternoon

After the Ice-cream lecture, we went on a tour of Bristol University, led by two current students. They showed us around the area, pointing out the different departments, including Social Sciences, Drama, Music and Humanities. We were also shown one of the student accommodation buildings, as well as other facilities, like the job centre and a few of the many libraries. The tour helped us to understand what being at university was like, and gave us a better insight to student life- our tour guides were also very helpful, and answered all of our questions. Furthermore, for those of us who don't live in Bristol it was nice to see a bit of Bristol City Centre. It was very relaxing to spend the afternoon outside in the sun, and I think we can agree that it was a very enjoyable part of our week.

The HH Wills Physics Building

The Indoor Sports Centre

Ben Lang Talk – Thursday Morning

On Thursday Morning, we had a talk from Ben Lang, a PhD student on his research into the behaviour of photons interacting with electrons in "quantum dots" inside crystal structures and the quantum behaviour they exhibit. He showed us several diagrams and simulations and his talk was extremely interesting. Ben gave us a valuable insight into what being a PhD student was like, which several of us are considering after completing our secondary and undergraduate educations.

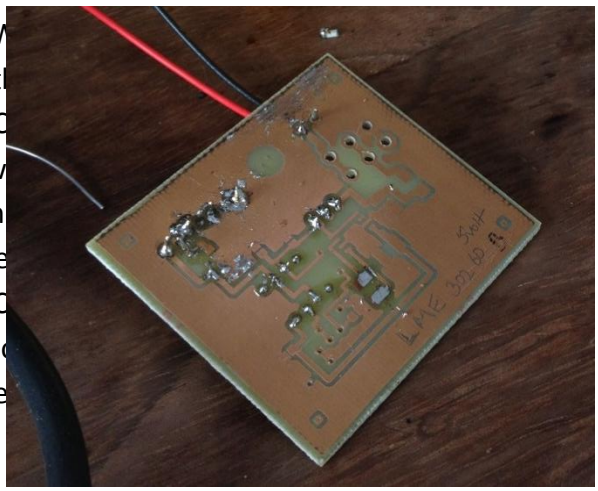
Undergraduate experiments – Thursday morning

Gemma Winters organised some undergraduate experiments to for us to test, and we went to the undergraduate lab to test them. We researched refractive indices to see the effects of dispersion as we transmitted microwaves into a prism. The prism was 'invisible' to microwaves, so we expected the waves to just pass straight through. We measured the angle at which the microwaves entered the prism at regular intervals of 5˚, and the intensity at which they passed through in mA, until the microwave no longer reached the receiver. Then we repeated the experiment using beads inside the prism, which did refract the microwaves, we put the results into an excel spreadsheet, and made a graph from the

results. Using the graph, we calculated the refractive index of the prism, using the equation $n = \frac{\sin i}{\sin r}$. This was enjoyed by all involved, as the experimentation was fun and helped consolidate our knowledge of waves and refractions.

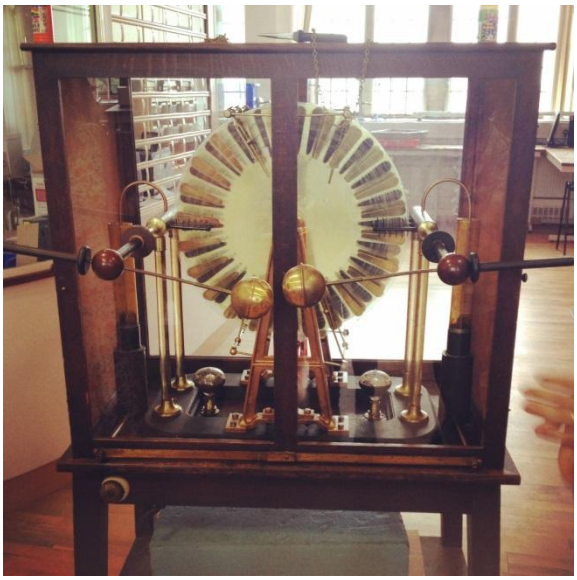
Building circuits (Tom Kennedy) – Tuesday and Thursday afternoons

On Tuesday afternoon, after a very busy morning, we were taken down to the project lab to meet Tom Kennedy. Tom explained to us that our project would be to make an amplifier for an experiment that he was running. Initially, most of us had no experience soldering so the first part of this session was spent learning how to solder. We practiced by soldering resistors to a perfboard, this was a very good way to practice to soldier, before the more challenging PCB (printed circuit board). W found that there was a very big leap from t relatively big perfboard to the much smaller PC Although we found that the PCB w considerably more difficult, it gave us a chan to refine our soldering technique. It was ve satisfying to add the components to our PC and by the end of the second session Thursday, many of us had finished to produce working amplifier.



Wimshurst machine -Thursday afternoon

After we had finished our work with circuits we were called into the 1st years project lab where a wimshurst machine (see below) was sitting. Two volunteers were called to step on two separate polystyrene blocks, while the handle on the wimshurst machine was turned. Little did the participants know that the turning of this handle was producing static electricity, this was done by friction between metal brushes and insulated disks. The static electricity was charging each of the two participants with opposite charges; a noticeable visual effect of this static electricity was that their hair stood on end. At the end of the demonstration, the two brass balls were brought together to produce a spark, this discharged the static electricity. This was a very



exciting demonstration, for both the participants and the audience, it helped to reinforce our knowledge about static electricity.

Quantum Photonics Talk – Thursday Afternoon

On Thursday afternoon we had a talk from Nick Russell from the Centre for Quantum Photonics. During this talk we learnt about how light could be used to power computers, how quantum computers worked and their uses. These uses included calculating numbers quickly for deciphering codes, which had many real world applications. It was then explained to us how difficult it was to build a quantum computer and how everything had to be isolated for it to work properly. He then answered every question we had in a way which was easy to understand, including explaining to us what Hawking radiation is. We also had a demonstration of interference patterns made by lasers, which was an interactive way to understand the concepts. The talk was very interesting and Nick was obviously enthusiastic about his subject; many of the group enjoyed this talk as it was an introduction to Quantum computing.

Stefan Lines Talk – Friday Morning

The Second astrophysics talk was very interesting. This one was about exoplanets (planets outside our solar system) and binary systems (2 stars orbiting I single point). Stefan told us about the different types of astrophysicist, which helped the group to understand the organisation of the field. This was our last talk and perhaps one of the more exhilarating; the prospect of life in other planets was intriguing. Many of the students in the group hope to go into astrophysics in the future, this created much interest.

The Group

Although everyone was nervous and shy on the first day, we quickly made friends. The wide range of knowledge and understanding of physics brought diversity to the group, and helped us bond as we all shared our expertise with others. By the second day we were all good friends, and enjoyed each other's company. Working in groups when doing experiments brought us together. Towards the end of the week we all felt very comfortable around each other- lunchtimes were particularly fun. We worked well together and we hope to keep in touch with the rest of the group in the future.