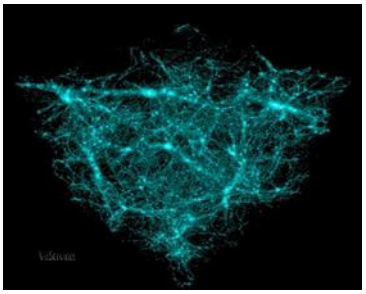
Work experience report 2015

Despite work experience at Bristol University sounding formal, the atmosphere was very much the opposite. The talks and experiments we did varied from talks about particle physics, to talks about student life, to finding the wavelength of a microwave and the speed of light. Between these talks and experiments, where both the lectures and work experiencers were highly enthusiastic to talk about physics and life at University, there were breaks in-between. As a result, the work was both interesting and relaxed. We wore casual/formal clothing (many of the males wore polo shirts and fairly plain (simple patterns at most) T-shirts and jeans or shorts, while the females wore T-shirts and jeans and this was acceptable).

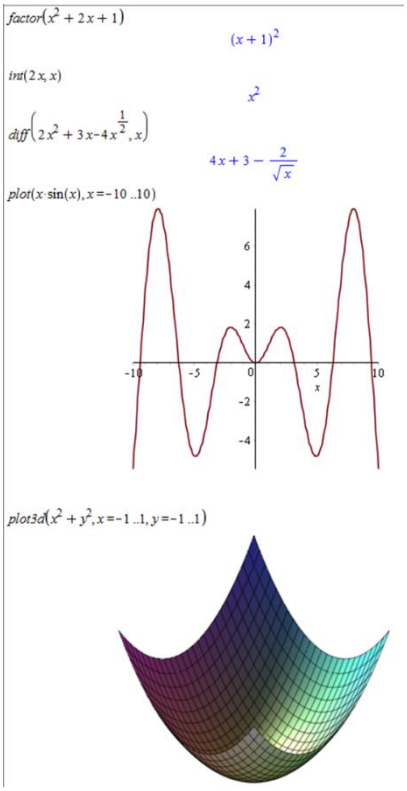
Paul Giles Talk – Cosmology and Dark Matter – Monday morning



On the first day Paul Giles came to talk to us about galaxy clusters and how they contain thousands of galaxies, each being able to move about in the cluster but being bound by gravity within it. This talk was incredibly interesting and touched upon red shift, special relativity and explained to us how the theory of dark matter came into existence. We were intrigued to find out that the mass composition of the universe consists of 3% stars, 12% gas and 85% dark matter, where there is five times as much dark matter as normal matter. Paul also talked us through special relativity and how gravitational lensing comes about, when light from a galaxy is bent as it passes around a galaxy in front, creating a lens flare on the image. This was predicted initially by Einstein, who said massive objects bend space-time. The lensing is caused by all the mass, including dark matter. However, dark matter is strange because it doesn't affect collision-less galaxies, and it doesn't interact with itself at all. The Bullet Cluster was also introduced to us, where Paul explained that it is a high energy merger between two galaxy clusters. By the end of this talk the group came to the conclusion dark matter shouldn't be called dark matter at all, but in fact transparent matter: we can see through dark matter to stars and galaxies behind it but it is still there.

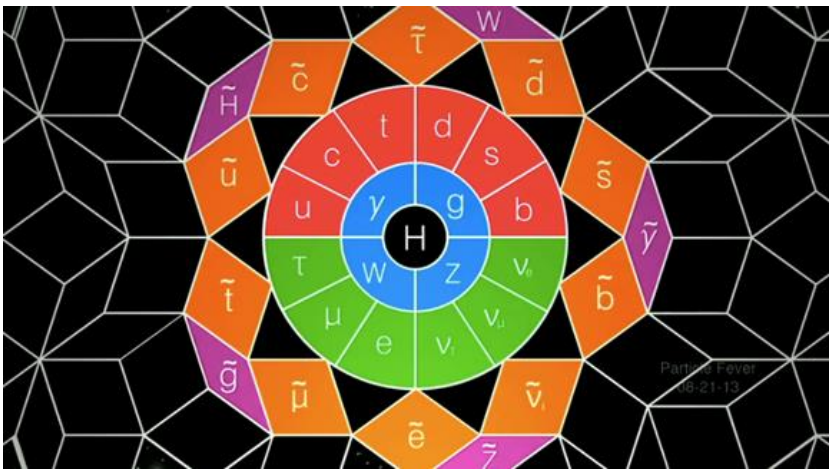
Theoretical physics 'experiment' – Maple – Monday afternoon

On Monday afternoon we were given a short sheet that taught us how to use the software Maple. None of us had used Maple before, so it was really interesting so see how quickly we could pick things up. The programme is a computer algebra system that we were using to calculate answers to mathematical problems. Maple is really advanced and can be used to solve many problems very quickly. The session really tested our ability to pick up something new and apply our maths to solve the questions.



Chris Lucas talk – Supersymmetry and the LHC – Monday afternoon

On our second lecture, the last on the first day, we had the pleasure of being taught by Chris Lucas an enigmatic PHD student of particle physics whose amiable attitude made for an enjoyable and intriguing lesson with his vast knowledge also making it a worthwhile and informative one. The talk was well structured and given, first giving us a brief overview of the standard model of particle physics; its successes and flaws from the 1960/70 till now. Despite Chris having little experience with lectures beforehand he kept us engaged throughout his introduction of SUSY theory and the tales of his working team at CERN, who are known jokingly as the 'Stop working team' as they are looking for anti-top quarks or stop squarks.



A diagram of 'SUSY' theory, similar to Chris'.

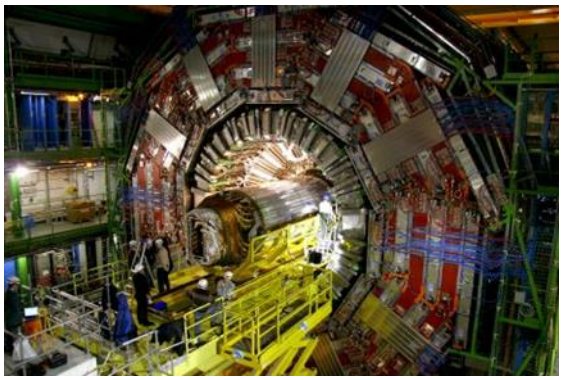
Chris gave an informative lecture that was punctuated with enough light hearted humour to hold all our attention in his grasp and thus helped us learn to a much greater standard. High points of the lecture included him talking about the opposition of the LHC, making light fun of the accusations that it will destroy the world and of the video clips claiming that it already has, not to mention his indignation that his car was the first to be consumed by the advancing "Black Hole". His talk on the health benefits of being struck in the face by a particle beam that goes at 0.999999991 times the speed of light, more beneficial than we had previously thought. His pride that his friend had made a diagram of the CMS detector with a man beside it that was exactly his friend's height to a millimetre and the story that CERN's builders used liquid nitrogen to freeze an underground glacial river which was where they wanted the CMS detector to be. The lecture which lasted an hour gave a wealth of information on the work at CERN, the LHC and how its detectors and trigger system work, the most commonly asked questions of particle physicists (asked by people who don't have the privilege of being particle physicists) as well as, the afore-mentioned, standard model and SUSY theory. His lecture not only helped us comprehend particle physics in a better clarity and gave us an insight into people's misconceptions and fears on particle physics and physics alike but also inspired us to continue on with physics and hopefully make a future for ourselves in physics and particle physics research.

"Explain That" Physics "toys"- Undergraduate Labs – Tuesday morning

After being kindly welcomed into the common room on Tuesday morning, we were escorted down to the undergraduate lab with rows of intriguing models and representations. Dr Helen Heath and Gemma Winter demonstrated a few of the models such as the Chladni Plate, Wilber force pendulum and jumping rings. Following the introductions to all the physics toys, we were let loose to indulge in our curiosities before pairing up and selecting one toy to focus on to explore and explain the physics behind it to the rest of the group. At the end of our session we learned from not just Helen and Gemma but each other all the laws and physics incorporated within each model and we left feeling as we if we had an insight in what a physics student would partake in as well as a walk through history.

Robin Aggleton talk – Supersymmetry and the LHC part two – Tuesday morning

We had a talk from Robin Angleton, who spoke to us about the theoretical side of working at CMS, as well as how he contributes to the CMS experiment. Robin firstly talked about the standard model of particles that we have been using is good especially with the addition of the Higgs Boson however it isn't complete. He says this because there are many things that the standard model cannot prove, such as dark matter, why gravity is so weak or why if the big bang created all of the matter that it did but why did not create an equal amount of anti-matter. He then moved on to tell us about what they are doing at CMS. The experiment they are trying to prove is a theory called super symmetry. We were given a brief explanation of super symmetry, it is particles that are completely symmetrical to its corresponding particle, which will have the same name except the symmetrical ones will begin with an "s". So far the theory is that these symmetrical particle or SUSY are heavier than their corresponding particle but cannot be seen. If this is proven it should be able to prove or help better understand the matters of dark matter, gravity and matter vs anti-matter.



Robin then told us about some of the work that the theorists need to do to be able to get these results. He also told us how theorists have to compare their theories with the experimenters, which is usually a back and forth discussion or argument in most cases, as the experiments will know the physical limits of the machine. He told us that this would cause the theorists to have to change their theories so that the LHC will be able to test it, otherwise if there theory cannot be tested so that it can be proven/unproven then it cannot be used to support anything. He then he went on to talk about some of his experiences that he had at the LHC, such as how he had to working in the trigger room on the day it was restarting to make sure nothing went wrong. He also said that he tends to work in the trigger room in shift making sure the experiment is working how it should be. Robin also told us how there are many people from all over the world that come to work at CERN, which shows and also how there are language lessons that you can take in the LHC as an extra that you can take if you wanted. He also spoke a little about accommodation that CERN and how there are apartments provided and that they are quite close to the CMS experiment.

For more information about the CMS experiment visit CERN's website:
http://home.web.cern.ch/about/experiments/cms

Mechanics – Some educational research – Tuesday afternoon

After lunch on Tuesday we were given a force concept inventory, which is a short paper designed to test understanding of the Newton's laws, and highlight some common misconceptions. The paper contained no maths whatsoever, so it relied solely on the understanding of forces, inertia and motion, and applying these to real situations. Our answers were being used to try to understand why people often get the questions wrong, and how the forces from air resistance and friction can sometimes cloud our understanding to what is really going on. We all found this paper really challenging, but afterwards we learned a lot about forces and how our intuition may be misguided. We discussed with Dr Heath why we thought what we did, and she helped us understand why the correct answers were correct. Overall the session was really useful to help develop our understanding of Newton's laws.

Xander Warren talk - Material science – Tuesday afternoon

As our last event of Tuesday, we had an especially interesting talk given by Xander Warren on the subject of the science of materials. He explained to us how his work with EDF energy involved looking at data to explain as to why the materials used in nuclear reactors decay in ways that lab experiments do not simulate. He explained that the most common reason for the decay of nuclear reactors was the phenomena of 'creep cracking'. Creep cracking is the tendency of materials to deform or deteriorate as a result of long-term strain, with it forming microscopic cavities which can compromise the structural integrity of a material (especially metal). These cavities can expand and eventually form together and appear as a crack. Xander explained to us ways in which to observer materials suspected of being subject to creep cracking, including the use of a scanning electron microscope, making practise of the technology of transmission electron microscopy or utilising magnetic force microscopy. He also explained how metals (dependent upon their ratio of Chromium to Nickel), can be classified as either Austenite or Fernite (or other). All in all the talk was informative and useful and delivered in an interesting manner whilst still giving us a deep insight into the field of material science and what prospects it holds.

Programming with visual Python – Wednesday morning

As mentioned in the many lectures we had, many of the physicists that work and study here have used some kind of programming language in their work and research. Helen showed us the programming language of Python but in a visual version. This allowed us to programme the computer and then it would present it in a 3D visual import.

I myself have never really done any programming before so this was a first time for me; but fiddling around with the code I eventually got an idea of what was going on. There were many websites online where they can help and give tutorials on how perform certain things with the Python code. Helen gave us some activities to do with the code if we wished to, but mostly (if this was a first time programming) was trying different things with the code to figure it all out.

After having a lot of fun with Python and having some lectures from PHD students encouraging coding, I have taken up a free online course to teach myself, programming. The website to do this is called Code Academy. On the website it says it will take up to 13 hours to get through all the lessons, and then some to develop a speed and commutability with the code you are writing. I would defiantly recommend having a go yourself. From this work experience I would say knowing how to programme will be very helpful to you in the future when applying for jobs and if you plan to do Physics in the future.

http://www.codecademy.com/

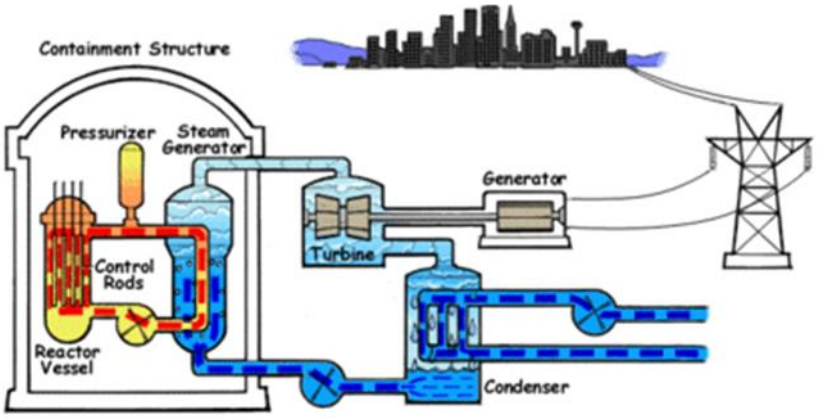
https://www.python.org/

Chris Hutton talk – Nuclear energy and waste

Our next lecture was with Chris Hutton who is a PhD student working on creating a diamond radiation detector for use at the radioactive waste depository at Sellafield. He explained to us how your average nuclear fission reactor works and talked about the different types of reactor in use over the world! He then discussed with us the amount of energy that the UK uses and how much each type of energy source contributes to the total amount of energy needed using a website I will link below!

After this he went on to discuss the downsides of nuclear energy which is mainly the radioactive waste it produces. This waste is stored in a facility called Sellafield near the Lake District and he explained how this waste is stored. Whilst on that topic he talked about the problems our grandparents who created the first Magnox nuclear reactors have created for us. When our grandparents took the waste to Sellafield they stored it in a steel magnesium compound which wasn't the best idea because magnesium reacts with water which led to the pond where the waste was stored having a thick and difficult to clean layer of highly radioactive magnesium hydroxide at the bottom of the cooling pond.

A pressurized water reactor (PWR) -



Then Chris went on to explain what he is working on for his PhD and why it is needed. There is an old waste chamber at Sellafield were any electrical device that is dropped into it to detect the levels of radiation or take pictures of the room die before they can get useful readings. So his job is to create a radiation detector that can withstand the radiation whilst getting readings of that radiation. To do this he has created a detector that is largely diamond. He has tested this detector in a chamber with one of the waste products of nuclear fission which is Cobalt 60 and so far his results have been perfect and its future looks promising!

http://www.gridwatch.templar.co.uk/

University tour – Wednesday afternoon

After being cooped up in the HH Wills Physics building for the past two and a half days, we had the chance to explore the rest of the University of Bristol. We were accompanied by two of the university's ambassadors who were able tell us what the places were and their importance.

In the sweltering heat of 1st July, we made our way around Bristol, visiting the Arts and Social Sciences library, the Life Sciences building and the Wills Memorial Building among others. It was interesting to see some of the rest of the city campus and have a chance to talk to under-graduate students who know what it is like to live and attend university in Bristol. The places we visited ranged in look and mood; from the modern, social faculty libraries to the mock-Victorian Wills Memorial Building in which we were told to imagine the sound track from Harry Potter as we entered. This experience gave an insight into what a Bristol University student would see and do on a day to day basis. Overall, it was a fun and interesting activity to do for students who are likely to attend university in years to come.

Sam Morley-Short talk – University life – Wednesday afternoon

On Wednesday afternoon we had a rather abstract talk with PhD student Sam Morley-Short on life at University. The talk was extremely useful and detailed. It didn't go too far into what Sam was researching for his PhD as he knew we didn't have the sufficient amount of knowledge to understand his project and may not have been as useful or interesting. Instead, he gave us tips on how to make the most of life at University.

The hour given to the session involved a lot of discussion and interaction- we were encouraged to ask questions at any time and the responses returned were really detailed and thorough.

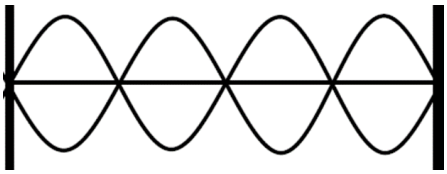
Furthermore some useful tips were given, such as how to make the most of free time, the procedure of learning in the University, book suggestions and memory techniques. For example, Sam told us that if we wanted to make the most of time spent carrying out chores, we should listen to audiobooks while we work.

He recommended some apps for your laptop or smartphone, such as flux, which reddens your laptop and smartphone screen before you go to bed and gives a much higher quality sleep, and an app that records your sleep cycle and quality, which is common across all mobile platforms. Some book suggestions were also made, which included 'Moonwalking with Einstein' and 'Become a Superlearner', two very accessible texts written for the less experienced mind.

Overall the hour was laid back and interesting, with useful and applicable information that would be relevant to anyone who studies at University.

Experimental work in the undergraduate lab – Thursday morning

Thursday morning started off with 2 different experiments prepared by Gemma Winters. We were split into two groups to work on two different tasks. The first consisted of measuring the wavelength of microwaves. At first this seemed a challenging assignment, but when we used our knowledge of standing waves, this is something that could easily be obtained. By creating a simple set up of the apparatus we used, this included a transmitter, receiver, several mirrors and a partial reflective mirror, we composed an experiment to measure the maximum and minimum points along the wave. We measured them by reading the current on the receiver, then by plotting a graph, which produced a sine wave to work out the difference between the maxima and minima. By multiplying this by two gave us the wavelength of microwaves.



The other group were given the task of finding an accurate prediction of the speed of light with equipment such as an oscilloscope, an L.E.D. and a large length of optical fibre (in excess of 150m). We were given a worked method of which to follow which involved using an oscilloscope to find the delay in light transmission caused by the light having to travel through different lengths of optical fibre. Once having collected are results we plotted the results on a graph and then used the equation to work out an estimate for the speed of light:

$$t = t_o + \frac{nx}{c}$$

The result was a surprisingly close accurate to the actual value of the speed of light (where

$c =$ The speed of light, seen famously in Einstein's $E = mc^2$). Overall this was a great example of how physics experiments can give a real and accurate answer to age-old questions.

Nathan masters talk – Thursday morning

Nathan gave us a talk on nanoscience and how his studies are going towards developing a piece of equipment that would be able to diagnose sepsis. He worked on developing a cantilever that would vibrate very precisely, such that when a molecule landed on the cantilever it would vibrate more slowly. This small change in vibration could be used to detect additional mass on the cantilever. The cantilever is coated in a variety of materials including gold and a polymer, the polymer layers have very specific holes so that only the molecule associated with sepsis can land on the cantilever and slow the rate of vibration. This was a very interesting talk that allowed us to see how a physicist could work with other departments like Biology and Chemistry, he showed us that research in physics can also have applications in the medical world.

Finding the Higgs – Friday Morning

On Friday morning we were given a talk by Maarten van Dijk about the CMS experiment in CERN and how particles are detected. This was quite complex, but gave us a lot of insight into how CERN detects these tiny particles. After the talk we were shown around the research laboratories where research is done into designing better particle detectors, we were lucky enough to even handle a photomultiplier tube, which converts single photons into single electrons before multiplying the signal for detection. After a tour of the research laboratories we went down to the computer room to search for signs of the Higgs Boson using real data from the CMS experiment. This was really fascinating and allowed us to get a better understanding of what goes on at the LHC.

Overall, the work experience at Bristol University made us feel no regrets by the end of it all. Both the Physics aspect and advice given for the future, during question time which happened at the end of each talk, intrigued and helped us all. Despite the work experience was a formal one, it did feel as if everyone was welcome no matter how good at Physics they were. The whole experience was not only extremely fascinating as we got a sense of the wide range of fields that you can get involved in as an physicist, but a chance was presented to be yourself in a subject which all felt passionate about. For this reason the work experience was matched by none.

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