KES Physics Newsletter

Summer term 2017

Matthew Latter

Studied Physics, Maths, Music tech, Further maths (AS)

Reading Acoustical engineering at Southampton University

At KES 2008 - 2015

So I've just finished the first week of my summer placement. I'm working at an acoustic consultancy company in London of all places and I can confirm that it is awesome. It's been truly satisfying to see all of the things I have learned over the past two years put into practice and it is really rewarding to see that my knowledge in the field of acoustics can be put to good use.

One of the things I have been tasked to do over this past week is to perform reverberation time calculations of room which are yet to be constructed. Reverberation is the property of a room by which a sound persists after it has ceased. If the reverberation time of a room is too long, then speech will become mangled and unintelligible due to the reflections and echoes and acoustic damping panels will have to be applied to the walls of the room. To perform these calculations I was required to learn how to read architectural drawings and floor plans.

Another thing I was tasked to do was to prepare and audio demonstration of background noise. In the near future, a representative from the company will go to a recording studio (where the background noise is a minimum), and show the clients a true representation of how loud traffic noise will be in the building they are designing and also how loud the fans will be that they intend to put on the roof. With this information the client can then take these factors into account when designing their building.

In order to monitor noise accurately in different locations, it is necessary to go to those locations with a sound level metre and take both attended measurements of noise as well as to leave a sound level metre behind in a safe place to regularly transmit back to the office. I mention a safe place as usually the sound level metres are to be put on the roofs of buildings and as such I have witnessed some breath-taking views of London over the past few days.

I really couldn't recommend a summer placement enough. If you do go to university, definitely do one.

This term has (as you might expect) largely focussed on exams! However, we did also have our short option modules this term. The options were, astrophysics, quantum mechanics, and functions of a complex variable. As they all sounded so interesting, I decided to go to all three.

Robert Clemenson

Studied Physics, Chemistry, Maths, Further maths

Reading Physics at Oxford University

At KES 2008 - 2015

The first week of the astro course largely focussed on exoplanets and their detection (an exoplanet being a planet outside of our own solar system). It's astounding just how many exoplanets have been discovered in the last 30 or so years, and the sheer diversity of these planetary systems. Take Osiris (formally HD209458b), it orbits exceptionally close to its parent star (about 1/8th of Mercury's orbital radius). As a result of this close orbit, its atmosphere is 'blown off' by the star, leaving an extended trail of atmospheric elements in the surrounding region of space. Back to our own solar system, Enceladus (the 6th largest moon of Saturn) has a hard surface of 99% water ice, with a LIQUID water ocean beneath (Jupiter's moon Europa is also known to have a liquid ocean). Hydrothermal activity on the floor of this ocean is not dissimilar to areas found at the bottom of our own oceans (search 'black smokers') which are known to support life. If one of these ocean worlds was found to support life, the field of biology would absolutely explode (and about time too…).

In the past two newsletters, I mentioned meeting Professor's Stephen Hawking, and Andrew Wiles… In keeping with this tradition… I bumped into somebody with a far greater knowledge of time and space than either of them… The sixth Doctor himself! Colin Baker! Though this isn't strictly 'physics news', I felt it was too cool not to mention!

I also attended a lecture by Astrophysics professor Jocelyn Bell Burnell, celebrating the 50th anniversary of her discovery of the first pulsar. She was very wrongly (in my opinion) excluded from the Nobel Prize awarded for their detection.

Timothy South

Studied Physics, Government and Politics, Maths, Further maths (AS)

Reading Aerospace engineering at Bristol University

At KES 2008 - 2015

Well since the last update I have taken exams and received my exam results and you may (or may not) be pleased to know I passed them all and am through to my 3rd year so you'll be getting plenty more updates! In the last update, I discussed the aluminium wing we made and tested. To continue from this, we had to write a detailed report on the entire process. I was tasked with, as well as writing about the deflection and rotation, making all the graphs from the structures test. As you can probably tell, this was nowhere near as enjoyable as the making, testing and breaking part but that's University for you. As for our results compared to other groups, we had the best report and the best build quality but were a mere second in Structure performance and let's not talk about mechanisms and control. Overall, we came joint second (even though team C were worse than us) which is obviously devastating but I did get a first in this unit so it wasn't all for naught. I didn't get a chance last time to talk too much about the two additional units we did this term so I will do now. First is Vibrations which is as simple as it sounds. When I say simple I mean that is all about wobbly things but working out that wobble can be rather tricky. It's mostly about balancing out different types of motion but instead of just considering the stiffness as you might (using k=F/x) we also must account for damping and if there is resonance. The other new unit I did this term was Flight Mechanics. This was mainly about how we balance forces on an aircraft using different control surfaces (mainly the elevator, ailerons and rudder) and I found this unit extremely tricky however… In the exam, we had answer 3 out of 5 questions and fortunately for me 2 of those questions were the same, word for word, as 2 that had been on past papers had been using for revision. ALWAYS DO PAST PAPERS, this is Tim Souths 1 step guarantee to education success. I have a few words left so I will just leave a recommendation for anybody who likes astronomy (and you should, planets are pretty). Watch Crash Course Astronomy on YouTube. It is hosted by Phil Plait and, while a little patronising, teaches you about planets, stars, galaxies and cosmic forces almost as well as Miss Heggie. Have a good summer.

There are numerous methods of understanding how nature works. A lot of my work is experimental. Earlier this year, I described some experiments we were performing describing the formation of sand dunes due to the flow of water over a flat bed of sand. We perform carefully designed experiments which allow us to control many of the variables such as grain size, flow speed and direction and fluid density. This allows us to determine the fundamental relations between these parameters and quantities such as the growth-rate and size distribution of the sand dunes. As such these experiments allow us to establish the details of the processes that take place in sand dune formation.

Paul Jarvis

Studied Physics, Chemistry, Maths, Biology

Read BA and MSci natural sciences at Cambridge University

Ph.D. in Geology from Bristol University

Currently a post-doctoral research assistant at Cambridge University

At KES 2001 - 2008

However, if we want to get a complete understanding of how sand dunes are created, we need to combine this work with other methods. One very useful tool is computer simulation. For this purpose I have traveled to visit collaborators in Paris who have developed a computer program which can model sediment transport. It is possible to write down the equations which describe the formation of sand dunes. Unless you make lots of simplifying assumptions, it is impossible to solve these equations exactly. However, methods to get approximate solutions exist (think numerical integration if you have done that in A-level maths). These so-called numerical methods frequently contain thousands of operations and so often need to be performed on computers and can (in some cases) take days to finish. However, they allow investigation of parameters that are hard to control in an experimental setting, such as variable wind direction.

To be able to write computer programs is a very useful skill for a scientist. As mentioned above, it allows you to get approximate solutions to equations that cannot be solved exactly. During my career, I have written or contributed to programs to simulate the aggregation of volcanic ash particles in eruption columns, the sinking of spheres though fluid interfaces, and now the evolution of sand dunes. All of these problems are difficult to fully investigate through experiments alone and being able to write computer code opens a hugely diverse range of topics you can study

Alex Broad

Studied Physics, Maths, Psychology, Further maths (AS)

Reading Physics at Swansea University

At KES 2012 - 2014

This semester has arguably been the most interesting so far, due to my project dissertation. I mentioned it last time but, to recap, my project was focussed on string theory. The aim was to examine the thermodynamics of strings and how they behave when energy is supplied to or taken away from them. Last term, I had gotten as far as reviewing the background mathematics of string theory and briefly examining how high energy strings behave thermodynamically. This term, I started focussing on what happens when a gas of strings is brought into contact with a gas of ordinary particles. This involved a lot of maths, and involved treating the mass of the string as a variable. This sounds odd but, in string theory, the mass of a string can change if its energy is varied. By doing the maths, I found the interesting result that the strings act as a thermostat to the gas. This means that, regardless of the initial temperature of the gas of ordinary particles, the strings can heat (or cool) the particles to a defined temperature, called the Hagedorn temperature (I briefly mentioned the Hagedorn temperature in the last newsletter). This is a very strange result and could have some interesting applications. However, this result is highly theoretical, and relies on many assumptions such as the strings having a very high energy. Furthermore, the Hagedorn temperature is predicted to be extremely high, at about $10^{30}K$. This means that any experiment attempting to measure the thermostat effect would have to reach extremely high energies - ones which are impossible to reach in any current or foreseeable experiment. Therefore, this result in string theory has no possible applications. However, fortunately for me, there is another type of matter for which the maths is very similar. Hadrons (protons, neutrons, mesons etc.) behave very similarly to strings, and have their own Hagedorn temperature at about $10^{12}K$. This is much lower and therefore more measurable. By re-working the maths, I was able to show that hadrons have a sort-of latent heat capacity. At the Hagedorn temperature, hadrons have a 'boiling point' at which they separate into quark matter. I managed to demonstrate that there is an energy required to cause the transition. This is analogous to the energy needed to separate a liquid into a gas.

Note from the editor:

If I could diverge from the topic of physics for a moment, it's been a great pleasure for me, writing my own entry, and a greater pleasure still reading the entries of the other contributors. I would like to take this opportunity to thank Alex, Matt, Paul, and Tim for giving up a chunk of their time to make this newsletter happen. I would also like to say thank you to the science department at KES, not just for the education they provided each of us, but for supporting this project, in particular to Ms Heggie.

I sincerely hope that the entries have provided some of you with food for thought, and possibly some light entertainment (they certainly have for me).

I'm very keen to keep this project going for as long as it is relevant and useful, for this reason, I would love to hear back from as many of you as possible about what you liked/disliked, would like to see more of etc.

If any of you are interested in getting involved once you leave KES, I'd be thrilled to hear from you. Ms Heggie has my details, so please, get in contact!

Enjoy your summer!

I look forward to writing to you again in December!

Robert Clemenson