KES Physics Newsletter

Summer term 2018

The end is nearly upon me. After much consideration I have decided to change my course from the four year integrated masters, to the three year bachelors. I shall be taking a year out to assess what I want to do with my life, whether it be applying for the masters in audiology, pursuing a career in charity (one of my extra-curricular passions) or doing a PGCE to get into teaching. As such this is my penultimate newsletter entry, but rest assured this edition will be a humdinger.

Matthew Latter

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

Reading Acoustical engineering at Southampton University

At KES 2008 - 2015

So here are my new modules; Architectural acoustics is more or less how it sounds, it's the acoustics of architecture (shock horror), how a building responds to sound stimulus and how to design and modify buildings to make sure speech is intelligible, that privacy between rooms is assured and that any noise from building services (air conditioning, heating etc.) doesn't interfere with work or living. It's more or less exactly what did in my summer placement.

Biomedical Signal and Image Processing is by far my favourite module this semester (although it's definitely the one I'm worst at). In this module we look at signals from biomedical equipment such as ECGs (heartbeats) and EEGs (brainwaves) as well as images like MRIs and CT scans. Basically we look at how to obtain this vitally important information from the human body and how to convert it to a form that a doctor or surgeon can understand.

Human Response looks at how exposure to noise and vibrations effects the human body, how your hearing can deteriorate in certain conditions and how your body responds to extreme vibration and the diseases and health hazard associated with this. This module piques my interest as it shares common themes with audiology (which I may look into pursuing).

In addition to this I have been continuing with my individual project which I have modified such that it can now be used to extract any kind of biological cell from any kind of fluid. Pretty cool stuff if I do say so myself. That's the almighty power of acoustics folks!

Zak Goble

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

Reading Physics at Manchester University

At KES 2010 - 2017

I'm Zak, and this is a generic introduction into my part of the newsletter.

We've moved into our 2nd, and final, term of the year at Manchester after a pretty decent set of exams to finish the first term. This term, I'm studying five more modules, including maths (decent), properties of matter (boring), electricity and magnetism (sick), vibrations and waves (just pendulums, really) and advanced dynamics (properly advanced).

Maths this term has focused heavily on calculus; in particular, complicated and pointless functions. I'd list some of them, but you'd get bored of my section and go back to reading Rob's instead, so I won't bother. In properties of matter, we've looked at some of the properties of crystalline structures and the wave deflections from them as well as interactions between different states of matter, such as liquids and gases, which were pretty swanky. The content of electricity and magnetism includes understanding the maths behind electric and magnetic fields and features cool words, like 'flux' and 'weber' (pronounced 'vaber'.) Maxwell's equations underline every aspect of the course. The content is awesome in its own right, but the subject's lectures are bolstered by the fact that our lecturer does a Kahoot quiz at the start of every session, so coming up with a hilariously savage username every week pretty much dominates the work in that course. Vibrations and waves...yeah, pendulums are pretty much it to be honest. Nobody really has a clue what's going on in advanced dynamics because, as the name suggests, it's advanced. It's a lot of useless and boring notation rather than any actual crunchy physics. The lecturer is also an evil, miserable man. Good teacher, though.

The best part about this term so far is that the memes and the banter have reached a breathtakingly exquisite level now that lectures have started to be podcast. Every somewhat DJ-like hand gesture from lecturers is captured and sent straight to the Tomorrowland mainstage via Photoshop for maximal meme-age. Being in a physics degree, we've got a few trainee hackers on the course that have managed to change the coding when playing Kahoot quizzes, allowing them to use these Photoshopped images as their display name, optimising their savagery towards lecturers. This is an equally generic closing sentence to my part in this newsletter. Zak.

This term, my lectures have included; optics, statistical mechanics, lots more quantum mechanics, and an additional course on advanced classical mechanics.

In addition to my normal studies, a substantial amount of my time has been spent on writing applications for various summer research programs. If successful, I hope to tell you all much more about these in the next couple of newsletters!

Robert Clemenson

Studied Physics, Chemistry, Maths, Further maths

Reading Physics at Oxford University

At KES 2008 - 2015

With regards to lab work, this term I spent two days working in the electronics lab. My lab partner and I built a few different analogue circuits, designed to solve various algebraic and differential equations. The general method here was to look at the form of the equations to be solved, and using the equations of the different circuit components, build a circuit whose components produced an output voltage governed by the same form of equation to be solved. The output voltage was then displayed on an oscilloscope, thus giving a visual display of the desired solution form. (Sounds confusing… Very simple to look at in a lab!)

At the beginning of next term, I will give a brief 15 minute presentation to the other physicists in my college and our college tutors on an area of physics of my choice. This forms part of the practical aspect of my degree, and all physicists in my year must take part. The title I have chosen is 'Symmetry in physics'. You probably have some idea of what I mean by 'symmetry'. In our everyday experience, we may describe something as symmetric if it looks the same viewed from some other angle, or perhaps, looks the same when looked at through a mirror. This intuitive idea of symmetry is not too far removed from the basic elements of symmetry within physics. From a mathematical point of view, symmetries are described in generality by a branch of mathematics called 'group theory' (something I recommend the budding mathematicians reading this look into for an idea of what to expect from a maths degree!).

In general, we can define a 'symmetry' as some aspect of the system that remains unchanged, when we perform a transformation on the system. A transformation here could mean a number of things, such as rotating the system, or boosting it off in some direction at some speed. For example, imagine you are looking at a meter ruler from across the room. Rotating your head sideways while you look at the ruler, of course, doesn't change

To quote a wise man, "Three years down… One more to go… We're getting there!" I have now finished my third year at University and have effectively done enough work to earn a bachelor's degree.

Timothy South

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

Reading Aerospace engineering at Bristol University

At KES 2008 - 2015

To start off with, the composite rocket project I was doing as part of the SEDS society (Students for the Exploration and Development of Space) failed to launch. First, I should probably explain what a composite is. Basically, a composite is the combination of a material that may not be that strong on its own with a resin or epoxy (fancy glue) to create a new material that has superior properties to more conventional materials. The first issue was that we ran out of time to make the composite rocket body ourselves and so had to buy one, which turned out to be much heavier than those of previous years, which defeated the whole purpose of using composites! Then we ran out of time altogether and the rocket never got to fly. Let's hope for better next year!

As for actual University work, I had coursework in Control and AVDASI 3 (aircraft design) as well as exams in Sensors, Signals & control, Aircraft Propulsion and finally Structures & Materials. The control coursework was, shall we say, eventful. The task was to design a controller for a Quanser, which is basically a helicopter on rails. We were given all these different methods for designing a controller but in the end, I found the best method was to guess values that worked for the controller and go backwards from there. The big problem than came in trying to test the controller was people (not me) kept breaking the Quansers which meant that I didn't get to test mine until the eleventh hour, though when that time finally came, it worked perfectly.

When looking back I think that, although I didn't enjoy the year as much academically compared to last year, this year, in many ways, was my best year at university yet. When you eventually go to university to study physics or something else (not biology!) make sure you sign up to these 3 different types of society. Your course society as they will probably put on a lot of events that will involve free pizza, a project-based society as this will give you opportunities to apply the skills you've learnt to something you enjoy and a sports or social society as this is a great way to spend your time doing something worthwhile. Don't make the same mistake as me and wait until your third year to get involved! Anyway, until next year (and it should be a good one!).

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 the University of Geneva

At KES 2001 - 2008

You will have recently seen images from the eruption of Kilauea volcano, Hawaii. A friend and colleague of mine, Dr. Julie Oppenheimer, a research scientist at the Lamont Doherty Earth Observatory (LDEO), Colombia University, spent time there collecting data from the eruption and I have spoken to her about her work.

Can you give a background to Kilauea? Kilauea is a shield volcano and erupts hot (~ 1000 °C) and runny lava. It has a summit crater (Halema'uma'u), and two rift zones (linear alignments of cracks) including the East Rift Zone (ERZ).

What has happened recently? Until April, both Halema'uma'u and Pu`u`Ō`ō, a crater in the ERZ, contained lava lakes. In April, the lakes began overflowing until, on 30th April, the crater floor at Pu`u`Ō`ō collapsed. Days later, cracks opened in the ERZ, with extruding lava first observed on 3rd May. The lava lake levels dropped, suggesting magma was draining into the ERZ, which has been continuously erupting since. The lava level in the summit crater has kept falling, leading to explosions caused by magma-groundwater interaction and crater wall collapse into lake.

What did you do there? As part of a team from LDEO and the University of Hawaii Hilo, we used visual and infrared cameras on drones to map lava flow advance. Primarily, we recorded the location of flow fronts, allowing calculation of advance speed and direction. We also collected data to make 3D maps of the flow surface, measured the velocity within flows, and observed flow interaction with natural obstacles, including trees in a forest.

Why is your work important? Our data allowed real-time identification of safe locations and helped decision makers determine where people were allowed. We mainly worked at night, when helicopters could not fly and our drones were the only "eyes in the sky". Additionally, our observations can be used to test models of lava flows and improves our understanding of these processes.

Alex Broad

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

Read BSc Physics at Swansea University

Reading MSc Physics at UCL

At KES 2012 - 2014

I'm now approaching the end of my second-term lectures in my MSc in Physics at UCL. So far I have been completing lectures in biophysics, statistics and climate physics. My most interesting module this term has been Advanced Topics in Statistical mechanics, in which we have covered topics such as droplet nucleation, the dynamics of randomly moving particles, running basic computer simulations and the true meaning of entropy. The latter topic has certainly been the most interesting to me. Entropy is a way of giving a number to a system quantifying its freedom of movement (people may call it a measure of disorder, but this turns out to be a terrible definition!). Historically, people became very confused over how a world of reversible dynamics (i.e. no particular reason for time to go forward rather than backward) can give rise to the irreversible processes we see every day, such as heat dissipating from a cup of tea as it cools, or the gradual sharing of heat throughout the Universe as it expands. It's been very interesting learning about the reasoning that changed our understanding of our irreversible Universe.

Aside from modules, I've been continuing with my MSc project. I started work last term on a project concerning bacterial mechanosensitive channels. These are a type of protein found in a lipid bilayer (cell membrane) which are able to respond to mechanical forces from a pressure difference on either side of the cell. Their purpose is to let water and other solutes through the membrane when the pressure gets too great on one side. This prevents the cell membrane from rupturing. My project has been to run highly coarse-grained (zoomed-out) simulations on a small group of channels to see how they interact with one another. By using computer simulations, I am able to change all kinds of properties of the mechanosensitive channels. It's early days at the moment, but so far I have been able to change the strength of the bonds holding the channels together and plot their size against the pressure against the membrane. I found that this has no effect on the channels' gating threshold. The 'gating threshold' means the pressure at which the channels go from a state of 'open' to 'closed'. This summer I will study the effects of having many different types of channel on one membrane.

Note from the editor:

At the end of the second year of this project, I would like to thank Alex, Paul, Tim and Zak for their contributions. With a special thank you to Matt, as this is his last newsletter for the foreseeable future! I hope all of you at KES have enjoyed reading their entries as much as I have!

I would also like to convey our thanks to the KES science department, and in particular to Ms Heggie, for their continued support and enthusiasm for this project.

I would love to hear from students about what they liked, disliked, want to see more/less of, etc. One change that was made this year, as a result of discussion with a group of students, was the introduction of extended pieces. This year Matt, myself, and Alex each wrote a double page spread on a specific area of interest. This will continue onto next year, with the other contributors alternatively writing a longer piece each.

Good luck to all of those leaving KES this year! I would be thrilled to hear from any of you who are interested in getting involved with this project! (In particular, any students that could help us balance our gender ratio a little bit!!)

I look forward to writing to you all again in December!

Robert Clemenson