KES Physics Newsletter

Autumn term 2017

Matthew Latter

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

Reading Acoustical engineering at Southampton University

At KES 2008 - 2015

This term I have thus far been primarily concerning myself with my Individual Project. The title of which is "A low-cost device for separating rare cells from blood samples".

My project concerns using ultrasonic waves to levitate blood samples and force the cells toward a surface coated in antibodies where the cells of interest will get stuck. The cells in question being those responsible for allergic reactions.

So I'm basically levitating blood to cure allergies. Sounds like magic, and yet, it is not. It is the almighty power of engineering! (Suck it physicists)

Being a lot more biological in nature than anything I have done previously, I thought this a daunting challenge. However, due to the vast range of materials available to us students I did not find this a difficult barrier to overcome.

My other modules this semester are 'Noise Control Engineering', 'Acoustical Engineering Design' and 'Ocean Acoustics and Biomedical Ultrasound'.

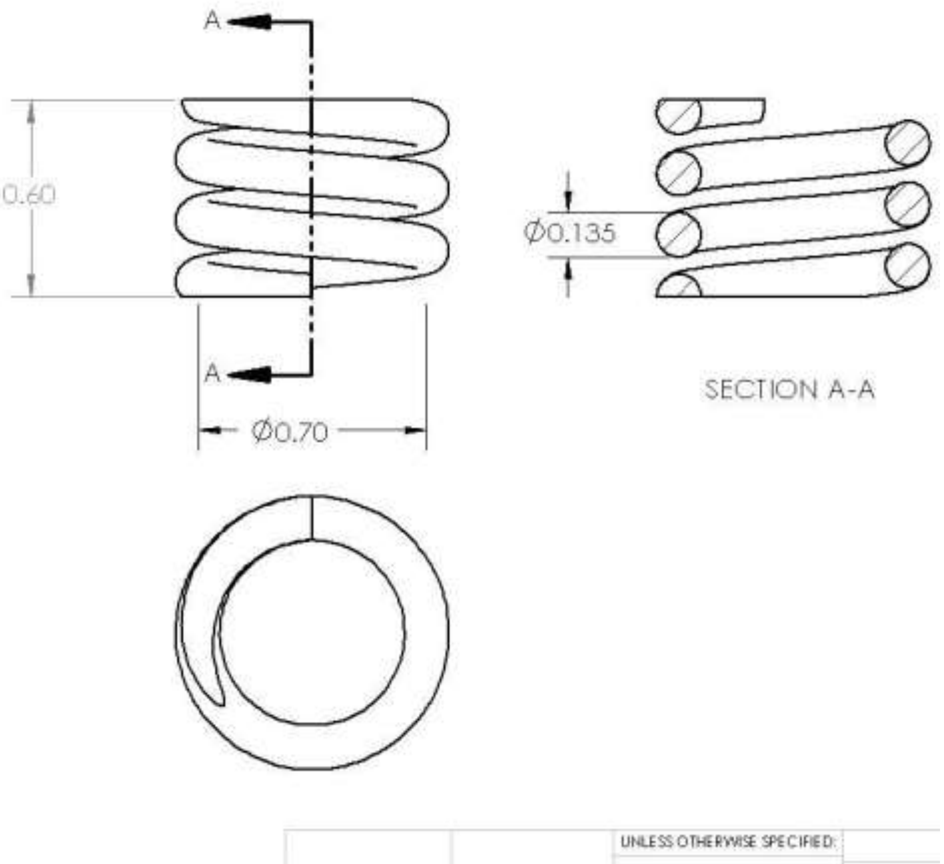
Noise control is exactly how it sounds, consisting of all the methods consultants manage noise with a view to apply it in buildings and vehicles. It not that interesting but is pretty useful.

So far in Design, I have (in a group) designed a suspension system for a train and have just started the second project of the module, to design a muffler for a car exhaust. This is going to be a challenging task as we will have to decrease the transmitted engine noise by 10 dB in a given frequency range. Ten whole decibels doesn't sound like a lot, but due to its logarithmic scaling, it equates to us making the car over 8 times quieter than without the muffler. And given it will have to not exceed a certain size lest it look ridiculous and impractical, I'm sure plenty more hurdles will throw themselves up along the way.

By far my favourite module this semester is Ocean Acoustics and Biomedical Ultrasonics. In this module we look at how sonar systems work, how ultrasound is used in hospitals, in military vehicles and how Whales and Dolphins use echolocation to 'see' their surroundings despite the many complications that arise from their environment (bubbles, waves, reflections from the sea surface and seafloor etc.). In particular, my favourite aspect is how modern man-made sonars mimic those employed by whales and dolphins (which is how I justify taking the time out of my busy day to watch Blue Planet II).

In addition to my current degree, I have also recently been researching Master's degrees. Although my Engineering degree is already an integrated masters, I have decided that I do not want a career in engineering and that I want a career in Audiology. Hence I will be applying to study here in Southampton for a further two years after my current undergraduate degree is completed.

The picture below depicts the spring designed for the train. Eight of these springs will be used in parallel for each train carriage, effectively distributing the stiffness across each wheelset to provide the ideal comfort index.



Zak Goble

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

Reading Physics at Manchester University

At KES 2010 - 2017

I'm Zak, and I'm a mug that does Physics at Manchester.

Physics has been pretty sweet so far. It may have been breathtakingly terrible all throughout year 12 (I feel your pain, year 12s) but you start to learn some swanky stuff after that. In our first term, we're doing 5 modules; maths, mechanics, special relativity, astrophysics and physics in everyday life. There isn't much new maths in the first term on top of what you learn at A level, which is handy, because it's the first lecture on a Monday morning that you're allowed to turn up half asleep for. We don't learn much in astrophysics, because our lecturer is the unrivalled king of dead jokes as well as ludicrously incorrect algebra. We have, however, in the brief moments in between sighs after comparisons are made between dead stars and Bruce Forsyth, learnt about what keeps a star from collapsing under gravity and their approximate lifetime. Our mechanics lecturer is an old, camp Sheldon Cooper and he's utterly fabulous. The content builds on energy relationships, polar co-ordinates, circular motion and vectors. We've learnt a wide range of completely pointless, albeit somewhat interesting, facts in physics in everyday life; we calculated the theoretical maximum height for a high jump, which is around 7 metres, and discovered that the colours in a secondary rainbow are the wrong way around. For special relativity, we've got Brian Cox. It's an absolute madness. His beautiful voice is enough to make me consider switching teams. In the first few lectures, he smashed physics to pieces by giving us all the quantities that don't function as they should when travelling at high velocities. Length appears to contract, time appears to dilate, momentum, energy and velocity itself all appear to turn to insanity. He showed that time travel was very much possible when travelling fast enough.

One of the physics attractions in Manchester in particular is the Lovell telescope at Jodrell Bank. Our merry gang of physicists got to visit near the start of the term during a field trip in which we spread happiness and joy to the local community, as I always do. We perform lots of calculations in past papers, unequivocally the best source of revision, regarding its ability to detect and resolve distant stars and always find that we're wrong because we forget to account for the blurring effects of the atmosphere. At least we're learning. Zak.

Lecture topics this term have included, electromagnetism, thermal and statistical physics, quantum mechanics, and some more maths!

Building on the work in electromagnetism we did last year, this term we have focussed more on understanding how light (which is an electromagnetic wave) propagates though vacuum and through matter. It's very satisfying, to see the laws of optics (Snell's law, law of equal angle of reflection etc) fall out of a relatively simple calculation in electromagnetism.

Robert Clemenson

Studied Physics, Chemistry, Maths, Further maths

Reading Physics at Oxford University

At KES 2008 - 2015

In 5th week, I attended a talk by Professor Michael Duff of Imperial college/Oxford on M-theory (a unification of various string theories). You may have heard that string theory predicts the existence of extra dimensions (M theory predicts 11 in total). A perfectly reasonable question you may be asking is; 'where are these dimensions?' of course, we can move about in three spatial dimensions, plus 1 temporal dimension (time is considered to be the 4th dimension in Einstein's theory of relativity). But that still leaves 7 apparently unaccounted for… One way of accounting for these extra dimensions is by compactifying them. That is, to say that they are very small (and in fact periodic). A famous analogy is as follows; to a tight rope walker traversing a cord, they appear to be able to move only in one dimension (backwards and forwards). However, an ant on the same cord would be able to walk along in the same direction as the tight rope walker, but also along the circumference of the cord.

I have also undertaken a small amount of practical work this term. One lab involved using a Michelson interferometer as a spectrometer. I was doing this lab work around the same time that the physics Nobel Prize for this year was announced. It was awarded for the detection of gravitational waves. These waves were detected using very similar apparatus to the standard Michelson interferometer (though about two and a half miles long, compared to our 30cm or so equipment…).

I have three big units this year that last over both semesters; Structures & Materials, Sensors, Signals & Control and an Individual Research Project (IXP). For my IXP I am researching different controller designs of both conventional re-entry vehicles (Apollo, Soyuz, etc.) and space planes (Space Shuttle and Buran) and how they could be implemented into the controller of the HL-20. Before you ask, the HL-20 is a concept personal launch system designed by NASA and although it was never fully built or tested, the design has been heavily researched as a computational model which is what I will, in the long term, be applying my research to. For now, however, I am just investigating controller designs which has been quite tricky as I haven't been taught the control unit yet (it's in the next semester).

Timothy South

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

Reading Aerospace engineering at Bristol University

At KES 2008 - 2015

My smaller units this term have been Aerodynamics, Computational Aerodynamics, Optimisation Theory & Applications and Aerospace Systems Engineering. I'll be honest, I'm not exactly sure what systems engineering is (the definition we were shown was about 100 words long) but in the unit, we worked in teams to design a landing gear extension and retraction system. This included creating system function diagrams, working out probabilities of failure and creating the electronics and hydraulics schematics for the sub systems. The unit, as a whole, has involved working with a lot of new and unfamiliar concepts which is probably why I enjoyed this unit so much as it was completely different from everything else we have been doing.

I think the most important thing I have taken from this semester is that to be a good engineer (or in your case, physicist), you need to have an understanding of parts of the subject outside your usual scope. It doesn't matter the level of understanding, as long as you are aware of the key concepts. It will help you in both your own work and in communications with those outside your area as, you will find, the lines in science are well and truly blurred.

It's not all work though, as outside of university I have won a water rocket competition and started to help design a composite rocket in the Space Society, started playing table tennis on a bi-weekly basis and I have been to Rubik's cube competition (What a nerd!!! Am I right?). Keep studying hard and you may have as cool a social life as me...

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

As I write this, I am at the airport waiting for my flight to New Orleans for a meeting of the American Geophysical Union, which is annually attended by about 20,000 scientists. Such meetings are a really important part of working in scientific research. Throughout the week, different sessions are held on particular topics where people will present their recent work. It is a much more enjoyable way to find out about active research than just reading about it. Additionally, it is an important opportunity to network and meet with other researchers who are working in your area. Often they will have ideas for how you may improve a particular experiment, or you may have knowledge than can help them solve a problem.

One thing I will be doing this week will be meeting with a professor from Arizona State University, who I am about to start working with on a new project to try and understand the lifetime of volcanic ash clouds. This is an important issue, as volcanic ash has consequences for human respiratory health, and the aviation industry. When Eyjafjallajökull erupted in 2010, an ash cloud spread across Europe leading to an effective shutdown in air traffic that caused billions of pounds of damage to the global economy. We want to perform experiments where we create analogue 'ash clouds' in the lab. In particular, we are interested in the formation of 'ash-fingers'. In the picture of the Eyjafjallajökull eruption, these can be seen as streaks of ash particles falling out of the cloud. Understanding how they form and how quickly they reach the ground is important for trying to predict how long ash clouds will remain in the atmosphere. Hopefully our experiments will be able to improve models of ash-clouds, allowing better predictions of their behavior.

Alex Broad

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

Read BSc Physics at Swansea University

Reading MSc Physics at UCL

At KES 2012 - 2014

Since completing my degree at Swansea university, I have moved back home to study for an MSc in Physics at UCL. My modules this term are Advanced Quantum Theory, Mathematics for General Relativity and Galaxy Dynamics, Formation and Evolution. Each module has been very interesting in its own right, but I'd probably choose General Relativity as my favourite. I took a module last year on the topic, but this year has made me realise how little I actually knew back then. This module focusses more on applying tensor algebra and calculus in order to form the components of the Einstein field equations, as well as some applications. The content perhaps doesn't yield many interesting concepts as last year, but it helps a lot to understand the theory by deriving it from first principles. Advanced Quantum Theory is fairly similar in that respect. The module is very maths-heavy, and involves topics such as time-dependent perturbation theory and the WKB approach for quantum tunnelling (quantum tunnelling is an unusual effect, in which the uncertainty of a quantum particle's position allows it to travel through certain barriers or potentials, even if it doesn't have the energy to).

This term I made a start on my Master's project in biological physics. My project concerns a particular type of proteins, called 'mechanosensitive channels', which react to various stresses and pressures by opening and closing certain pores in a cell membrane. How these channels behave is fairly well understood on a single-channel level. What is not very well understood is how the channels communicate with one another. Recent studies have shown that these mechanosensitive channels do not act in isolation to one another, and it seems that the opening of one channel causes thousands of neighbouring channels to do the same. My project is essentially to study how these channels may or may not communicate under the influence of mechanical forces. This project involves the use of thermodynamics and statistical mechanics, and mostly involves using computer simulations to study the channels. At the moment, the project is only in its initial stages and, so far, I have only been getting to grips with various computer languages. But I should have plenty to talk about next term, when I project really gets underway.