KES Physics Newsletter

Spring term 2017

Matthew Latter

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

Reading Acoustical engineering at Southampton University

At KES 2008 - 2015

As mentioned previously, this semester I have been designing a loudspeaker cabinet as part of a group project. To many, a loudspeaker cabinet may seem like just a box, however, there are many practical considerations to take into account. For example, what should it be made out of? Wood seems like the best option as it's strong, cheap and easy to work with. Hang on a minute! What is that Mr. Lecturer (Keith to his friends)? You want it to weigh less than 2kg? Well, this changes things, most woods are far too heavy for what we want. We'll have to do research and come to the conclusion that the mysterious material known as Falconboard is right for the job, what with its honeycomb structure making it strong, rigid and lightweight at the same time. Excellent, so we'll make a box out of Falconboard, job done. Hold up. What's that rumbling I feel in my bones? No, it can't be. Not resonances. The frequency response is not flat (there are harsh peaks in amplitude at certain pitches). What can we do to solve this? Maybe our box shouldn't be a box after all. Maybe we need to alter its geometry to ensure that no sound radiating from the front of the loudspeaker interferes with sound radiating from the back. But that's not all, we're going to have to alter the volume of air inside the speaker. As air is a compressible gas (with an associated stiffness), the air inside the cabinet acts like a spring pushing on the driver (the bit making the noise). To get around this we put a little port in a geometrically opportune location on the cabinet. This can also be used to boost a certain frequency that may be lacking, as defined by the Helmholtz equation (basically what happens when you blow over a glass bottle). As you can see there are many practical considerations to take into account when designing a loudspeaker which make for a really interesting and engaging project. As part of this project, I attended a trip to Maidstone, Kent where we went to the headquarters of KEF: a company that designs and manufactures loudspeakers. It was really interesting to see their (professional) take on the process, from the design conception, to the simulation and computer modelling; from the digital signal processing aspects, through to the construction of the final product.

Robert Clemenson

Studied Physics, Chemistry, Maths, Further maths

Reading Physics at Oxford University

At KES 2008 - 2015

This term I have been studying a wide range of interesting topics including; Vector calculus, electromagnetism, waves and normal modes, along with mechanics and optics continuing on from last term.

This term I did three weeks work in the electronics labs. Although labs tend not to be my most favourite thing about my course... These were particularly interesting. In one lab, we designed and built a simple circuit out of electronic devices called 'flip flops' capable of storing memory. These simple circuits were precursors to many more complex circuits found in technology we take for granted today.

In classical mechanics this term, we were introduced to Lagrange's formulation of classical mechanics. As a general tool for determining the equation of motion of a system, this technique is very powerful, but it also has a certain degree of subtlety about it. Many basic results, such as the conservation of linear (and angular) momentum and energy, fall out at as consequences of the mathematical formalism.

My highlight this term was undoubtedly the Boyle society dinner. Each year my college (University college) hosts a dinner for all associated physics and engineering students, fellows and tutors. The name pays homage to Robert Boyle, a physicist who did a great deal of pioneering work into the theory of gasses while at Univ. At the dinner, two speeches are given, one by a pair of engineers, one by a pair of physicists. Each subject speech is designed to provide insult and degradation to the opposing subject. This year, I was chosen to deliver the speech on behalf of the physicists, which was a great privilege.

In eighth week I attended a talk by Professor Andrew Wiles, entitled 'Rational points on elliptic curves'. This was a very interesting aside from my usual study into a purer area of mathematics. Towards the end of the talk, Professor Wiles related this topic to his proof of Fermat's last theorem.

Some updates from the last letter. I passed my space systems module so I'm now officially a rocket scientist (it's not as impressive as it sounds). We also finished our aluminium wing for AVDASI and performed some tests on it. The first test was an aerodynamic test in the open wind tunnel (figure 1). We were testing for lift and drag performance at different angles of attack as well as the performance of the flaps. One of our group leaders decided to add an extra feature on the leading edge (front) of our wing called vortex generators. These made the boundary layer, a very small layer of airflow on the surface of the wing, turbulent allowing the boundary layer to stay attached to the surface of the wing closer to the trailing edge (which is good it would usually become detached causing drag). If you didn't understand that then that makes two of us, anyway, I think it worked so this test went down as a success. The second test was a more important test to me as it was a structural test (which was my main specialty on this project). The wing was set up on the rig, as shown in figure 2, and "lift" was applied to the tip of the wing via a hand crank. I had the glamorous job of helping to create a graph on the fly of our wing deflection against load. The aim was for the wing to be able to take at least 900N of load, which is about 1.3 Tim's. Unfortunately, it did not make it and failed at 850N, about 1.25 Tim's, which was a little disappointing. This just goes to show the importance of practical testing against mathematical modelling as in our calculations the wing was not designed to fail.

Timothy South

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

Reading Aerospace engineering at Bristol University

At KES 2008 - 2015

Figure 1.

Figure 2.

Have you ever performed the falling-sphere viscometer experiment? It is a classical technique used to measure liquid viscosities. The experiment involves dropping a sphere through a large vertical tube of liquid. By measuring the spheres's velocity, you can calculate the viscosity of the fluid. When I did this experiment in year 12, we used a 2 m long tube filled with glycerol. The tube had a rubber bung on the bottom end. Unfortunately, during the experiment, the bung was accidentally kicked off and we left a large puddle of glycerol on the classroom floor (some of teachers/technicians who were around in 2007 might remember this).

Paul Jarvis

Studied Physics, Chemistry, Maths, Biology

Read BA and MSci natural sciences at Cambridge University

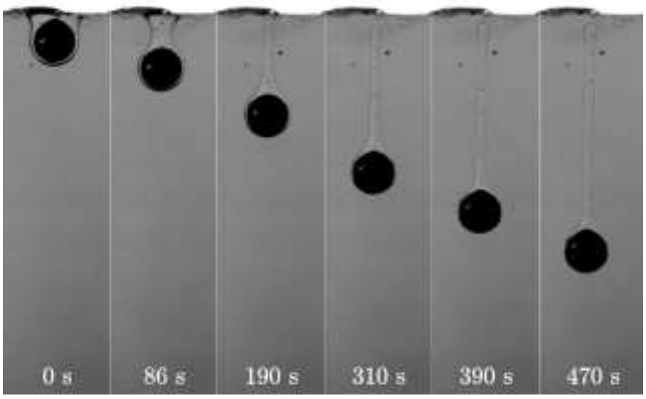
Ph.D. in Geology from Bristol University

Currently a post-doctoral research assistant at Cambridge University

At KES 2001 - 2008

Despite falling-sphere viscometers being around for over 250 years, similar experiments are still being carried out at the forefront of research. Some colleagues and I have recently written a paper on experiments studying what happens when falling spheres encounter a fluid interface. The figure shows a sphere settling from oil into golden syrup. It can be seen that the sinking process entrains oil, in the form of a tail, into the golden syrup. We showed that the larger the viscosity of the upper fluid relative to the lower fluid, the larger the volume of entrained fluid. Additionally, if the upper fluid was less viscous than the lower, no tail formed at all.

We performed these experiments to understand some of the processes that occur prior to volcanic eruptions. Magmas are mixtures of molten rock and solid crystals, and mixing between magmas of different compositions is a common phenomenon in magma storage regions beneath volcanoes. When scientists try to model the magma mixing process, they normally ignore the effect of the solid crystals because how solid particles behave at the interface between different fluids is a big unknown. Hopefully, the results of our experiments can help inform future magma mixing models, providing us with a greater understanding of the processes that might lead to volcanic eruptions.



Alex Broad

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

Reading Physics at Swansea University

At KES 2012 - 2014

This semester has consisted of modules on cosmology, climate physics, particle physics and atomic physics. Being in my final year, I have also started working on my project dissertation. My project is theoretical and focussed on string theory or, more specifically, the thermodynamics of strings. String theory is basically the idea that fundamental particles actually consist of one dimensional strings, and the results that arrive from this have many implications including the unification of gravity with the other forces. Aside from its most famous results, string theory also has some strange implications, including the temperatures at which strings exist. This is what I've mostly been focussed on this term. To understand the thermodynamics of these strings, I've had to read up a lot on string theory and about how strings move through space. In passing, I've learned some both fascinating and incredibly strange facts. My favourite of which is that the more basic forms of string theory require 26 dimensions to work, as opposed to the 4 space-time dimensions that we are used to. It's quite an interesting result that there could be an extra 22 dimensions that we don't know of. Also, in studying the thermodynamics of strings, I've learned that high energy strings only exist at a single temperature, called the Hagedorn temperature. This means you can keep adding energy to a string without increasing its temperature, which is very different from what we are used to. One of my favourite aspects of my degree is that you get to mathematically prove strange and interesting facts like these. Anyway, moving on from string theory, perhaps one of the most interesting things I've been studying this term is cosmology. In this module I've learned about what people know about dark matter and dark energy (which is actually very little!) and how the types of matter in the Universe affect the evolution of the size of the Universe. So this term for me has mostly consisted of a lot of theory and a lot of maths! As the semester continues, I will carry on working on string thermodynamics and will start finding out what happens when a gas of strings is brought in contact with a gas of ordinary particles, and so will be able to tell you all about that. Hopefully I'll find out more interesting stuff along the way!