

# Classroomphysics

The newsletter for affiliated schools

June 2012 Issue 21

## Ten years of IOP's Teacher Network

As physicist Niels Bohr possibly pointed out, prediction is very difficult, especially when it is about the future.

If you had asked me 10 years ago, when I first became involved with IOP's Teacher Network, what it would look like now, I doubt that my prediction would have been accurate.

The Teacher Network started with just six pilot network co-ordinators. We began by all having different ideas about what was needed locally. Partly this was playing to our own experiences and skills, but it was also because local needs varied and because of other factors such as geography (not the subject, the actual terrain).

After our initial success we continued to expand. Now we have around 50 network co-ordinators across England, Scotland, Northern Ireland, the Republic of Ireland and Wales. Not only do we have a bigger Teacher Network today but the success of the model has paved the way for the growth of other similar networks.

In England we now have the Stimulating Physics Network, of which the Teacher Network is a part. Network co-ordinators have influenced the creation of networks in Africa and the Perimeter Institute in Canada now has a network in full flow. The Royal Academy of Engineering has also begun its own network based on our model.

In Scotland, Ronna Montgomery and her team of co-ordinators are at the forefront of development, support and training for the changes to the curriculum.

In Ireland the co-ordinators have done a great deal to ensure that teachers are kept up to date with what is happening in physics education in the rest of the British Isles.

In Wales, the day meetings organised in both the north and south continue to deliver fantastic speakers and workshops to teachers from a large proportion of secondary schools.

What about the next 10 years? I hope that in time we will start to see the IOP Teacher Network as a mechanism for feeding back information about what works in the classroom; improving on available resources and ways of teaching, and building a



The IOP Teacher Network comes together to celebrate its 10th birthday.

community that is reflective in its practice and works together to give students the best experience of physics.

So if you are in one of the minority of schools that has yet to be involved in the networks then why not join us now and be a part of our next decade.

**For more information:** go to [www.iop.org/network](http://www.iop.org/network) and click on your area of the map to locate the physics network co-ordinator nearest to you.

**Gary Williams**, national co-ordinator, Institute of Physics Teachers Network

## Editorial



Welcome to the last edition of *Classroom Physics* for this school year. Our front-page story looks at the development of our Teacher Network over the last 10 years. If you have not yet been to a local event, perhaps now is the time to give it a go. There are one-day CPD events all around the country over the next few weeks; see p6 for further details. There is an update on our community website, *talkphysics.org* on p2, and news of the Education Forum, which is your opportunity to have a say about the future of the curriculum and examinations.

Pages 2 and 3 have news of two new IOP resources, the long-awaited *Teaching Medical Physics* and some short careers films, *Physics Lives*. If you have a seismometer languishing in your department, then read the article on p5.

The IOP physics prize winner at the Big Bang Fair in March is featured on p3 and the winners in the EDT's Engineering Education Scheme on p5. There is news of a European-wide project-based competition, "Odysseus", for teams of students aged 14–18 on p4.

The teaching tips this month feature advice on teaching about kinetic theory and Brownian motion (p7) and a visual aid for introducing the MRI scanner (p8).

Affiliated schools will also be receiving additional resources. These include a copy of the 2011 Nobel Prize in Physics poster, STFC posters celebrating the centenary of the discovery of cosmic rays, and the *Teaching Medical Physics* and *Physics Lives* DVDs.

If you would like to order any other resources from us, please go to [www.iop.org/education](http://www.iop.org/education) and click on "I am a teacher". You can ask for additional materials at any time by e-mailing [education@iop.org](mailto:education@iop.org). Remember to keep us informed if there are any changes to your school affiliation details, so that we can give you the best service possible.

Have a good summer!

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## Talk Physics is relaunched

 [talkphysics.org](http://talkphysics.org) | Linking teachers of physics



An improved version of the Institute's *talkphysics.org* website is being launched in June.

The site links teachers of physics and has had a successful first two years, averaging 65 discussion posts per week among its 5700 members, and with several people posting for the first time each week.

Discussions have included requests from non-specialist teachers for ideas on a year-7 sound demonstration lesson for a job interview ("Thank you all for your help! My lesson went really well, I had great feedback from the kids and got the job!"), a KS3 mechanics activity using an air crash "black box" ("Thank you for your ideas...this will be great for the summer term as a project...") and how to safely use a Van de Graaff

generator at an open day ("Fabulous!...Now I feel very confident indeed!").

Improvements to the new site include:

- simplified log in with e-mail address or username – never forget your log-in details again;
- preview function before submitting – no more spelling mistakes;
- the ability to tag content, enabling quicker and more targeted search responses;
- enhanced notification control, giving you the power to choose the notifications that you receive;
- equation editor to use in writing posts.

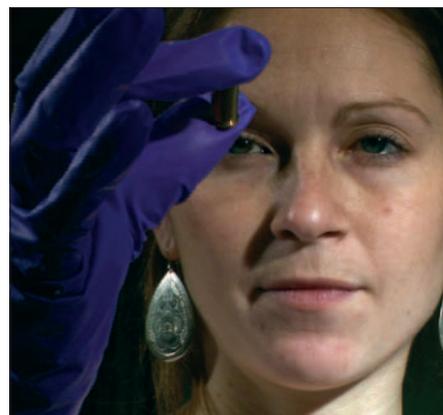
If you would like to join, register today at [www.talkphysics.org](http://www.talkphysics.org). If you have not logged in for a while, now is a great time to take another look.

## DVD explores physicists' lives

The Institute of Physics has released the *Physics Lives* DVD, which contains a series of four short films that focus on the working lives of university-based physicists.

Each film follows a different researcher: a theoretical physicist who spends time in his bath working on a problem that has a \$1m prize waiting for whoever is able to solve it; a space plasma physicist who wants to be the first person to unlock the secrets of the aurora; a forensic scientist who is using physics to devise a completely new way to help catch criminals; and a physicist-entrepreneur who has developed a machine to monitor air quality.

Suitable for students between the ages of 14 and 19, the films are a resource for both teachers and career advisers wanting to demonstrate the broad range of work that physicists do, why they do it and how their research is applied to real-world problems.



*Dr Melanie Bailey from the Ion Beam Centre, University of Surrey, analyses gunshot residue.*

**For more information:** please e-mail [hestem@iop.org](mailto:hestem@iop.org) to find out more about this new DVD and if you would like additional copies.

## Would you like to help shape physics education? Education Forum calls for new members

Are you interested in contributing to the Institute's education policy and providing advice and feedback during this period of change?

Perhaps you would like to help with organising teacher events and conferences?

If you can answer "yes" to these questions, you might consider joining the Institute's Education Forum.

The forum is open to members of the Institute or to the nominated teacher in an

affiliated school. It meets periodically and we also exchange views on the *talkphysics.org* forum. Recently, we have had discussions about the structure of GCSEs, the new National Curriculum and UCAS admissions.

**For more information:** if you are interested in joining the Institute's Education Forum, please go to [www.iop.org/educationforum](http://www.iop.org/educationforum) and apply to become a member.

# IOP prize at the record-breaking Big Bang Fair

A student from The Royal Grammar School in Guildford is this year's winner of the Institute of Physics prize for the best physics project at the National Science and Engineering Competition at The Big Bang Fair 2012.

Several hundred young people competed for a range of prizes, including UK Young Scientist and Young Engineer of the Year.

Mark Hammond won the physics award with his project on "Ozone layer monitoring". He also won a CREST award trip to the US to represent Great Britain at the Intel International Science and Engineering Fair. He received his prize from the IOP president Prof. Sir Peter Knight at the show's awards ceremony.

Mark employed a number of skills to excellent effect with his project, including electronics, construction, data collection and analysis, internet research and data presentation on *Google Maps*.

Charles Tracy, head of education pre-19 at IOP and one of the judges of the physics prize, was impressed with the winning project and student: "We liked this project a lot because it brought together so many aspects of physics and, in that sense, typified physics research. Mark had a thorough and clear understanding of the physics he used and explained this (and the whole project) clearly and enthusiastically. He also encountered a number of unexpected problems along the way that



Mark Hammond (right) with Prof. Sir Peter Knight (centre) and Greg Foot, "science junkie" (left).

he tackled and solved admirably. Mark is already an impressive scientist."

A record-breaking 56 000 people attended the Big Bang Fair 2012. The National Exhibition Centre in Birmingham was a popular venue for the biggest show held so far. Visitors of all ages had a great

time, with 98.5% of them reporting that the event was enjoyable. More than nine out of ten 8–19 year olds said that they would recommend The Big Bang Fair to their friends.

Next year's show will take place at ExCel, London, on 14–16 March 2013.

## Support your students with the free 'Teaching Medical Physics' DVD

Our newest DVD is included with this issue of *Classroom Physics* and contains both the updated version of our ever-popular *Teaching Medical Physics* resource and video clips of the 2011 IOP Schools Lecture "From X-rays to antimatter: the science of seeing inside your body". Both are intended to support the teaching of GCSE and standard-grade science using examples that have been taken from the field of medical diagnostics.

The *Teaching Medical Physics* resource contains seven sets of presentations, worksheets and teacher notes on the topics listed in the table.

To complement the chapter on electrocardiograms, a poster of the heart has kindly been provided by the British Heart Foundation.

A leaflet providing guidance on careers in medical physics has also been supplied by the Institute of Physics and Engineering in Medicine (IPEM).

Teaching resources	Curriculum links	Schools lecture
Pulse oximeters	Visible and infrared light Diodes	Chapter 2: pulse oximetry
Ultrasound scans	Sound Longitudinal waves	n/a
X-ray imaging	Electromagnetic spectrum Background radiation	Chapter 3: X-rays Chapter 5: CT scanning
Electrocardiograms	CRO traces Frequency	n/a
Magnetic resonance imaging	Radio waves Electromagnets Electromagnetic induction	Chapter 6: MRI Chapter 8: functional MRI
Gamma camera	Types of ionising radiation Half-life	Chapter 4: nuclear medicine
Positron emission tomography	Isotopes Momentum conservation	Chapter 7: PET scans

**For more information:** visit [www.teachingmedicalphysics.org.uk](http://www.teachingmedicalphysics.org.uk) where the resources are also available

and the full version of the schools lecture can be downloaded from [www.iop.org/schoolslecture](http://www.iop.org/schoolslecture).

# Cutting Edge delves into diving and cycling

Throughout 2012, join world-class researchers and Team GB/Paralympics GB stars in locations across the UK, to see athletic demonstrations, discuss elite performance and share your views on the research behind the UK's sporting achievements.

Visit the world-class Plymouth Life Centre on 5 July to hear about the research that lies behind the perfect dive. Andy Banks, coach of Team GB stars such as Tom Daley, will discuss how research brings out the best in his athletes. Prof. Alan Wing, an expert in human movement, will discuss what his work tells us about how divers synchronise their movements and Prof. Andrew Lane will discuss "emotion regulation" – working



with athletes to maximise their performance under pressure. On 19 July, sports scientist Prof. Steve Haake will host an evening of debate looking at the research that lies behind Team GB's success. Visit the Scottish

Exhibition and Conference Centre in Glasgow to put your questions to the experts and take part in a demonstration-packed, interactive evening. A world-class cyclist will join the panellists Dr Harry Rossiter, a physiology expert discussing how to enhance elite performance in sport, and Prof. Louis Passfield exploring the fine line between nutrition and doping in sport.

At both events, Dr David James will lead discussions on how far research and new technologies should be used in the quest to win gold.

**For more information:** visit [www.rigb.org/cuttingedge2012](http://www.rigb.org/cuttingedge2012) to find out more and to register for free tickets.

## Science festivals set to light up the summer

This summer, more than 300 scientists, thinkers, comedians and writers will be celebrating all things scientific at *The Times* Cheltenham Science Festival (12–17 June). The programme is a mix of cutting-edge discoveries, provocative debates, comedy, cabaret, family fun, hands-on experiments and workshops with topics ranging from medicine to technology, economic recovery to energy and the role of science in society. Festival directors Mark Lythgoe and Kathy Sykes are looking forward to the six-day event: "We love the fun and variety of this festival, and the blend between the absurd and the serious, the universal and the personal. Join us in June and discover the world around you in a new light."

If you have already made plans for your half-term break but still want to attend a science festival, Aberdeen will be hosting the British Science Festival later in the year. The Institute has organised a day of "Science in the quad" activities on 8 September at Robert Gordon's College,



*Dr Hal's sparks demonstration at the Times Cheltenham Science Festival.*

and again there will be a range of excellent talks, workshops and drop-in activities, such as "Physics in the field" and Prof. Martin Hendry's talk "20/20 vision: the future of astronomical observation". Robert Gordon's College will also be hosting the IOP Schools and Colleges Lecture "Physics and the games: a winning formula" on 7 September.

**For more information:** if you want to find out more about *The Times* Cheltenham Science Festival, visit [www.cheltenhamfestivals.com/science](http://www.cheltenhamfestivals.com/science). Contact Stuart Farmer (e-mail [stuart.farmer@yahoo.co.uk](mailto:stuart.farmer@yahoo.co.uk)) or visit [www.britishsciencefestival.org](http://www.britishsciencefestival.org) for further information about the British Science Festival.

## Students journey into space with Odysseus

The Odysseus Contest is a project-based science competition for groups of students aged between 14 and 18 years.

Students who would like to participate in the competition must form teams of two to five members, with a teacher as coach, and submit an innovative project based on one of three categories:

- the solar system;
- spaceships and global co-operation;
- co-evolution of life.

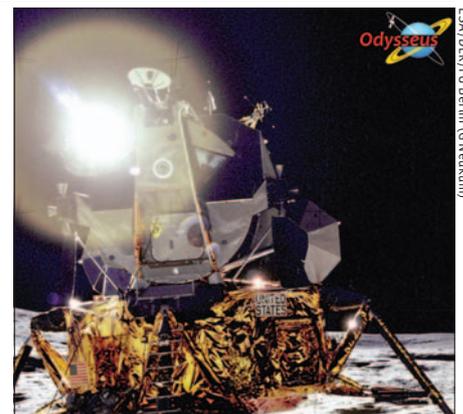
Teams were able to register their details from 1 May 2012 and the competition is open for submissions from 1 July 2012 to

15 January 2013.

Participants will be competing to win a once-in-a-lifetime educational experience at Space Expo, based at the European Space Agency's largest technical establishment in the Netherlands.

If you have students dreaming of careers in space exploration this might be the contest for them.

**For more information:** for the key dates relating to the contest and to find out more about this exciting opportunity, visit [www.odysseus-contest.eu](http://www.odysseus-contest.eu).

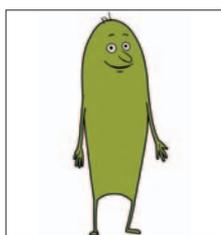


*Spaceship and global co-operation (one of the categories from the competition).*

# Nobel prize and Oxford Sparks websites

One of the best ways to make physics come alive is by telling stories about physics discoveries and the people who made them. However, if this is to be done with accuracy, the teacher needs to know a great deal of historical and scientific background, preferably from sources other than *Wikipedia*. A number of such alternative sources have recently been developed, including <http://trailblazing.royalsociety.org> – an interactive timeline of 60 key scientific articles published by the Royal Society; [www.chemheritage.org](http://www.chemheritage.org) – a rich archive about chemistry; and [www.nobelprize.org](http://www.nobelprize.org), which contains an abundance of information about the different prizes and all past prize-winners.

The Nobel prize website, in particular, contains video clips of interviews with Nobel laureates and their lectures, detailed biographical information about them, articles about the physics behind the prizes, and the historical and scientific



Tour the LHC with the Oxford Sparks character.

backgrounds against which the key findings and developments were made. This makes it the ideal resource to direct students towards when they are researching a number of

different topics.

A team at the University of Oxford have been developing “Oxford Sparks” ([www.oxfordsparks.net](http://www.oxfordsparks.net)) – an online showcase of scientific research at Oxford. The highlights of the site are two-minute animated “nuggets”, each covering a different area of cutting-edge science. The Large Hadron Collider (LHC) is the first topic developed and there are associated teaching resources. The activities range from looking at the footprints of the Higgs Boson, to how



The magnets in the LHC ring.

the different LHC detectors are “looking back in time”, to a particle quest. This last activity is aimed at KS5 students and helps them to gain a deeper understanding of both the science of the Standard Model and the nature of science.

**For more information:** visit the Nobel prize ([www.nobelprize.org/nobel\\_prizes/physics](http://www.nobelprize.org/nobel_prizes/physics)) and Oxford Sparks ([bit.ly/J12UgT](http://bit.ly/J12UgT)) websites to find out more.

## Wind drives physics students project win

A team of year-12 physics students from Teesdale School in Barnard Castle have recently won the prestigious Nissan Rose Bowl award. As part of the EDT’s Engineering Education Scheme, the students spent six months producing a feasibility study into how wind power could reduce their school’s energy budget. The group examined wind turbines and visited Newcastle University for a three-day workshop where they were able to design a prototype machine. They were backed by GlaxoSmithKline who provided ongoing support to both the school and students. Iain Clyde, the director of science



at Teesdale School, said that the assessers had been very complimentary about the students’ work and the clarity of their report: “I am very proud of the team...There has been a lot of hard and detailed work for which the Nissan Rose Bowl is just reward.”

Each group of students competed in regional events to showcase their projects and deliver a presentation, and were assessed by a panel of industry representatives. The scheme enables students to work on real-world industrial problems set by companies involved in the initiative. It aims to enhance employability,



The award-winning team with teacher and mentors at the EDT’s celebration event.

increase awareness of STEM (science, technology, engineering and maths) careers and courses, and provides students with access to role models and mentors.

**For more information:** contact EDT (e-mail [info@etrust.org.uk](mailto:info@etrust.org.uk) or tel 01707 871 528) or visit [www.etrust.org.uk](http://www.etrust.org.uk).

## What do you see – scrap metal or a seismic observatory?

Since the British Geological Survey’s School Seismology Project was launched in 2007, it has helped to make classroom-based science more engaging and relevant.

More than 500 schools across the UK and Ireland now have a seismometer and many have managed to set up their own seismic observatories, which can detect and analyse seismic signals from large earthquakes originating anywhere in the world, as well as more esoteric vibrations ranging from ocean waves to church bells.

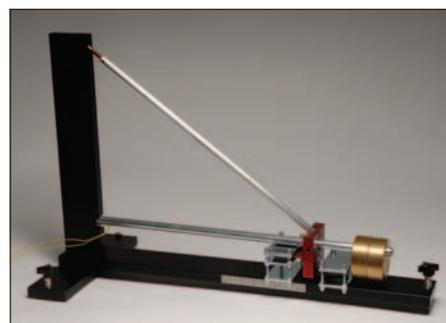
In 2011, the winner of the IOP prize for the best physics-based project at the Big Bang Science Fair went to a student from Thomas Hardy School in Dorset, who used one of these instruments.

Your school may already have one of these

seismometers. It might be in the science department’s storeroom or even in the geography department. Perhaps the teacher who first obtained the equipment has since moved on.

Why not arrange to have a refresher course in making use of this valuable resource? Paul Denton of the British Geological Survey can arrange training workshops for teachers or technicians who would like to learn how to make best use of their seismometer.

A set of simple classroom activities have also been written in collaboration with the Gatsby Science Enhancement Programme. These activities are freely available from the National STEM Centre’s website ([www.nationalstemcentre.org.uk](http://www.nationalstemcentre.org.uk)).



A school seismometer system ready to work.

**For more information:** contact Paul Denton (e-mail [pdenton@bgs.ac.uk](mailto:pdenton@bgs.ac.uk)) to arrange a workshop or visit [www.bgs.ac.uk/ssp](http://www.bgs.ac.uk/ssp). The seismometer equipment is available from Mindsets ([www.mindsetsonline.co.uk](http://www.mindsetsonline.co.uk)).

# Events

## EVENTS FOR TEACHERS

### Astrophysics

*University of London Observatory, Mill Hill*  
12 June

This one-day course focuses on key theories of space science using the facilities at the observatory. The course fee is £150 but a bursary is available to cover cost. Details: visit [www.slcs.ac.uk/go/lon/inc11001](http://www.slcs.ac.uk/go/lon/inc11001).

### Day Meeting for Teachers of Physics

*RAF Museum Cosford, Shropshire*  
13 June

This all-day free event will include a varied programme, a choice of workshops, lunch, refreshments and a goody bag. It has been organised by local physics teachers who run the local network: Nicky Thomas, Richard Bonella and Tom Dawson. Details and booking: contact Tom Dawson (e-mail [physicsiseasy@googlemail.com](mailto:physicsiseasy@googlemail.com)).

### Rugby Meeting

*Rugby School, Warwickshire*  
14 June

The 24th annual meeting for teachers of physics in schools and colleges will provide a mixture of information, stimulation and communication, as well as an exhibition. Details and booking: visit [www.iop.org/rugby](http://www.iop.org/rugby).

### IOP Teacher Network for North Wales Conference

*Bangor University*  
19 June

This year is the fifth annual conference and it is as packed as usual with exciting workshops. If that isn't enough, there is a lunch, goody bags and a lecture on lasers from IOP president Prof. Sir Peter Knight. Details and booking: contact Andrea Fesmer (e-mail [andrea.fesmer@talk21.com](mailto:andrea.fesmer@talk21.com)).

### A Day for Everyone Teaching Physics

*Durham University*  
21 June

A free day for anyone teaching physics, including a keynote lecture that will link physics to the latest developments in forensic science, given by Prof. Julie Mennell. There will be workshops and an exhibition. Details and booking: visit [www.sciencelearningcentres.org.uk/centres/north-east](http://www.sciencelearningcentres.org.uk/centres/north-east).

### South West Physics Teachers' Conference

*St Luke's Campus, University of Exeter*  
22 June

This will be an event for anyone involved in the teaching of physics – teachers and technicians. It will comprise a lively programme of lectures and workshops. Details: contact Alison Alexander (e-mail [alisonalexander@aol.com](mailto:alisonalexander@aol.com)).

### Physics and Science Teaching at KS4

*Manchester Metropolitan University*  
22 June

This one-day event features a mixture of presentations and an exhibition. Details and booking: visit [www.sci-eng.mmu.ac.uk/physics2012](http://www.sci-eng.mmu.ac.uk/physics2012).

### Masterclass for A-level Physics

*Science Learning Centre London*  
2 July

This course supports the teaching of A-level physics. The course fee is £150 but Impact Award bursaries are available to cover costs. Details and booking: visit [www.slcs.ac.uk/network/11296](http://www.slcs.ac.uk/network/11296).

### Summer Physics Update

*University of Birmingham*  
6–8 July

A three-day residential course featuring a mixture of talks and hands-on workshops based at the university's physics department. Details and booking: visit [www.iop.org/update](http://www.iop.org/update) or contact Manchi Chung (e-mail [manchi.chung@iop.org](mailto:manchi.chung@iop.org)).

### Space Conference for Science Teachers

*Science Learning Centre East Midlands and the National Space Centre*  
7–8 July

We aim to show how space can be used as an inspirational hook to deliver curricula in STEM subjects in schools and colleges. Practical hands-on sessions give insights into the role of space in modern life and how to relate these to a range of science topics. Details and booking: contact the Science Learning Centre East Midlands (e-mail [slcem@le.ac.uk](mailto:slcem@le.ac.uk) or tel 0116 252 3771).

### Active Approaches in A-level Physics

*Science Learning Centre London*  
11 July

This course supports the teaching of A-level physics. The course fee is £150 but Impact Award bursaries are available to cover costs. Details and booking: visit [www.slcs.ac.uk/network/11090](http://www.slcs.ac.uk/network/11090).

## EVENTS FOR STUDENTS

### IOP 2012 Schools and Colleges' Lecture – Physics and the Games: A Winning Formula

This free lecture for 14–16 year olds, given by a team from Sheffield Hallam University's world leading Centre for Sports Engineering Research, continues its tour. Details: visit [www.iop.org/schoolslecture](http://www.iop.org/schoolslecture).

### GCSE Physics Taster Events

These events are for students who are just about to start or who have just started GCSE physics (usually year 9). You are invited to

bring a group of students to this free half-day event at a SEPnet partner campus. This event covers "Energy and energy resources" and consists of a lecture and a circus of hands-on activities. Details: e-mail [gcse@sepnet.ac.uk](mailto:gcse@sepnet.ac.uk).

### National Space Academy Year-10 Careers Events

*National Space Centre, Leicester*  
25 June and 2 July

These free events are for high-ability students and aim to show the diverse job and career opportunities available within the UK space industry, including how studying science subjects at A-level can open doors into exciting careers. Details and booking: visit [www.spacecentre.co.uk/Page.aspx/228/CAREERS](http://www.spacecentre.co.uk/Page.aspx/228/CAREERS).

### Physics at University Taster for Year-12 Students

*University of Surrey*  
26 June, 10 or 17 July

This full-day event gives sixth-form students the opportunity to get a feel for life at university. They will have a lecture from one of our academics, a practical in our undergraduate labs, a campus tour and a chance to meet and talk to some of our students. Details and booking: contact Clare Harvey (e-mail [c.l.harvey@surrey.ac.uk](mailto:c.l.harvey@surrey.ac.uk)).

### Physics Competition for Year-12 Students

*University of Surrey*  
2 or 3 July

Schools and sixth-form colleges can enter teams of six pupils into this one-day challenge. Instructions will be provided on the day and no prior preparation is required. Details and booking: contact Clare Harvey (e-mail [c.l.harvey@surrey.ac.uk](mailto:c.l.harvey@surrey.ac.uk)).

### The Physics Paralympian 2012

2 July – Northgate High School, Ipswich  
10 July – Uppingham Community College, Rutland

These parallel competitions are for teams of four year-9 students; book early to secure a place for your school. Details: East of England, contact Gerry Blake (e-mail [g.blake@sep.org.uk](mailto:g.blake@sep.org.uk)); East Midlands, contact Helen Pollard (e-mail [h.pollard@sep.org.uk](mailto:h.pollard@sep.org.uk)).

### Space School

*University of Kent*  
4–5 and 11–12 August

The university is now recruiting 11–18 year olds for this year's Space School. It will be held on campus during the first two weekends of August to coincide with the annual Perseid meteor shower. Details and booking: visit [www.kent.ac.uk/physical-science/spaceschool](http://www.kent.ac.uk/physical-science/spaceschool).

# Teaching about particles and kinetic theory

Kinetic theory is one of the “big ideas” in science. Although the mathematical developments go beyond GCSE, an understanding of the core ideas is a powerful tool for GCSE science courses. Thinking about the causes of observed behaviour involves model building and theorising, and the story of the development of kinetic theory demonstrates the interaction between observation and experimentation.

Your first port of call for teaching support might be *Practical Physics*, where there is a whole section called “Molecules in motion”. The suite of experiments leads students from the classification of solids, liquids and gases into considering why there is this variety of forms. They can build theories about the atomic structure of matter, guided by the hints given by the many experiments, and discuss the limitations of any models they are shown or devise themselves.

## Brownian motion: facts and myths

Robert Brown is correctly referred to as having observed the jittering motion of small particles. But he wasn't the first to record the observation, and he did not observe the motion of actual pollen grains. The title of Brown's paper was “A brief account of microscopical observations...on the particles contained in the pollen of plants”. Pollen itself is too large (and hence has too much mass) to be small enough to be buffeted significantly by water molecules. A recent reference pointing this out in *Nature* (10 March 2005 p137). The first recorded observation of what we now call Brownian motion was made in 1785 by Jan Ingenhousz using charcoal dust (*Nature* 7 June 2001 p641). Having used particles derived from living matter, Brown had to try several other inanimate substances to convince himself that the motion he observed was not something to do with a “life force”, but a property of all microscopic matter. This “systematic investigation” is what won Brown the accolade of having the jittering motion named after him, work that Ingenhousz did not need to do.

## Brownian motion in a smoke cell

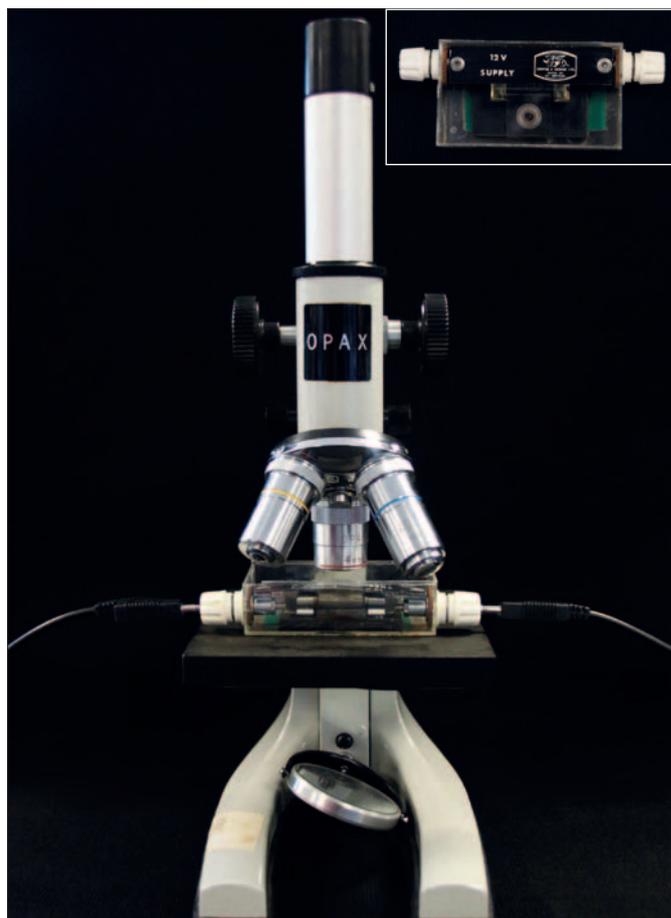
This is a “classic” experiment that gives strong circumstantial evidence for the particulate nature of air. You might have some smoke cells languishing in your cupboards, but not be sure how to set them up effectively. The advice below comes from *Practical Physics*.

## Technical notes

The smoke can come from a piece of burning cord using a dropping pipette or a burning straw (preferably a paper art straw). The straw should burn at the top and then be extinguished. The bottom end of the straw should poke into the plastic smoke container. The cell might need to be cleaned if a waxy or plastic straw has been used. Remove the glass cell from the assembly to clean it. Afterwards, push it fully back into the assembly. It might help to wet the outside of the glass tube. You will find it helpful to clean the glass cell after every five to 10 fillings to obtain the best results; otherwise the light intensity is reduced. The cell is illuminated from one side to make the smoke particles visible under the microscope. A small piece of black card prevents stray light from the lamp reaching the eye. The lamp is placed below the level of the glass rod to minimise convection.

## Procedure

- A** Fill the cell with smoke using a dropping pipette and cover it with a glass cover slip. This reduces the loss-of-smoke rate from the cell.
- B** Place the cell on the microscope stage and connect to a 12 V power supply.



The smoke cell under a microscope and the cell seen from above (inset).

- C** Start with the objective lens of the microscope near the cover slip. While looking through the microscope, slowly adjust the focus, moving the objective lens away from the cover slip, until you see tiny dots of light.
- D** Watch the particles carefully. Note what you see.

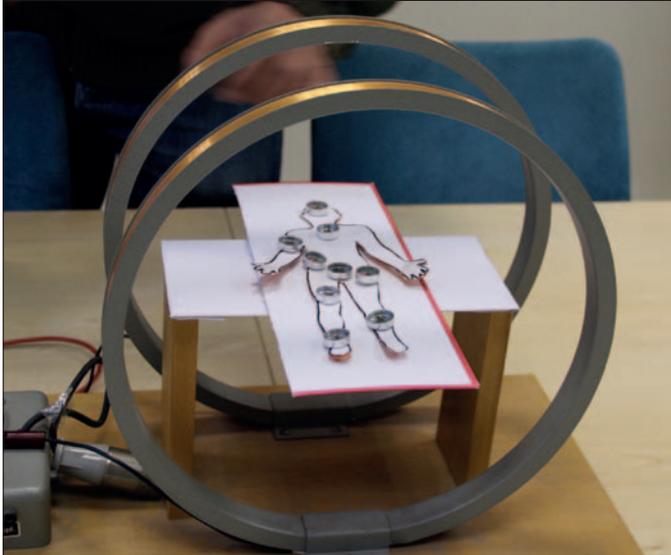
*Practical Physics* has some detailed teaching notes on how you might discuss what is seen with your students. In addition there is a short video, produced by the National STEM Centre and the Institute of Physics, which clearly illustrates how to show the movement of particles by Brownian motion.

Instead of using the traditional smoke cell, the video shows how Brownian motion can be observed in a suspension containing micrometre-diameter polystyrene spheres. Using a microscope and video camera, students can observe the motion of the polystyrene spheres. The video also shows how Brownian motion can be simulated using a vibrating loudspeaker, table-tennis balls and a small balloon.

If you don't have any smoke cells, you can buy a Brownian motion pack from Mindsets online. The very modestly priced pack includes Brownian motion fluid (as described in the video mentioned above), two CD-ROMs (with background information, details of experimental protocols and video clips) and an information booklet.

**For more information:** the pages in *Practical Physics* are available at [www.practicalphysics.org](http://www.practicalphysics.org) – then click on “molecules in motion”. The video is available to view at [www.nationalstemcentre.org.uk/elibrary/resource/4098/brownian-motion](http://www.nationalstemcentre.org.uk/elibrary/resource/4098/brownian-motion). The Brownian motion pack is available from Mindsets online at [www.mindsetsonline.co.uk](http://www.mindsetsonline.co.uk) – then search for “Brownian motion pack”.

# A visual aid for introducing magnetic resonance imaging to students



Helmholtz coils and “the patient” used to demonstrate an MRI scan.

In this demonstration, coils, plotting compasses and a neodymium magnet are used to represent the magnetic resonance imaging (MRI) scanner, hydrogen nuclei (within the patient’s body) and radio waves, respectively.

### Apparatus required

- A pair of coils (e.g. the Helmholtz coils supplied with Teltron tubes).
- A power supply (capable of supplying a current of 1 A for coils).
- Several plotting compasses (to represent hydrogen atoms).
- Card, scissors, Blu-Tack (to make a “patient”).
- A neodymium magnet.

### Demonstration

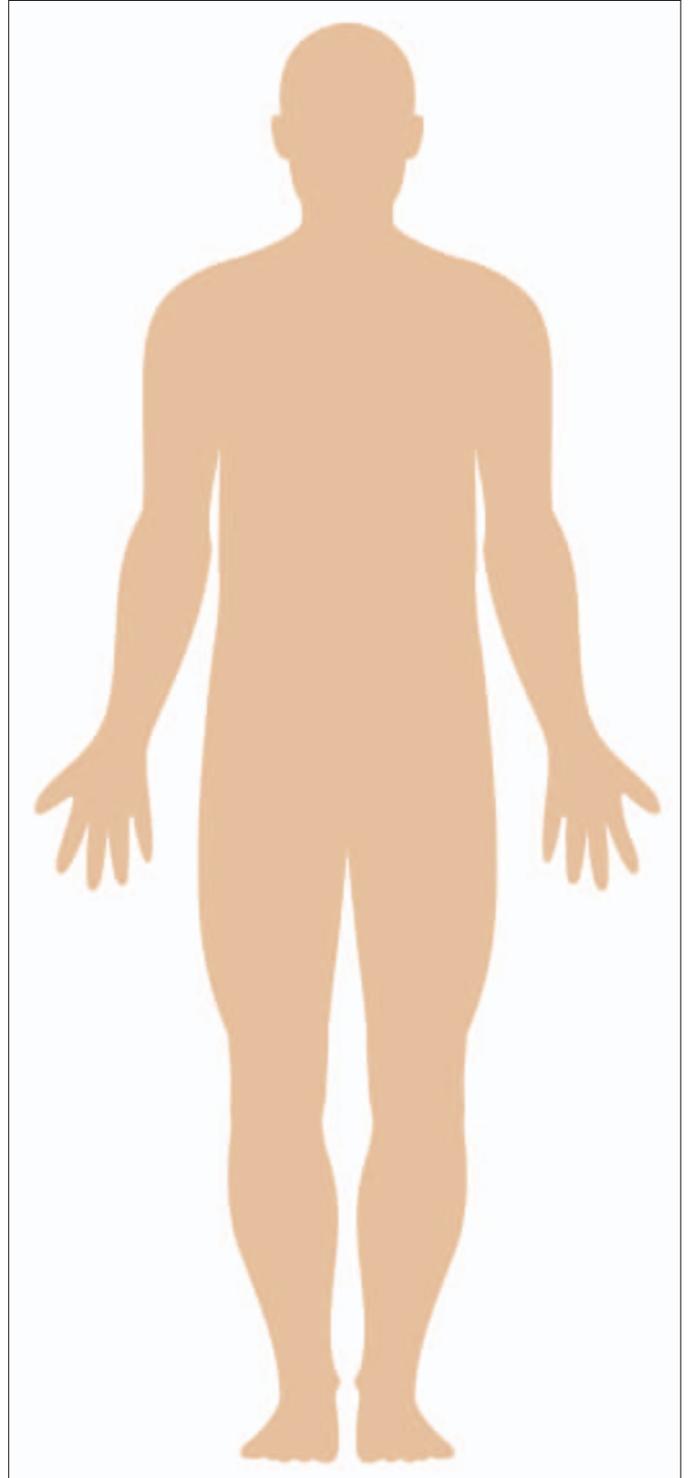
- Photocopy the body shape (right) onto the card and attach plotting compasses using the Blu-Tack.
- Place the coils so that the axis is approximately east-west and connect the power supply to the coils in series.
- Limit the current to 1 A. Place the patient in the field and the plotting compasses should align with the field.
- Bring the magnet up to the patient (along the north-south direction) and show the students that the compass needles have been disturbed.
- Remove the magnet and the needles re-align with the main magnetic field.

### Discussion

When discussing the demonstration it is worth pointing out two important differences between what happens in a real MRI scanner and the demonstration above.

1. The alignment of hydrogen nuclei in the body prior to placing the patient in the scanner is random (unlike the plotting compasses, which align north-south).
2. In a real MRI scanner the hydrogen nuclei are disturbed by the oscillating magnetic field of a radio wave (rather than the static magnet field of a neodymium magnet).

**For more information:** further details about the principles of MRI



Body outline to use in MRI visualisation.

are available in the enclosed *Teaching Medical Physics* DVD (MRI teaching notes and chapters 6 and 8 of the 2011 IOP Schools Lecture).

**Dr Taj Bhutta**, careers and student officer pre-19, Institute of Physics. With thanks to **Debbie Hill** of The Institute of Cancer Research who introduced the idea to me.