{jIAPS I-2008}

Journal of the International Association of Physics Students

... the President of IAPS

ICPS 2007 was bigger and more popular than ever, this time the conference was fully booked by June and we now have to wait until August until the next one in Krakow, so the question is how are we going to fill the time? Clearly there is a great demand for international physics related events and for chances to meet and talk with people with different experiences.

Some ideas are easy to come up with, you can hear from dozens of different people about their trip to CERN or how they are helping to combat the declining popularity of science in their countries with outreach activities and science fairs. Great, but we want more, what we really would like is to hear what you would want to do in terms of events or even better, something you think would be interesting for other IAPS members and you would like to organize with our support.

If that grabbed your attention and you want to get up, act and do something, but are not sure what, that's ok too. IAPS has all sorts of jobs for volunteers; big and small, from long term projects to one off tasks, we need trip organizers, webmasters, translators, recruiters, promoters and so on. Currently we are planning trips, getting funding for next year, updating our IT infrastructure and already preparing the next issue of jIAPS. Plenty to do for all kinds of physicists! It doesn't even matter if you are not our member of any local or national committee, IAPS is for all physics students and we are always interested in finding connections to new parts of the world. So get involved.

Tomi Pieviläinen
President of IAPS

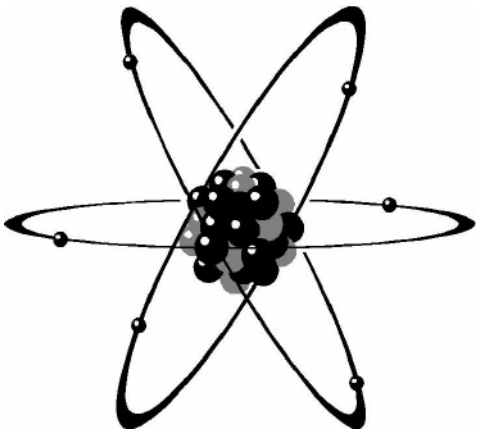
... the Editor

Hello and welcome to my first ever issue of jIAPS. This issue is full of exciting physics including an interview with Nobel Prize winner Gerard t'Hooft and articles on everything from finance to flying machines.

We also have a letter from the IAPS president urging you to get involved. I would like to add my voice to this call; IAPS is nothing without its members and jIAPS is nothing without its writers and contributors. jIAPS needs stories, write and tell the world what you are doing in you research, what role you think physics students play in the world or about anything physics related. I would also welcome pictures, cartoons, or jokes. Please do not hesitate to make your voice heard.

I would like to thank all the contributors to this issue of jIAPS and once again I hope you enjoy it.

Anne Pawsey



Journal of the International Association of Physics Students (jIAPS)
This issue of jIAPS was produced by Anne Pawsey and Job van der Zwan with support from Jim Grozier, Laura Pickard, and Cary Pint. Contributions by Jim Grozier, Keith Lambkin, Emily Fair and Colin Stuart, Richard Branch, Pim Lubberdink and Bernadette Kruijver, Leila Satay, Christopher Bailey.

jIAPS is the journal of the International Association of Physics Students (IAPS). IAPS is an international, non-political, non-governmental, non-profit-making, student-run educational association. It comprises students and recent graduates who are interested in physics (hereafter physics students). Its aims are to encourage physics students in their academic and professional work in an international context, to promote peaceful relations among physics students around the world and to expose them to the international community, help them to build professional relations and foster a collaborative attitude amongst young physicists across the globe. For contact information see http://www.iaps.info

Would you like to write for jIAPS?

Do you write? Can you communicate science? We need articles for our upcoming issue. We are looking for articles covering all aspects of physics, from the latest breakthroughs in laboratory research all the way to the physics of Iron Man, and everything in between. If the subject is interesting and is somehow related to physics, we would be glad to hear about it. Try your hand at scientific journalism, or just send in a comment on something you think other physicists should know about. Strong opinions and controversial topics welcome.

Do you have ideas already? Great! If not, don't worry, we have.

What are the issues facing young physicists today? Is industrial physics crushed by the sublime thrill of unravelling the mysteries of the universe, or does anyone actually need astrophysicists and theoreticians when we already have poets?

Whatever your point of view, whatever your issue, let us know what you think.

How to contact us

President: thepresident@iaps.info
Executive Committee: ec@iaps.info
jIAPS Editor: jiaps@iaps.info

{jIAPS}

Upcoming events

Title	International Young Scientists' Conference on Applied Physics
Date	11th-13th June 2008
Location	Kyiv, Ukraine
Details	www.rpd.univ.kiev.ua/conference/icap/index.php?eng
Title	IAPS / Mafihe Summer School- Nanophysics
Date	7th-14th July 2008
Location	Gyenesdiás, Hungary
Details	http://nyisk.mafihe.hu/
Title	International Conference of Physics Students 2008
Date	6th-13th August 2008
Location	Cracow, Poland
Details	http://www.icps.agh.edu.pl/
Title	Simposio Nacional de Estudiantes de Física 2008,
Date	18th-22nd August 2008
Location	Lima, Peru
Details	ec@iaps.info
Title	54th International Student Conference
Date	18th August-12th Specember 2008
Location	Tokyo, Japan
Details	http://isc-japan.net/english/index.html

For more information on all of these events please see the IAPS website: www.iaps.info

Sir Joseph Rotblat, 1908-2005

Sir Joseph Rotblat – physicist, Nobel peace prize winner and honorary member of IAPS – died on 31 August 2005, at the age of 96.

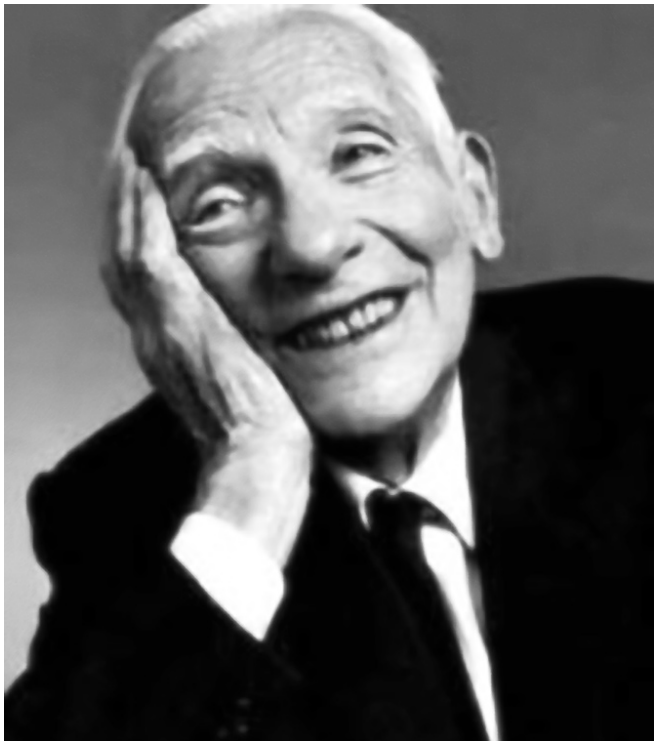
Born in Warsaw in 1908, the young Rotblat grew up during World War 1. The war damaged his family's prosperity so much that in order to achieve his dream of becoming a physicist, he had to work as an electrician during the day and study by night. Leaving Poland just before Hitler's invasion, Rotblat moved to England and worked in Liverpool with James Chadwick (discoverer of the neutron). In 1944 he moved to Los Alamos in the USA to work on the atomic bomb. He left the project when it became clear that its original motivation – the threat of a Nazi atom bomb – was no longer a possibility.

After the war, Rotblat learned that his wife – who had remained in Poland in 1939 because she was ill – had died in the Warsaw ghetto, possibly at the hands of the Nazis.

For the rest of his long life, he campaigned against the manufacture and use of nuclear weapons. In 1955 he was one of a small group of physicists who signed the Russell-Einstein Manifesto, calling for a halt to the production of nuclear weapons. He also applied his knowledge of nuclear physics to medicine as a professor of physics at London's St Bartholomew's Hospital where he pioneered the use of both cobalt-60 and iodine-131 for radiotherapy and diagnostics respectively. His techniques were initially opposed by the physicians who must have felt that a pure scientist had no place in a hospital.

Otto Frisch, the discoverer of nuclear fission, worked with Rotblat at Los Alamos; in his autobiography, What Little I Remember, Frisch said: "He was a kind, outgoing person, always looking after others, always trying to help people. He … has done as much for peace as anyone I know."

In 1957, Rotblat organised the first of many Pugwash Conferences on Science and World Affairs. These conferences gave rise to the Pugwash organisation of concerned scientists which has campaigned for 50 years against nuclear weapons. Rotblat was its first Secretary-General. In 1995, his efforts were recognised with the Nobel Peace Prize, awarded jointly to Pugwash and Rotblat.



Jim Grozier Reflects on his Experience of this Remarkable Man.

I remember Sir Joseph Rotblat speaking at the first ICPS I ever attended, in 2001, when he was 92 years old. He gave an impassioned speech and then opened up the meeting for contributions from the floor, and it turned into a debate about ethics in science. Afterwards, many of us signed the Pugwash Pledge:

"I promise to work for a better world, where science and technology are used in socially responsible ways. I will not use my education for any purpose intended to harm human beings or the environment. Throughout my career, I will consider the ethical implications of my work before I take action. While the demands placed upon me may be great, I sign this declaration because I recognize that individual responsibility is the first step on the path to peace".

In summer 2005, the Pugwash organisation sent out an announcement about the 50th anniversary of the Russell-Einstein Manifesto on July 9th,

and encouraged supporters to write to Rotblat and congratulate him on the anniversary and on all the work he had done to promote peace. (I guess they knew he was dying by then). I made a mental note to do this, but missed the anniversary, and consequently, when I did write, was able to place it in the context of the terrible bombings that had occurred in London two days before. I wrote:

"I understand that Saturday July 9th was the 50th anniversary of the Russell-Einstein Manifesto, when you and your colleagues stood up and spoke out about the evils of nuclear weapons.

Two days before that, of course, we had a horrific, but timely, reminder about the evils of using science to kill and destroy. OK, the terrorists' bombs were maybe simple devices which did not need a scientist to make them; but the bombs which prompted the attack were much more sophisticated. I recently learned, to my horror, that a satellite technology department at a university near me had been involved in the Iraq war, and that very probably, the work of physics students like myself had contributed to the death and destruction there.

When it seems that "they" - the military machines and the people they serve - have all the trump cards, it is good to know that Pugwash, and organisations like it, are there to support those of us who recognise the ethical implications of our work."

I also reminded him about his ICPS lecture and told him that if London succeeded in its bid for ICPS 2007, I would try for a re-run of the 2001 debate. A few days later I got the following reply:

"Dear Jim Grozier,

Thank you very much indeed for your kind letter of congratulation. I was most gratified to read it.

I wish you all the best with your bid to acquire the ICPS for London in 2007, and particularly support putting the Pugwash Pledge on the agenda. I don't know whether you know the Hans Bethe quote:

"Today we are rightly in an era of disarmament and dismantlement of nuclear weapons. But in some countries nuclear weapons development still continues. Whether and when the various Nations of the World can agree to stop this is uncertain. But individual scientists can still influence this process by withholding their skills.

Accordingly, I call on all scientists in all countries to cease and desist from work creating, developing, improving and manufacturing further nuclear weapons - and, for that matter, other weapons of potential mass destruction such as chemical and biological weapons."

I would like to see an endorsement of this call by the scientific community.

Thank you again for your kind letter.
Yours sincerely,
Joseph Rotblat."

Six weeks later, Rotblat was dead.

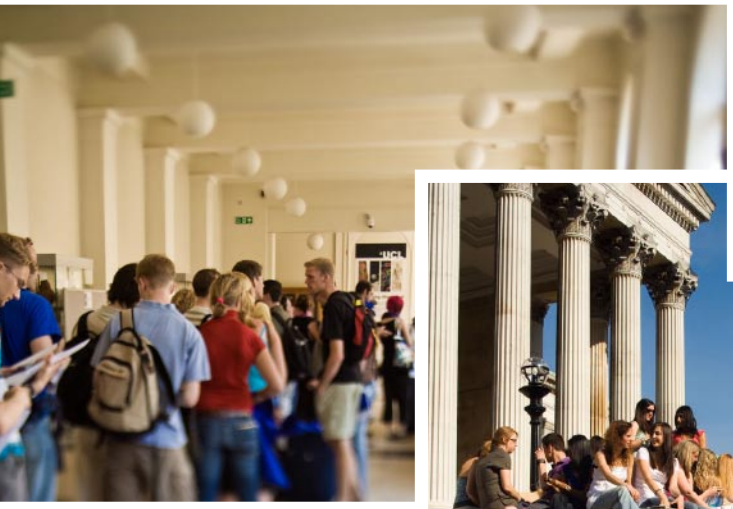
To my shame, and despite the dying wish of a great man, I have not pushed for the inclusion of an ethics slot in the ICPS 2007 programme, and it now looks unlikely that there will be one. However, another idea has occurred to me. ICPS 2008 will take place in Poland, Rotblat's native country, and it will be the centenary of his birth. What better time and place to continue the work of this pioneer of human values in science?

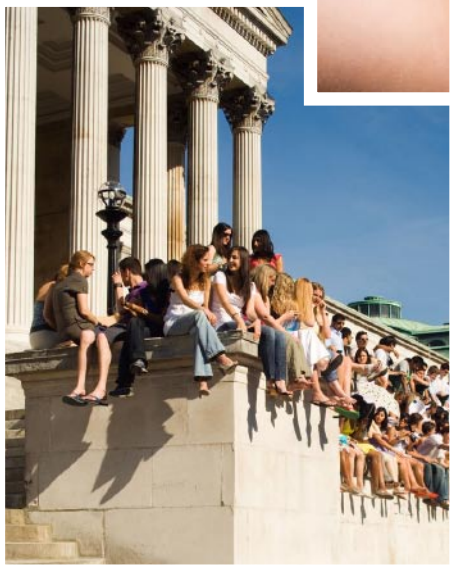
Student Pugwash is a lively, vibrant organisation and is concerned with all fields of science, not just nuclear weapons. Find out more from:

http://www.spusa.org/ (USA).
http://www.student-pugwash.org/uk/ (UK)
http://www.cam.ac.uk/societies/pugwash/ (Cambridge University, UK)
http://www.union.ic.ac.uk/scc/pugwash/v3/index.php?section=1 (Imperial College, UK)
http://quis.qub.ac.uk/pugwash/ (Queens University, Belfast)
http://student.pugwash.no/ (Norway)
http://www.pugwash.nl/young/ (Netherlands)
http://www.pugwashgroup.ca/csyp/index.htm (Canada)
http://www.scienceandworldaffairs.org/Vol2No2.htm (Int. Student/Young Pugwash Journal)

highlights of ICPS07 in London

(for more, check out 'past events' on iaps.info)





Science Made Fun

By Emily Fair and Colin Stuart

As Physics students at the University of Manchester, we are only too aware of the stigma that is attached to physics and indeed all Science subjects. Despite this we both strongly feel that science is a vital part of both the history and the future of mankind. This may seem like a bold statement, but science impacts all areas of life and provides the technological and medical advancements that are often integral to our survival.

Unfortunately, particularly with Physics, the number of students who actually study science at University is dwindling. We feel this is largely because science is often seen as the 'nerdy' subject at school, or comes across as being really difficult. Lots of children are not being inspired by science, they do not realise all the amazing careers it can open up for them and how exciting it can be to study it.

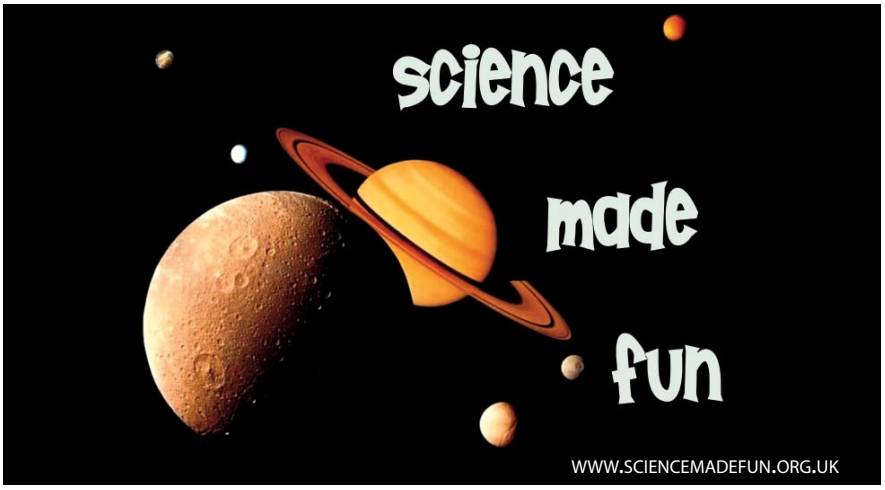
On 25th January 2007 Colin Stuart set up an organisation called 'Science Made Fun'. To try and engage young minds and get them enthusiastic about science. Originally the plan was to record a weekly podcast on a random science topic of our choice and present it in a fun and interesting way to encourage our listeners to be as fascinated by science as we are. We made provisions on the website for listeners to request topics and leave comments. Within a few weeks we had received over a thousand hits to the site. On the strength of this we decided to set up a proper website which contains not only the podcast but also more information about who we are, plus links to other sites and a forum that topics can be discussed in.

Since then, two other students at the University of Manchester have joined the team. Helen Cooper, who is studying Zoology, writes podcasts on animals and a fellow Physics student, Clara Nellist. Clara has offered to write podcasts for us and also provide some animation for the site. Several other students, who have heard about us, have also asked how they can help out. We have been amazed at the response and enthusiasm we have received for the project. It appears that there are many students who are aware of how important it is to get future generations excited about Science and are keen enough to get involved with organisations like Science Made Fun.

At the moment we are looking into expanding the organisation to incorporate video podcasts which we will record at the University of Manchester. We are also organising live shows, including demonstrations activities and games, which we will be taking into schools and other youth group in Greater Manchester. On 21st March, we are going into Sale High School, Manchester where we will be making podcasts with groups of eleven year olds; the best of which we will record and publish on our website.

Currently, we are undergoing fundraising activities in order to provide the equipment we need to do the live shows. Donations can already be made on the website and we are looking into corporate sponsorship.

We really hope that Science Made Fun can make a difference by showing that there are many incredible areas of Science and that it is a topic well worth pursuing in education. By sharing our passion for the subject we hope to breed enthusiasm in the young minds of today and switch them onto a subject is critical to so many aspects of life.



Gulliver's Travels and Kepler's Mistaken Ingenuity

This intriguing tale illustrates how the physics of Kepler's third law of planetary motion influenced the thinking of Jonathan Swift's epic novel 'Gulliver's Travels'. Exploring the relationships and physics discoveries of Galileo Galilei, Johannes Kepler & Jonathan Swift, a proposal is set forth to explain one of the most puzzling passages in 'Gulliver's Travels' and to attempt to find out if Swift really knew the planet Mars had 2 moons, over 150 years before they were officially discovered.

I first came across the following tale in the excellent book by Derek York, 'In Search of Lost Time'. Since then I have found numerous references and opinions on this tale and developed some of my own. Using Derek York's book as a primary source and supplementing facts from other sources (included in the references) I put together a presentation. The aim of this presentation was to promote interest in physics through the use of mathematics, influential characters and humour. This presentation won the Institute of Physics Young Physics Conference Post Graduate lecture competition 2005 (Dublin, Ireland) and was later presented at the International Conference of Physics Students 2006 (Bucharest, Romania). This is the tale…

By Keith Lambkin

Gulliver's Travels – the epic story by the Irish author Jonathan Swift – was first published in 1726. After adventures in Lilliput (a land of little people) and Brobdingnag (a land of giants), the central character, Gulliver, finds himself in LaPuta, a land inhabited by highly intelligent people. It is at this stage of the book (Part III:III:IX) the following 'puzzling' passage appears…

"Certain astrologers… have likewise discovered two lesser stars, or satellites, which revolve about Mars, whereof the innermost is distance from the centre of the primary planet exactly three of it's diameters, and the outermost five; the former revolves in the space of ten hours, and the latter in twenty-one and a half;…"

Swift's "two lesser stars, or satellites, which revolve about Mars" are quite obviously a reference to the two moons of Mars, Phobos and Deimos. Although Swift's numbers for the moons' orbital distances and diameters are not completely correct, they are in the right range, differing by approximately 30% from their true values. But here is the puzzle; the two moons of Mars were discovered by Asaph Hall, at the US Naval Observatory, Washington DC in 1877. But this is 151 years after the first publication of Gulliver's Travels. So the question is, did Jonathan Swift just guess Mars had two moons or did he have some scientific insight into his choice, and if so, what?

Immanuel Velikovsky (1895-1979), a Russian psychiatrist, believed he knew the answer. In his well read book 'Worlds in Collision' (1930) Velikovsky claims "The collision between major planets… brought about a birth of comets...at least one of these comets in historical times became a planet (Venus)". He apparently believed that approximately 3000 years ago, out of the belly of Jupiter came forth a comet which hurtled its way through the solar system. This comet narrowly missed Mars (then lying in an inner orbit between the Earth and the Sun) but passed close enough to pull away its atmosphere and send the planet into a highly elliptical orbit around the sun. The comet itself became trapped in the sun's gravitational field and eventually settled down into what we now know as the planet Venus. At this time Mars, during its highly elliptical orbit, passed close to the Earth on a number of occasions. So close in fact that people could not only see Mars and its two moons, but were also able to make detailed observations of the two moons' approximate sizes and periods. These observations, Velikovsky believed, were recorded in an ancient manuscript. Swift, managed to get his hands on this ancient manuscript, hence find out Mars had two moons, but unfortunately this manuscript is now…lost!

Perhaps today's science community would have little trouble dismissing Velikovsky's theory as mere fantasy, so let us look at another possible solution to the two moon problem. Johannes Kepler (1571 - 1630) was conceived on 16th May 1571 at 4:37am. Now, if his parents kept records like that how did they expect their son to grow up to be anything but a scientist! He grew up in a time surrounded by witchcraft and astrology and is probably best know today for Kepler's laws of gravitational motion.

Introducing another great scientist of Kepler's era, Galileo Galilei (1564 - 1642) had been announcing a series of spectacular astronomical discoveries with his telescope. Now it is important to note that Galileo did not invent the telescope, although he did make his own. A man by the name of Thomas Harriett was making detailed maps of the moon in Oxford with his own telescope in 1609 before Galileo had made his first. Galileo was however the first to publish results based on his telescopic observations and hence became associated with the telescope itself. Although not always just, the academic credit generally goes to those who publish results first, as is the case today.

As with many telescopic astronomical observations of the time, initial discoveries came fast but verifications of discoveries took months or even years. The prudent Galileo, knowing well the trade off between publishing first and the time delay to verify results, devised an ingenious system. He would announce his potential discovery in a (Latin) statement, scramble all the letters up into an anagram and send this anagram to his rivals, without spending potentially wasteful time trying to verify their results. If his discovery turned out to be true (i.e. verified by someone else) Galileo would then release the key to unscramble the anagram and hence claim the discovery as his own. Similarly, if the discovery turned out to be false, he would never release the key and hence no one would be any the wiser.

In 1610, Galileo discovered using his telescope what he thought were two moons of Saturn, (they later in fact turned out to be the rings of Saturn). And he wrote:

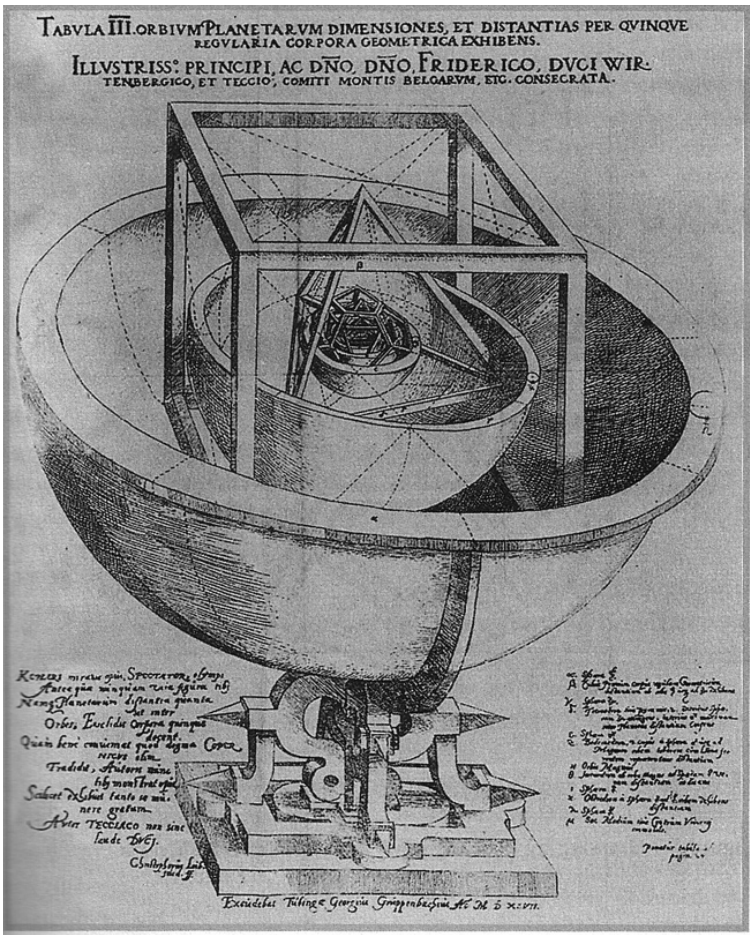
I have observed the highest planet (Saturn) in triplet

Well, in truth he wrote this in Latin which is:

Altissimum planetam tergenimum observavi

and then scrambled this up into the anagram:

SMAISMRMILMEPOETALEUMIBUNENUGTTAVRIAS



KEPLER'S MODEL OF THE UNIVERSE AS A SERIES OF NESTED GEOMETRICAL SHAPES.
FROM KEPLER'S MYSTERIUM COSMOGRAPHICUM, 1596

Now, Kepler got his hands on this algorithm and knowing Galileo had a telescope, was intrigued to determine what Galileo had discovered. Using great ingenuity, Kepler managed to decode this anagram, or at least he thought he had. He unscrambled the letters to form the following Latin phrase:

Salve umbistineum geminatum Martia proles

which Koestler translates as:

Hail burning twin, offspring of Mars

Kepler believed that Galileo had discovered two moons around Mars. This was great news to Kepler because he was a big fan of geometry in the solar system. He knew that Venus had no moons, the Earth one; for Mars to have two, with Jupiter four, created the series 0,1,2,4… which fitted in perfectly with his geometric outlook of the planetary system. Granted, the letters of his unscrambled version didn't perfectly match the anagram, but Kepler was convinced that he had decrypted Galileo's anagram.

Now to pose another question, could the idea of Swift's "two lesser stars, or satellites" have originated form Kepler's "twin, offspring of Mars"? Perhaps, but in order to give any credibility to this connection, a link must be shown proving that Swift knew of Kepler and his writings. First, let us take a quick look at Kepler's 3rd Law of planetary motion. It states: The square of the period of any orbital body is proportional to the cube of the semi-major axis of its orbit. Mathematically this can be expressed

$$T^2/R^3 = 4\pi^2/GM$$

Where T = period (time for one complete revolution), R = orbital distance (distance between the centre of mass of each body), G = universal gravitational constant (6.67 x 10-11 $N \cdot m^2/kg^2$), and M = the mass of the larger (centred) body.

Basically what the equation is saying is that the property period squared over the distance cubed in any closed system is equal to a constant. Or alternatively, that period squared is proportional to the distance cubed. Taking a brief example of the Earth going around the Sun; T = 365.25 days, R = 1 AU (astronomical unit) then T^2/R^3 = 133407 units*. Compare this to Mars going around the Sun where Mars has a period T = 686.98 days, R = 1.52 AU this gives T^2/R^3 = 133410 units*. To all intents and purposes the same number (differing only by a fraction of a percent). The equation works.
Now, let us look at the rest of the passage from Gulliver's Travels which was started above. It continues:

"…so that the squares of the periodical times are very near in the same proportion with the cubes of their distance from the centre of Mars, which evidently shows them to be governed by the same law of gravitation that influences the other heavenly bodies."

Here Swift is making a direct reference to Kepler's 3rd Law. Let us substitute Swift's values for the periods and distances of his two moons orbiting Mars. The innermost moon (Phobos) has T = 10 hours and R = 3 Mars diameters, which gives T^2/R^3 = 3.704 units†. The outermost moon (Deimos) has T = 21.5 hours and R = 5 Mars diameters,

* $Days^2 / AU^3$

which gives $T^2/R^3 = 3.698$ units†. To all intents and purposes the same number (differing only by a fraction of a percent). Swift did know of Kepler's writings.

At this point Velikovsky is well within his right to jump back into the tale claiming Swift proves his (what seems outrageous) theory. The reason your moons obey Kepler's Law is because they came from his previously mentioned lost manuscript. This manuscript contained recorded observations of actual moons (as Mars was closely passing by Earth in its highly elliptical orbit!) and actual moons would obey Kepler's laws because that is the way moons behave.' One has to admit, however unlikely, that this is a good argument. Good, but with one small flaw. In 1726 when Gulliver's Travels was first published, the mass of Mars was not known. What has that got to do with anything one might ask. Let us look at the following example: the right hand side of our equation contains all constants, with M being the mass of Mars in this case. Substituting in the true mass of Mars as known today (0.64 x 1024 kg) we get a constant of 22.22 units†. Using the value that Swift used for the mass of Mars we get from above a constant equal approximately 3.7 units† as seen previously. But these constants differ by over 600%. Sorry Velikovsky, real moons can't deviate from nature by 600%. Your argument is invalid. Swift knew of Kepler's writings and yes Swift's values equaled the same constant but they equalled the wrong constant. Swift guessed the mass of Mars to make his values work.

So in summary, how could Swift have known about Phobos and Deimos? He could have guessed, it would have been a pretty amazing guess but perhaps a guess none the less. He may have had psychic powers or maybe the Martians told him! He may have got the idea from another writer or philosopher from that era. Voltaire (1694-1778) a French philosopher of the time had mentioned he believed that Mars had two moons, but more so for artistic reasons than scientific ones. Swift may have learnt of the two moons from Velikovsky's ancient lost manuscript. Or maybe, Swift's "two lesser stars, or satellites" could actually have been Kepler's 'twin, offspring of Mars', which were actually Galileo's 'two moons of Saturn', which were actually the 'rings of Saturn'?

To conclude, did Jonathan Swift just guess Mars had two moons or did he have some scientific insight into his choice, and if so: what? The answer? Well, you decide!

Actually, all presented explanations are wrong: Jonathan Swift knew of the moons of Mars because Gulliver was in fact an interstellar space traveler. (picture from the animated movie "Gulliver's travels beyond the moon")

† *Hours² / Mars Diameters³*

References:

1. *Gulliver's Travels, Jonathan Swift, (numerous publishers, numerous years)*
2. *In Search of Lost Time, Derek York, Institute of Physics Publishing, 1997*
3. *Ringside seat: sometimes, in science as in boxing, you want to be up close; sometimes you want to keep your distance, Neil deGrasse Tyson, Natural History, Oct. 2004*
4. *Galileo's Anagrams and the Moons of Mars, MathPages.com, http://www.mathpages.com/home/kmath151.htm*
5. *Worlds in Collision, Immanuel Velikovsky, (numerous publishers, numerous years)*
6. *A Short Biography of Kepler, NASA, http://kepler.nasa.gov/johannes/*
7. *The Decline of Astrology and The Christian Cult, esoterism.ro, http://www.esoterism.ro/english/declin-astrology.php*
8. *The Irrepressible Galileo Galilei, Deborah Houlding, http://www.skyscript.co.uk/galileo.html*
9. *The Sleepwalkers, Arthur Koestler and Herbert Butterfield, Penguin, 1964.*
10. *The Mysterious Moons of Mars, Lee Krystek, 1997, http://www.unmuseum.org/marsmoon.htm*

A Fantastical Flight-of-Fancy

"First parabola in five minutes" crackles the intercom. I look around the cabin as a wave of excitement washes over its occupants, all strapped into their seats, all wide-eyed and expectant. In a few minutes time, the pilots of the A300 Zero-G plane would steer the aircraft to its orientation position ready for injection into a ballistic trajectory. This orientation happens to be at 47 degrees to the horizontal and would take twenty seconds of pulling up to reach, all the while us experiencing 2g. And then the A300's engines would be cut. The plane would be jettisoned into projectile motion at over 500 kmh…and we would be weightless. The Captain counts down the time till the pull-up phase… "One minute".

By Richard Branch

We had arrived in Bordeaux a week earlier as participants in the European Space Agency's 8th Student Parabolic Flight Campaign. To start with we had re-assembled our experiment after its journey from Leicester and then suitably padded its sharper edges for safety during the flight. The transparent sample boxes that would be vibrated in microgravity in an attempt to observe density-driven segregation of granular material were filled with a variety of populations, including sand, ball bearings and Mars soil simulant. The experiment had then to be 'cleaned' - stray particles in microgravity could easily be inhaled by an experimenter or sucked into the venting system of the aircraft - and loaded onboard the A300, before inspections from the engineers ensued. Time had been devoted to practising again and again the procedures that we would undertake on the flight: with possible disorientation and illness in microgravity, we wanted to be well trained.

Now we were sitting on the plane at 20,000 ft, ready to fall from the sky in our familiarisation flight. "30 seconds" sounded the Captain. Silence fell over the cabin as people prepared themselves for the hypergravity phase. We would remain perfectly still here in an attempt to prevent sickness. "20". I look out of my window at the A300 wing, which will give away our orientation."10". My pulse is racing. "5…3,2,1, pull-up"! A heaviness immediately infuses my body, much stronger than I had imagined, as I am pushed down into my seat. The Captain calls out the angle of attack…"30"… the A300 wing is at a startlingly steep angle to the horizon, yet inside the plane there is no sensation of such an orientation as we continue being pulled down into our seats…"40"… I'm tensing my legs and stomach muscles as hard as I can as advised by the flight surgeon to keep my blood from rushing to my lower body. My heart is beating so fast and strong, and I'm holding my breath, waiting for the word…"Injection"!

Having loosened our straps, we rise into the air as the plane falls from beneath us. The cabin erupts in ecstasy as everybody senses at the same time that they are without weight. A strange yet pleasant sensation pervades my body and I immediately lose all sense of orientation - I can see my seat between my legs but I cannot say whether it is above or beneath me. The Captain continues his angle of attack announcements…"20"… the cries of delight continue from within the cabin as we remain floating from our seats…"30"…I'm aware that the hypergravity phase is due back soon and…"pull-out"…before I know it I'm being pulled down back into my seat again, that strange sensation gone and my perception of orientation immediately restored. I'm still tingling though and I'm smiling, in awe of the previous twenty seconds of magic.

PHOTOGRAPH BY JASPER GREEK GOLANGCO

Four more parabolas follow, with some gravity defying stunts on display from the flight safety attendants in the open part of the cabin, and I begin to get used to the loss of sense of orientation, relying only on my vision to guide me. I have a bottle filled with coins, which duly perform dream-like dances in the microgravity phases. I notice that with only the internal friction of our joints to overcome as well as the inertia of our limbs, our arms and legs are easier than ever to move. So easy in fact that one of the students struggles to catch objects thrown to him as his hands overshoot the target from excessive application of force. His arms do not weigh anything and nor does any other part of him. This is a most strange feeling.

After landing, people stand around on the tarmac in front of the A300, bewildered, trying to explain what had happened to them moments earlier. Frowning, they shake their heads and hands in frustration as they desperately try and find the words to describe their feelings, but the words do not come. It is very difficult to describe the feeling associated with being weightless. It simply is like nothing else I have ever experienced.

The next day Keith and I sit back as Daniel and James prepare for the first experimental flight: recording equipment is checked, in-flight protocols are rehearsed and the pair begin to psych each other up, 2g press-ups featuring. As more and more flying students arrive, a nervous-excitement falls over the workshop. I watch the blue flight suits scurrying back and forth dealing with last-minute issues. An announcement is made for medication delivery and a queue rapidly forms for the single white pill, which should keep flying stomachs calm. The word 'HOPE' is appropriately etched on each one, leading to a few increased heart rates. Caffeine tablets are also distributed to counter any sleepiness due to the sickness pill on the flight. Flying students are advised to visit the lavatory prior to plane-door-closing at 0900. The flight has been redirected to Corsica due to bad weather over Gascoigne, increasing the flight time by one hour. Students are reminded that, with no toilet onboard, empty water bottles may be used if the situation becomes desperate, especially considering the effects of the caffeine pill. Moments later they are off.

At about 1330 people start to gather at the security gates after an announcement is made that the A300 is due back soon. And then there it was taxiing back from the runway, from its most unusual of flights. The plane almost sounded tired as it came into its parking area with its engines whirring to a halt. The gantry slowly made its way to the aircraft door and we were allowed to enter the parking area. As I walked to the gantry with my camera, ready to capture some post flight shots of the occupants for pos-

terity, I wondered what we would encounter. Would our teammates crawl out weary from the flight, nauseated from the experience or would they be brimming with joy? It appeared to be the latter. From their accounts it sounded as if they had had the time of their lives, which was reinforced by the footage we saw from the in-flight recording shortly afterwards in the workshop. There on the screen were Daniel and James spinning, twirling and rolling in mid-air! What's more, the experiment appeared to have worked. The equipment had run perfectly and the behaviour of the granules had been as expected. For the first time, density driven segregation had been observed!

As I waited in the queue for my medication the next day, quips were exchanged between flying students, similar in tone to those exchanged before an important exam – nervous excitement was definitely present. I was given a white pill and a yellow pill and immediately swallowed the former. Hopefully I would not need to use the caffeine pill, though from the accounts of Alessandra from Italy the previous day, who fell asleep during one of the parabolas and had to be strapped in, there was always the possibility of needing a boost. A worse scenario of course would be the loss of my vision and hearing while conscious, as had happened to Jean from France during a parabola of the familiarisation flight (he had actually expressed more surprise at the feeling of weightless, which says something about its extraordinary sensation)! Possibly worse still would be the fate of an unfortunate experimenter the year before, who had had his vision turned up-side-down for the duration of the flight!

We took our seats in the A300 and sat patiently as the plane door was sealed. Nobody could now get on or off – we were destined to be subjected to the extreme manoeuvres that the aircraft was now warming up in preparation for. I remember being amused by the 'fasten your safety belts' sign being lit up, with the characteristic chime along with it, as if this was a normal flight. Indeed, the scene looked fairly normal: familiar plane chairs flanked by those familiar portholes. Looking up to the main stretch of the plane however revealed a different scene: this had been hollowed out, with no chairs or baggage racks present and the walls, ceiling and floor had been covered in white foam. Soon we would be expected to leave our seats and make the most of our time in this area as the plane purposefully dived to the ground! Hardly like a normal flight.

A little while later we were in the air. Some students chattered excitedly, others slept from the drugs. Soon the seat belt sign was withdrawn and everybody quickly set about tending to their experiments. The main tube of the plane was a busy hive of blue, orange and black flight suits as everybody prepared for the impending parabolas. "First parabola in ten minutes" sounded the Captain over the intercom. An excited cheer. "Five minutes". The black suits, CEV (French Test Flight Centre) personnel disappeared to the cockpit area.

An artist's rendition of what it's like to be in parabolic flight. (picture © esa)

The 'Orange Angels' positioned themselves evenly down the aircraft, acting as the flight safety attendants. Blue suits assumed comfortable positions, namely laying down by their experiments for the first parabola, which was purely to get accustomed to floating. "One minute"! Silence. Excitement. Heavy pulses.

"30 seconds…20…10…5…3, 2, 1, pull up". Our bodies immediately feel the strain of the 2g phase, a little more bearable this time around due to our horizontal orientation. Still, my contact lenses make their way to the corners of my eyes and it feels as if they are going to be pulled out! The Captain calls out the angle the A300 is making to the horizontal: "30…40…". I remember the words of the Captain in our flight briefing – "this plane is not flying – this plane is falling - and you are inside it"!

"Injection"! The 2g phase disappears within a second leaving us weightless. I'm rendered speechless as my body rises off the padded floor, vaguely aware of other persons tumbling around me, but I'm too preoccupied with trying to control my own acrobatics to take a good look at what must be a hilarious sight – we're all over the place.

The feeling inside me due to being weightless did not take me by surprise as it had done on the familiarisation flight, but now in this nearly free-floating environment I was astonished by the complete lack of control we were experiencing. Holding onto a support strap with one hand, I was pivoted around with my legs flailing wildly as I tried desperately to gain some sort of control over my body's motion, but it was useless. My upper body was now above me and continued to pivot around from its original inertia. As we had been told, swimming actions were completely useless, the stabilising friction of water not being present, and our instinctual leg and arm movements only added to the amusement of the CEV flight attendants who watched on, ensuring that our waving and kicking was not endangering anyone nearby.

"20 …30…pull out!" We all drop to the floor at unnatural speeds as the 2g phase sets in for twenty seconds. I stay as still as I can to prevent sickness, still gasping at the previous twenty seconds of complete craziness. The heaviness of the 2g phase subsides and the hissing of the cabin pressurisation system informs us that we are back in level flight.

Thirty more parabolas ensue. A friend describes the microgravity scene as a 'phantasmagoria'. It is certainly not a typical one to observe: people executing impossible manoeuvres in mid-air; others performing completely effortless gymnastics about tethers; some nonchalantly lying on the ceiling, some casually swimming across the floor; bottles and their contents swinging and swirling about in wonderfully unnatural ways; long hair swaying as if underwater; your own self hanging in a non-existent medium with a freedom about you that you have never felt before. I content myself for a few moments now and then looking at my feet as I effortlessly swing them back and forth, suspended by nothing. An otherworldly elegance surrounds people in the absence of weight, when they are used to it that is. Their posture, the way they carry themselves, the way they negotiate the environment, is very distinct.

Naturally, surrounded by such delights, a great deal of discipline is required to concentrate on the task at hand. For us it is easier, since our experiment presents an all-too-fantastic view through the transparent bulletproof box protecting us from the metal moving at high speed inside. Our dancing weightless samples captivate us as they marvellously arrange themselves into high and low-density bands across the sample box, like no other sample on Earth could do. The results will have implications for geophysical studies of low-gravity bodies such as asteroids, comets and moons.

There are a few hiccups in the flight for those students feeling a little queasy – luckily we have all been supplied with sick bags to contain anything that escapes from us. A friend, who was ill in all three gravity phases at one stage, later discusses the relative merits of vomiting in the different cases. They are all uncomfortable but at least the microgravity scenario provides an interesting sight after the event – my friend described how after being sick into the bag he looked inside to see the vomit glide to its base before evenly coating its walls in near slow motion!

There is time for a few more stunts in the final parabola, including press-ups in the 2g phase, which I find almost impossible to do, as well as some very difficult looking juggling, and then the flight is over. But the Campaign continues. Following the writing of our reports, two of the most successful teams will be selected to fly again in professional campaigns! And for a long time those students fortunate enough to have participated in such an amazing event will inform those around them about parabolic flights and the wonders it opens up to science and the space industry, their enthusiasm permanently forged through their experiences in the European Space Agency's Student Parabolic Flight Campaign.

Interview with Gerard 't Hooft

By Pim Lubberdink and Bernadette Kruijver

We met Gerard 't Hooft in his office in Utrecht, the Netherlands. We asked him about his recent book "Planetenbiljart – science fiction en echte natuurkunde" (Planet billiards – science fiction and real physics, unfortunately not available in English). In this book the Nobel Prize winner imagines the future. But unlike science fiction writers, he keeps in mind nature's laws. In the first chapter he describes how, as a child, he dreamt about spaceships and visiting other planets. To make this possible he made up the principle of anti-gravitation.

The idea to investigate the laws of nature and make fantastic discoveries is a dream I had when I was a kid. It was an exciting period. Possibly even more exciting than today, because there were so many really unknown things. Nuclear physics for example. Nobody understood completely what happened inside an atom and it was still a mystery how protons and neutrons interacted. Back then, Einstein was thinking about space and time and he made some incredible discoveries. So you really could start to dream about space ships and going to the moon and beyond.

I come from an intellectual family. My mother's side of the family had a lot of scientists: physicists, mathematicians, zoologists. Of course that influenced me, but I believe that my interest in science was mostly personal. When I was young, I was fascinated by nature much more than people. Girls often play with dolls or animals, but they didn't interest me I was only curious about nature. Gears: they were marvellous things! To dismantle an alarm clock: that was amazing!

But not everyone in his family was enthusiastic when Gerard decided to study physics. His father was engineer and he tried to get his son more interested in technology.

Actually, he was a bit surprised that I had no interest at all in cars, radios and so on. In my opinion a car was too complicated and moreover it had already been invented by somebody else. It was completely finished. I had the feeling that I could not come up with anything to improve it and there was no anti-gravitation involved.

Technology wasn't my first interest. But one day my father gave me a small book about how to make a radio. I really enjoyed this! It was this set with transistors and so on. Nowadays radios do not contain transistors anymore, there's only a chip inside and there's not much to see. Even with a microscope you can not figure out how it works .That's not much fun. But with this set, you could really see how a radio works. You could see the antenna, and you knew: that will cause a current to be induced. The small book explained how you should build it, but as soon as I understood the circuits I started to try to improve it and do it differently. I wanted to improve the manual, but that turned out to be quite hard.

So a curious and critical attitude is something you need to become a good physicist. Can you teach anyone such an attitude or is it really a personal feature?

You cannot teach someone to like something. But if someone is interested, then you can help them by explaining how to look at certain problems. The way to ask a question for example. You have to learn from your own mistakes. When you're a kid, you make a lot of mistakes. You think you know everything, but clearly you don't know anything. Somebody should point out the mistakes and say: "Look; this can be improved. You have to do it this way". If you are not allowed to make mistakes, you will never learn how to do it properly and when you finally hear how it should be done, it makes a bigger impression, because you discovered how hard the problem was yourself.

Children should be taught a critical attitude. But adults also often show a lack of self-criticism: they are very impressed with their own 'discoveries'. But they don't see that it's not as perfect as they think it is. If you have an idea, you should be the first to see the errors and shortcomings of it.

In conclusion: don't be satisfied too easily with your own results.

Yes. You should always ask yourself the question: is this the best way? Can I improve this? When

you solve an incredibly hard problem, the solution is often incredibly complex. Then you should ask yourself: "Is this really that hard? Can't I do it in a different, easier way?". Very often it turns out that there is indeed an easier solution and often other people have to discover these. When I first wrote down my own discoveries, they were quite complicated. A few years later a colleague with a total different view on the matter discovered a way to formulate it in a much more elegant way. Those moments are very important.

This happens everywhere in scientific research. Everything is written down in study books: "this is how you do physics, end of story". In other scientific fields it also works this way: things that at first were hard to understand are now a commonplace and we can continue from that point. Thirty years ago, I had the idea that I was the only one who used certain mathematical techniques and knew about how certain theories should be constructed. At that time, I was very good at it. But now there are hundreds or maybe thousands of people who are familiar with these procedures. It is almost impossible for me to compete with this younger generation. They are working on it full time and I think they're doing a fantastic job. Keep on going! But I can't keep up with that anymore.

And that's the way it should go in science. The scientist who first makes the discovery, has a hard time dealing with it. But when all pieces of the puzzle fall into place, the complete picture looks so much easier.

Gerard 't Hooft has two daughters: Ellen and Saskia. Do they also have a career in science?

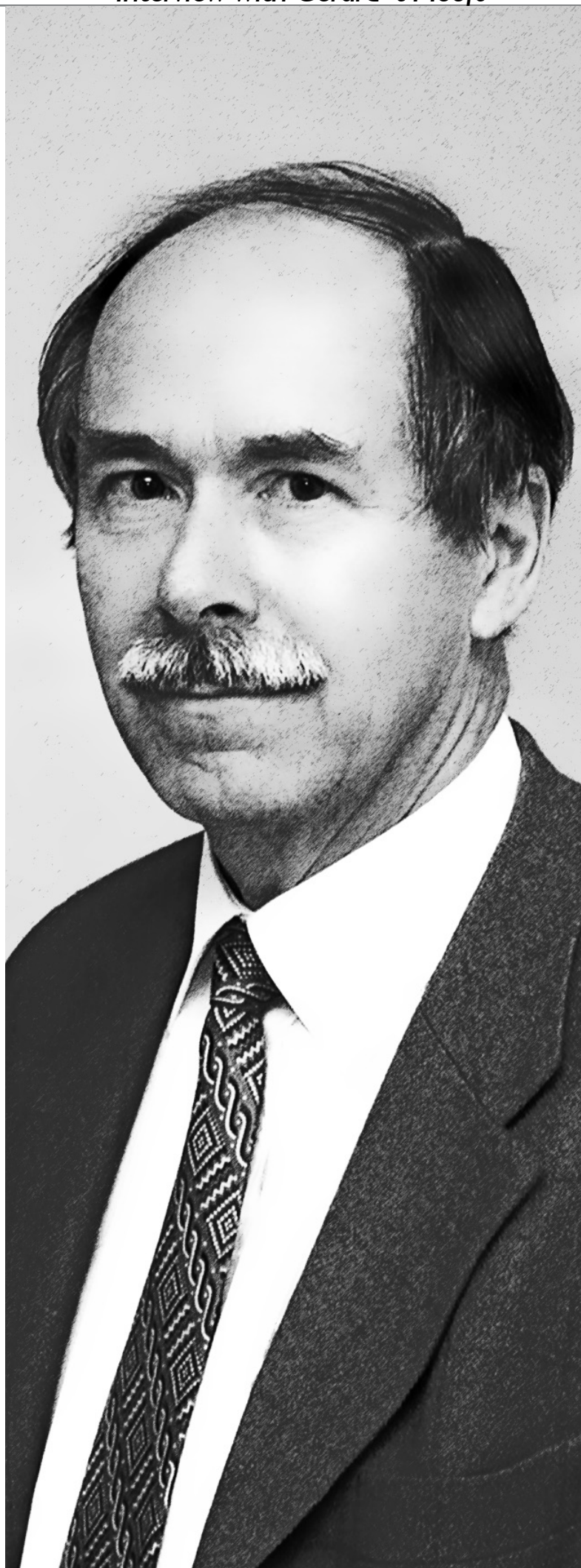
No, they're doing something completely different. When you have children yourself, you will discover: you can tell your kids anything, but they will go their own way anyway. What you teach them is mostly what you don't tell them directly: that is what is in your body language.

Do you think it is a pity they didn't pursue a career in science?

Yes and no, it is just the way they are. I always told them: "You should organize your life in a way that you find most interesting and most enjoyable. That's also what I did."

So at home, physics was not frequently discussed, but 't Hooft likes to explain his discipline in a popular scientific way to other audiences.

How you talk about your research depends on your audience. I like doing this, but I also think it is



something you should do when you reach a certain point in your career. You should then pass your knowledge on to others. I like to emphasize the scientific way of looking at the world, because our society is misses that sometimes. Many people have a totally non-scientific approach towards things that really matter. Regarding the world's energy problem or regarding evolution theory for example. Many people have ideas that do not answer to what you would call science.

Some people lack a critical attitude. In addition there's not much notion of the amount of scientific work that is done. People don't realise how much is achieved by science. On the subject of evolution, I have an e-mail discussion with someone who adheres to the biblical version and is not willing to change his view. This person obviously doesn't have any idea what biology and other sciences already know about this subject. This person persists: "Mistakes were made; the dates aren't correct and so on. The bible tells it in a more beautiful way, so I want to believe it." It is very hard to convince people that we've already passed that point over a hundred years ago.

In science, you're always allowed to doubt a theory. You always have the right to say: "I do not believe this. I think it might be different, so please defend your view." That is legitimate. So I really don't mind going into discussions with people. But some people live in a completely different world and that bothers me sometimes. They have never read any scientific magazine to check how people came to certain conclusions. Of course you can not lead away people from their religious point of view, that's impossible and you should not even want that. But you could try to give them some insight into scientific methods.

At the IMAPP-symposium 2006 (Nijmegen, the Netherlands) 't Hooft talked about the fundamentals of quantum mechanics. In this lecture (viewable at http://www.math.ru.nl/IMAPP-symposium/) he states that quantum mechanics gives the outcome of statistical experiments but it doesn't provide fundamental laws.

Our discipline has now reached a point where we can start asking very fundamental questions, about matter, about forces and about the universe. You could not have hoped for a reasonable answer to these questions if you had asked them 30 years ago. Now we're ready to say something meaningful about the origin of the universe and we can compare our theories about it with what we know about elementary particles. We still bump into serious problems, but now we can formulate these problems precisely and investigate them.

The string theory looks impressive and promising, but it has its problems and limitations. We try to look at these problems in various ways. The researchers of the string theory are often to easily pleased with their answers. I'm usually inclined to point out the problems. String theory runs into problems which we can not solve. The question should then be: "Can't we improve this and do it a different way?". The theories about particles, fields and forces are always based on quantum mechanics. This is a really beautiful theory that works extremely well. But we run into problems on a very elementary level if we use it to describe the entire cosmos. I ask questions that have also been asked by others since the introduction of quantum mechanics, because there's still something strange about this quantum mechanics. It appears that it doesn't describe a

THE REAL REASON WE HAVE TO SUFFER THIS "QUANTUM MECHANICS" BUSINESS.

reality that we're used to classically. If you state this, you often get the reply that you should keep up with the present: "The classical period is history and now we think in a quantum mechanical way!". That might be true, but there's still an unsatisfying side to quantum mechanics. I'm not the only one who thinks this, but most people come a different conclusion.

I think that in the end there should be a theory which doesn't contain any quantum mechanics at all. It should describe everything in a very rational way, but the equations are to hard to solve. Then the only thing we can do is to apply certain approximation methods. We don't have a hundred per cent control over all the variables of nature, that is impossible and too complicated. So we will have to use statistical methods to find out how nature works. And the statistical method may eventually result in what we now call quantum mechanics. And at that point, quantum mechanics has become an answer to a question. Because now we don't know the question that well, but we do know the answer: the answer is quantum mechanics. But the question could be "Look, these are the equations for describing nature, but they're too difficult to solve exactly. What can we tell about the statistics of the solutions?"

Gerardus 't Hooft was born on July 5th 1947 in Den Helder, the Netherlands. He spent most of his childhood in The Hague. He studied physics at the University of Utrecht and completed his PhD there in 1972.

He worked at CERN and Utrecht and he is currently a Professor of theoretical physics at Utrecht University. In 1999 he received the Nobel Prize along with Martinus J.G. Veltman for "elucidating the quantum structure of electroweak interactions in physics".

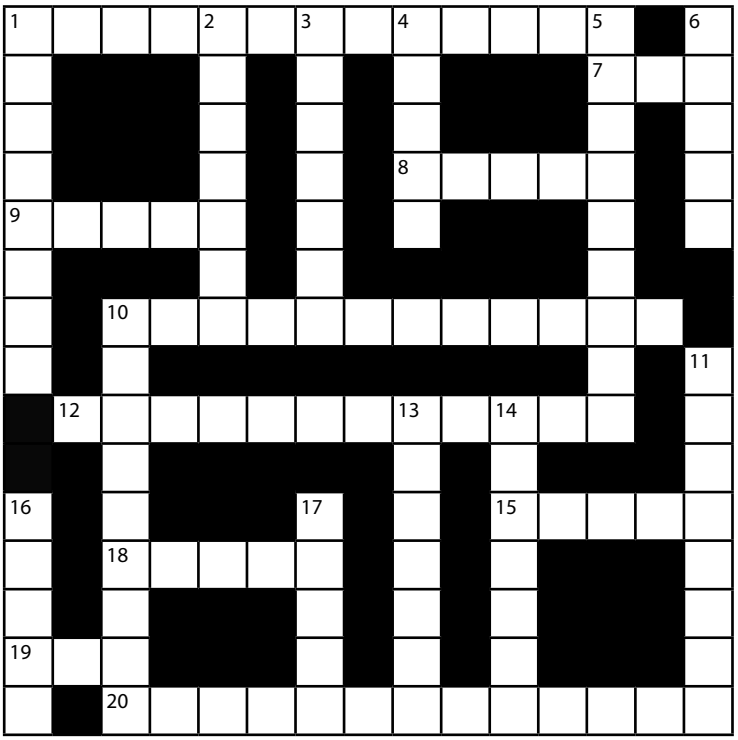
Cryptic Crossword

DOWN:

1 This defect is vacant (8)
2 Standard candle is not constant (7)
3 Integer mountaineering (7)
4 Togetherness (5)
5 Colour is depressed, but favoured by HRH (5,4)
6 Look up (or down, it makes no difference) (5)
10 A waltz with a cake - how much is there? (9)
11 Winner of prestigious prize (8)
13 Multi is confused by causes (7)
14 High coefficient of friction (3-4)
16 Nuclear physicist, known for alien thought (5)
17 Open toothed fastening (5)

ACROSS:

1 Maestro bisected (13)
7 Essence of 4 down (3)
8 Magnetic man (5)
9 Megagram (5)
10 And another thing. Broke? Dial Lady Toni! (12)
12 Theory five of accelerating universe (12)
15 Sodium is at the start of the directory (5)
18 Grind e away on charged particle to break CP (5)
19 Qualification (3)
20 Aircraft with low orbital inclination (8,5)



Scan and send your solutions to the editor (jiaps@iaps.info) and be in with a chance to win a copy of "On the Shoulders of Giants" edited by Stephen Hawking. The closing date for entries is July 1st.

For Love or Money?

Should a physicist's loyalty lie in the pursuit of science or a big bank balance?

By Leila Sattary

More and more graduates are using their academic grounding in physics to secure high-earning-jobs in finance. In a 2004 survey[1], 12.6% of physics graduates in the UK entering employment ended up in business and financial professions – the second-largest sector after clerical and secretarial occupations. The finance sector typically seeks physicists who have completed a PhD or one of the new specially designed financial physics masters' courses that gear them up for a life in finance. While the benefits to the individual are obvious - good money and an office with air con - some in the physics community are concerned by the trend. So is financial physics just another career path or is it a waste of good physicists?

As the world of finance relies more and more on maths and computing, the need for graduates with practical experience in both is rising. Physicists are prized for their skills in programming, modelling and data analysis. The majority of these physicists eventually become quantitative analysts ("quants"), who typically develop models to support traders and risk managers in large corporations.

While there are some similarities between physicists and quants the key difference is their goals and philosophies. The quant develops methods to assist the corporation in making more money. Meanwhile the physicist normally works by building on others achievements to discover something new or find innovative and useful applications for completed research. Most important, the research is shared through peer-reviewed journals, allowing it to be critically assessed and for others to build on the findings.

The other obvious difference is the salary: typically, a PhD graduate with no finance experience can expect a starting salary of £35,000, rising quickly to six-figure sums that a physics researcher can't compete with. Also working in finance has the advantages of a structured career, regular promotions and greater job security; in research, most graduates are on fixed term contracts.

So why do people jump ship? Perhaps after a few years at university they realise that physics is not for them. The lure of money is the key. Any mathematics-related PhD has a special pass into the world of finance, while physics graduates in particular have proved their numeric and analytical skills. All a company needs to do after stealing them from science is to mould them into money-driven business machines.

It seems such a shame to see bright would-be physicists swallowed into the world of finance and business. With their numbers dwindling, the last thing we need is trained physicists being turned to the "dark side" with the promise of high salaries and company cars. If we study physics because of our desire to know how things work, surely those abandoning the subject haven't appreciated the wonders that physics has to offer. Physics promises the answers to so many of life's mysteries, and a career in science gives the chance to do something for the wider world. To forgo these opportunities for

For some, the choice between love or money is easy

1 Survey Results from www.prospects.ac.uk

a mundane life of numbers, money and suits seems a crime. Surely a quest for knowledge is a more rewarding goal?

I doubt that many people begin a physics degree with the aim of selling their souls to finance. They must have started with greater aspirations, so where does it all go wrong? There are fewer students taking A-level physics and fewer physics graduates, yet there is an increasing demand for them in research, industry and especially education. It is essential to not let their number drop any lower. If no action is taken in the near future then it's only a matter of time before the scientific research output grinds to a halt.

The only way to reverse the flux of potential researchers turning to finance and other such sectors is to promote their position in society: scientific research is not seen as glamorous as the world of finance, yet physicists get access to supercomputers, miniature black holes, particle accelerators and much more. People need to be better informed about scientific careers by allowing students greater research experience earlier in their careers. In addition, the teaching and education of physics must be further updated to keep the original motivation and intellectual spark burning far longer than the latest stock-market trend.

Leila is studying physics at St. Andrews University

Phil Symes got a job as a risk consultant in London shortly after finishing his PhD in particle physics in early 2006. The work involves calculating the probabilities associated with financial risks.

"Finance companies are reliable employers, and jobs are readily available. On the other hand, there aren't enough jobs in physics, and those that are available are massively underpaid and only last for 2-3 years. By the time you have done a degree and a PhD, you will be at least 25, probably older, and will have no savings, pensions, etc.

This is all fine if you intend to stay single or marry well. Otherwise, if you want to receive the market rate for the work you do, motivated more by a sense of fairness than by greed, then you will have to "sell out" to finance or industry.

Financial services is the UK's biggest economic sector, contributing 18% to the country's GNP, and this sector is growing. London is fast overtaking New York as the world's biggest financial centre, and the money made is vital to the country's economy.

It is therefore important that many of the country's highly skilled and quantitatively able people work in the financial sector. Work in finance ranges from the menial (such as auditing) to the glamorous (derivative pricing). This is an exciting time to be working in the field, and the work can be rewarding.

The question for many is not whether to get into finance, but how to get a job that will maximise their potential as soon as possible. In fact, if we can change the image of physics from that of a hard subject done by geeks into the subject that is a gateway into finance and good jobs, then maybe we can reverse the decline in undergraduate physics applicants".

Jim Grozier, a mature PhD student at Sussex University, says he would never even contemplate going into finance.

"But then I am in the lucky position of having the big expenses behind me: my flat paid for, my children grown up. We have got to find a way of giving young physics graduates, with all those responsibilities still to come, an incentive to remain in the field, which means better salaries and more job security. After all, society needs physicists; it does not need financiers.

At our university we have recently lost a very good lecturer to the finance industry because he could not afford to bring up his young family on a postdoc's salary, nor could he afford to risk the responsibility of a mortgage on a short term contract. Mind you, there are other factors; I once met a PhD student who was determined to go into finance when he graduated because "academia is too laid back for me – I'm too much of a driven person". You can't please everyone!

I also cannot help feeling that if people want to go into finance they should study finance, and not physics. I'm aware that finance needs certain mathematical and problem-solving skills, but I'm sure these skills could be taught instead in a financial context, as part of a financial course. Using physics as a route to finance for those already committed to it, as Phil suggests, might help to boost departmental intakes, but would seem to me to be a rather perverse and dishonest solution to the problem. And purpose-built financial courses would presumably also serve to prepare the unwitting employee for the dog-eat-dog nature of the culture for which he or she is heading, where secrecy, short-termism and the narrow interests of the company replace the concepts of openness and the greater world good. Physics PhDs who have become used to such things as peer-reviewed publications will have a nasty shock awaiting them when they swap the lab for the stock exchange".

The Biefeld-Brown Effect

In November 2006 I was fortunate to be given the opportunity to address the Institute of Physics (IoP) Young Physicists Conference on the subject of the Biefeld-Brown effect. Whilst this was not the first time I have given this talk, I was again surprised that no one in the audience had previously heard of this remarkable effect.

By Christopher Bailey

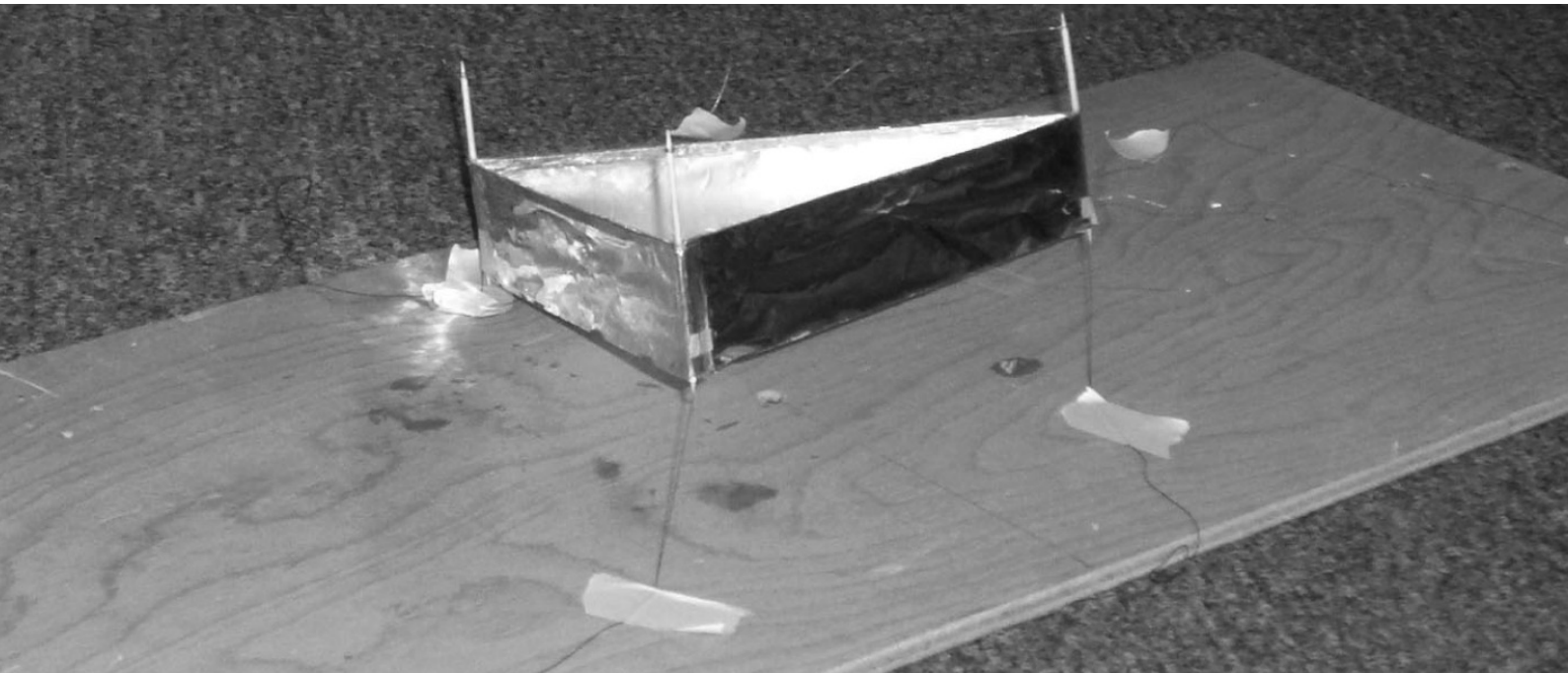
The Biefeld-Brown effect was initially discovered by Thomas Townsend Brown, a lab technician at Denison University in Ohio in the 1920's. Whilst using a Coolidge tube to experiment with X-rays Brown discovered that upon application of a high voltage to the tube, it experienced a force nothing to do with the X-rays. The most striking manifestation of this force is that it can be used to levitate objects.

Also at Denison was a Dr. Paul Alfred Biefeld. It was the work that Biefeld and Brown did together on this subject that led to it being named after them. They found that the effect could be generalised to any asymmetrical capacitor (that is a capacitor with one plate having different dimensions to the other) to which a high voltage is applied.

Brown spent a lot of his life investigating and experimenting with this effect, and it is by looking at his patent record that we can build up an idea of how his understanding of it developed. In his 1928 patent on the effect, Brown describes it as "a method for controlling gravitation and of deriving power therefrom". In his first patent, Brown frequently confuses the concepts of gravitation and electro-magnetism, and his belief that this might be a method by which UFO's could operate is thus understandable. It is unfortunate that his earlier writings and beliefs taint this fascinating subject with the label of pseudo-science, a label commonly induced by the mention of UFO's.

Throughout the next few decades Brown worked for many large organisations including both the U.S. Navy and Lockheed Vega. The Biefeld-Brown effect was of significant interest to these organisations and much work was done on it, particularly during the 1940s and 50s. Brown's patent, granted in 1960, gives, the best description of the effect: "when two capacitors of appropriate form are held in a fixed space relation, and immersed in a suitable medium, and charged to an appropriate degree, a force is produced tending to move the pair of electrodes through the medium."

However, while this patent gives the best description, it his 1965 patent which has generated the most controversy. In this, he says that "when all bodies beyond the apparent effective range of the field have been removed, the



force does not reduce to zero." This means that the force is non-zero even in a vacuum. This is a profound statement which has been both proved and disproved many times over. Whilst current understanding of the effect and the dynamics behind it mean this could never be the case, those who believe it to be true maintain the observed vacuum force is an additional background effect. Whether there is indeed another much weaker effect that only becomes apparent in a vacuum, or whether data appearing to prove this is incorrect, there is still a lot of disagreement. If only to disprove this radical theory for definite, more work needs to be done on the subject.

Which leads me to the question, why isn't more work being done? When I first read about this effect, I felt it to be so bizarre that it couldn't possibly be true. For this reason, I decided that I had to test it for myself. Within a couple of hours I was able to make a piece of simple equipment to dramatically demonstrate the effect in my own home. When suitably powered, the device, known as a 'lifter,' actually hovers in mid air. Whilst I would recommend anyone with an interest should try a similar test to satisfy their own curiosity, I should point out that very high (30kV) voltages are required to produce adequate lift. This of course presents its own health and safety dangers, and so extreme care should be taken when using this kind of apparatus. The flight of the lifter can be sudden and dramatic, so it is absolutely essential that the lifter is well tethered to restrain it.

Not only does the lifter have no moving parts, but it requires no fuel, produces no thermal signature and is silent during flight. To me, these all seem like such highly desirable characteristics, that military applications should be abundant.

So again I pose the question, "why isn't more research being done?" If an apparatus to test the effect can so easily be created at home, then surely it cannot be too difficult to experiment with, refine, improve and optimise it. Current understanding is that the Biefeld-Brown effect is an application of electro-hydrodynamics (EHD). However, whilst EHD is understood, its exact relationship to the Biefeld-Brown effect is apparently not, which I find a little curious.

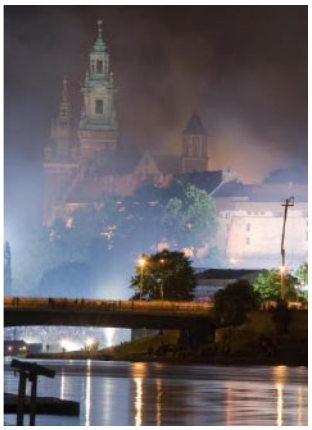
I find it almost sad that a phenomenon such as the Biefeld-Brown effect, with so much history, so much mystery and so many potential uses, is not better understood. Maybe its shadowy history means researchers do not take it seriously, or maybe there is a general assumption that someone else already understands it. Either way, I can only hope that after reading this you are too are enthused, as I was, to go out and investigate it further. You may find there is nothing more to discover, and that the lack of research is simply because there are no practical uses or you may discover a completely new and unknown aspect of it. Only time and determination will tell.

Some people say that all basic discoveries in physics have already been made; that the only real work left to do requires massive resources and huge teams of collaborating scientists. They are clearly misguided. The Biefeld-Brown effect is a clear example of one of the many areas where we still do not fully understand how the basic relationships and forces that govern our universe are applied to an apparently simple situation.

Christopher Bailey
St John's College, Oxford

The 2008 International Conference of Physics Students in Cracow, Poland





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Delegates to ICPS will have opportunity to visit some interesting places in the city as well as beyond Cracow. There will be a few guest lectures covering a variety of physics topics. We have also prepared the traditional social programme including the National party, where each nation represented at the conference presents some national food and drink and performs a little show (song, dance, comedy etc.). Participation is not mandatory, but if you participate, please prepare for it. It is usually enjoyed by all.

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