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Detecting Earthquakes and Nuclear Explosions

1 February 2012 at the IOP



Dr Cyril Isenberg (above) began the branch 2012 London lecture season at the IOP with his talk highlighting earthquake and nuclear explosion detection.

Earthquakes can be devastating and significantly disruptive, with human casualties, collapse of buildings, disruption of traffic via opening fissures on the roads, and many other damaging phenomena.

Best known examples are the San Francisco earthquake in 1906, the more recent 17 October 1989 and another one affecting the West Coast of America in 1995.

This region is prone to earth tremors, as is situated on the St Andreas Fault. Other earthquakes include the one affecting Alaska in 1964 and in Kobe, Japan, in 1995 (7.2 magnitude of the Richter scale).

Earthquakes result from a build-up of stresses within the rocks until they are strained to the point beyond which they will fracture.

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The End of the World in 2012? An Astronomer's Evidence Professor Dame Jocelyn Bell-Burnell FRS page 3 and following pages. **EEESTA Seminar, Public Engagement Grant Scheme, Branch Dinner** page 4. **NPL is opening its doors** page 5. **Astrophysics and the Anthropic Principle and What shadows we are and what shadows we pursue: medical imaging from roentgen to MRI** page 8. **The Physics of Superheroes** page 9.

The pressure builds up around the boundaries, with consequent release of elastic energy in the form of seismic waves which cause the damage.

Seismic phenomena occurs in narrow continuous belts of activity, which correspond with the junction of lithospheric plates, this including the circum-Pacific belt, the Alpine-Himalayan belt, and the ocean ridges.

The Richter scale of magnitude is based on the amplitude of the seismic wave from the Earth's centre, amplitude depending exponentially on the magnitude.

There are 4 varieties of seismic waves: 1-P waves, a longitudinal wave due to the elastic nature of the mantle. They are fast waves; 2- S waves or transfer waves, slower than P waves; 3- Love waves, that are transverse waves and slower than S waves and 4-Rayleigh waves, the slowest of all of them.



Mike Quinton (above) helped with a wave demonstration

Seismographs are instruments that measure motions of the ground (either seismic, volcanic in origin and other sources such as nuclear explosions) and transversal movement of the building with a recording graph.

Inertial seismographs have levers, a weight (the internal mass) that can move relative to the instrument frame. Any motion of the ground moves the frame.

The mass tends not to move because of the inertia, and by measuring the motion between the frame and the mass, the motion of the ground can be

determined. Early instruments used optical levers or mechanical linkages to amplify the motions involved, then recording on paper.

Modern seismographs use electronics. In some systems, the mass is held nearly motionless relative to the frame by an electronic feedback loop. The motion of the mass relative to the frame is measured, and the feedback loop applies a magnetic or electrostatic force to keep the mass nearly motionless.

The voltage needed to produce this force is the output of the instrument, which is recorded digitally. In other designs the weight is allowed to move, and the motion produces a voltage in a coil attached to the mass and moving through the magnetic field of a magnet attached to the frame.

Seismometers were sent to the Moon in the Apollo mission and moonquakes were detected.

These instruments have played a significant role in the detection and specification of the Earth's of internal structures.

Hopefully, they will also play a pivotal part in the building of structures aimed at withstanding earthquakes.

Dr Nuria M Calvo

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The contents do not necessarily represent the views or policies of the Institute of Physics, except where explicitly stated.

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The End of the World in 2012? An Astronomer's Evidence

Professor Dame Jocelyn Bell-Burnell FRS

15 February 2012, London Centre



Imagine ten months from now, it is the morning of the 21st December the last Friday before Christmas, schools are breaking up and people are frantically doing their last minute shopping. The clock turns to 11:11 it does not turn to 11:12 because the World has been destroyed and we are all dead! Many people believe this will actually happen, in fact an industry has sprung up publishing books and releasing a blockbuster film to cash in on this 'prophesy'. If there is the remotest chance that such a catastrophe could occur then why are crisis meetings not being held at the UN? Why are underground shelters not being excavated under mountain ranges? Why are food, fuel and medicines not being stockpiled? Why are survival colonies not being constructed in orbit or on the Moon? The answer is simple: It is all complete nonsense!

On 15 February the branch was fortunate enough to have Professor Dame Jocelyn Bell-Burnell speak to a packed Rutherford Lecture lecture theatre about this so-called prophesy of doom. Her lecture came about because while lecturing in the United States somebody would always ask her 'Is the World going to end in 2012?' Being a responsible scientist she decided to research the subject.

It all has to do with an ancient civilisation called the Maya that flourished in what is now Mexico in the two millennia before Christ. They were accomplished mathematicians and astronomers. They produced calendars that spanned long periods of time. Their last calendar which started on 11 August 3114 BC will end on 21 December 2012 AD. Some people have speculated that the Maya did not extend their calendar beyond this date because they somehow 'knew' the World would end on that day - that's it!

Dame Jocelyn made it very clear that there is no historical or archaeological evidence that the Maya intended the end of their calendar to mark the end of the world. She believes the Maya would have treated it in the same way we celebrated Millennium Night - with a party and a day off! She believes 11:11 AM 21st December 2012 was chosen because it is the northern hemisphere winter solstice when the Earth is at full tilt and the Sun is at its lowest point in the sky. This makes sense, a precise astronomical event that you can use to start the next calendar. The Mayan calendars were also inscribed in stone, they may simply have not had a rock big enough to go further into the future!

As the calendar ends with an astronomical event Dame Jocelyn decided to survey geophysical and astronomical threats that could befall the Earth. These include:

- Geomagnetic Field Reversals
- Solar Storms
- Asteroid Impact
- The planet Nibiru
- Planetary alignments perturbing the Earth's orbit

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**Branch Members are invited
to the EEESTA Seminar: -**

"Discovering the Hidden Universe"

**Exciting Results from the Herschel
Space Observatory**

Wednesday 14th November 2012

Weston Auditorium, De Havilland Campus,
University of Hertfordshire,
Hatfield. AL10 9EU.

Free event but BOOKING REQUIRED

Enquiries and telephone bookings:-
0845 474 3341

Or online at: -

<https://bookwhen.com/p8ujr/201211141730/597>

Seminar Speakers:

Professor Michael Rowan-Robinson
Past President RAS, Imperial College (former
Head of Astrophysics)

Dr Göran Pilbratt
European Space Agency and Herschel Project
Scientist

Professor Matt Griffin
Cardiff University and Principal Investigator for
the UK-led SPIRE instrument

Event timetable

5:30 pm Arrival and registration. Refreshments
and networking

6:45 pm Welcome

6:50 pm Chairman's opening remarks.

6:55 pm EEESTA Award

7:00 pm Speakers' Presentations

8:00 pm Summing Up: Chairman

8:10 pm Open forum: Questions & Answers

9:10 pm Closing remarks: Chairman

9:25 pm Vote of thanks

9:30 pm Close and depart



**PUBLIC
ENGAGEMENT
GRANT
SCHEME 2012
ROUND 2**

Do you have a fantastic idea for making physics accessible? Do you want to reach a wider audience? Do you need some support to make your outreach activity happen?

Then why not apply for a Public Engagement Grant from the Institute of Physics? They are worth up to £1000 and aim to support physics-based public outreach activities throughout 2012.

Application forms and guidelines for the grant scheme are available online at www.iop.org/activity/outreach/, or by e-mailing physics.society@iop.org.

Closing date: 30 April 2012

IOP Institute of Physics

DATE for Your Diary

BRANCH DINNER

8pm 21st Nov 2012

At

The IOP

Following the talk

**The working brain:
what physics can tell us
about autism, shopping
and learning algebra**

By

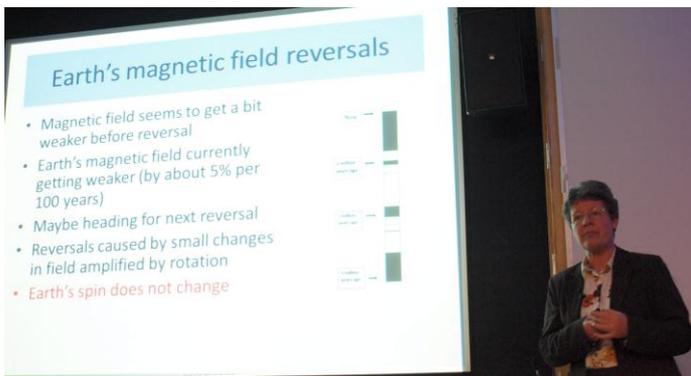
Professor Stephen Swithenby

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Above: (left to right) Professor Peter Kalmus, Professor Dame Jocelyn Bell-Burnell and Branch Secretary Len Lewell

There is evidence that in the past the direction of the Earth's magnetic field has changed direction - flipped. Towing a magnetometer across the Atlantic sea floor has revealed mirror images of alternating directions of magnetisation either side of the mid-Atlantic ridge. A crustal construction zone, magma swells up and spreads creating new sea floor. As the magma cools and solidifies it is magnetised by the geomagnetic field leaving a record in the rock of the direction of the Earth's magnetic field. From this we see that the geomagnetic field reverses on average every 300,000 years (the last was 750,000 years ago so we are well overdue).



Many living things, including birds, can sense the geomagnetic field and use it for navigation. They would obviously be affected by a reversal but a flip does not occur overnight it takes about 5,000 years to complete, giving animals time to adapt. As Dame Jocelyn points out, there have been eleven reversals since our tool making ancestors H.habilis evolved two and a half million years ago - and we are still here!

“NPL is opening its doors, come and be amazed

Following on from the success of the 2010 Open Day, the National Physical Laboratory (NPL) will be holding another open event on Wednesday 14 March 2012 so you can see for yourselves the amazing research we do.

Whether you have visited NPL on numerous occasions or not at all, have you ever wondered what goes on in some of those laboratories? Well, this is your opportunity to find out! The breadth and variety of activities we are involved in will astound you.

As the UK's National Measurement Institute NPL develop and maintain the nation's primary measurement standards, to ensure accuracy and consistency around the world. As well as being the home of the metre, the kilogram and the second, our scientists use measurement to solve all sorts of problems in all sorts of places - from cancer treatment, Earth observation, farming, mobile phones, GPS, electronics, and countless others. Wherever measurement is needed, NPL is there.

We will have a variety of science laboratories open as well as a programme of short talks and exhibits to showcase our world-leading science. Come along, meet our scientists and prepare to be amazed!

All are welcome to come to our Open House, but you must pre-register at

<http://www.npl.co.uk/openhouse>

Our Sun also has a magnetic field which periodically reverses but despite being a much more massive body a solar field reversal occurs in much less time. The interval between maxima (when the Sun's magnetic field is at full strength) is approximately eleven years. Maxima are also when sunspots and solar storms are most numerous. A solar storm is a jet of protons and electrons emitted from the Sun. When these particles strike the upper atmosphere they give rise to beautiful auroras.

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The last maxima was in the year 2000 the next will be in 2013 (not 2012). Dame Jocelyn reminded us that a solar storm has never killed anybody or caused a building to collapse although they can disable satellites and we are now more dependent on satellite services such as GPS. She produced a chart of number of sunspots against date. The peaks corresponding to maxima were very clear but also noticeable was that the peaks were in groups of lower and higher amplitude. It is predicted the 2013 maxima will be the lowest in a hundred years.

A threat we are very familiar with is asteroid impact. A massive impact 65 million years ago is believed to have caused an extinction event that wiped out the dinosaurs. Dame Jocelyn produced an image of Barringer crater in Arizona. This mile wide crater is believed to have been made by an object 50 metres in diameter. The object that exterminated the dinosaurs is believed to have been a kilometre across. The Earth is struck by an asteroid this size every 50 to 100 million years so again we are due for another impact. Last October a small asteroid passed between the Earth and the Moon. Around the globe several telescopes are dedicated to Near Earth Object Monitoring. The speaker showed a photograph of the Pan Starrs telescopes under construction in Hawaii which will scan the night sky for objects under 200m in diameter that come close to the Earth. Interestingly Dame Jocelyn stated that the technology to deflect an asteroid is already available. She said the worst thing we could do is to try and blow it up using a nuclear weapon - a la Bruce Willis - this would create millions of objects to track. A better way is to coat the object with a white deposit or erect a solar sail on it and use the radiation pressure of sunlight to push it out of harm's way. The only NEO astronomers are concerned about is an asteroid called 1950DA which will come uncomfortably close to the Earth in 2880.

Nibiru is a planet that was supposed to have been discovered by the ancient Sumerians about 2500 BC. The pseudo-science community have suggested this planet will

collide with the Earth in December. There are many problems with Nibiru: Why did not other stargazing civilisations such as the Mesopotamians, Babylonians and the Chinese also discover it? Nibiru is said to have an orbital period of 3600 years (Pluto 248 years) this means it has a very large orbit but to collide with the Earth its perihelion point must lie inside the Earth's orbit. This can only come about if Nibiru's orbit is unbelievably eccentric. At the time of 'discovery' Nibiru would have been ten times the distance to Pluto against a very crowded starfield background. Assuming the Sumerians had not discovered the telescope then to be a naked eye object at that distance Nibiru would have to be 150 times the size of the Sun and have a mass of 3.3 million Solar masses - we are not taking about a planet! Dame Jocelyn did mention the possibility that Nibiru could be a brown dwarf - a star that did not quite make it. The Sun is unusual in that it is solitary, most stars are in multiple star-systems. Our nearest stellar neighbour, proxima centauri, is part of a trinary star system. However a brown dwarf would be a daylight object even at four astronomical units.



There were many questions even after the talk had officially ended.

Occasionally the planets line up in what is called a conjunction where they can all be seen in a small area of sky. Venus and Jupiter will be in conjunction on the 13th of March. Could the

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The branch newsfeed and calendar are at <http://london.iop.org>

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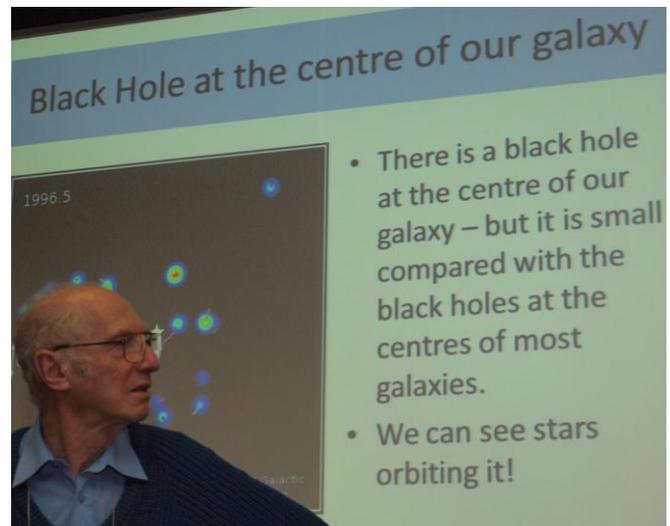
combined gravitational pull of the other planets pull the Earth into a different orbit? The speaker produced a pie chart showing the relative gravitational influence of the other bodies on the Earth. Nearly all the chart was due to the Sun with a thin sector representing the Moon. The combined contribution of the other planets is one two hundredths of the Moon and could not be seen on this scale. In 2000 five planets and the Sun were in conjunction with the Earth. In 1962 five planets, the Sun and the Moon were in conjunction. There are no major conjunctions in 2012.



At the centre of all galaxies lies a monster - a supermassive black hole. The speaker showed a clip of stars orbiting an invisible object at the centre of our galaxy. It can be viewed at <http://www.youtube.com/watch?v=7vcSKbXnLJA&feature=related> One star can be seen to describe a complete orbit. Another star, designated SO-45, moves in a straight line. When asked about this Dame Jocelyn suggested its orbital plane is edge-on to our line of sight. Could an alignment of the Sun and the black hole at the centre of the Milky Way throw the Earth out of the Solar System? Coincidentally the Sun and Black Hole are in conjunction on the 21st December.

As supermassive black holes go the one at the centre of our galaxy is a tiddler, weighing in at a mere four million solar masses. The galactic centre is also 26000 light years away

In short the gravitational pull of the Sun on the Earth is one hundred billion times stronger than the black hole.

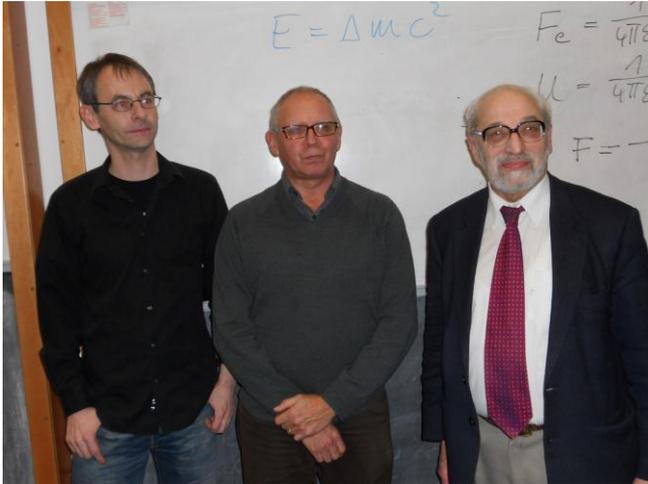


Surprisingly the one threat the discoverer of pulsars did not discuss was supernovae. The red supergiant Betelgeuse is regarded as a potential supernova and astronomers have recently noticed an unusual variation in its light curve indicating it is becoming unstable. Fortunately it is 640 light years away so when it does go off we will get an impressive light show but no damage.

Dame Jocelyn concluded her lecture by asking what was going on? Why do so many people choose to believe in the most fantastic, unsubstantiated theories? As she says we are not rational beings. She showed us one of her favourite websites <http://www.manyendings.com> This site lists doom prophecies that were going around in various years and there are a surprising number of them. In 1954 a cult predicted the end of the World. The American psychologist Len. Festinger used his graduate students to infiltrate the cult in order to study them. They patiently waited for the appointed hour and waited and waited and waited until at two in the morning the cult leader announced he had received a

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**Astrophysics and the Anthropic Principle
Joint IOP SEKAS Meeting
14 February 2012
University of Kent at Canterbury**



Above: (Left to right): Dr Dirk Froebrich, from the School of Physical Sciences at the University of Kent, Mr Paul Andrew, the President of SEKAS, and Dr Cyril Isenberg, University of Kent.

Dr Froebrich showed, after a speedy review of the physical concepts required in his analysis, that it was not possible for life to exist in the current form with the proportion of carbon in the human body, if the physical constants did not have their current values.

Dr C Isenberg

What shadows we are and what shadows we pursue: medical imaging from roentgen to MRI. Kent Centre 28 February.



Left to Right: Dr Stephen Duck, from the Kent and Canterbury Hospital, Dr Peter Dawson, Vista Diagnostics Ltd and Dr Cyril Isenberg, University of Kent.

Dr Peter Dawson gave an most interesting explanation of the MRI imaging process with lots of remarkable scans.

Dr C Isenberg

**The End of the World in 2012? An Astronomer's
Evidence continued from page 7**

revelation that God was so happy with the devotion of the group he had decided to postpone the apocalypse! To the psychologists surprise this did not undermine the faith of the cultists, the opposite happened, it reinforced it!



This was a laughable example of cults others have been very tragic. In 1997 comet Hale-Bopp was visible from Earth, a UFO cult in California believed a spacecraft was in the tail that would take them to a new planet but they would first have to surrender all their worldly possessions including their bodies. Police later found the remains of 39 cult members. Dame Jocelyn reminded us the Internet can be used to disseminate misinformation. One site, belonging to the 'Institute of Human Continuity' makes several references to the Columbia Pictures film '2012' and is believed to be a subtle form of advertising for the film. The speaker said one way you could recognise it was not an academic site is that it is too professional! She recommended people should receive their information from real academic sites such as iop.org and look for sites ending in .ac.uk and .edu. Finally Dame Jocelyn said that to stop people believing in doom prophesies we must improve our teaching and communication of science.

So don't use the Maya as an excuse for not doing Christmas this year, get the turkey on order!

Len Lewell.

Photographs from Mike Quinton.

The Physics of Superheroes IOP 29 February 2012



Above: Left to Right Professor Peter Kalmus, Dr Diane Crann, (our Hertfordshire Centre representative), and Professor Alan Davies

This lecture aimed at exploring and explaining the scientific and non-scientific background in the powers and superpowers of some of the comics action heroes (i.e. Marvel comics and DC comics in the USA). A superhero could be defined as a "type of stock character dedicated to protecting the public". "They require superhuman powers to be deemed superheroes" (Wikipedia). Many of their actions appear to exhibit correct principles of physics. They are antagonised by villains who may also possess superpowers. Chronologically speaking, we could consider 3 phases: a Golden Age (1938-1956), Silver Age (1956-1970) and a Bronze Age (1970s-onwards).



Some heroes and their idiosyncratic powers were discussed. Superman is known to launch himself alongside skyscrapers via giant leaps.

To do this, Superman must generate an initial velocity of 200 feet/sec. Newton's laws of motions were implemented here, and by knowing that $F = m \cdot a$, the gravity on the planet Krypton must have been 17 times greater than on Earth. By using Newton's formula of gravity, we could estimate Krypton's density and for Krypton's gravity to be 17 times greater than the Earth, it must have had a core of neutron star matter at its centre (no surprise here that Krypton exploded!).



Above: Spider Man Superman and Prof. Davies

Gwen Stacey, Spiderman's girlfriend dies from a fractured cervical spine as she falls (head down) from a building (The Green Goblin has orchestrated this). Spiderman acquired his powers after being bitten by a radioactive spider, but he invents and manufactures his own web. It is plausible to consider that had Gwen fallen vertically with the head up, she could have potentially survived the fall. Spiderman's web elasticity is different in quality from the web generated by spiders. Ideas of impulse and momentum were discussed here.

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Moving onto Electricity and Magnetism, arch-villains Electro and Magneto (and also Superboy) were introduced. Dillon (later Electro) was struck by lightning and consequently, obtained his powers. He can generate massive quantities of electricity, employ this electrostatic energy as lighting arcs from his fingertips and can also glide over power lines by using the electricity contained therein for propulsion. Magneto controls magnetism and manipulates metal (ferrous and non-ferrous). He also has the property of levitation, which could be explained by diamagnetism. When a magnetic field is applied to diamagnetic materials (Au, Ag, water and water-containing objects), their magnetic domains align in the opposite -repulsion-, consequently, producing a levitating phenomena.



In Materials Science we mentioned Wonder Woman, a warrior Princess of the Amazons endowed with magical powers and bearer of the bracelets of victory. These are made of amazonium, which has the property to deflect bullets and withstand impact force and stress.

In the Field of Molecular Physics, the climbing ability of Spiderman was presented, suggesting the analogy to gecko feet. Gecko feet have millions of microscopic hairs, encased in tiny pads. It seems that Van der Waals forces confer the adhesive properties to geckos, enabling them to walk smooth surfaces, though geckos move slowly!

Ant Man, The Shrinking Violet and the Atom all have the ability to diminish their own sizes at will, with no resulting abnormalities in their physiology. If these heroes become smaller than subatomic particles, they would not be able to breathe oxygen, their blood pressure would increase up to 40 times, the perception of light would be different,- as they would be smaller than cones and rods-, and their voice would be practically inaudible!! Additionally, their sartorial requirements would have to simultaneously adapt to their changing sizes. This is not the case with Hulk, who rips off his clothes when gaining size.



Finally, Superman characteristically carries in his hands big buildings, like pizzas from the oven to the table. He adeptly moves and relocates orphanages without any disruption in the building structure. However these constructions are not designed to move around frequently and do not withstand bending and/or torsion forces. In this case, the physics isn't correct.

It was an entertaining, stimulating and enjoyable evening, with a significantly enthusiastic participation of the attendants.

Dr Nuria M Calvo

Photographs from Mike Quinton

Very Early Career Physics Communicator Awards

20 November 2012 at the IOP

For details see

http://www.iop.org/activity/groups/subject/pyscom/prize/page_50554.html