Science in public: finding a Higgs boson in the media spotlight

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Outline

• Why the Higgs matters
• The story (as seen by me)
• Some results
E = mc^2
High energy wave means small wavelength

Low energy wave means long wavelength
High energy density

THEN

Lower energy density

NOW
Here’s one we made earlier...

\[ E = mc^2 \]
Here’s one we made earlier…

Energy, $E = mc^2$
$\int \mathcal{L} \, dt = 1.08 \text{ fb}^{-1}$

$\sqrt{s} = 7 \text{ TeV}$

**ATLAS**

Events

```
10^6
10^5
10^4
10^3
10^2
10
10^{-1}
10^{-2}
```

```
80 100 200 500 1000 2000
```

$m_{ee} [\text{GeV}]$

- Data 2011
- $Z/\gamma^*$
- Diboson
- $t\bar{t}$
- W+Jets
- QCD
- $G^*(1000 \text{ GeV})$
- $G^*(1250 \text{ GeV})$
- $G^*(1500 \text{ GeV})$

$q$

$z/\gamma$

$e^+$

$e^-$
Science & the media

• A complicated relationship, often characterised by fear, mistrust and misunderstanding on both sides

• But for both sides, it starts with…
...Science & the public

• We need public support for what we do
  • *We ought to share the wonders we find*
• The media want viewers/listeners/readers…
  • *Outside of our own specialities, we are the public*
• We and the rest of the public need to talk to each other
  • *Much (though not all) of that is via media*
The early 1990’s

• Sudden(?) realisation that we had better engage.
  • “Public understanding of science”, “deficit model”… data-collection, evaluation… many cycles (currently “public engagement”)
  • But the fundamental shift in attitude was “this is an important activity for scientists”
The LHC startup: 2008
Episode 01: Codename Eurostar

Codename Eurostar

The first in a series of films following a team of physicists involved in research at the new Large Hadron Collider (LHC) at CERN in Switzerland.

Gavin, Jon and Adam have a cunning plan to find the Higgs Boson, an elusive particle which physicists have been trying to find for over 40 years. One of the main aims of the LHC is to discover once and for all whether the Higgs actually exists or not, and "Eurostar" might just hold the key to finding out...

Click here to watch Episode 2

Sign up here to be notified when the next episode is online.
on a new technique for finding the Higgs using ATLAS, one of the LHC’s two main all-purpose detectors. The group’s name derives from its origins as an informal collaboration – facilitated by the Eurostar rail link – between London-based experimentalist Jon Butterworth and Paris-based theorist Gavin Salam. Butterworth’s PhD student Adam Davison makes fun of the name on camera, but it seems to have stuck. The site itself is supported by the UK Science and Technology Facilities Council’s “Science in Society” programme, with films produced by documentary filmmaker Mike Paterson.

Who is it aimed at?
Although CERN researchers will undoubtedly get a kick out of spotting their colleagues in the background, students interested in science are the site’s main audience. Such students will benefit from seeing how science really works – including the disappointing/boring/frustrating bits – and there are some teaching resources available on the site to help them. Unfortunately, the films contain relatively little physics, so anyone who wants more than a cocktail-party-level understanding of the Higgs, the LHC or Project Eurostar itself will need to dig into the site’s “further reading” section.

What are some highlights?
In one segment of the “Problems” episode, several researchers struggle to explain what caused the LHC to be shut down last autumn – without using the phrase “blew up”, which is apparently off limits. “Engineering breakdown”, “technical malfunction” and “catastrophic release of liquid helium – wait, scratch the ‘catastrophic’ bit’ are some of the euphemisms they offer; but amid the silliness, their explanations are sound and easy to follow. At the end of the same episode, Salam, the Eurostar theorist, suggests that the universe is like a piece of music. With the lower-energy collisions at Fermilab’s Tevatron, he says, we could hear the double basses, but the LHC will add the cellos – and from there, we will begin to figure out what the rest of the orchestra is playing. In a field full of analogies, most of them over-used, this one feels both fresh and insightful. But here’s hoping the next episodes in the series contain some new science, not just new metaphors.
The Physics behind the paper behind “Colliding Particles”
By Jon Butterworth

This post also at The Guardian.

This is a bit of a niche post but there was recently a review in Physics World of these videos I'm in about research at the Large Hadron Collider (LHC). While generally positive, the review pointed out that although the videos are partially based around a particular scientific paper about how one might find the Higgs boson (referred to in the films as the "Eurostar paper"), they don't really explain the physics behind it, being focussed more on "how science works" than a specific result. Fair comment. So here is my attempt to explain the physics behind this paper to an intelligent but non-specialist audience.

I'll concentrate on explaining the new ideas in the paper rather than giving a summary of why the Higgs is interesting or what the LHC is. I wrote something about that at the end of this article for the BBC, and might try again at some point. But I'll assume some familiarity with what the LHC is. For now, you need to know that if the Higgs boson exists, and if
The physics behind the paper behind Colliding Particles

The Colliding Particles films show a lot about how particle physics is done, but don't contain much actual physics. This was my first ever blogpost, which explains some of the physics.

This is a bit of a niche post but there was recently a review in Physics World of these videos I'm in about research at the Large Hadron Collider (LHC). While generally positive, the review pointed out that although the videos are partially based around a particular scientific paper about how one might find the Higgs boson (referred to in the films as the "Eurostar paper"), they don't really explain the physics behind it, being focused more on "how science works" than a specific result. Fair comment. So here is my attempt to explain the physics behind this paper to an intelligent but non-specialist audience.
COLLISIONS TOOK PLACE AT A RECORD LEVEL OF 7 BILLION ELECTRON VOLTS
The LHC: worth the wait?

I have never seen so many physicists in the media as there were in September 2008. There we were, often nervous, always excited, trying to explain what the Large Hadron Collider would do (teach us more about the universe) and what it wouldn't do (destroy the universe). One particularly bizarre memory is of retiring to a pub in Westminster, finally exhausted by the LHC event I was helping with, and continuing to get updates ON MY OWN EXPERIMENT from the BBC news ticker on the TV in the corner. Beams have gone both ways round the LHC... Beams successfully stored... Ah, those were the days! It doesn't get much better than this.

Sadly of course, it didn't. It got a lot worse.

The truth is, while you may have thought we were nervous and excited about being on Breakfast TV, meeting the Minister, blinking in the glare of unaccustomed publicity, we were really nervous and excited about the LHC.
Gallery of images from the CERN laboratory

Andrew Marr, Professor Brian Cox and Professeur Jim Virdee
Some dates...

Robin does lots of gigs. You might find some of them at places like Entst24.com, etc. Here are a few:

[photo © Rob Greig]

**BOOK CLUB** - award winning comedy readings from very bad books.

**THE IMPORTANCE OF BEING INTERESTED** - 2013 tour: Charles Darwin, Richard Feynman, Aristotle and the joy of picking shells up on the beach and realising that being self-conscious in a big universe is a darn good thing.

**DECEMBER**

**9 LESSONS AND CAROLS FOR GODLESS PEOPLE**
15/12/2012 The Bloomsbury
London

[event series link]

Welcome to the website of Robin Ince, comedian, writer and that sort of thing. Twitter @robinince. Robin's agents: noelgay.com
For live event booking enquiries, email warren@lakinmccarthy.com or call 020 8530 5179.

**latest news...**

**THE INFINITE MONKEY CAGE DOWNLOADS NOW LIVE**

Robin and Brian's BBC Radio 4 comedy/science series is on air again at 4:30PM Mondays. this week featuring Jo Brand talking of brain things. Shows repeat on Tuesdays at 11PM.

Programme [homepage](#) has more info, and more downloads are at [TIMC Podcast Page](#), including iTunes subscription. Twitter is @themonkeycage.

**MORE 9 LESSONS AND CAROLS**
2011 DVD AVAILABLE

28/1/2013

Jon Butterworth, UCL
Stars of UK Comedy and Science Stand Up Against Unfair Libel Laws in West End Show

Big names in UK comedy, science and politics come together on stage to tell us that England’s libel laws have become a dangerous joke.

The Big Libel Gig on Sunday 14 March 2010 at the London’s Palace Theatre will raise funds to support the Coalition for Libel Reform. An eclectic line-up, including Dara Ó Briain, Tim Minchin, Marcus Brigstocke, Robin Ince, Ed Byrne, Shappi Khorsandi, Professor Brian Cox, Simon Singh, Professor Richard Wiseman, Dr Peter Wilmshurst and Dr Ben Goldacre, is supporting the campaign for a public interest defence to protect writers, bloggers, academics, human rights activists and performers.

The Big Libel Gig is the brainchild of comedian Robin Ince - whose previous successes include the annual Nine Lessons and Carols for Godless People shows and who will be hosting the evening - and Simon Singh, the science author and broadcaster, who will be talking frankly about the impact of libel fears on scientific debate.

Simon Singh, who is currently being sued by the British Chiropractic Association, said: “Peter Wilmshurst, Ben Goldacre and I will talk about being sued for libel. Peter is being sued for raising concerns about a heart device. He faces bankruptcy by coming up against our draconian libel laws. We are all put at risk if doctors and scientists are scared to speak out because of English libel laws.”

Stars of the show will tell the audience that England’s unjust libel laws are preventing free speech and open criticism of big corporations and powerful institutions. They will call for others to support the campaign for a public interest defence and join them in signing the petition for libel reform at www.libelreform.org. The Big Libel Gig will be the culmination of Libel Reform Week, which will raise awareness of English libel laws and urge political
Back to the LHC: 9 days later
This Week's Rumor

Posted on April 21, 2011 by woit

A commenter on the previous posting has helpfully given us the abstract of an internal ATLAS note claiming observation of a resonance at 115 GeV. It's the sort of thing you would expect to see if there were a Higgs at that mass, but the number of events seen is about 30 times more than the standard model would predict. Best guess seems to be that this is either a hoax, or something that will disappear on further analysis. But, since spreading well-sourced rumors is more or less in the mission statement of this blog, I think I'll promote this to its own posting. Here it is:

Internal Note
Report number ATL-COM-PHYS-2011-415
Title Observation of a γγ resonance at a mass in the vicinity of 115 GeV/c2 at ATLAS and its Higgs interpretation
Author(s) Fang, Y (-) ; Flores Castillo, L R (-) ; Wang, H (-) ; Wu, S L
(University of Wisconsin-Madison)
Subject category Detectors and Experimental Techniques
Accelerator/Facility, Experiment CERN LHC ; ATLAS

Rumours of the Higgs at ATLAS

Many of us on the ATLAS experiment at CERN have been a little more busy than we anticipated this Easter. I tried to explain why on Channel 4 news.

You may have seen reports of rumours of .... dramatic findings at the Large Hadron Collider over the past few days. I haven't commented on them here so far since the rumours are based on a leaked internal document.

Nevertheless when Channel 4 asked me about it I thought I should go on:
Some results
\[ m_H = 126.5 \text{ GeV} \]

\[ H \rightarrow \gamma \gamma \]

\( \sqrt{s} = 7 \text{ TeV}, \int Ldt = 4.8 \text{ fb}^{-1} \)

\( \sqrt{s} = 8 \text{ TeV}, \int Ldt = 5.9 \text{ fb}^{-1} \)
$H \rightarrow ZZ^{(*)} \rightarrow 4l$

$s = 7$ TeV: $\int L dt = 4.8$ fb$^{-1}$

$s = 8$ TeV: $\int L dt = 5.8$ fb$^{-1}$
Local Significance

ATLAS

\[ \sqrt{s} = 7 \text{ TeV: } \int L dt = 4.6-4.8 \text{ fb}^{-1} \]
\[ \sqrt{s} = 8 \text{ TeV: } \int L dt = 5.8-5.9 \text{ fb}^{-1} \]
A Level Science entries

- Biology (16-18)
- Chemistry (16-18)
- Physics (16-18)

A Level Entries

- 60,000
- 50,000
- 40,000
- 30,000
- 20,000
- 10,000
- 0

A Level Science entries

- Biology (16-18)
- Chemistry (16-18)
- Physics (16-18)
University Entry:  
Physics (including Astronomy/Astrophysics)

- 2005  3069
- 2006  3060
- 2007  3349
- 2008  3452
- 2009  3721
- 2010  3827

Source: IoP Nov 2011: Accepted places
What we may learn from the LHC

- How well the Standard Model works above the electroweak symmetry breaking scale
- Why the W and Z have mass and the photon is massless
- Where mass comes from
- Possible new particles and forces (supersymmetry?)
- Possible new dimensions of space
- Mini black holes/quantum gravity
- Physics in a fundamentally new regime
The beginning of physics above the Electroweak Symmetry Breaking scale...