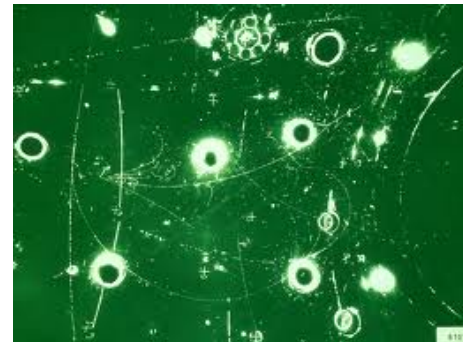
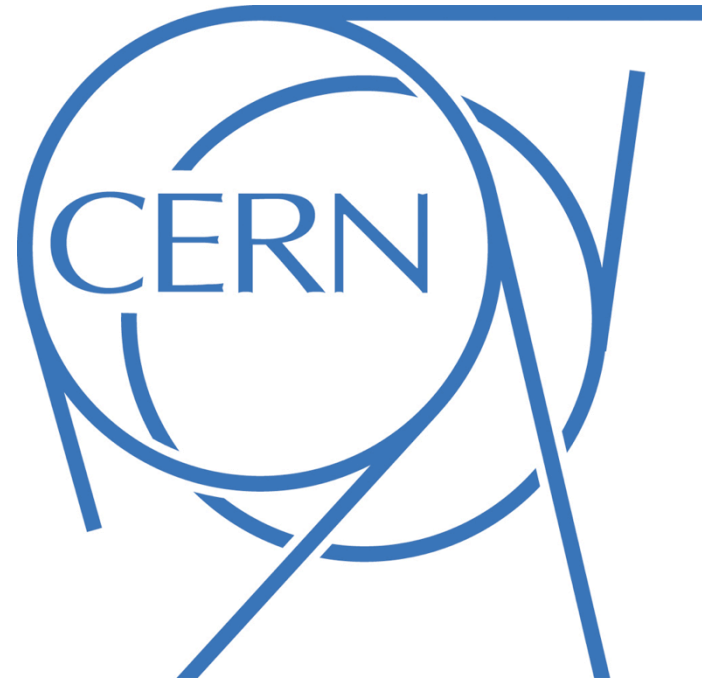


Welcome to CERN

- European Organization for Nuclear Research
- Particle physics/HEP
- The theory of everything ...
- [“The God particle”](#)



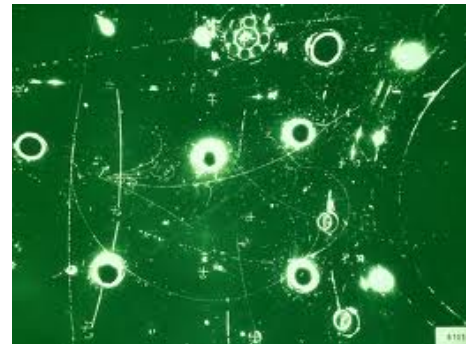
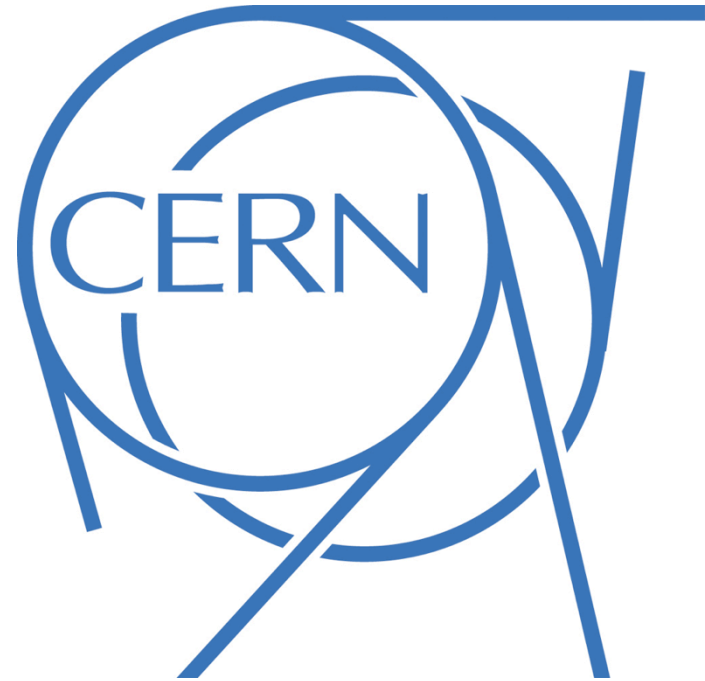
Welcome to CERN

C

Centre ...

Long discussion in
Copenhagen in June 1952

...



Welcome to CERN

C

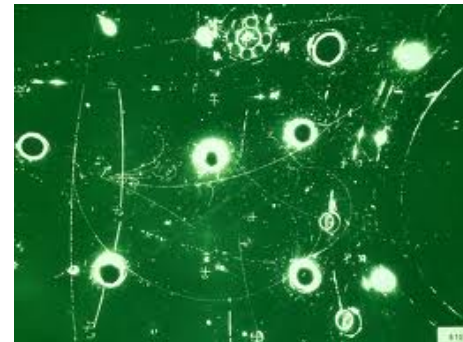
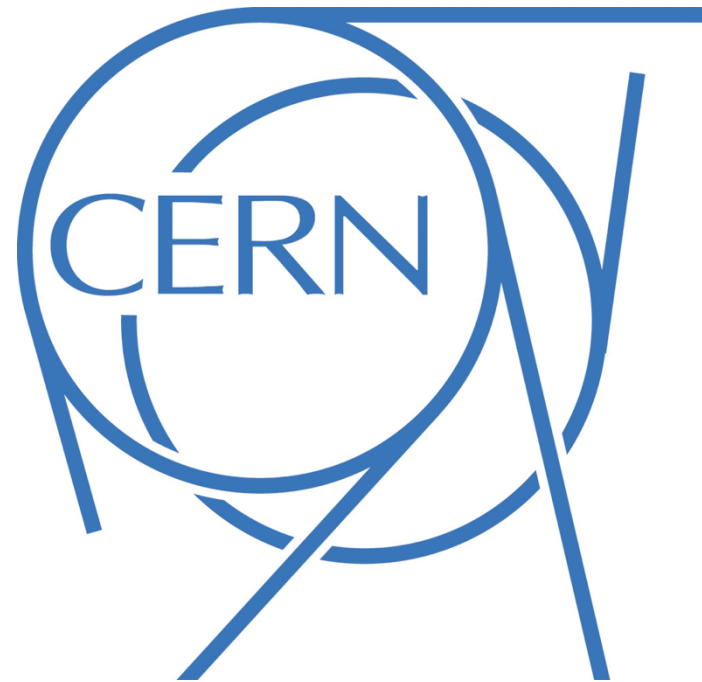
Centre ...

Cabale

Casino

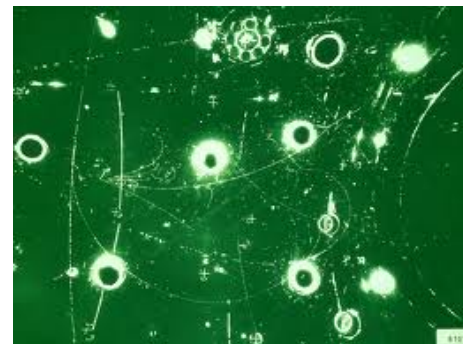
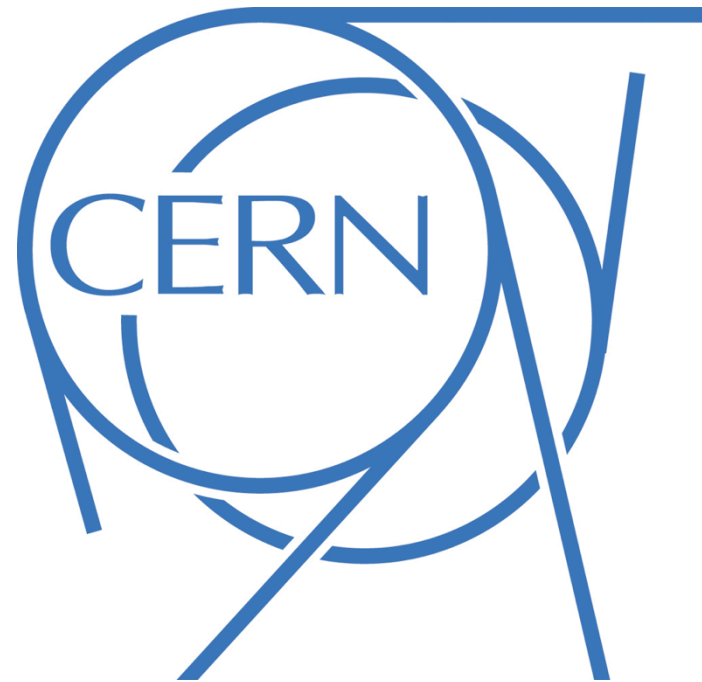
Concubinage

Cirque



Welcome to CERN

- European Organization for Nuclear Research
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- [“The God particle”](#)





Da hun var liten kikket CERN-sjef Fabiola Gianotti filosofisk opp på stjernene. I dag er hun selv blitt en fysiker-stjerne
FOTO: Martin Slottemo Lyngstad



En kort samtale med den store partikkel-popstjernen

What is CERN?

- CERN is the world's largest particle physics centre
- Particle physics is about:
 - elementary particles which all matter in the Universe is made of
 - fundamental forces which hold matter together
- Particle physics requires:
 - special tools to create and study new particles

CERN is:
-~ 2500 staff scientists
(physicists, engineers,
...)
-2000 Sub-contractors
- Some 12000 visiting
scientists (half of the
world's particle
physicists)

*They come from
900 universities
representing
80 nationalities.*



Searching for Higgs



The Nobel Prize 2013 in Physics



Here, at last!

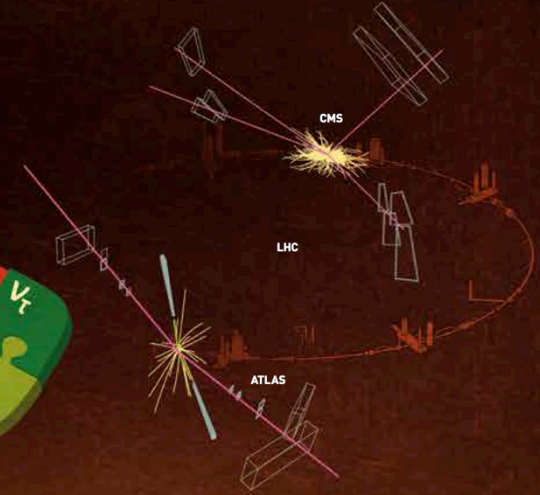
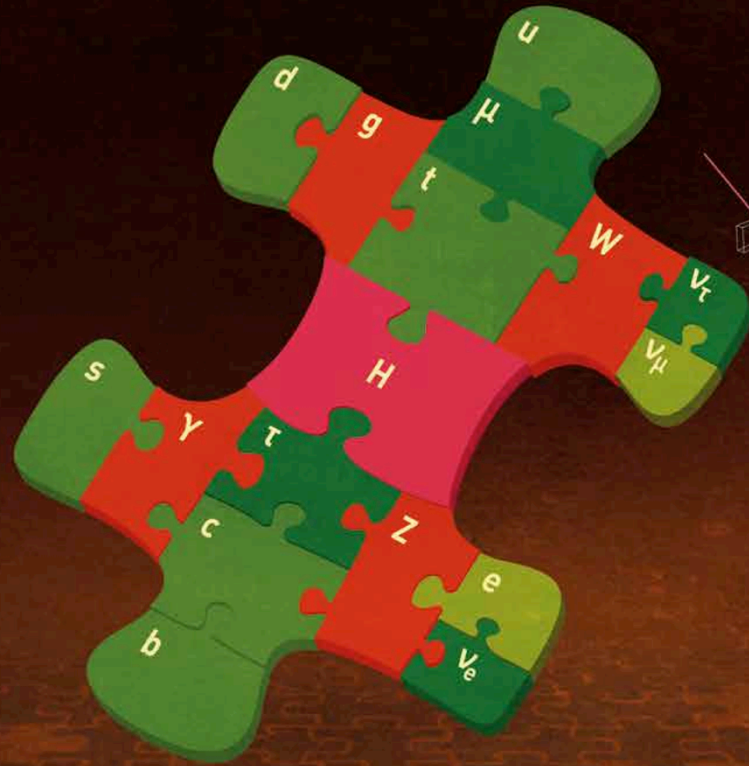
François Englert and Peter W. Higgs are jointly awarded the Nobel Prize in Physics 2013 for the theory of how particles acquire mass. In 1964, they proposed the theory independently of each other (Englert did so together with his now-deceased colleague Robert Brout). In 2012, their ideas were confirmed by the discovery of a so-called Higgs particle, at the CERN laboratory outside Geneva in Switzerland.

The awarded mechanism is a central part of the Standard Model of particle physics that describes how the world is constructed. According to the Standard Model, everything – from flowers and people to stars and planets – consists of just a few building blocks: *matter particles* which are governed by forces mediated by *force particles*. And the entire Standard Model also rests on the existence of a special kind of particle: the *Higgs particle*.

The Higgs particle is a vibration of an invisible field that fills up all space. Even when our universe seems empty, this field is there. Had it not been there, nothing of what we know

would exist because particles acquire mass only in contact with the Higgs field. Englert and Higgs proposed the existence of the field on purely mathematical grounds, and the only way to discover it was to find the Higgs particle.

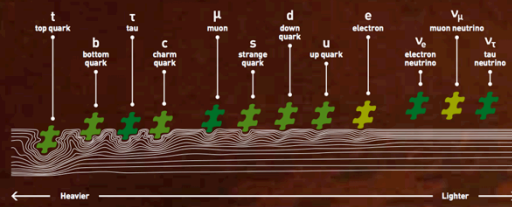
The Nobel Laureates probably did not imagine that they would get to see the theory confirmed in their lifetimes. To do so required an enormous effort by physicists from all over the world. Almost half a century after the proposal was made, on July 4, 2012, the theoretical prediction could celebrate its biggest triumph, when the discovery of the Higgs particle was announced.



ATLAS
In the collision, a short-lived Higgs particle is created, which decays into two muons (tracks in red) and two electrons (tracks in green).

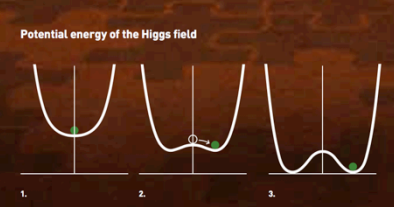
CMS
A short-lived Higgs particle is created in the collision and decays into four muons (tracks in red).

The Particle Collider LHC
Protons – hydrogen nuclei – travel at almost the speed of light in opposite directions inside the circular tunnel, 27 kilometres long. The LHC (Large Hadron Collider) is the largest and most complex machine ever constructed by humans. In order to find a trace of the Higgs particle, two huge detectors, ATLAS and CMS, are capable of seeing the protons collide over and over again, 40 million times a second.



The Field
Matter particles acquire mass in contact with the invisible field that fills the whole universe. Particles that are not affected by the Higgs field do not acquire mass, those that interact weakly become light, and those that interact strongly become heavy. For example, electrons acquire mass from the field, and if it suddenly disappeared, all matter would collapse as the suddenly massless electrons dispersed at the speed of light. The weak force carriers, W and Z particles, get their masses directly through the Higgs mechanism, while the origin of the neutrino masses still remains unclear.

Broken Symmetry
The Higgs mechanism relies on the concept of spontaneous symmetry breaking. Our universe was probably born symmetrical (1), with a zero value for the Higgs field in the lowest energy state – the vacuum. But less than one billionth of a second after the Big Bang, the symmetry was broken spontaneously as the lowest energy state moved away (2) from the symmetrical zero-point. Since then, the value of the Higgs field in the vacuum state has been non-zero (3).



The Puzzle
The Higgs particle (H) was the last missing piece in the Standard Model puzzle. But the Standard Model is not the final piece in the cosmic puzzle. One of the reasons for this is that the Standard Model only describes visible matter, accounting for one sixth of all matter in the universe. To find the rest – the mysterious so-called dark matter – is one of the reasons why scientists continue to chase unknown particles at CERN.



François Englert
Belgian citizen. Born 1932 in Etterbeek, Belgium. Professor emeritus at Université Libre de Bruxelles, Brussels, Belgium.

Peter W. Higgs
British citizen. Born 1929 in Newcastle upon Tyne, United Kingdom. Professor emeritus at University of Edinburgh, United Kingdom.

BROKEN SYMMETRIES, MASSLESS PARTICLES AND GAUGE FIELDS

P. W. HIGGS

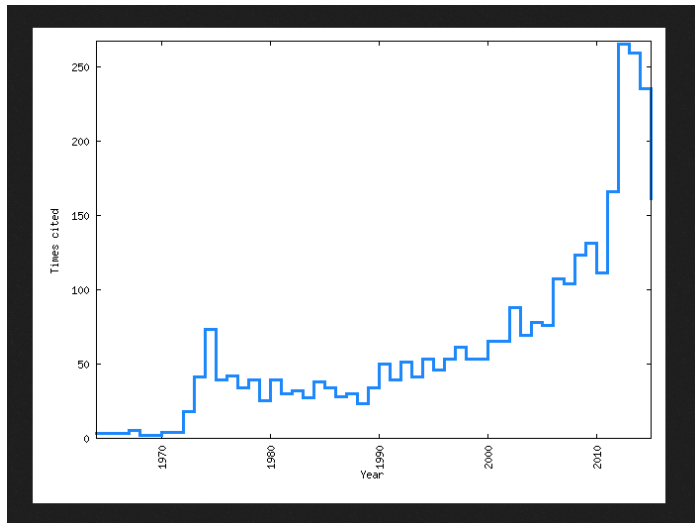
Tait Institute of Mathematical Physics, University of Edinburgh, Scotland

Received 27 July 1964

Recently a number of people have discussed the Goldstone theorem ^{1, 2)}: that any solution of a Lorentz-invariant theory which violates an internal symmetry operation of that theory must contain a massless scalar particle. Klein and Lee ³⁾ showed that this theorem does not necessarily apply in non-relativistic theories and implied that their considerations would apply equally well to Lorentz-invariant field theories. Gilbert ⁴⁾, how-

ever, gave a proof that the failure of the Goldstone theorem in the nonrelativistic case is of a type which cannot exist when Lorentz invariance is imposed on a theory. The purpose of this note is to show that Gilbert's argument fails for an important class of field theories, that in which the conserved currents are coupled to gauge fields.

Following the procedure used by Gilbert ⁴⁾, let us consider a theory of two hermitian scalar fields





Observation of a new boson at a mass of 125 GeV with the CMS experiment at the LHC [☆]

Universally Available

This paper is dedicated to the memory of our colleagues who worked on CMS but have since passed away. In recognition of their many contributions to the achievement of this observation.

CMS Collaboration*

CERN, Switzerland

32 pages article – 16 pages of authors 😊

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The Ashlad and His Good Helpers : illustrating the BEH Mechanism



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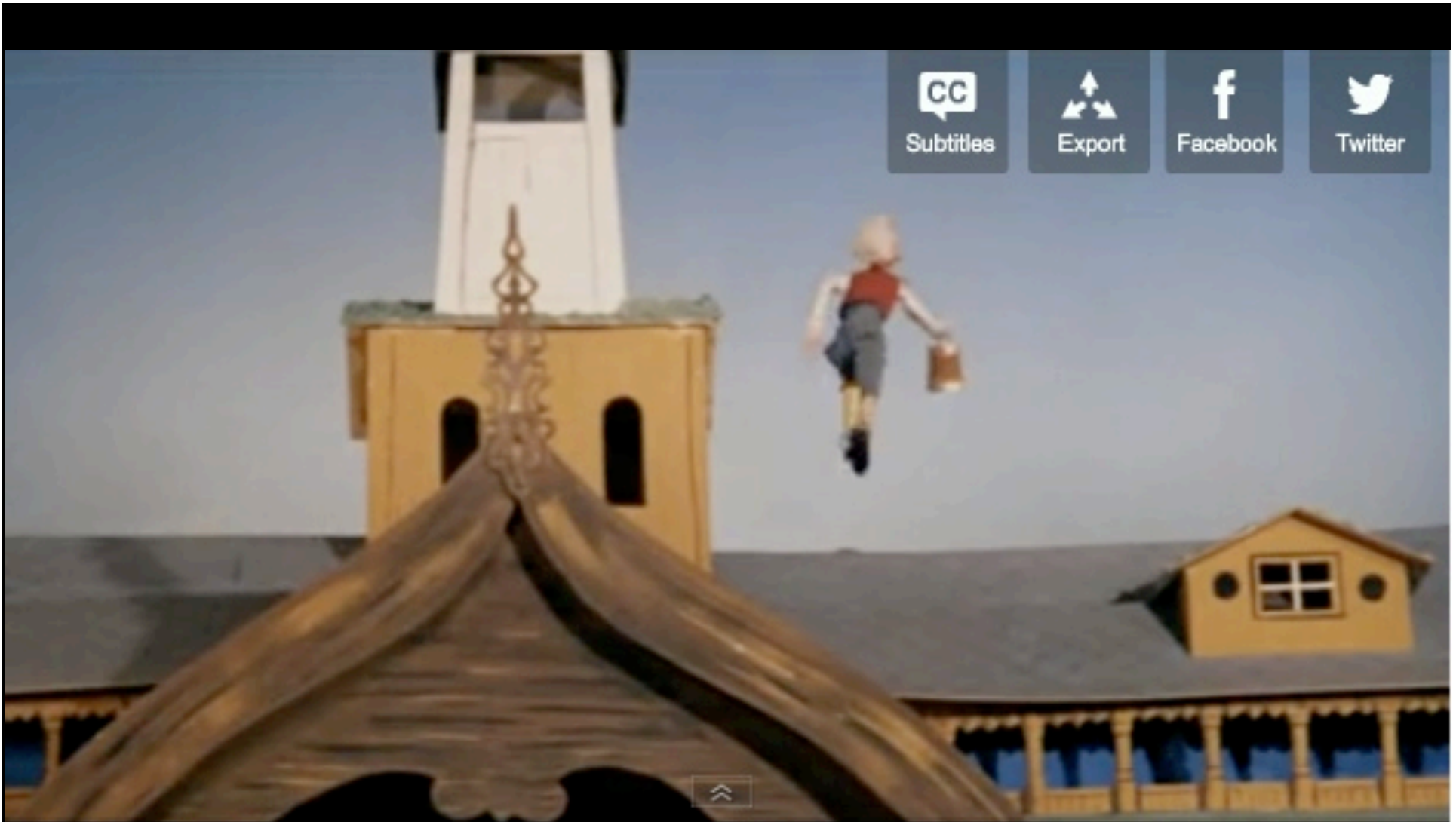
http://www.dailymotion.com/video/xdfg8h_the-ashlad-and-his-good-helpers



“Get me water, within 3 minutes, from the end of the world!”



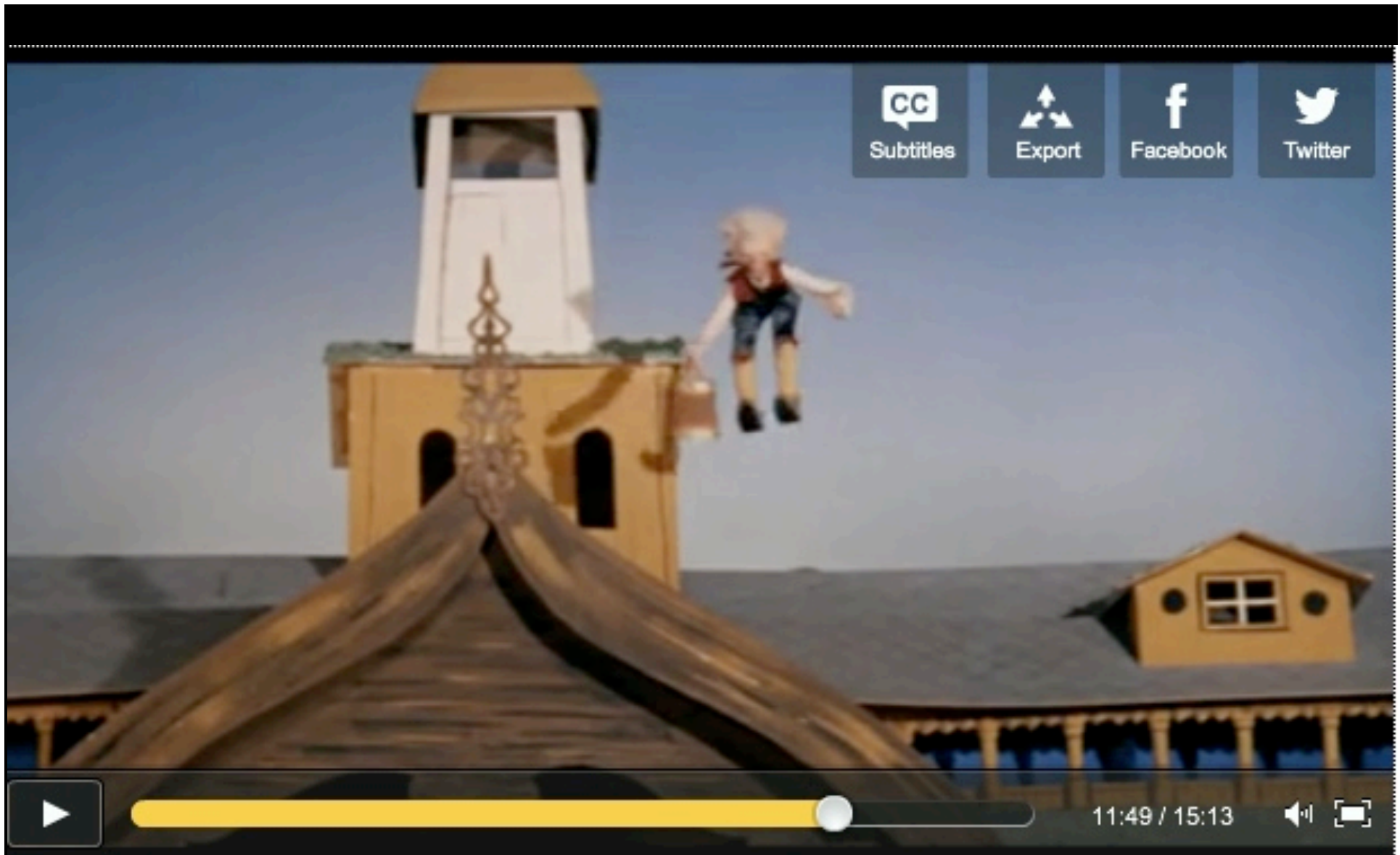
Hold on – what is happening? The man removes his weights!



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“Your Majesty, I will be straight back!”



Some 15 seconds after departure our friend is back!
This man is certainly not made by matter influenced by the
Brout-Englert-Higgs (BEH) mechanism.

Literature

A Hole in Texas

Herman Wouk

Engler og demoner

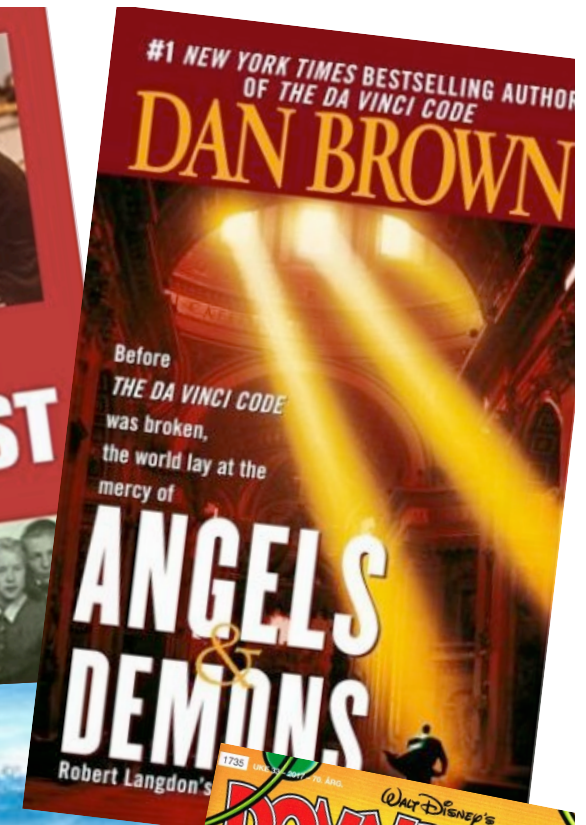
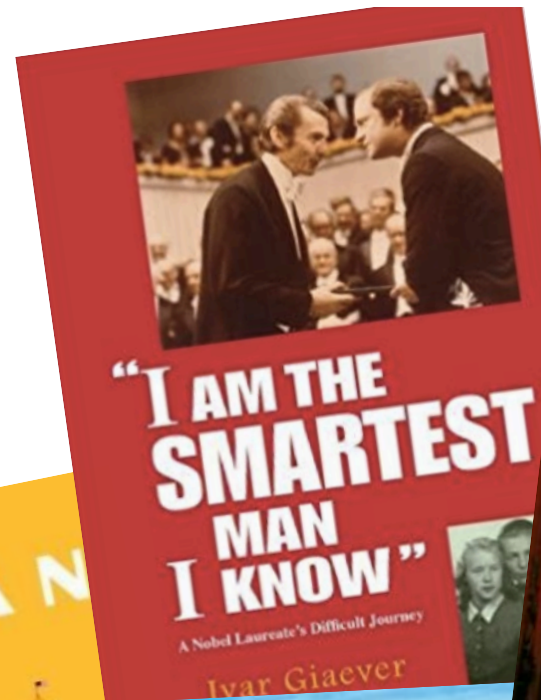
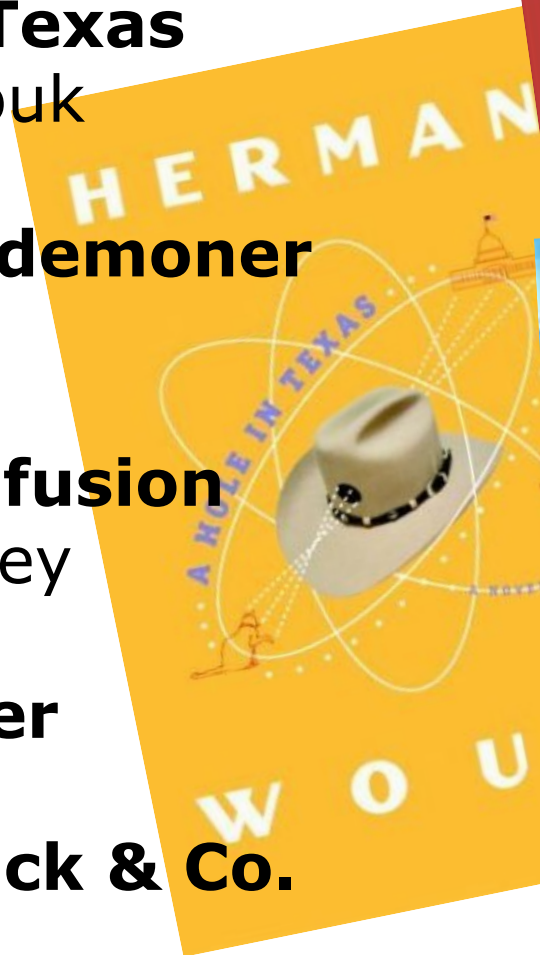
Dan Brown

Catalyzed fusion

Francis Farley

Ivar Giæver

Donald Duck & Co.



Film

