The science of ethics
and
the ethics of science

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Forum for the Future

ASTRONOMY ★ ASTROPHYSICS

UNIVERSITY of GLASGOW

Science:

The intellectual and practical activity encompassing the systematic study of the structure and behaviour of the physical and natural world through observation and experiment

From the New Oxford dictionary

Ethics:

1. Moral principles that govern a person's behaviour, or the conducting of an activity

2. The branch of knowledge that deals with moral principles.

From the New Oxford dictionary

3 schools of ethics in western philosophy:

- Aristotle

  Virtues are dispositions to act in ways that benefit both the person possessing them and society.

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HUNTINGDON LIFE
ANIMAL KILLERS
CLOSE THEM DOW

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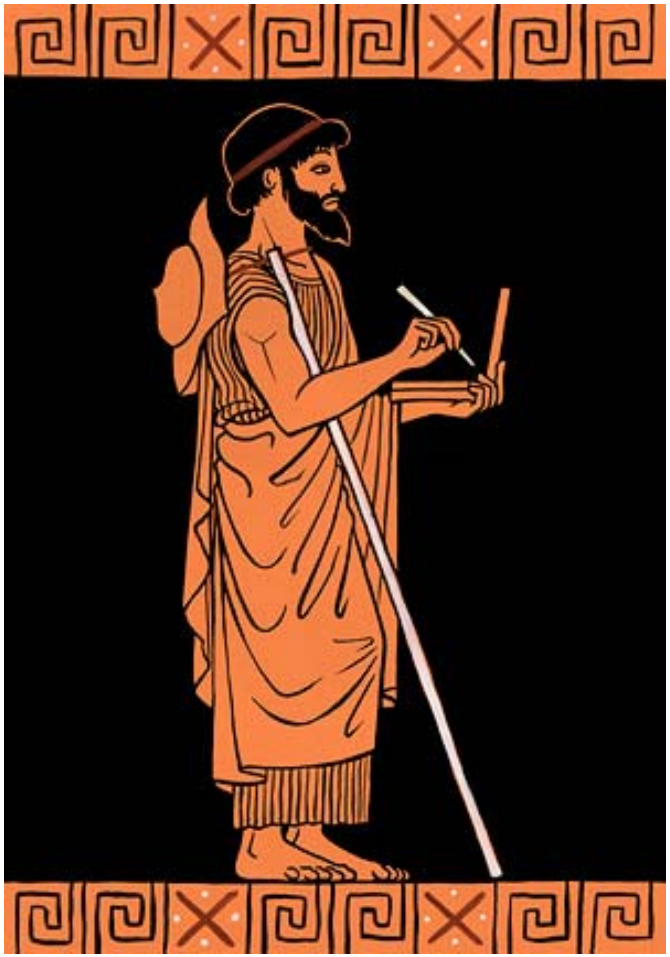
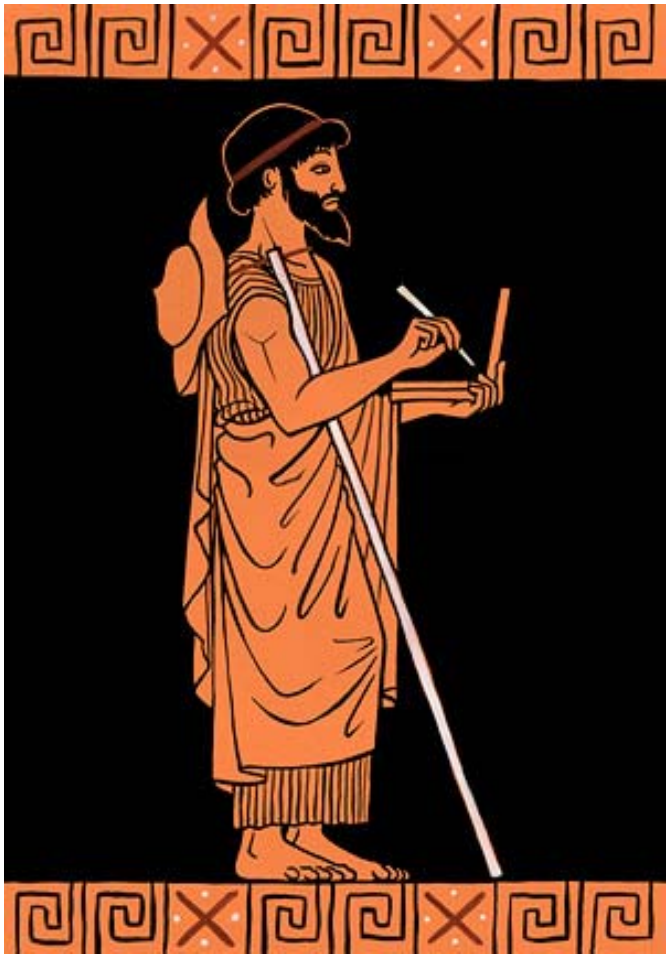
  but how do we measure and compare happiness'?

  should we focus only on the consequences, rather than the motive or intrinsic nature, of an action?



Herodotus, c.500 BC

"A decision was wise, even though it led to disastrous consequences, if the evidence at hand indicated it was the best one to make; and a decision was foolish, even though it led to the happiest possible consequences, if it was unreasonable to expect those consequences"



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Ethics should not be left only to scientists

Ethical issues in scientific research

Two main questions:

1) *How* science should be conducted

2) *What* science should be conducted

Ethical issues in scientific research

Two main questions:

1) *How* science should be conducted

2) *What* science should be conducted

Two distinct types of 'bad science'

Both have potential implications for sustainable development

1) *How* science should be conducted

Two categories of scientific misconduct:

- Negligence
- Deliberate dishonesty

Following the essay 'Misconduct in Science', by Vincent Hamner (1992)

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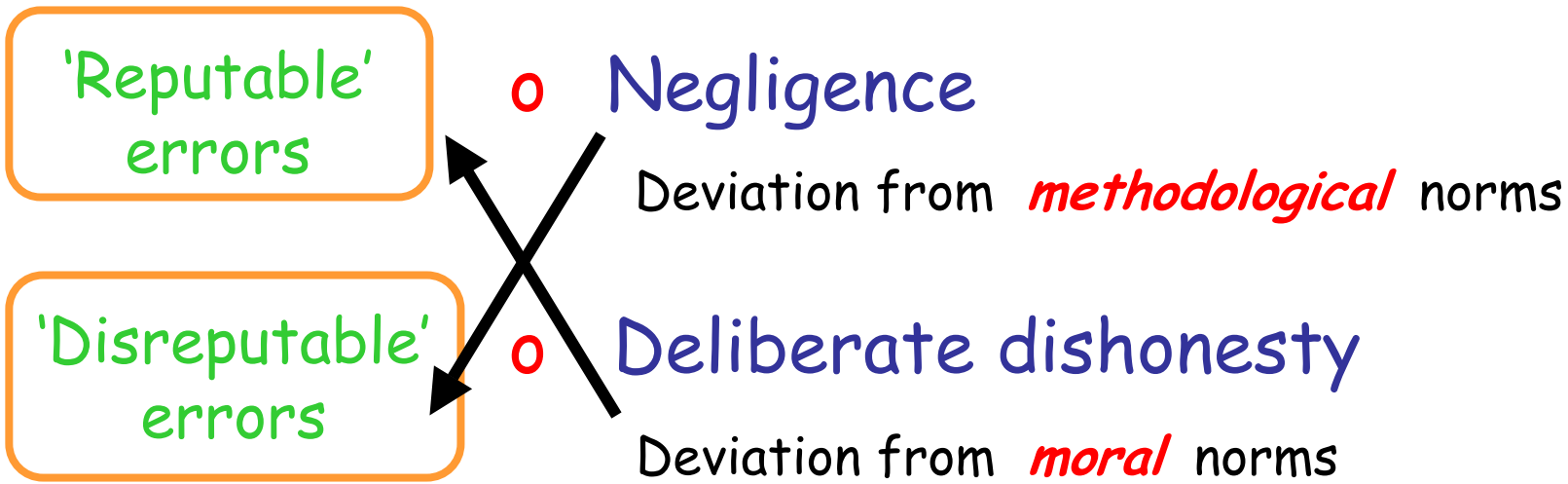

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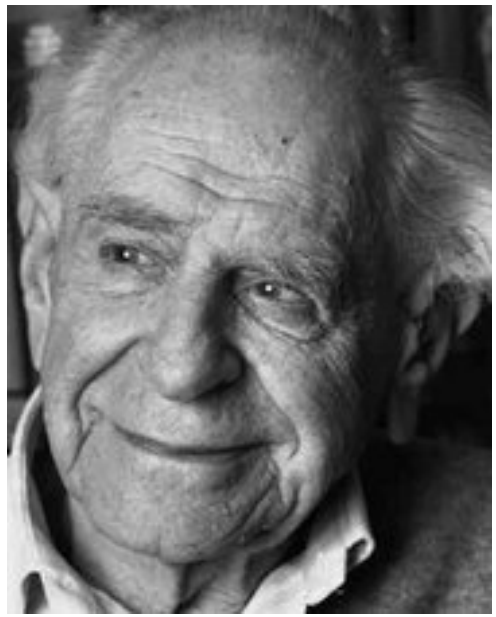
Methodological Norms – The Scientific Method:

- Characterisation
- Hypothesis
  (hypothetical explanation)
- Prediction
  (logical deduction from hypothesis)
- Experiment
  (test of all of the above)
- Evaluation and iteration
  (peer review / reproducibility)

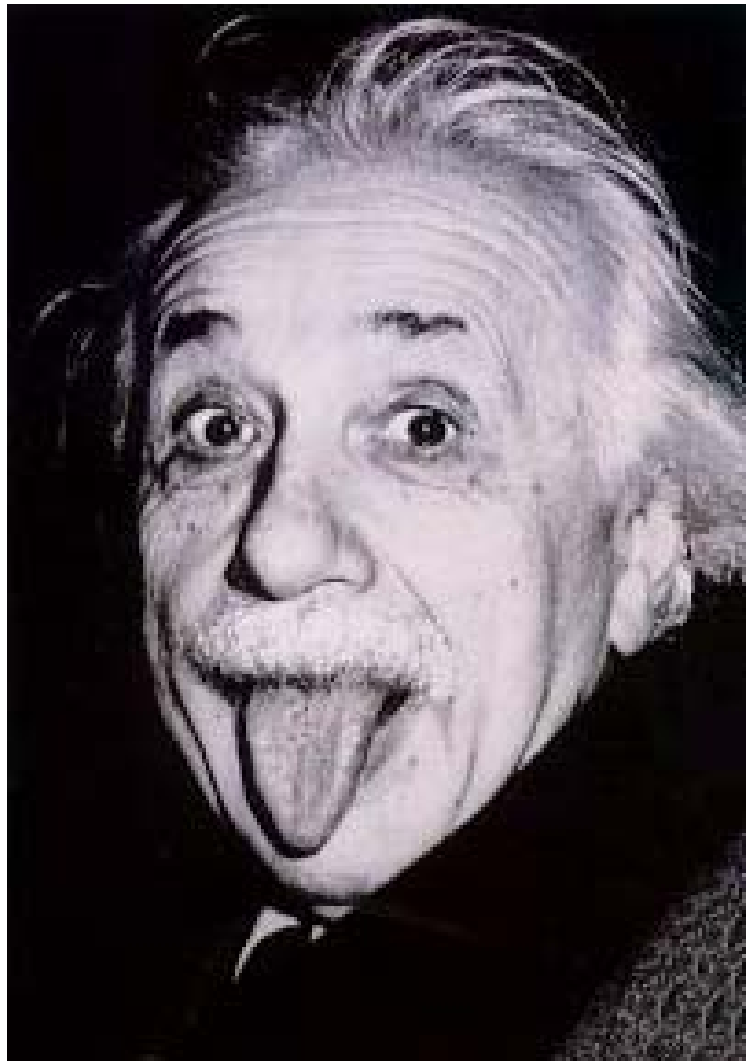


Karl Popper
(1902-1994)

The Scientific Method in action:

Albert Einstein's Special Theory of Relativity

World Year of PHYSICS 2005



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The Scientific Method in action:

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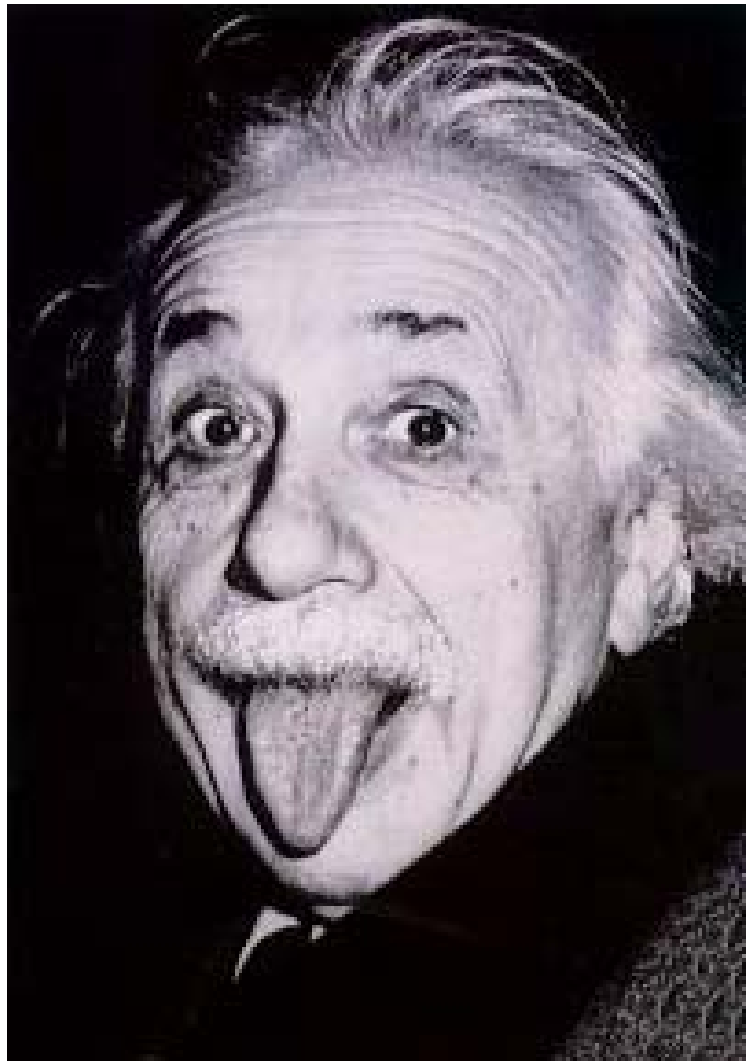
$$E = mc^2$$



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Classical Physics:

"All the World's A Stage"

- Isaac Newton's physics assumes *absolute space and time.*
- Working out how things look to different observers follows simple rules, in different *reference frames*

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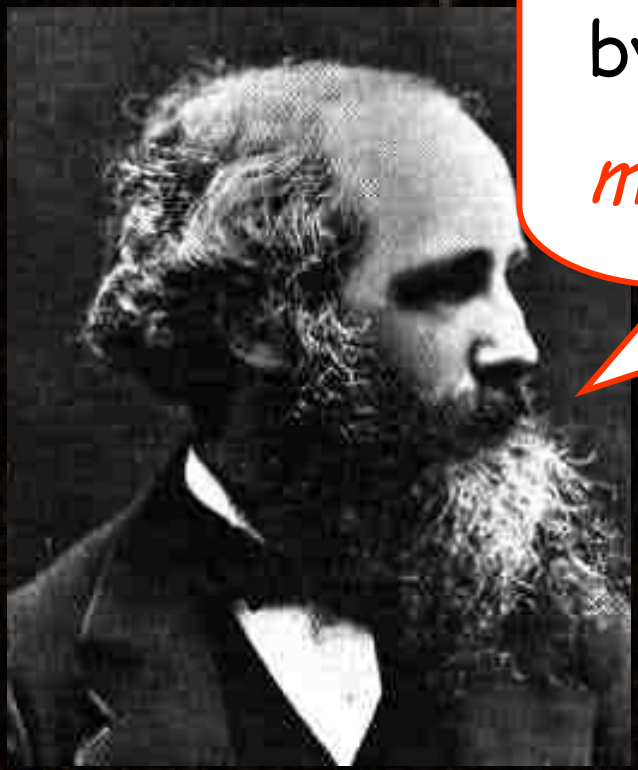
Viewed from the blue car's rest frame

Classical Physics:

James Clerk Maxwell's theory of light



Light is a *wave* caused by varying *electric* and *magnetic* fields

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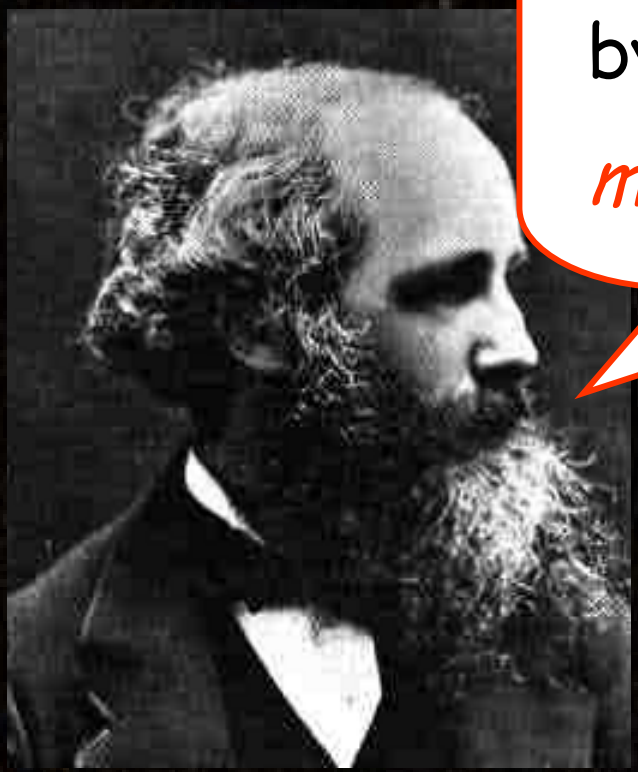

Light is a *wave* caused by varying *electric* and *magnetic* fields

Static charges → electric fields

Moving charges → magnetic fields

But which charges are static and which ones are moving depends on your point of view. Surely your theory of light should be the same for everyone!...

Static charges → electric fields

Moving charges → magnetic fields

The Scientific Method in action:

Albert Einstein's Special Theory of Relativity

- Characterisation — Maxwell's theory same for all observers
- Hypothesis — speed of light same for all observers
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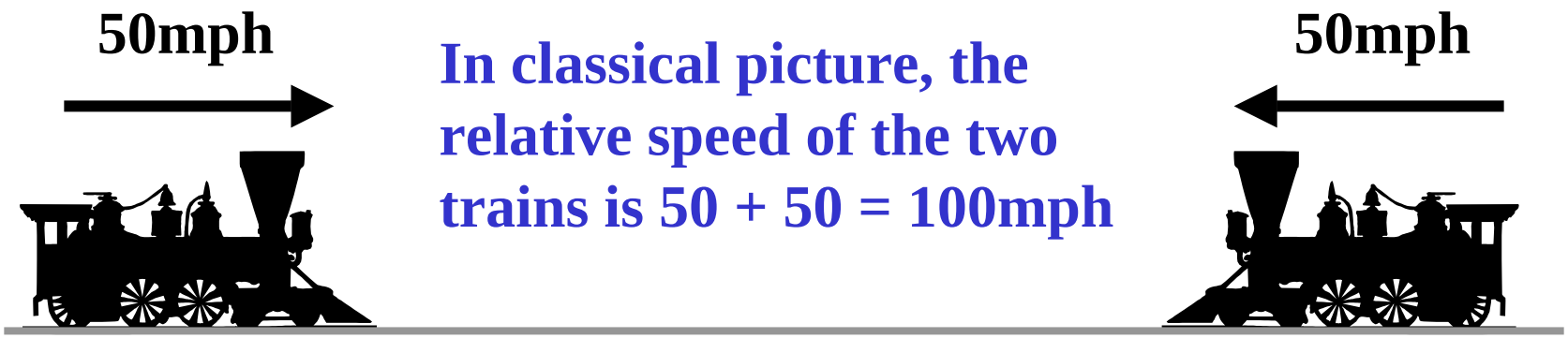
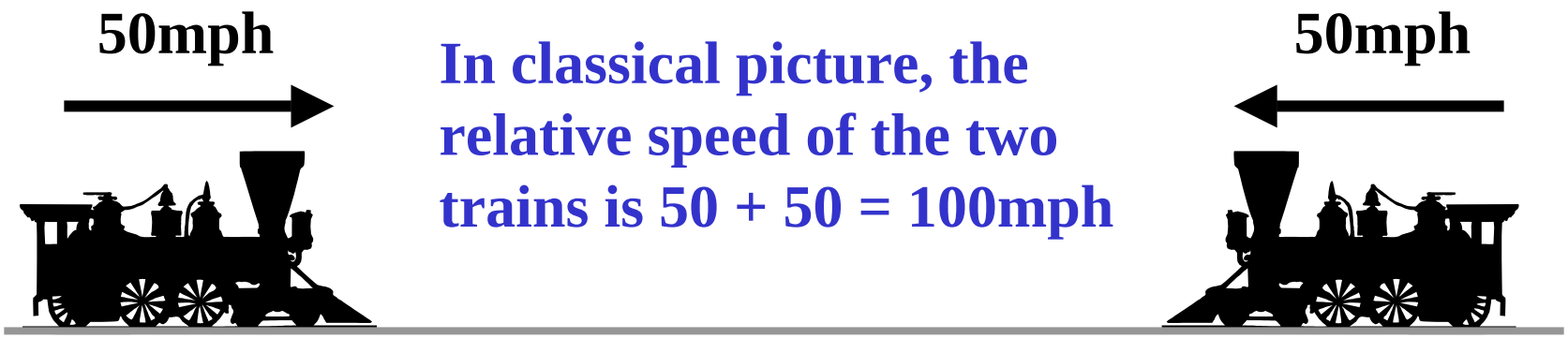


In classical picture, the relative speed of the two trains is 50 + 50 = 100mph



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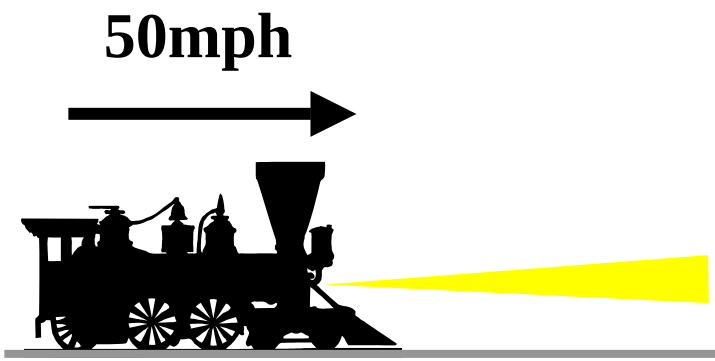
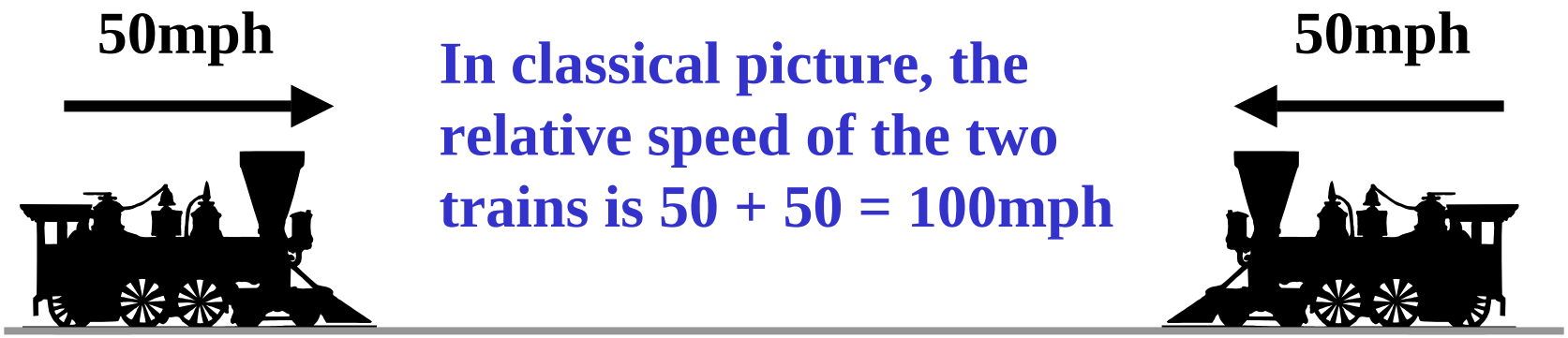


In Einstein's relativity, the speed of light is *unchanged* by the motion of the train

The Scientific Method in action:

Albert Einstein's Special Theory of Relativity

- Characterisation — Maxwell's theory same for all observers
- Hypothesis (hypothetical explanation) — speed of light same for all observers
- Prediction (logical deduction from hypothesis) — $E = mc^2$
- Experiment (test of all of the above) — The Manhattan project
- Evaluation and iteration (peer review / reproducibility) — 100 years of relativity



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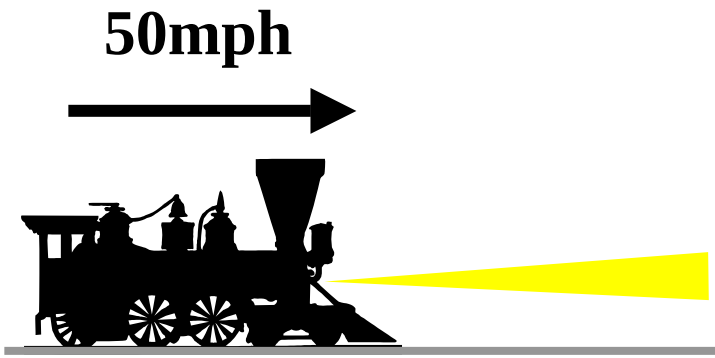

In Einstein's relativity, the speed of light is *unchanged* by the motion of the train

Einstein's relativity means there is no such thing as absolute space and time, only *spacetime*

What do we learn from this?

- Good science sometimes just requires imaginative thinking
  (Thought experiment)
- Good science builds on experience
- Good science makes testable predictions
- Good science can lead to bad applications
- (The Universe is a weird and wonderful place!)

1) *How* science should be conducted

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1) *How* science should be conducted

Moral Norms – proposed by Merton (1942):

- Universalism
- Communalism
- Disinterestedness
- Organised Skepticism

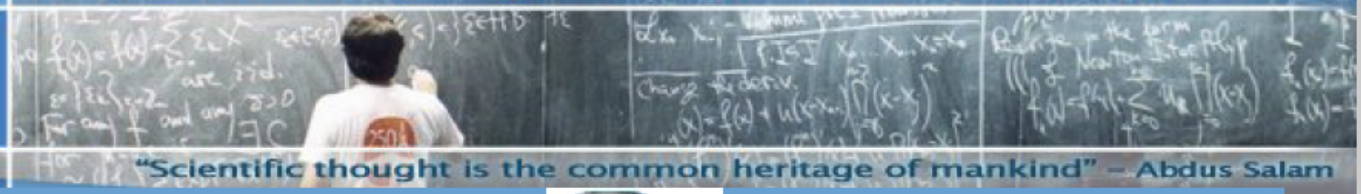
1) *How* science should be conducted

Universalism requires that science be independent of race, color, or creed and that it should be essentially international.

Communalism requires that scientific knowledge should be public knowledge; that the results of research should be published; that there should be freedom of exchange of scientific information between scientists everywhere, and that scientist should be responsible to the scientific community for the trustworthiness of their published work.

R.H. Brown, 'The Wisdom of Science' (1986)

the abdus salam international centre for theoretical physics



- Mission and legacy
- Organization
- Research
- Training and Education
- Scientific events
- Collaborations
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Italy
www.ictp.it

40 years of ICTP

Trieste Expo 2008

> OVERVIEW

Physics 2005

Abdus Salam (Nobel Laureate), the Centre
a tripartite agreement among the Italian
nd two United Nations Agencies, UNESCO and
ic institute for advanced studies and research,
eveloping countries. While the name of the Centre
ginnings, its activities today encompass most areas
ences including applications.

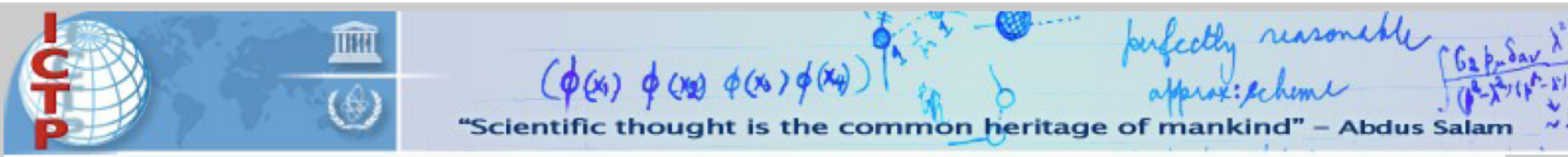
> NEWS FROM ICTP AND DAILY SCIENCE

- **Hilda Cerdeira Retires**

Hilda Cerdeira, the head of eJournals Delivery Service, retires after 18 years of service...

- **Physics World on ICTP**

"Physics World" publishes a feature article on ICTP...



Science, Cultural Heritage and Cooperation

Science reflects a basic drive to examine nature and search for the logical structure of the universe. It is a collective endeavour spanning generations and, as such, its practice and ability to flourish depends, among other things, on the social and cultural contexts in which it is pursued.

To different degrees, all societies have practiced science, perhaps because the scientific method, despite its imposing name, is the simplest, most natural and universal way of acquiring knowledge. It is the extension of our innate instinct to discover regularities in the world surrounding us.

From the prehistoric hunter trying to uncover the traces of possible prey, to the ancient Egyptian seeking to understand the cycles of the Nile floods, to the modern-day geophysicist trying to predict the impact of El Nino, reasoning has always been the same.

In both situations, the attitude is the same. In both situations, different hypotheses will be proposed and discarded on the basis of empirical evidence. The only difference lies in the amount of past experience brought to bear on the situations.

The scientific method, simply put, is timeless and universal. It is neither Northern nor Southern. In this sense, it is the "*common heritage of all mankind*."

ICTP believes that at least basic science results should be made free for everyone and sees science as a means for buidling bridges across cultural rifts. While ICTP's main mission is science, its programmes tacitly improve scientific cooperation among countries with diverse cultural and economic backgrounds. ICTP stands committed to such goals and encourages other organisations to join it in these efforts.

Sir John Sulston
vs
Craig Venter

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Forum for the Future

1) *How* science should be conducted

Disinterestedness requires that the results of *bona fide* scientific research should not be manipulated to serve considerations such as personal profit, ideology, or expediency, in other words they should be honest and objective; it does ***not*** mean that research should not be competitive.

Organized skepticism requires that statements should not be accepted on the word of authority, but that scientists should be free to question them and that the truth of any statement should finally rest on a comparison with observed fact.

R.H. Brown, 'The Wisdom of Science' (1986)

Who Owns Scientific Knowledge?

Professor Peter Saunders calls on all scientists to resist the privatisation of scientific knowledge by refusing to publish in journals belonging to publishers profiteering from closing off free access to scientific archives.

Patents and copyrights exist so that people can be rewarded for what they have invented or created. Recently, however, some corporations have been using them to gain ownership of things they didn't invent. No one invented the so-called breast cancer gene BRCA1 and the company that holds the patent didn't even do most of the work of discovering it; they only put the last piece into the jigsaw. No corporation invented the neem tree or Basmati rice. But that hasn't stopped them from filing patents. Now some publishers, notably Elsevier, are trying to do the same with scientific knowledge. They are setting up electronic archives that will effectively make them the owners of large amounts of scientific knowledge.

As with patents on genes, the problem arises largely because the law has failed to keep up with new technology. The scientific literature is vast, and it can be very hard to find the information you need. Most scientists know all too well that you can discover only by chance and often too late something it would have been very useful to know when you began your work. Someone may even have published essentially the same result a few years ago in a journal that your library doesn't take, and in an article whose title wouldn't have caught your eye even if you had seen it. Scientific results are generally picked up quickly, or not at all. If no one has cited a paper within two or three years of publication, the work it contains is very likely to be lost.

The development of highly efficient search engines will change this by making it possible to trawl through thousands of articles in an electronic archive and pick out the few that might be relevant to your work. This will greatly extend the amount of research that any scientist will be able to draw on and so makes the ownership of electronic archives crucial. Some publishers are now working hard to ensure that this knowledge belongs not to the scientific community, not to the general public, but to them. This is knowledge that they haven't even paid for.

It's important to remember that academic journals are not like other publications. The most obvious difference, and one that surprises outsiders, is that the authors are not paid. Neither are the reviewers, even though it is peer review that gives the journals much of their authority. The editorial board and the editors, too, generally receive no payment for their work. The publisher gets all that for free, and most insist that the author signs over the copyright as well.

The reason this arrangement has survived is that the journals have been the chief means of letting other scientists know about your work and of establishing your scientific reputation. The editors and reviewers, almost all in paid employment, have regarded their work for the journal as a part of their contribution to science. As long as the publishers made only reasonable profits, this was acceptable as payment for a useful service to the scientific community, though in recent years some commercial publishers have been raising their prices at rates far in excess of inflation or special costs like the price of paper.

As for the copyright, that didn't seem to matter too much. It doesn't cover the ideas in the paper, only things like the typesetting, the diagrams and so on. The chief effect of copyright was that anyone who wanted to reproduce the material in another publication (as distinct from merely using the results of the research) had to obtain permission and possibly pay a suitable fee. In recent years, it has become more important because it limited photocopying. That largely affected only teaching; there was relatively little effect on research.

Things are now changing. If material can be put on an electronic archive, and if almost every scientist will want to refer to the archive while carrying out research, then the copyright becomes very valuable. The copyrights that authors signed over without giving the matter much thought may now mean that the very results of their research are effectively the property of whoever owns the archive. Anyone will still be able to use the results for free, but only those with access to the archive will know they exist.

There's not much we can do about those papers for which the publishers already hold the copyright. They may not have paid for them, but the law says they own them. Scientists have just realised that their copyright is valuable, not because we expect to make money out of it ourselves, but because to assign it to a publisher may now mean that our fellow scientists will have to pay to use it.

The most vocal opponents to this privatisation of knowledge are a group who call themselves the Public Library for Science. They are demanding that all published papers should be placed on a free archive six months after they have appeared. They argue that this should not affect the sales of journals because people will still pay to see research as it appears, and they are asking scientists to sign a declaration that they will not publish in any journal that does not agree to this. So far almost 27000 scientists from 170 countries have signed. There is also a list of journals that have already agreed to make the papers they publish available after six months, and this includes the highly prestigious Proceedings of the National Academy of Sciences of the USA.

Setting up and maintaining an electronic archive is a considerable undertaking, and it is not clear what is the best way forward. Six months before access is free may be a long enough delay in some fields but not in others. It is not even obvious that there should be a single archive at all, whoever controls it. But at the very least, the Public Library of Science has drawn attention to the problem and well and truly thrown down the gauntlet: if what they are arguing is not practicable, then we have to find something better.

Over the past ten or twenty years there have been massive increases in the prices of many journals. Most university libraries have been forced to reduce the number of journals they take, which makes it harder for scientists to keep up with new work in their field. The publishers have thus increased their profits by providing not a better service to the scientific community but a worse one. We allowed that to happen by continuing to publish in overpriced journals. We must not repeat the mistake by allowing our work to disappear into overpriced archives. We must stop publishing in those journals.

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Global Environment

statement

Restoring Scientific Integrity in Policymaking

On February 18, 2004, over 60 leading scientists–Nobel laureates, leading medical experts, former federal agency directors, and university chairs and presidents–signed the statement below, voicing their concern over the misuse of science by the Bush administration. UCS is seeking the signatures of thousands of additional U.S. scientists in support of this effort.

Science, like any field of endeavor, relies on freedom of inquiry; and one of the hallmarks of that freedom is objectivity. Now, more than ever, on issues ranging from climate change to AIDS research to genetic engineering to food additives, government relies on the impartial perspective of science for guidance.

President George H.W. Bush, April 23, 1990

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Georges Lemaitre

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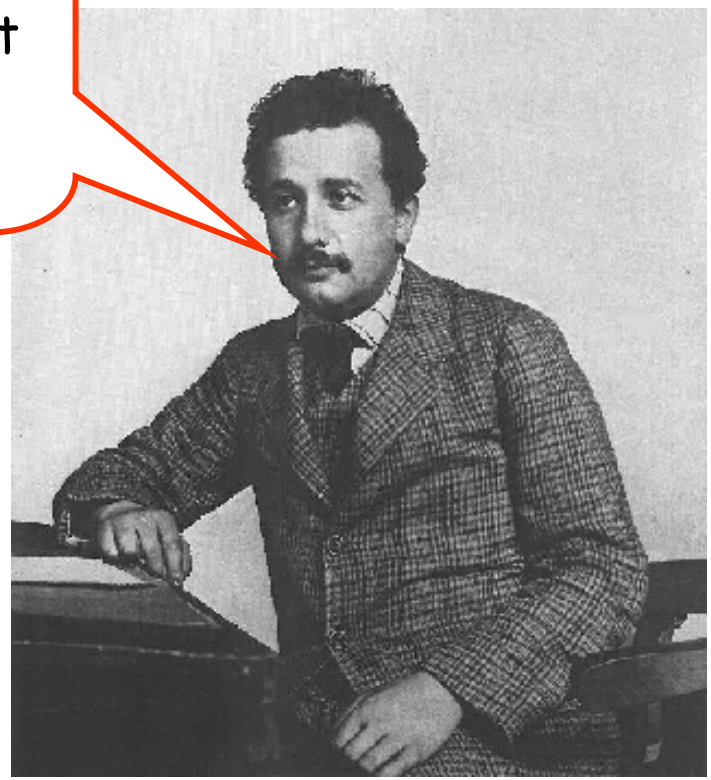
Your calculations are correct, but your physics is abominable



Some examples of suspect science…

- Cold fusion
- Perpetual motion machines
- Penta water
- Limescale remover
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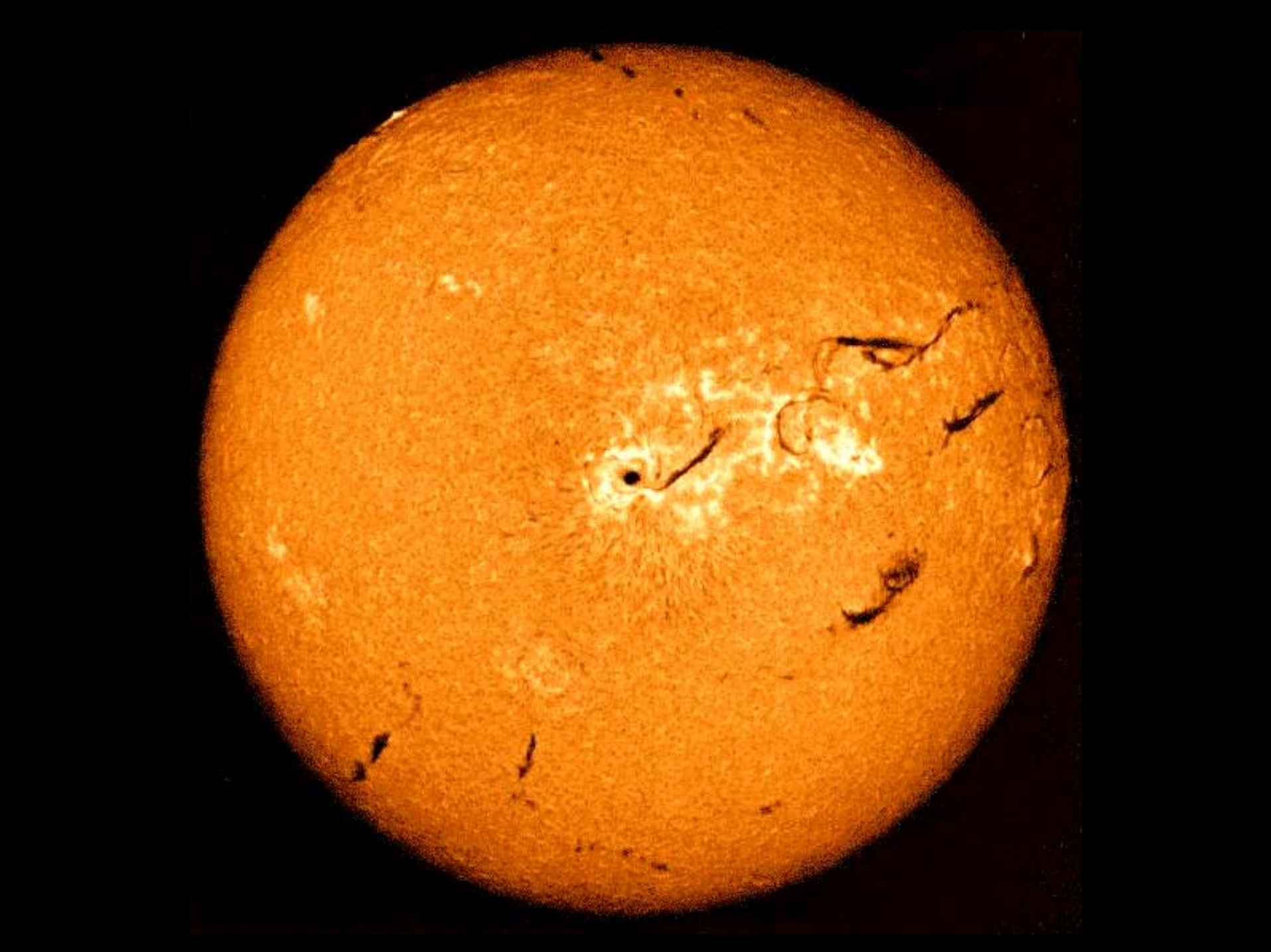
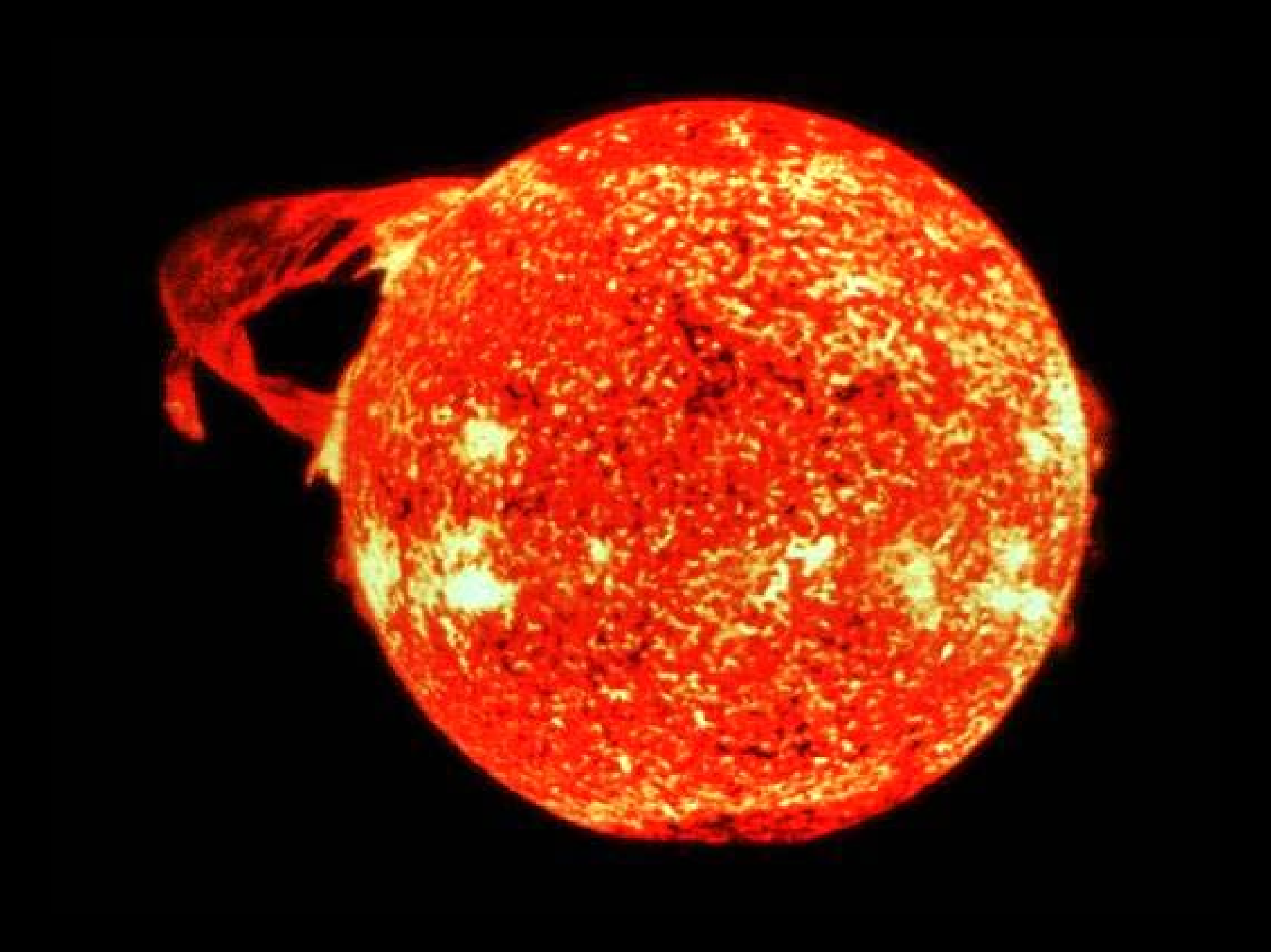
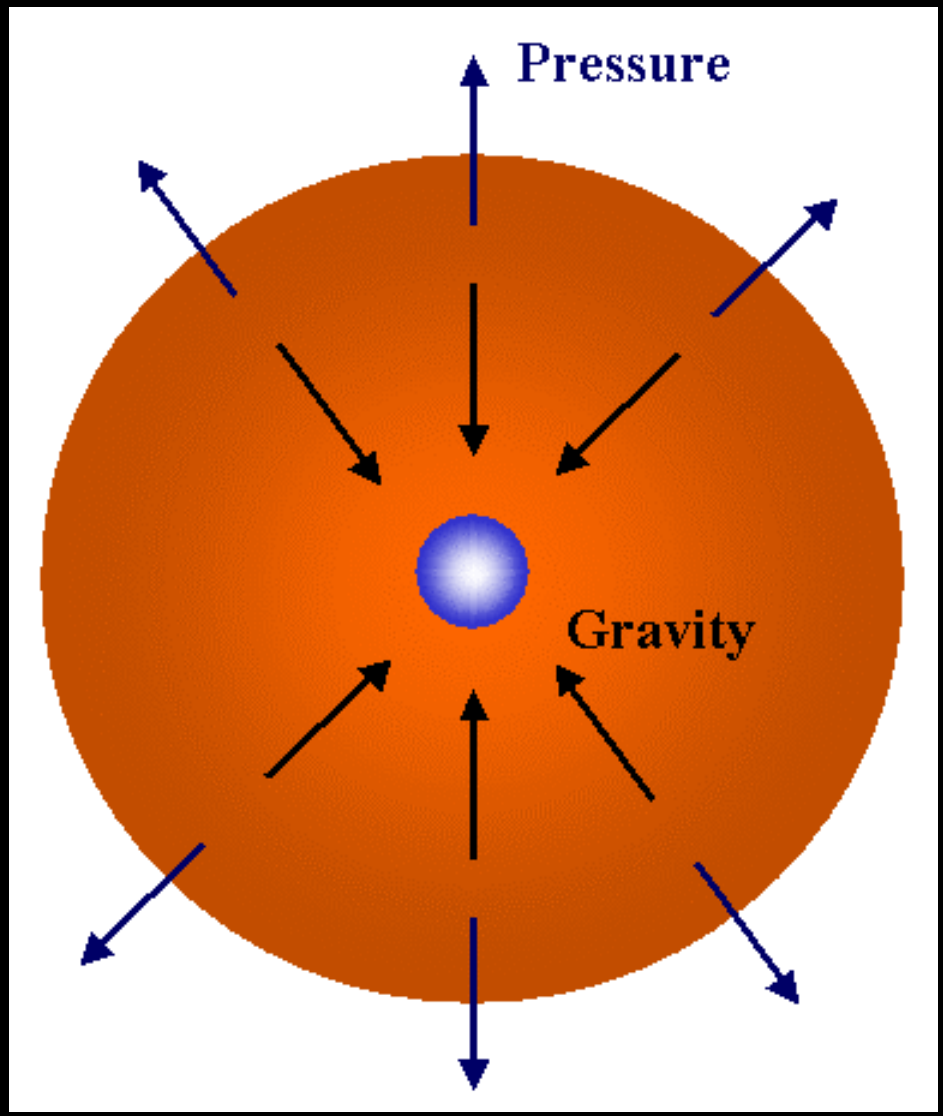
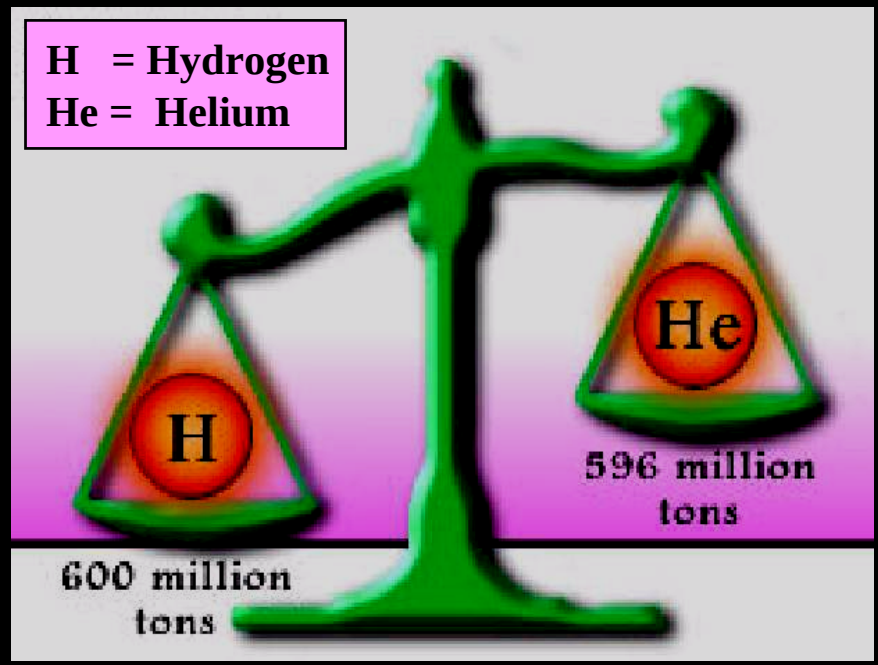




Hydrogen fusion – fuelling a star's nuclear furnace





$$E = mc^2$$

In March 1989 two highly respected scientists, Stanley Pons and Martin Fleischmann, claimed to have observed fusion in a test tube, at room temperature!

Unusually, they announced their discovery at a media press conference, before they had written any paper for publication in a peer-reviewed journal.

Sixteen years later, no conclusive proof of cold fusion has been found; no published results have repeated Pons and Fleischmann's claims (and they haven't published yet either!)

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- Perpetual motion machines
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A perpetual motion machine would violate the laws of thermodynamics.

So confident are scientists that this cannot happen, that the US (and UK) Patents Office refuse to consider patent applications for perpetual motion machines.

The media occasionally take up the story of 'self-taught scientists from the backwoods', like Joseph Newman.

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- Cold fusion
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- Yakult

Science sells!!!…

Some examples of suspect science…

- 'Perpetual motion' machines
- Cold fusion
- Penta water
- Limescale remover
- Yakult

…and it's hard for the public to tell fact from fiction

Role of the Media: a lot of hot air?…

- Scientific ignorance of the general public
- Tendency to oversimplify problem: 'black' and 'white'
- Perceived need for 'balance'
- Courting controversy
- Science versus Drama?

2) *What* science should be conducted

Some questions to ponder:

- What kind of science should we engage in?
- Who should decide?
- What ethical issues need to be considered, and how?
- Should there be differences between the developed and the developing world?

Big Science:

Research that is expensive and involves large teams of scientists

From the New Oxford dictionary

Big Science:

Research that is expensive and involves large teams of scientists

From the New Oxford dictionary

- *Can the developing world engage successfully in big science?*
- *Should particular fields of research be given priority / ignored?*

Big Science:

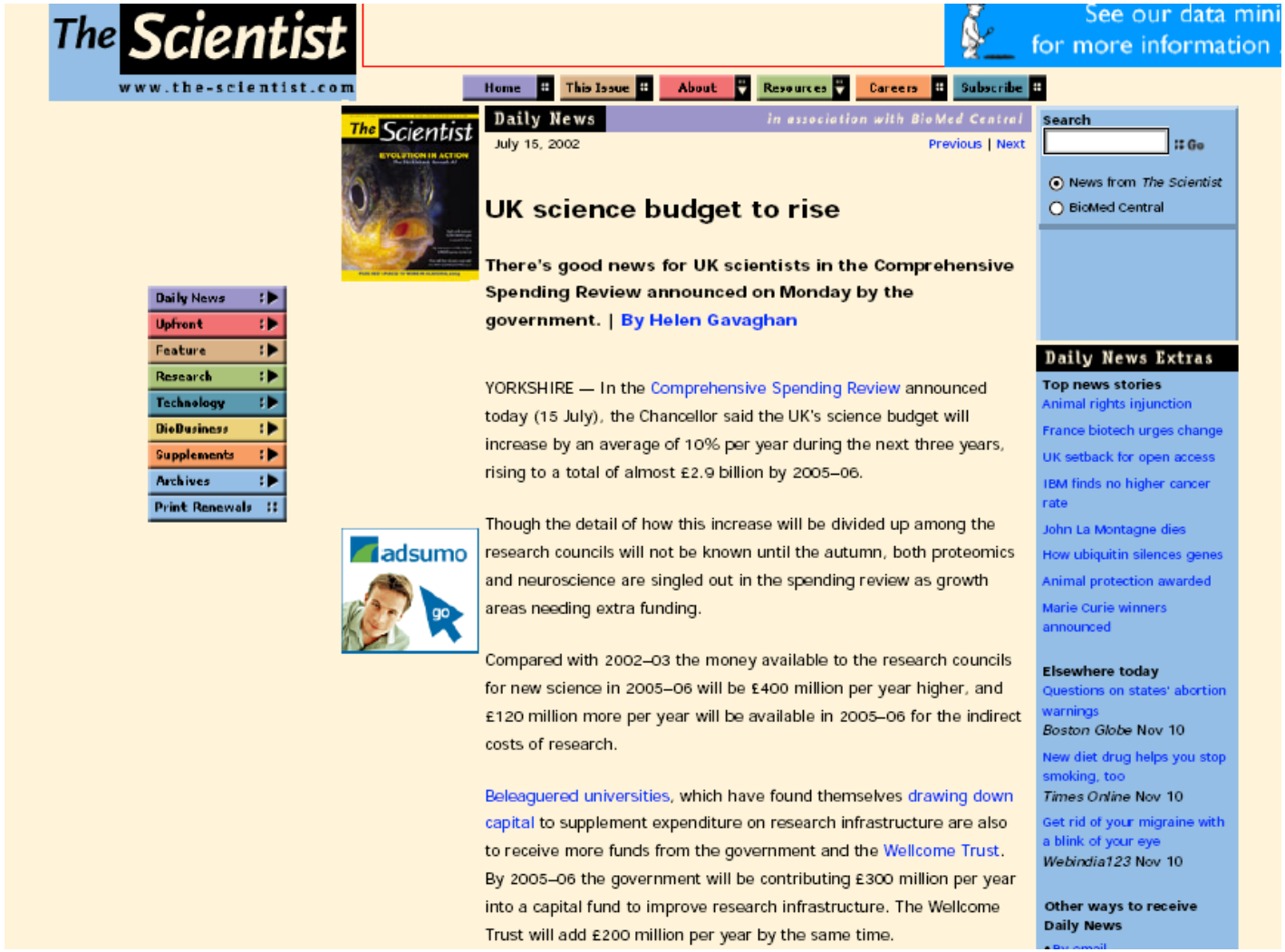
Research that is expensive and involves large teams of scientists

Blue Sky Research:

Scientific research which is not yet practicable or profitable

From the New Oxford dictionary

Is it ethical to engage in blue sky research?



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Daily News | In association with BioMed Central
July 15, 2002 | Previous | Next

UK science budget to rise

There's good news for UK scientists in the Comprehensive Spending Review announced on Monday by the government. | By Helen Gavaghan

YORKSHIRE — In the Comprehensive Spending Review announced today (15 July), the Chancellor said the UK's science budget will increase by an average of 10% per year during the next three years, rising to a total of almost £2.9 billion by 2005–06.

Though the detail of how this increase will be divided up among the research councils will not be known until the autumn, both proteomics and neuroscience are singled out in the spending review as growth areas needing extra funding.

Compared with 2002–03 the money available to the research councils for new science in 2005–06 will be £400 million per year higher, and £120 million more per year will be available in 2005–06 for the indirect costs of research.

Beleaguered universities, which have found themselves drawing down capital to supplement expenditure on research infrastructure are also to receive more funds from the government and the Wellcome Trust. By 2005–06 the government will be contributing £300 million per year into a capital fund to improve research infrastructure. The Wellcome Trust will add £200 million per year by the same time.

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Is it ethical to engage in blue sky research?

Research Councils UK: welcome

RESEARCH COUNCILS UK

Council homepage:

BBSRC
Biotechnology & Biological Sciences Research Council

CCLRC
Council for the Central Laboratory of the Research Councils

EPSRC
Engineering & Physical Sciences Research Council

ESRC
Economic & Social Research Council

MRC
Medical Research Council

NERC
Natural Environment Research Council

PPARC
Particle Physics & Astronomy Research Council

AHRB
Arts & Humanities Research Board

RESEARCH COUNCILS UK — Together in research

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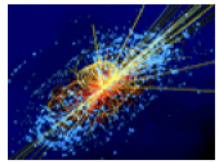
Welcome

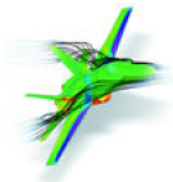


Research Councils UK (RCUK) is a strategic partnership set up to champion science, engineering and technology supported by the seven UK Research Councils. Through RCUK, the Research Councils are working together to create a common framework for research, training and knowledge transfer. In doing this RCUK will work alongside the Office of Science & Technology (OST) to further support for the UK's best academic researchers and deliver the best investment for society.

The partnership is led by the RCUK strategy group, which is chaired by the Director General of Research Councils and includes the Chief Executives of the seven Research Councils as Members.

About this website

This site incorporates pages from cross-council activities that predated the launch of RCUK - such as e-Science, Basic Technology and Genomics, together with jointly-run Council services.



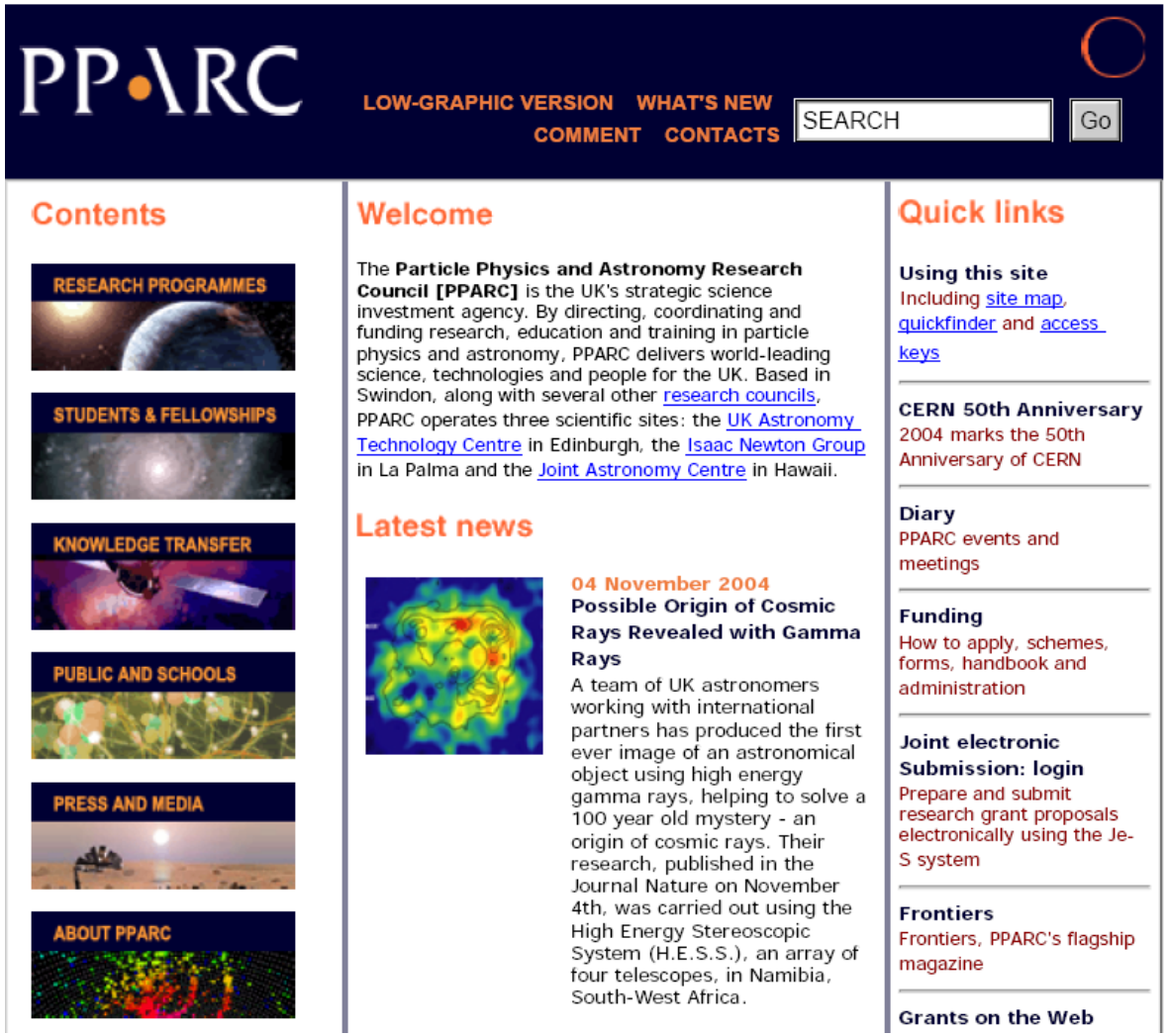
The Activities section offers links to new and established research and training programmes, to knowledge transfer initiatives, and to joint Research Council projects and programmes. The links page lists external websites related to the work of RCUK.

What's New lists all major additions and changes to this site, including official RCUK publications and news releases.

http://www.rcuk.ac.uk/ | Reviewed: 30/07/2004 11:23:43 | Contact

Is it ethical to engage in blue sky research?

The PPARC web site



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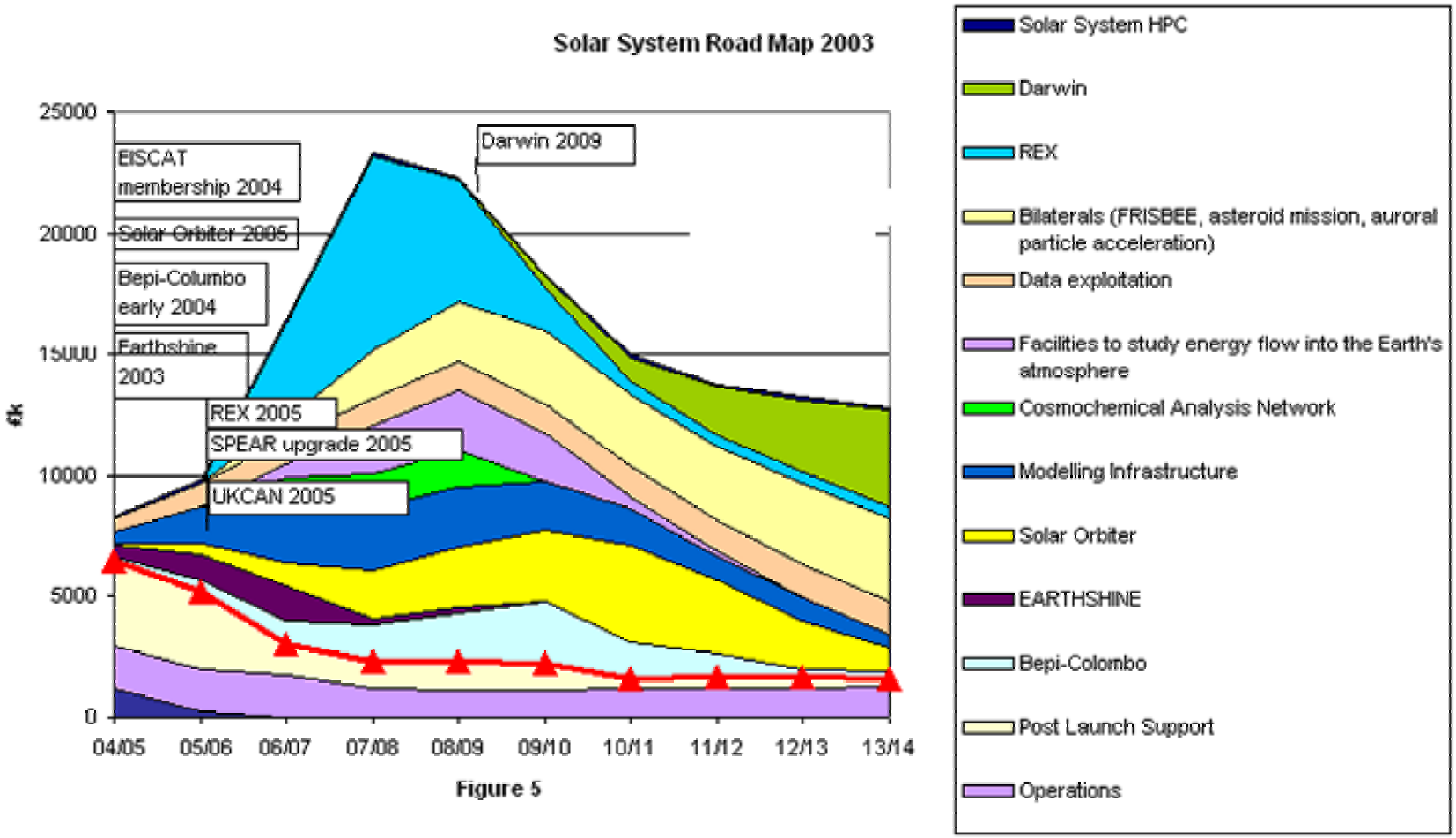

Figure 5

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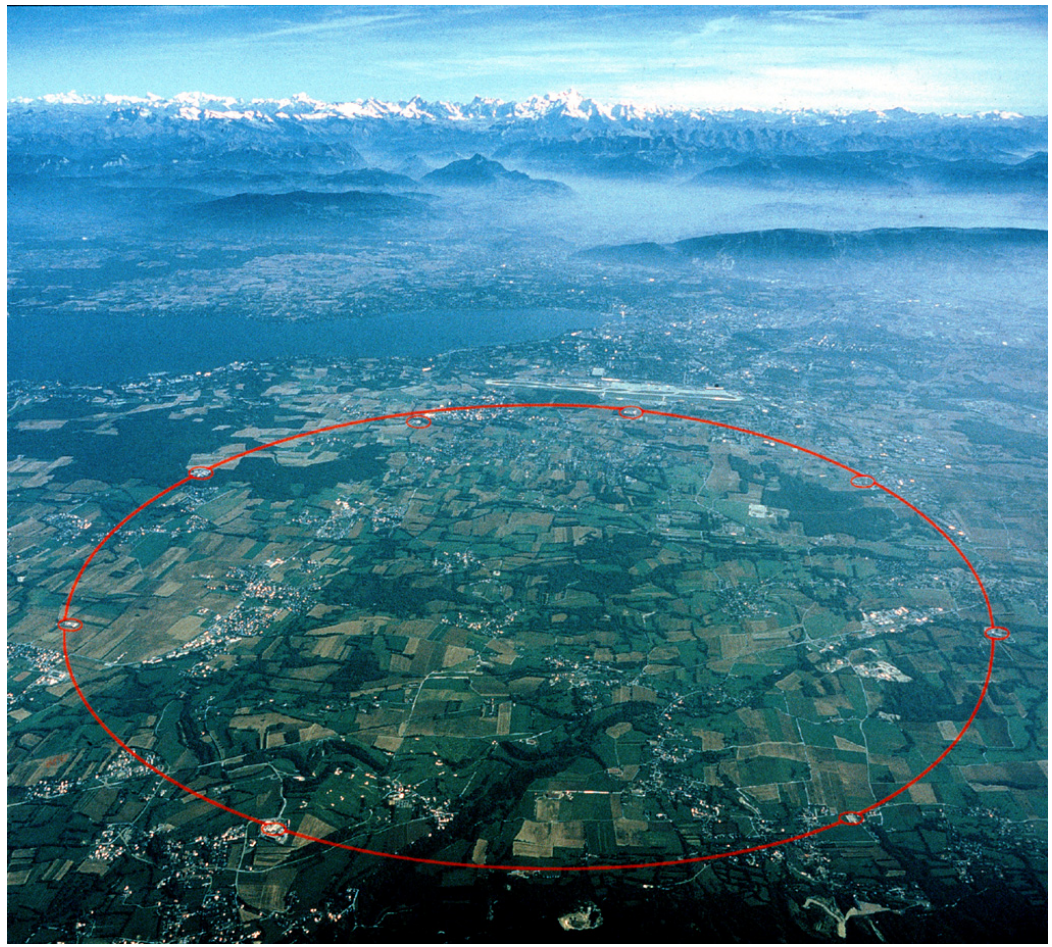
Is it ethical to engage in blue sky research?

CERN:
Annual budget
of ~ 1 billion
Swiss Francs



Is it ethical to engage in blue sky research?

Yes

Is it ethical to engage in blue sky research?

- Education and culture
- Technology spin-offs
- Outside investment
- The Virtual Observatory

27th INTERNATIONAL SCHOOL FOR YOUNG ASTRONOMERS

Al Akhawayn University, Ifrane, Morocco

July 02 - 23, 2004

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Science and Ethics: April 13th 2005

Forum for the Future

IAU Commission 46 (Astronomy Education and Development)

IAU Resolution on the Value of Astronomy Education passed by the IAU General Assembly, 2003

The International Astronomical Union.

CONSIDERING

1. that scientific and mathematical literacy and a workforce trained in science and technology are essential to maintain a healthy population, a sustainable environment, and a propsperous economy in any country

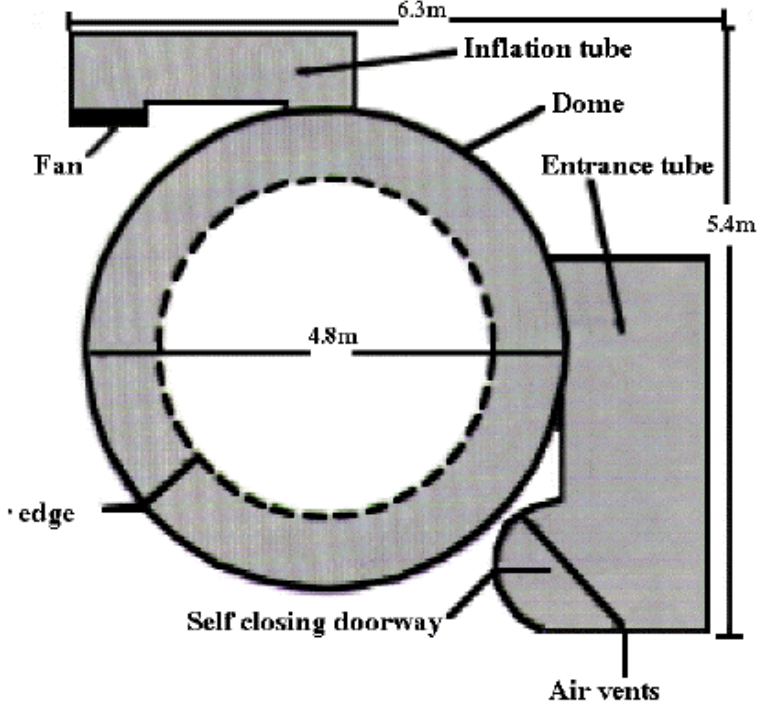
2. that astronomy, when properly taught, nurtures rational, quantitative thinking and an understanding of the history and nature of science, as distinct from reproductive learning and pseudo-science

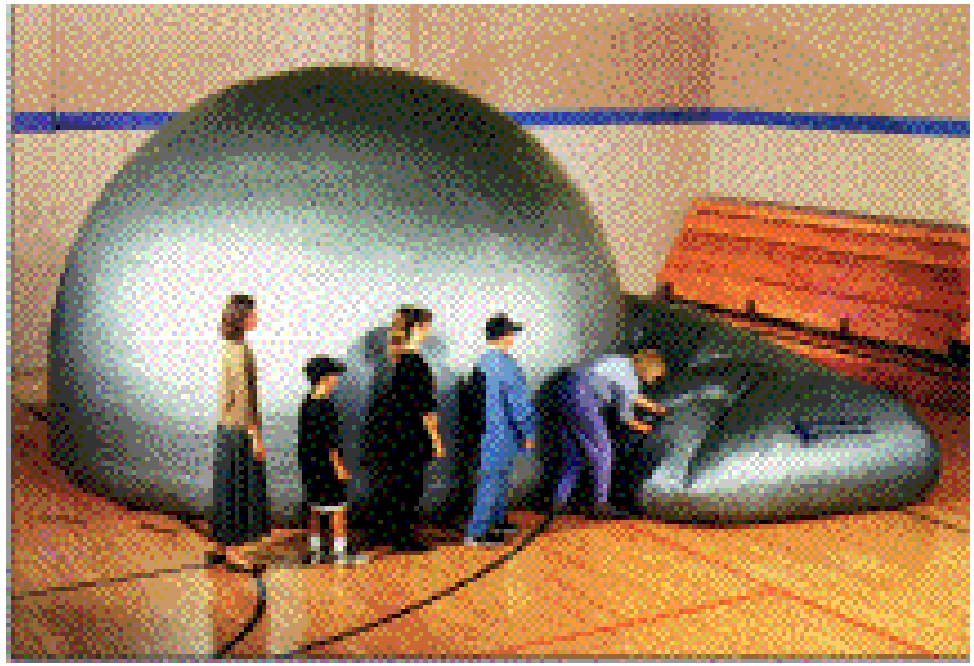
3. that astronomy has a proven record of attracting young people to an education in science and technology and, on that basis, to careers in space-related and other sciences as well as industry

4. that the cultural, historical, philosophical and aesthetic values of astronomy help to establish a better understanding between natural science and the arts and humanities

5. that, nevertheless, in many countries, astronomy is not present in the school curriculum and astronomy teachers are often not adequately trained or supported, but

6. that many scientific and educational societies and government agencies have produced a variety of well-tested, freely-available educational resource material in astronomy at all levels of education


6.3m
Inflation tube
Dome
Fan
Entrance tube
5.4m
4.8m
edge
Self closing doorway
Air vents

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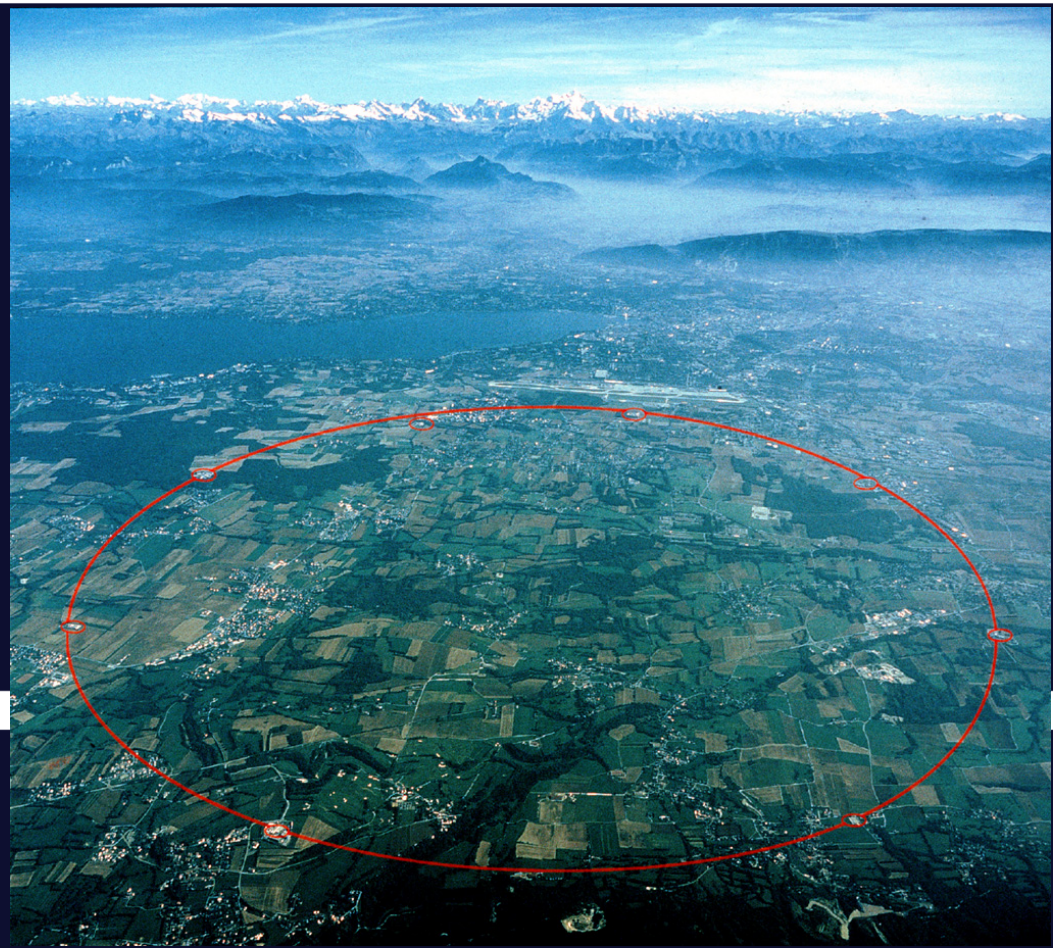
CERN

The world's largest particle physics laboratory

... where the web was born!

LHC

Dashboard
Cost to completion



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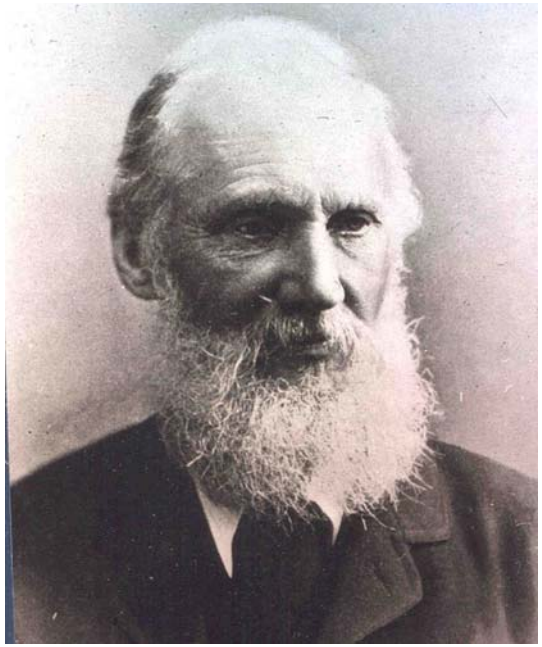
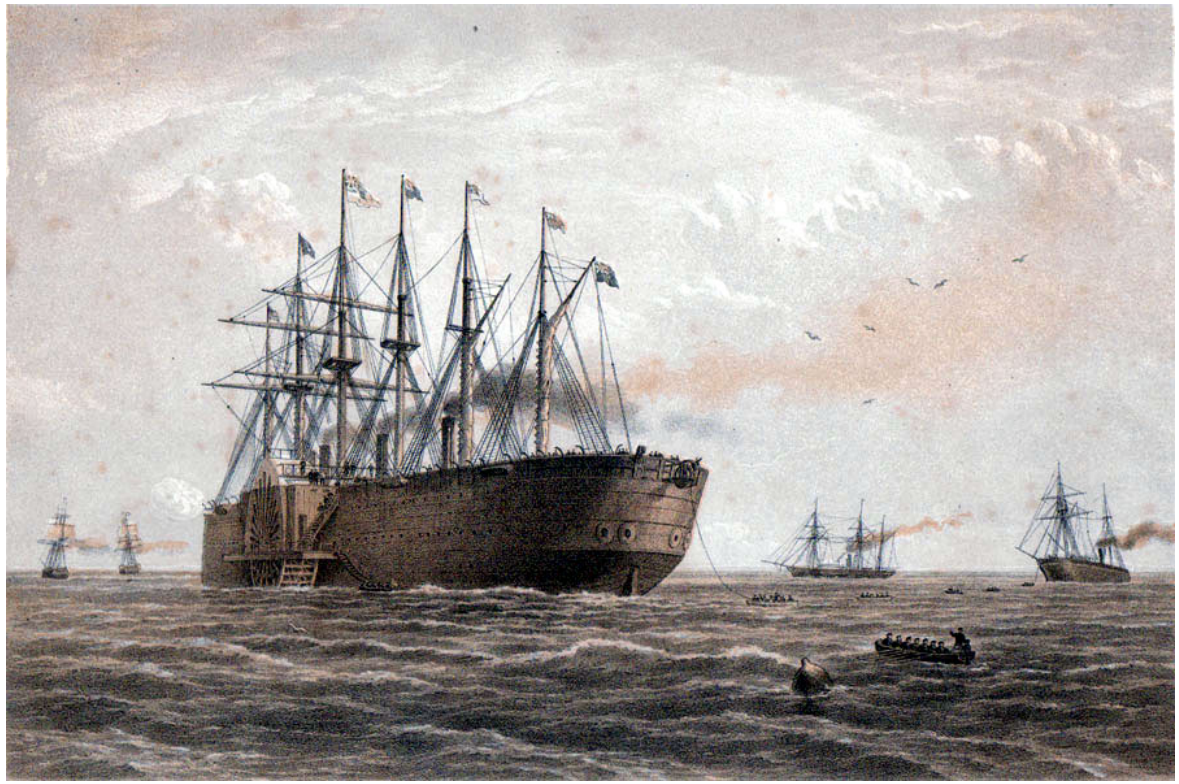
Tim Berners-Lee



William Thompson
(Lord Kelvin)
1824 - 1907



Devised method for practical transatlantic telegraphy

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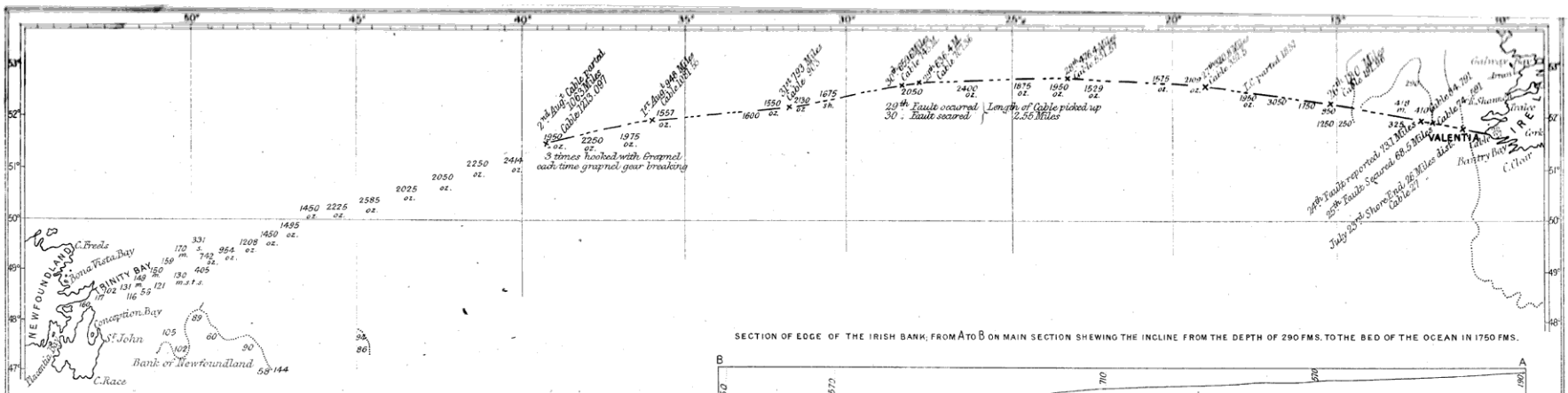
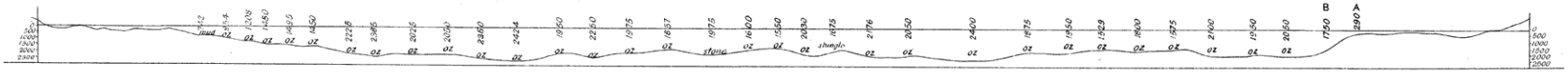


SECTION OF EDGE OF THE IRISH BANK; FROM A TO B ON MAIN SECTION SHEWING THE INCLINE FROM THE DEPTH OF 290 FMS. TO THE BED OF THE OCEAN IN 1750 FMS.

SCALE TO THE ABOVE SECTION

Fms 1000 500 0 1 2 3 4 5 6 7 8 9 10 SEA MILES

SECTION OF THE BED OF THE ATLANTIC OCEAN FROM VALENTIA TO TRINITY BAY, NEWFOUNDLAND.



ATLANTIC TELEGRAPH CABLE 1865.

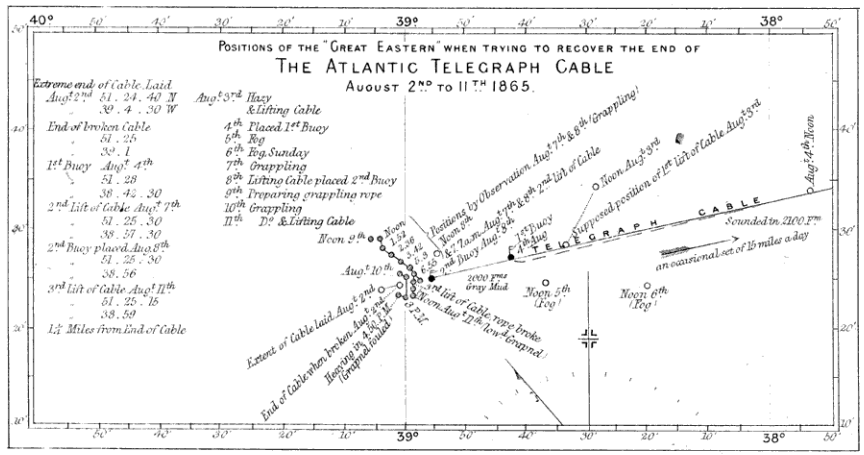
Chart

SHEWING THE TRACK OF

THE STEAM SHIP "GREAT EASTERN" ON HER VOYAGE FROM VALENTIA TO NEWFOUNDLAND

WITH THE SOUNDINGS - THE DAILY LATITUDE AND LONGITUDE - THE DISTANCE RUN

AND THE NUMBER OF MILES OF CABLE PAID OUT



LONDON. DAY & SON (LIMITED)

LONDON, DAY & SON (LIMITED)

Major facilities for big science - the observatories

Chile is extremely fortunate - probably more so than any other country at an equivalent stage of development - in possessing the natural conditions to enable it to attract major international scientific infrastructure. The only developing countries which have attracted equivalent scientific interest are those in the Middle East and Africa, which are rich in archaeological and cultural deposits. Unfortunately, such interest is not matched by infrastructural investment. Chile has hosted scientific events at international astronomical observatories in the Atacama Desert for over 30 years. These include the Cerro Tololo Interamerican Observatory in La Serena, the European Southern Observatory (ESO) at La Silla, and the Carnegie Southern Observatory at Las Campañas. New optical telescopes are being constructed at Las Campañas (the Magellan telescope), at Cerro Pachon (the Gemini Southern Telescope, which has a Northern Hemisphere counterpart at Mauna Kea) and at Cerro Paranal (the ESO Very Large Telescope). The Atacama Large Millimetre Array (ALMA), which will extend high-resolution radio astronomy to millimetre wavelengths, is to be located at Llano de Chajnantor.

IDRC Report 1999

Major facilities for big science - the observatories

The Chilean Government has exercised great wisdom in facilitating low-cost construction by granting duty-free and tax-free status to the observatories. In general, the boards of the observatories have granted Chilean astronomers 10 percent of the viewing time in return for the use of the sites and in recognition of the positive attitude of the Chilean government. Chile itself does not contribute directly to construction costs.

If Chile wishes to be at the cutting edge of world knowledge-development, there is no more promising area than astronomy for it to achieve this. The fact that the astronomers play in a different league to other Chilean scientists is underscored by the relative costs of the equipment to which they have access. FONDECYT currently has an equipment ceiling of about US $40 000, but the observatories each cost at least a thousand times as much.

IDRC Report 1999

Major facilities for big science - the observatories

It is encouraging to note that in the most recent agreement to build another foreign-financed telescope in Chile, the government has included a provision in the contract to ensure the participation of Chilean engineers in the construction and infrastructure activities. Gaining access to challenging assignments will be an advantage to the engineering profession in the country.

IDRC Report 1999

The EU's relations with Chile

The European Union and Chile sign a scientific and technological cooperation agreement

IP/02/1352 - Brussels, 23 September 2002

Philippe Busquin, EU Commissioner for Research, and Soledad Alvear, Chilean Minister of Foreign Affairs, today signed a scientific and technological cooperation agreement in Brussels between the EU and Chile in a ceremony attended by Mariana Aywlin, Chilean Minister of Education, in the framework of the special EU-Chile relationship. This is part of a process aimed at an association agreement, and both the EU and Chile have agreed to combine efforts on scientific matters. The cooperation agreement will allow scientists to take part in the other side's research programmes and joint research projects and also provides for visits and exchanges of technical experts, joint conferences and workshops, scientific networks and training, and the exchange and sharing of facilities and equipment. Initial joint initiatives will focus on the genome, biotechnology and health, information technology, food safety, sustainable growth and climate change. The agreement will be managed by a joint steering committee.

"In both Europe and Chile the essential contribution which science and technology make to sustainable economic development and competitiveness has been recognised", Commissioner Busquin said. "Research plays a very important part in improving quality of life and the environment. International cooperation helps provide joint solutions to global problems. The aim of the EU's scientific and technological cooperation with Chile is to support the internationalisation of the Chilean economy by helping it become knowledge-based. The scope for cooperation is well above what exists at the moment".

The EU's relations with Chile

As Minister Alvear put it: "Let us consider the agreement as recognition of the effort we have put into building a solid scientific and technological community capable of dialogue with its peers worldwide. We must try to boost and draw maximum benefit from cooperation activities between the European Union and Chile in areas of common interest in which scientific and technological research is being carried out."

Apart from the Chile-based European Southern Observatory (ESO), this kind of cooperation with Chile has until now been financed through the development fund. Under the new agreement Chile becomes a partner under the 6th Research and Development Framework Programme (2002-2006). The agreement extends beyond the confines of this Programme, however. Scientific cooperation will contribute to the creation of a joint scientific basis and enable Chile to open up its research system to make it part of the global effort.

The agreement is based on the principles of mutual benefit, reciprocal scope for access to each other's programmes and activities, non-discrimination, the effective protection of intellectual property and the fair sharing of intellectual property rights.

The aim is to support each other's economic interests, to reduce poverty and to achieve sustainable development.

US-VO Website

US National Virtual Observatory

search

VO Science Session at San Diego AAS Meeting
LSST Meeting
NVO Summer School
Data Inventory Service
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International VO Alliance

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Hyperatlas Standard
HotGrid: Graduated Access to Grid-based Science Gateways
Annual Report, Oct 2003-Sept 2004

NVO - Facilitating Scientific Discovery

NVO's objective is to enable new science by greatly enhancing access to data and computing resources. The NVO is developing tools that make it easy to locate, retrieve, and analyze astronomical data from archives and catalogs worldwide, and to compare theoretical models and simulations with observations.

These tools are based upon international standards developed in collaboration with the International Virtual Observatory Alliance.

We expect to deliver the first production quality services in early 2005. Some examples of existing prototypes:

- Use the VO Spectrum Services to analyze over 500,000 spectra.
- Cross-correlate objects from more than 15 surveys with SkyQuery
- Use YourSky to make custom infrared sky images based on DPOSS or 2MASS.

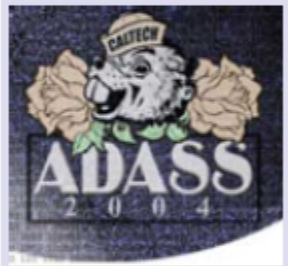
The NVO also provides software libraries and sample code of VO Services for people who want to write their own VO-enabled applications.

NVO - Data Access

The NVO encourages astronomical research organizations to make their data collections and source catalogs available via the standard VO protocols. These include image access, spectrum access, and catalog search.

A number of astronomical research facilities and survey projects are already making

ADASS XIV



October 24 - 27, 2004
Pasadena California.
More Information

Team Meeting

NVO Team Meeting
November 17-18, 2004

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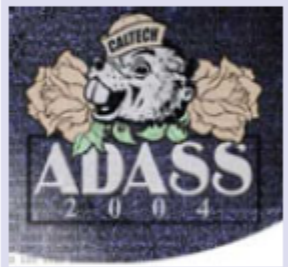

October 24 - 27, 2004
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Improving IT infrastructure benefits all

2) *What* science should be conducted

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