Physics and Society

Erik Ramberg
Saturday Morning Physics

- Relevance of physics to society
- How well do the two interact?
- Physics issues in society:
  - Energy
  - Environment
  - War
- Religion, Morality, Art and Science

- Welcome to the final class and graduation ceremony for Fermilab's Saturday Morning Physics
- We are very pleased to have had you visit Fermilab and interact with its scientists
- If you have found this program worthwhile, please tell your friends, family and neighbors.

Saturday Morning Physics

Session I

October 6 – December 8, 2012

Class is NEVER cancelled!

Oct. 6	Introduction to Science at Fermilab	Roger Dixon **Auditorium**	WH15 WH15 ACC	Ben Carls Roger Dixon Jacob Linacre
Oct. 13	Cosmology	Chris Stoughton	ACC ACC WH15	Yunhe Xie Mike Cooke Kalanand Mishra
Oct. 20	Detectors	Ron Lipton	DØ CDF MIPP	Sarah Lockwitz Daryl Hare Dave Mason
Oct. 27	Accelerators	Elvin Harms	CDF MIPP DØ	Xuebing Bu Javier Tiffenberg John Freeman
Nov. 3	Theory of Relativity	Dan Hooper	MIPP DØ CDF	Andreas Jung Kyle Knoepfel Benton Pahlka
Nov. 10	Quantum Mechanics	Patrick Fox	GCC SiDet Tech. Div.	Mathew Muether Hang Yin SungWoo Youn
Nov. 17	Energy and Climate	Chuck Brown	SiDet Tech. Div. GCC	Vasu Chetluru Jacob Anderson Tingjun Yang
Nov. 24	**No Class – Happy Thanksgiving**			
Dec. 1	Theory of Everything	Shabnam Jabeen	Tech. Div. GCC SiDet	Fan Yang Seema Sharma Mandy Rominsky
Dec. 8	Physics & Society	Erik Ramberg	***GRADUATION***	

Classes meet in One West

Lectures begin at 9:00 a.m. **Tours begin at 11:00 a.m.**

Web Address: http://smp.fnal.gov **Contact: sweber@fnal.gov**

Revised 10/03/2012

A Short List of Physics Nobel Prizes and their Impact

- **1901 – Wilhelm Rontgen:**
  - Discovery of X-rays

  → **MEDICAL IMAGING - an immediate benefit**
- **1903 – Henri Becquerel and Curies:**
  - Discovery of radioactivity

  → **RADIOACTIVE MATERIALS - the mystery of the nucleus**
- **1918 – Max Planck:**
  - Development of quantum theory

  → **COMPLETELY NEW VISION OF UNIVERSE –**
  (the core notion of randomness still hasn't percolated into society)
- **1938 – Enrico Fermi:**
  - Discovery of nuclear reactions

  → **NUCLEAR ENERGY AND WEAPONS**
- **1956 – Shockley, Bardeen, Brattain:**
  - Research on semiconductors and transistors

  → **CREATION OF SEMICONDUCTOR INDUSTRY**
- **1978 – Penzias, Wilson**
  - Discovery of cosmic microwave background

  → **VISION OF A BIG BANG - not everyone believes! Still!**
- **1986 – Binnig, Rohrer**
  - Development of scanning tunneling microscope

  → **MANIPULATION OF INDIVIDUAL ATOMS (future?)**
- **1987 – Bednorz, Muller**
  - Discovery of high temperature superconductors

  → **PRACTICAL SUPERCONDUCTORS - needed now!**

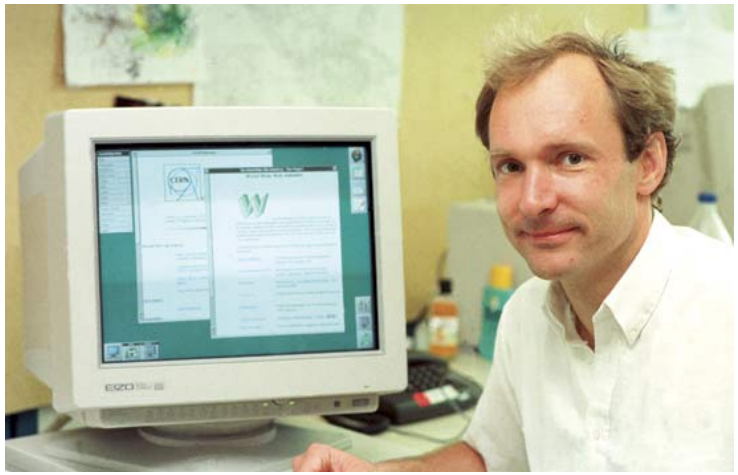
The return on investment in physics (and science in general) is enormous. For its own good, society should never skimp on research.

Practical applications for society can sometimes lag research by 30 years. Don't have a short term outlook!

Sometimes the biggest impact of science on society is philosophical; reshaping the vocabulary in which the world is described (e.g. "Big Bang", or "Schrodinger's Cat")

An Example of the Power of Physics: The Information Age

- Physics research has driven computing for much of its history:
  - Semiconductor industry is thriving. Started with the Nobel prize for physics in 1956 – Shockley, Bardeen and Brattain.
  - Many of the most complicated computing problems have a physics origin: atomic explosions, atmospheric and hydrodynamic phenomena, etc.
  - Creation of the World Wide Web was for particle physicists, both at CERN (Tim Berners-Lee-inventor of the protocol) and here at FNAL (early supporters of the program) and at SLAC (best web application at the time-SPIRES)
  - Creation of the next stage of information processing – The GRID – is being developed at CERN and FERMILAB and ANL, in cooperation with industry.



“Sir Tim Berners-Lee” of CERN

Welcome to CERN

CERN Information

CERN is the European Particle Physics Laboratory in Geneva, Switzerland.
Select by number information here, or elsewhere (Return for more).

Help [1]	On this program, or the World-Wide Web project [2].
Phone book [3]	People, phone numbers, accounts and email addresses. See also the analytical Yellow Pages [4], or the same index in French: Pages Jaunes [5]
CC Documentation [6]	Index of computer centre documentation, newsletters, news, help files, etc...
News [7]	A complete list of all public CERN news groups, such as news from the CERN Users Office [8], Cern computer center news [9], student news [10]. See also Private groups [11] and Internet news [12]

From other sites:-
1-24, <RETURN> for more, Quit, or Help:

Figure 2. The First CERN Linemode Browser

Contrary to popular belief, the Web did not initially take the CERN and high-energy physics community by storm. Hansjorg Klein of the Delphi collaboration recalls that a Hypertext Colloquium given by Berners-Lee at CERN in November of 1990 was “overwhelming to many physicists.” [15] Early efforts to get the Delphi experiment “on the Web” were not extremely successful.

Eric van Herwijnen remembers, “As for initial user reactions, I remember that no one believed in the Web at CERN in the beginning. Many people thought that Tim was not right in inventing yet another protocol (HTTP) - now they take part of the claim of having inventing it. The Web was only taken seriously here after Mosaic came along.” [15]

Paul Kunz, a mainstay of the high-energy physics computing community who was instrumental in establishing the first U.S. Website at the Stanford Linear Accelerator Center (SLAC), recalls “ The first I heard about the WWW was an article in a comp.sys.next newsgroup. Tim announced to NeXTStep users the availability of his application. My thoughts were something like: ‘what are these CERN people up to now?’ I had absolutely no interest as the application was pushed as a way to distribute documentation, and what developer finds documentation fun?” [15]

Others were quick to see the Web’s potential: In early 1992, Ruth Pordes and Jonathan Streets of the FermiLab Computing Division’s Online Systems Department (OLS) were considering the problem of providing information about online data acquisition systems to high-energy physics experimenters. Seeing the Web presentation to Artificial Intelligence in High Energy Physics (AIHEP’92) at La Londe, France in February 1992, Streets recommended the Web as being “the best thing around,” and OLS decided to

The first World Wide Web page

adopt it. [5] Paul Kunz attended the same presentation and recalls that the Web demonstration included a connection to the SLAC server, which was already in production at that time.

At the wrap-up session of the Computing in High Energy Physics Conference (CHEP) held at Annecy, France in September, 1992, Terry Schalk of the Santa Cruz Institute for Particle Physics (SCIPP) announced to attendees that the conference highlight for him had been the short presentation on the Web. Since then, Web applications have played a major role at the CHEP conferences. (CHEP97 in Berlin held joint sessions via videoconferencing with the Sixth International WWW Conference in Santa Clara, CA.)

Figure 3. is a photograph of a T-shirt made for CHEP92. The shirt bears the names of the 5 high-energy physics laboratories on the Web at the time - CERN, SLAC, DESY, NIKHEF, and FNAL. The joke amongst the designers of the shirt was that "maybe some day we'll have enough sites such that the names will go around the shirt wearer's chest."

Figure 3. The First WWW T-shirt

Bjorn Nilsson recalls that in June 1993, the ALEPH experiment at CERN was able for the first time to generally provide information previously limited to ALWS (the Aleph offline system) users. A Web version of ALWHO provided accurate phone list and e-mail data. ALWS HELP and detector status were also provided. [15]

In 1992, there were not enough web sites to fit on the front of a T-shirt

Sometimes the trivial spinoffs from physics research can be Earth-shaking in their impact!

So, how does 'Society' interact with Science?

- "Society" is basically whatever makes it into the newspapers (i.e. politics, technology, art, sports, religion, sex, etc) - the stuff that you never hear about in science class.

- Science has an enormous impact on society, as we've just seen, and this shows no sign of stopping. If anything, the importance will increase

- People love science, when it is well presented.

- But despite this combination of extreme importance to society and inherent interest from the public, news media typically short shrift science in a way they never would when reporting on politics or religion or sports.

- Furthermore, in America, people listen to judgments on society from political and religious leaders, but not nearly as much from scientific leaders.

Think about the impact Rush Limbaugh has, compared to James Hansen!

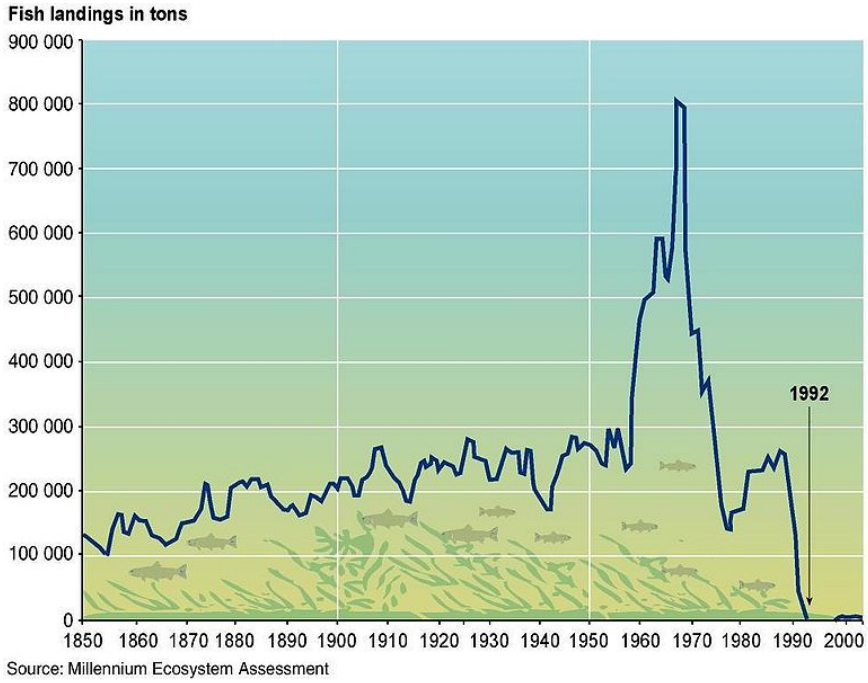
A Sample List of Questions for Science in Today's Society

- Is the Earth warming up? If so, can we alleviate this?
  - **"What is the priority for this?" is NOT really a question for science**
- Can we generate enough energy for all the people on the planet without harming the environment?
  - **"Who pays for it?" is NOT a science question**
- Can we reliably provide a defensive shield against missile attack?
  - **"Will this ruin the diplomatic standoff principle of 'Mutual Assured Destruction' and thus make us less safe?" is NOT a science question.**
- How healthy can we make people? What is the best way to feed everyone and provide clean water?
  - **"What if we have to require only 1 child/couple?" is NOT a science question**
- Are genetically engineered organisms effective
  - **Should they be patentable is NOT a science question**
- Can stem cells cure disease?
  - **"Is it moral to harvest embryos' is NOT a science question**

Make sure you know whether you are talking science or talking about something else!

An example of what happens when society doesn't listen to scientists

- In the 1960's, Newfoundland's cod fishery was highly successful, using modern trawling methods to increase the catch tremendously.
- Ecological scientists warned that this was unsustainable and would lead to a fishery collapse.
- There was great reluctance from Canadian society to put limits on the catch.
- The fishery indeed collapsed; there is now a moratorium on cod fishing in Newfoundland.
- The ecosystem is so badly damaged that cod might not ever return. More than 20,000 jobs are lost.



The Tragedy of the Commons

Anatomy of a Badly Reported Science News Story

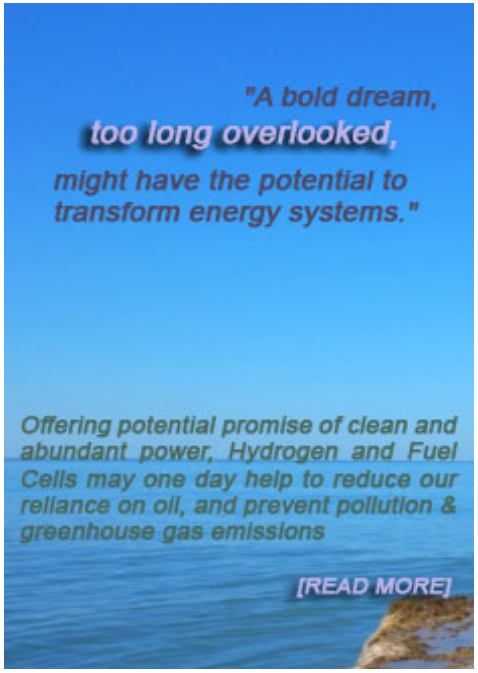
"But hydrogen offers a plentiful and clean form of energy and cannot be ignored, experts said. And the public is interested in the technology: when Honda announced its leasing program, more than 50,000 people registered for it online."

New York Times, September 23, 2008

What is a 'hydrogen fuel cell' and why did Presidents Bush and Clinton spend money on it?

- Google 'hydrogen fuel cell' to find The Hydrogen Fuel Cell Institute (www.h2fuelcells.org).

- Here are quotes from Dr. Robert J. Wilder, the President of the institute, in his commentary "The Promise of Hydrogen":



Paragraph 1: "At long last, a technology too long overlooked promises to transform society. Offering clean & abundant power, hydrogen-based fuel cells could soon end our reliance on oil and minimize emissions of pollution and global-warming gases."

Paragraph 13:"So why aren't fuel cells now powering our homes, offices, cell phones or cars around the world? Because until very recently their costs were far too high."

Hydrogen Fuel cells (cont.)

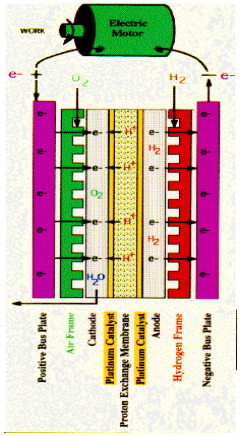
- Physics realities:
  - A hydrogen fuel cell creates electricity from the chemical oxidation of hydrogen.
  - Molecular hydrogen is required for this.
  - There is no molecular hydrogen on the planet Earth.
  - The best way to create hydrogen is to USE another energy source to split water, or to heat up a hydrocarbon and 'crack' it open to release the hydrogen.

Q: What energy source is used to create hydrogen?

A: Burning coal, oil and gas!!

Q: But aren't hydrogen fuel cells a great energy storage device?

A: Not if the efficiency of hydrogen production + storage + retrieval in fuel cells is LOWER than just charging up a normal battery.



Round trip efficiency
(electricity -> fuel cell -> electricity)
is about 40%.

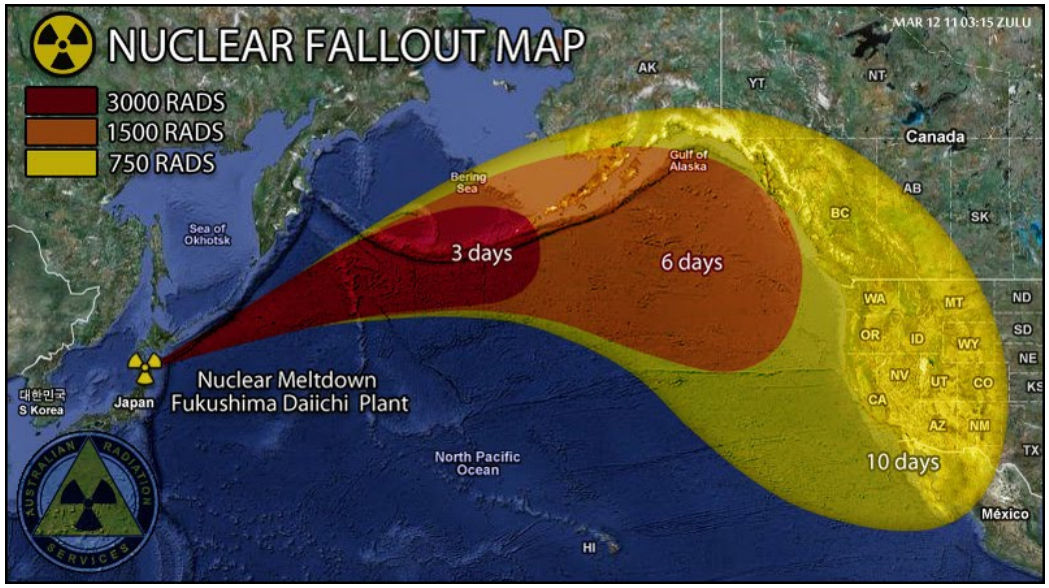
Meh!

(In Obama's administration, the physicist heading up DOE cancelled the H2 program)

What does Fukushima tell us about Physics and Society?

- People are rightly scared of dangerous things they cannot see.
- Panic is easy to induce. (Iodine tablets were sold out – in California!)
- Good reporting can overcome fears.
- Physicists do not explain radioactivity very well.

Sometimes, bad graphs just lie



What does this graph tell us? A ‘rad’ is a unit of total absorbed dose. Does this picture mean that there will be 1500 rads absorbed per person, or over the whole area of the Pacific Ocean? Over what time frame? A second? A year? A century? As you can imagine, these details about the localization and rate of radiation makes a HUGE difference!

The main culprit is the author of this terrible graph. But the plethora of units for describing radioactivity by physicists is partly to blame:

Rad, reontgen, gray, rem, Becquerel, Sievert, Curie

Conversions

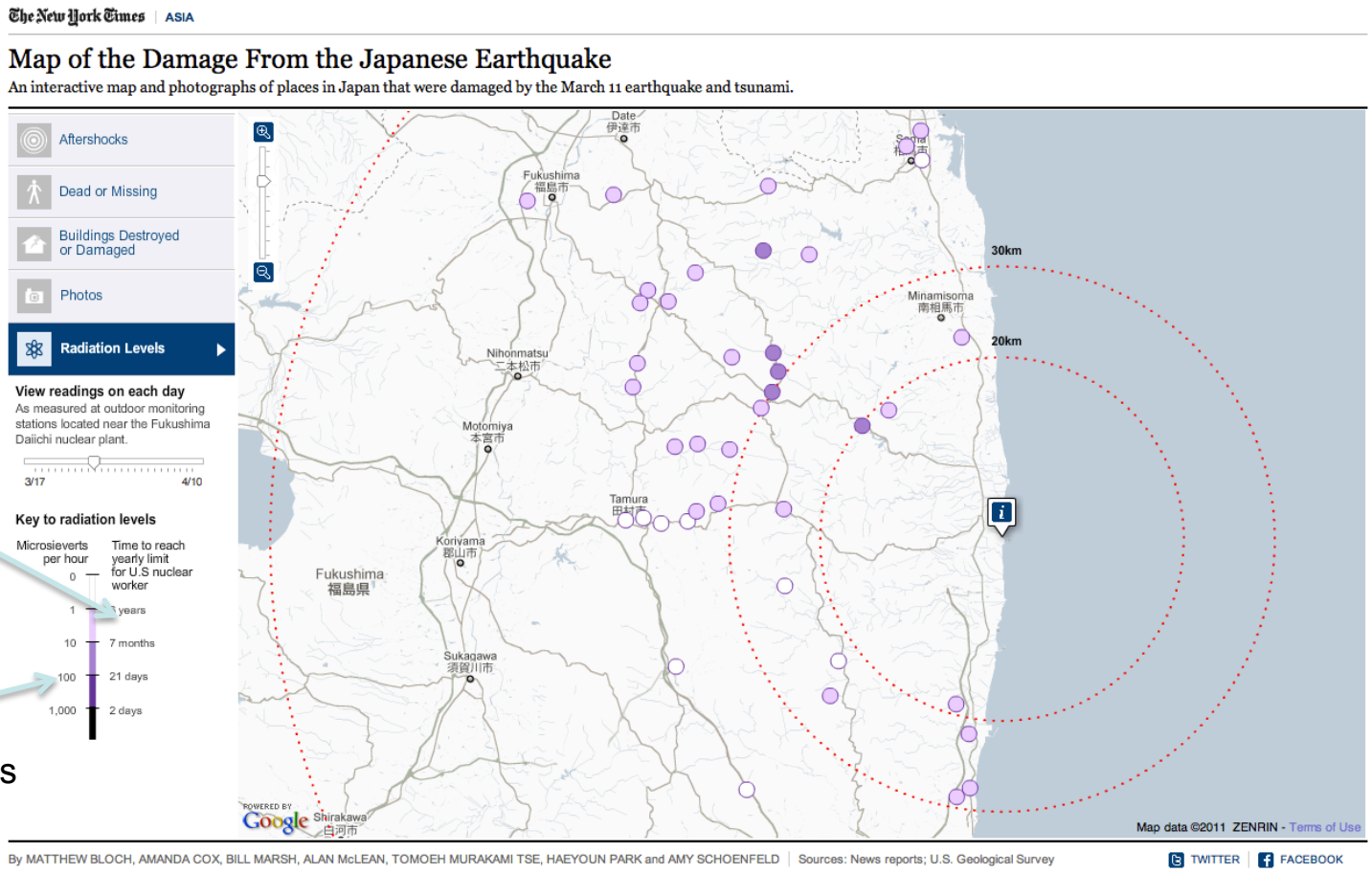
Conversion Equivalence

1 curie = 3.7×10^{10} disintegrations per second		1 becquerel = 1 disintegration per second
1 millicurie (mCi)	=	37 megabecquerels (MBq)
1 rad	=	0.01 gray (Gy)
1 rem	=	0.01 sievert (Sv)
1 roentgen (R)	=	0.000258 coulomb/kilogram (C/kg)
1 megabecquerel (MBq)	=	0.027 millicuries (mCi)
1 gray (Gy)	=	100 rad
1 sievert (Sv)	=	100 rem
1 coulomb/kilogram (C/kg)	=	3,880 roentgens

Conversion Factors

To convert from	To	Multiply by
Curies (Ci)	becquerels (Bq)	3.7×10^{10}
millicuries (mCi)	megabecquerels (MBq)	37
microcuries (µCi)	megabecquerels (MBq)	0.037
millirads (mrad)	milligrays (mGy)	0.01
millirems (mrem)	microsieverts (µSv)	10
milliroentgens (mR)	microcoulombs/kilogram (µC/kg)	0.258
becquerels (Bq)	curies (Ci)	2.7×10^{-11}
megabecquerels (MBq)	millicuries (mCi)	0.027
megabecquerels (MBq)	microcuries (µCi)	27
milligrays (mGy)	millirads (mrad)	100
microsieverts (µSv)	millrems (mrem)	0.1
microcoulombs/kilogram (µC/kg)	milliroentgens (mR)	3.88

Example of Good Reporting on This Topic



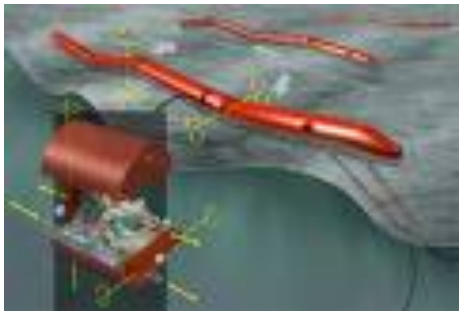
Time it takes to reach Radiation worker limit

microSieverts Per hour

In the age of the Internet, it is possible to deliver accurate and interactive information on matters of extreme importance.

Energy Sources

- The essence of the debate on energy is: what primary energy source do you want to use? There are 4 classes:
  - Hydrocarbon combustion
    - Coal, oil, natural gas
    - Biomass (no net emission of CO2)
  - Nuclear
    - Fission
    - Fusion
  - Terrestrial sources:
    - Geothermal
    - Tides and waves
    - Wind
  - Solar



Pelamis project in Portugal

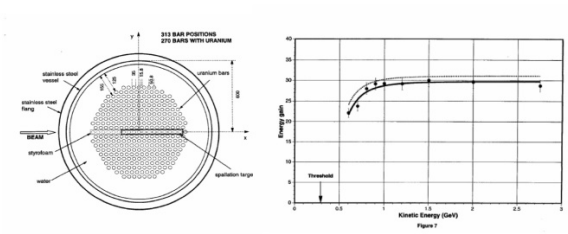
eSolar array in southern California

- What will drive this debate? –
  - Science (physics in particular)
  - Society (politics in particular)

An accelerator solution to the world's energy woes?

- Amazingly enough, accelerators can be the trigger mechanism in a relatively clean thorium reactor. 'ADS'=accelerator driven system
- These ADS's are 'sub-critical', meaning there is no way to induce a runaway chain reaction, unlike conventional reactors that need to be moderated.
- Thorium is thousands of times more abundant than scarce uranium-235. At present rates, uranium will last only 50 years!
- The by-products don't include the long-lived actinides. There is still radioactive waste, but it doesn't live thousands of years as in a uranium reactor.

Experimental Verification-S.Andriamonje et al CERN/AT/94-95(ET) Phys.Lett.B348:697-709,1995

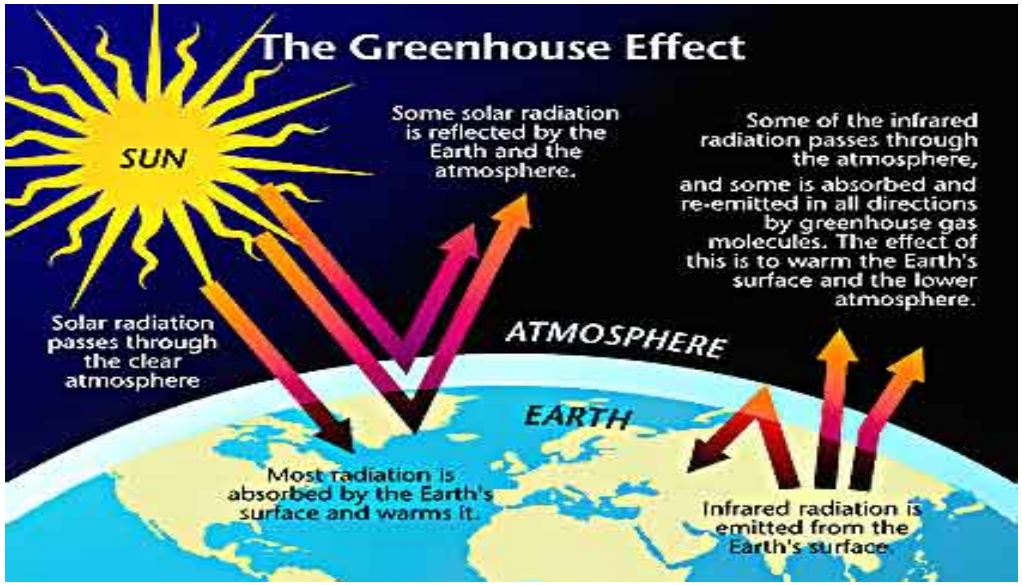


Energy amplification of x30 achieved at CERN.

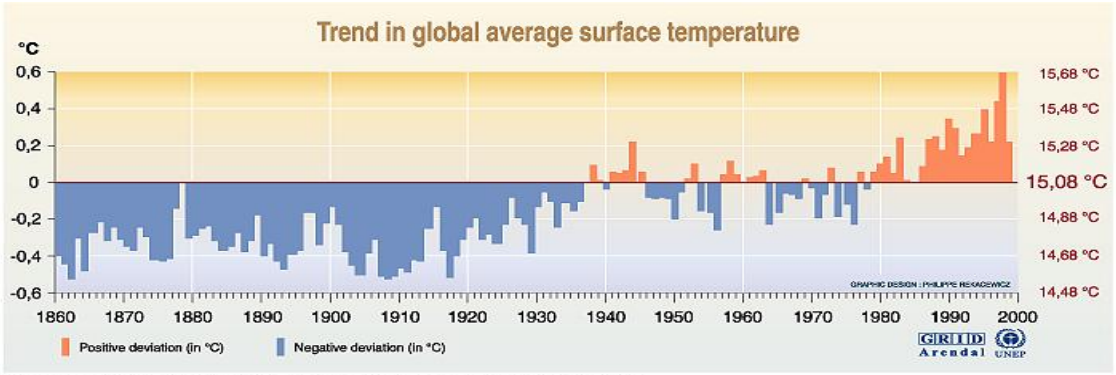
Why not here?

Physics and the Environment

- Fermilab is officially designated a National Environmental Research Park (one of only 6 in the nation) and is dedicated to the restoration of the original prairie grasses onsite.



The scope and cause of global warming is fundamentally a physics issue and MUST be addressed in a scientific, not a political way. Whether we want to change our means of energy production from fossil fuels to other sources is a political problem, not a scientific one.



Source: School of environmental sciences, climatic research unit, university of East Anglia, Norwich, United Kingdom, 1999.

0.5°

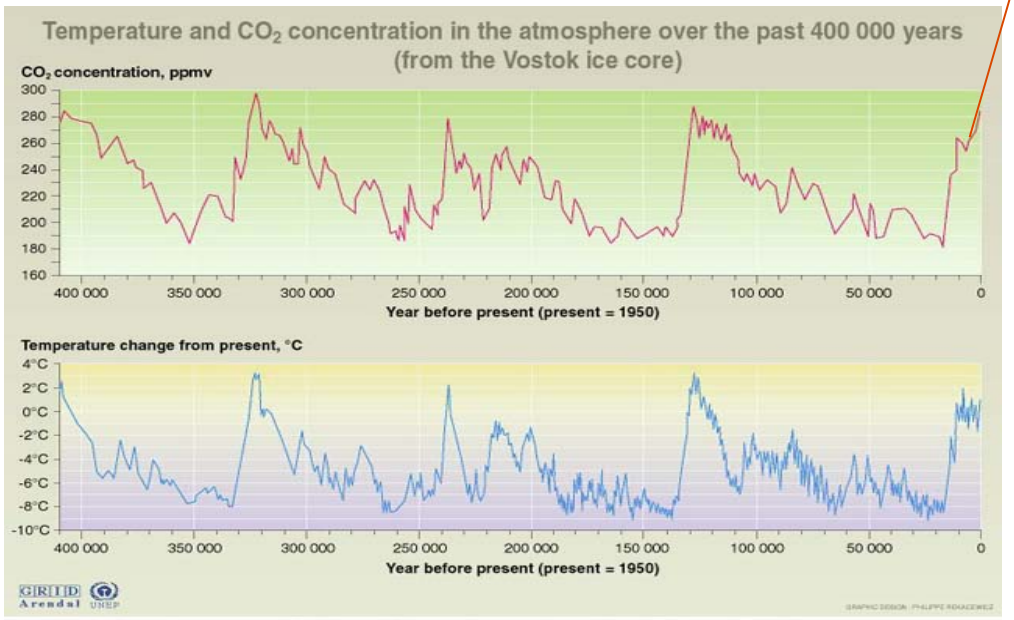
(6° change = Ice Age)

The figure shows the combined land-surface air and sea surface temperatures (degrees Centigrade) 1861 to 1998, relative to the average temperature between 1961 and 1990

The Vostok Ice Core

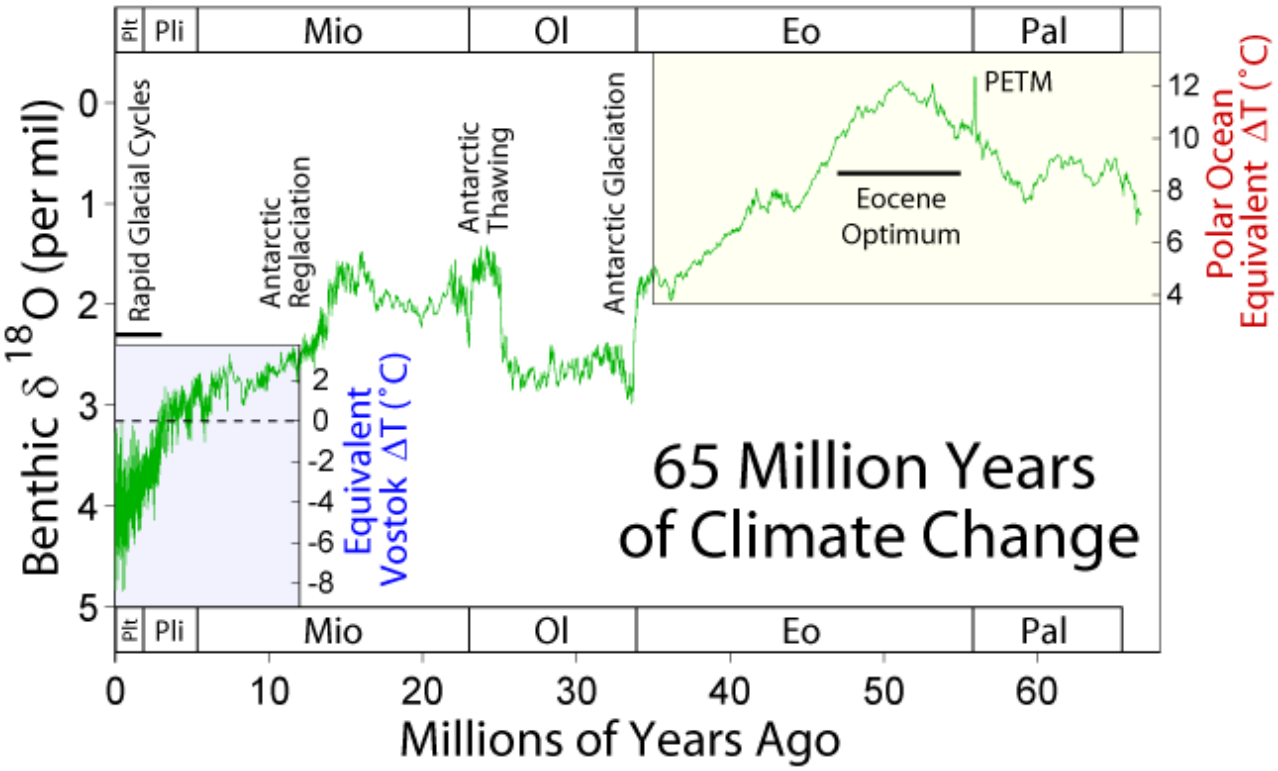
- CO2 levels and temperature seem to be highly correlated for 100's of thousands of years (Note the temperature swings in the bottom graph encompass several Ice Ages and warm spells)

- This is where the CO2 level will be around 2050



Source: J.R. Petit, J. Jouzel, et al. Climate and atmospheric history of the past 420 000 years from the Vostok ice core in Antarctica, Nature 399 (3/June), pp 429-436, 1999.

The Long View



Speaking from a very long time-scale viewpoint, it is likely the Ice Ages are over, and we are moving back into Miocene conditions. Hopefully we won't revive the Eocene (swamps in northern Canada!).

Does "Climategate" prove that global warming science is fraudulent?

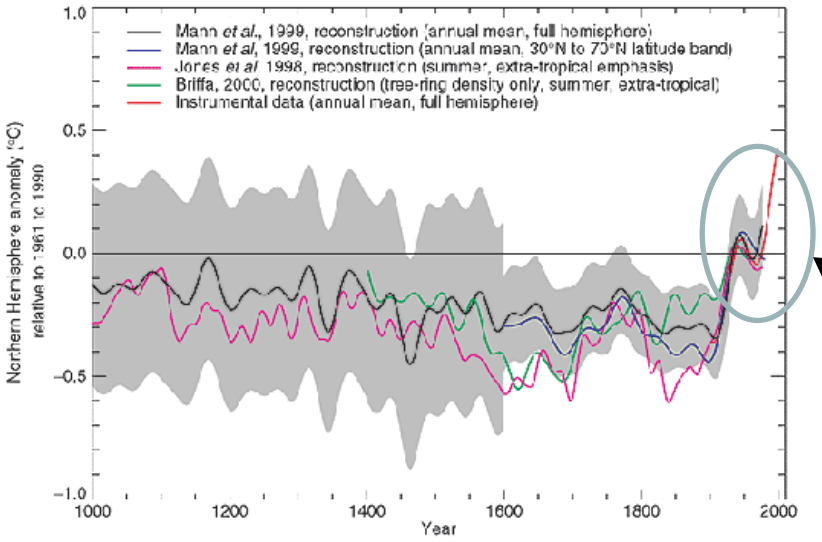
- A little while ago (Nov., 2009), hackers illegally obtained emails from the Climate Research Unit of the University of East Anglia – a major climate research site.

- One email from Prof. Phil Jones indicates he wants to avoid showing a subset of the data, so that he can "hide the decline"

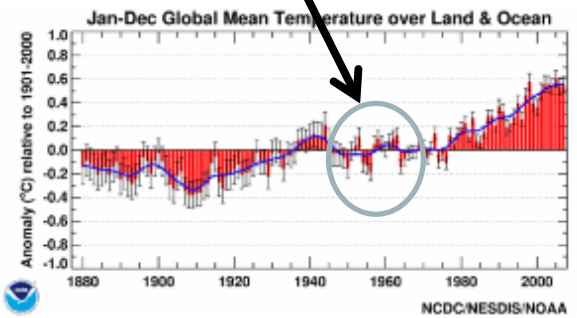
- In reality, nothing was 'hidden', since Jones had published many papers on this very subject.

- Innumerable global warming skeptics have pounced on this as confirmation of their deepest suspicion – SOCIALIST HIPPIES TRYING TO RUIN OUR STANDARD OF LIVING !

- But however you want to spin this particular issue, this last decade (2000-2010) is the hottest decade in the last 1000 years (probably the last million years). And we know why.



Some tree ring data shows this part is 0.2 degrees colder than stated. Jones didn't even 'hide' this. He wrote articles on it.



The Battle for climate science is “heating up” !!!

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Climate change denier Nick Griffin to represent EU at Copenhagen

BNP leader who believes climate change activists are 'cranks' will be member of European parliament's delegation

Toby Helm
The Observer, Sunday 29 November 2009
Article history

Nick Griffin amid an anti-BNP demonstration. Photograph: John Stillwell/PA

Nick Griffin, the leader of the British National party, is to represent the European parliament at the UN climate change conference in Copenhagen, which opens next week.

Last night politicians and scientists reacted furiously to news that the far-right politician and climate change denier should be attending the summit on behalf of the EU.

Inbox for ramberg@f... | Microsoft PowerPoint ...

In a speech in the parliament, Griffin [of the British National Party] denounced those who warn of the consequences of climate change as "cranks".

He said they had reached "an Orwellian consensus" that was "based not on scientific agreement, but on bullying, censorship and fraudulent statistics".

"The anti-western intellectual cranks of the left suffered a collective breakdown when communism collapsed. Climate change is their new theology… But the heretics will have a voice in Copenhagen and the truth will out. Climate change is being used to impose an anti-human utopia as deadly as anything conceived by Stalin or Mao."

This may be the most important issue in your life!
You need to choose sides.
And physics is the key to the debate.

Here is a small fraction of the organizations that are trying to warn our political leaders about the dangers of global warming

- US Geological Survey (USGS)
- National Academy of Sciences (U.S.)
- Woods Hole Resesarch Center
- National Center for Atmospheric Research (NCAR)
- NASA's Goddard Institute of Space Studies (GISS)
- American Association of State Climatologists
- Federal Climate Change Science Program, 2006 (the study authorized and then censored by Bush)
- American Chemical Society - (world's largest scientific organization with over 155,000 members)
- Geological Society of America
- American Geophysical Union (AGU
- National Oceanic and Atmospheric Administration (NOAA)
- American Association of State Climatologists
- Environmental Protection Agency (EPA)
- American Astronomical Society
- American Institute of Physics
- American Meteorological Society (AMS)
- American Association for the Advancement of Science (AAAS)
- Geological Society of London
- Chinese Academy of Sciences
- Royal Society, United Kingdom
- Russian Academy of Sciences
- Royal Society of Canada
- Science Council of Japan
- Australian Academy of Sciences
- Royal Flemish Academy of Belgium for Sciences and the Arts
- Brazilian Academy of Sciences
- Caribbean Academy of Sciences
- French Academy of Sciences
- German Academy of Natural Scientists
- Indian National Science Academy
- Indonesian Academy of Sciences

….etc

Here are some organizations dismissing the notion of global warming

- American Association of Petroleum Geologists (AAPG)
- Canadian Association of Petroleum Geologists (CAPG)
- U.S. Chamber of Commerce
- Heartland Institute
- Fox News and other media

A Dangerous Attitude in our News Media

"From: Sammon, Bill
To: 169 -SPECIAL REPORT; 036 -FOX.WHU; 054 -FNSunday; 030 -Root (FoxNews.Com); 050 -Senior Producers; 051 -Producers; 069 -Politics; 005 -Washington
Cc: Clemente, Michael; Stack, John; Wallace, Jay; Smith, Sean
Sent: Tue Dec 08 12:49:51 2009

Subject: Given the controversy over the veracity of climate change data……we should refrain from asserting that the planet has warmed (or cooled) in any given period without IMMEDIATELY pointing out that such theories are based upon data that critics have called into question. **It is not our place as journalists to assert such notions as facts**, especially as this debate intensifies."

Huh?? I thought finding out the facts was EXACTLY what journalists were supposed to do. Could there possibly be some reason unrelated to science that motivates this directive?

Global Warming – The EPA's View (and the way scientists should think)

- **What's Known for Certain?**
  - Scientists know for certain that human activities are changing the composition of Earth's atmosphere.
  - It's well accepted by scientists that greenhouse gases trap heat in the Earth's atmosphere and tend to warm the planet.
  - A warming trend of about 1°F has been recorded since the late 19th century.
  - Confirmation of 20th-century global warming is further substantiated by melting glaciers, decreased snow cover in the northern hemisphere and even warming below ground.

- **What's Likely but not Certain?**
  - In the most recent Third Assessment Report (2001), IPCC wrote "There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities."
  - As atmospheric levels of greenhouse gases continue to rise, scientists estimate average global temperatures will continue to rise as a result. IPCC projects further global warming of 2.2-10°F (1.4-5.8°C) by the year 2100.
  - The IPCC states that even the low end of this warming projection "would probably be greater than any seen in the last 10,000 years, but the actual annual to decadal changes would include considerable natural variability."

- **What are the Big Unknowns?**
  - The computer models used to forecast global climate change are still ill-equipped to simulate how things may change at smaller scales.
  - There is the possibility that a warmer world could lead to more frequent and intense storms, including hurricanes. Preliminary evidence suggests that, once hurricanes do form, they will be stronger if the oceans are warmer due to global warming.
  - Scientists are concerned that the accumulation of greenhouse gases could inject enough heat into Pacific waters such that El Niño events become more frequent and fierce. Here too, research has not advanced far enough to provide conclusive statements about how global warming will affect El Niño.

Physics and War

- World War II was perhaps the key event of the 20th century – it reshaped the nature of international relations such that we still feel its ramifications.

- 'Eggheads' played enormous roles in this conflict
  - Radar: Fermilab uses same type of Klystron power amplifiers developed for radar.
  - Codes and Code Breaking
  - Computing for Ballistic Trajectories
  - Atomic Bomb

- Scientists willingly played key roles in this conflict for the same reason everyone else did – the circumstances of that war called for sacrifice and effort from all.

- But a core group of scientists protested the notion of using scientific efforts to enhance war capability, and those same types of protests go on today.

First-Hand Account

Norman Ramsey Colloquium speaker on February 26, has faced the real issues of scientists in times of war

by Mike Perricone

Norman Ramsey has seen too much history to risk predicting the future, especially for the intervening weeks until his Feb.26 Fermilab Colloquium presentation on "Scientists in Times of War."

"The circumstances surrounding my giving the talk may be rather different by then," he said, as February opened with tensions unresolved over weapons inspections in Iraq. Whatever the circumstances,the talk will not be an academic exercise for Ramsey.

Before chairing the advisory committee that recommended establishing a national accelerator laboratory; before serving as the first president of Universities Research Association,Inc., the consortium contracted to run the laboratory;before having Fermilab's Ramsey Auditorium named for him; before winning the 1989 Nobel Prize in physics for developing the maser, used in atomic clocks; before launching his decades-long search for an electric dipole moment in the neutron...

Ramsey headed the group developing three-centimeter radar at the MIT Radiation Laboratory —and radar was regarded as a decisive factor for the Royal Air Force in the Battle of Britain.

Ramsey then joined the Manhattan Project in 1943 and served as Head of the Delivery Group at Los Alamos when the first atomic bomb was built and tested.

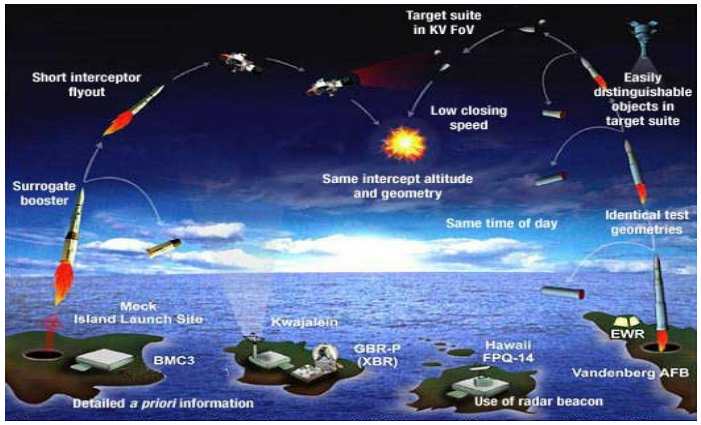
Another great scientist / warrior: Robert Wilson

"Robert Wilson gave our laboratory the distinctive character it possesses today," Witherell said. "We inherit from him the tradition of building large and powerful accelerators that open up new ways of exploring the fundamental nature of the universe. In addition, he planned and designed Fermilab's striking physical campus, from the restored prairie to the remarkable architecture, including several of his own sculptures. He had a vision of the laboratory as a cultural, recreational and educational center for the surrounding community, as well as a global research center open to the international community of scientists. He had a profound and unshakable commitment to human rights. Bob Wilson's legacy survives at Fermilab, in the surrounding communities and in the world of science."

Laboratory Director Mike Witherell at Bob Wilson’s Memorial

Cyclotron Group Leader in the Manhattan Project (youngest group leader)

The “Reverse” A-bomb Project: Missile Defense



Hooray! Only
5 out of 13 atomic
bombs got through
our defense!

Difficulties in testing the Missile Defense Program-
How are they addressed? Have you seen the data?

Missile Defense Fraud Accusation - Where's the Data Now?

I believe that the top management of the Pentagon's Missile Defense Agency (previously known as the Ballistic Missile Defense Organization) and its contractors have misrepresented or distorted the results derived from the experiment and rigged the follow-on test program that continues to this day. These deliberate actions have hidden the system's critical vulnerabilities from the White House, Congress and the American citizens whom the missile defense program was supposed to protect.

- Theodore Postol April, 2002

Although Postol's statements were debated intensely as to their political merits in the media, where was the data? We saw it at Fermilab. Was this statement true or false and why didn't the media report on the data?

Is it possible that the government would allow scientific results to be hidden from the public, or distorted?

Religion and Science

- Can a scientist be religious?
- Can a devout person be a scientist?

Father Timothy Toohig
(1928-2001)

THE EXPERIMENT HAS BEEN DONE AND
THE ANSWER IS DEFINITELY YES.

Father Tim was part of the fabric of Fermilab from its earliest days. In a 1987 essay, "Starting Fermilab: Personal Viewpoints of a Laboratory Director," Fermilab's founding director Robert Wilson wrote:

> It was not roses, roses, all the way. Tragedy began to strike as our numbers grew—disease, even death. Nowhere in the annals of physics are such things mentioned, nor had my previous experience prepared me to cope with them. Yet coping was part of the job. I soon found that Tim Toohig, a cracking good physicist at the Lab, as well as a Jesuit priest, would appear on such occasions full of compassionate sympathy and understanding. Despite a difference in our religious beliefs, we became close friends and the difference narrowed as my respect for Tim grew. He became the spiritual counsel for the project.

Tim loved particle physics, and he truly loved Fermilab. His spirit helped create the laboratory we know today. The Fermilab community and the worldwide family of particle physics will miss him greatly.

Religion and Science (cont.)

- One problem is when religion tries to confront science on its own turf.

- Evolution is currently the best example of this problem. (Astronomy used to be the big battleground) :

  – Many religious organizations deny that evolution of life forms has taken place on this planet.
  – There is no scientific basis for questioning the fundamental fact of evolution. The Theory of Evolution is on a scientific par with the Theory of Gravity or the Germ Theory of Disease.

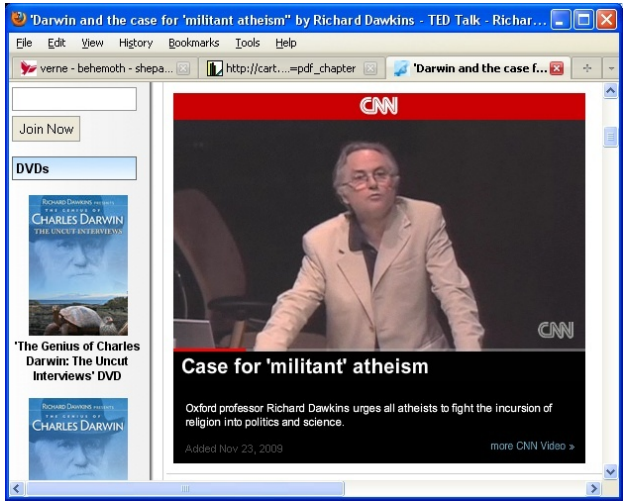
This is a silly battle to fight!! Evolution science is not going to go away. It is the most solid biological theory of all time.

Religion and Science (cont.)

- Does science try to invade religion's turf? Sometimes:
  - Using evolution as the only tool to discuss human interactions (i.e. "Social Darwinism") discounts the deep emotional and moral elements of society.
  - Cloning: there is no particular scientific reason to fear cloning (it is the same process as twinning), but there may very well be societal reasons.
  - Stem cells: medical advances seem to be certain if scientists experiment with stem cells. However, there are legitimate moral objections by some to making embryos a "tool".

- And "militant atheism" from scientists won't work. Religion is here to stay.

"I believe a true understanding of Darwinism is deeply corrosive to religious faith," - Richard Dawkins



The Deep Mysteries of Physics

- If you want to search for the sacred, majestic and mysterious in science:

FORGET ABOUT BIOLOGY !!
THINK PHYSICS !!!

- *What is Dark Energy? It pervades all of space time and is forcing the Universe to expand. Our best calculations are about a factor of 10^{60} in error.*

- *Why are the physical parameters of this Universe (including the amount of Dark Energy and Matter) so exquisitely balanced such that life can exist?*

- *Are there 10^{500} universes out there, and we landed in the hospitable one?*

- *What unknown mechanism sets the scale of masses of the fundamental particles? Even the Higgs theory does not answer that question. The value of those masses also seem finely tuned to allow life*

- *How can we possibly reconcile the random nature of Quantum Mechanics with our own notions of logic and causation? Can there be something hidden from us that is actually determining the interactions at the smallest level? Would that then make the Universe deterministic? Is Quantum Mechanics equivalent to "free will"?*

Catholic View on Science

- The Catholic religion, in its Catechism, has a particularly poetic and accommodating view on religion and science (obtained after 400 years of violent debate about it):
  - "The question about the origins of the world and of man has been the object of many scientific studies which have splendidly enriched our knowledge of the age and dimensions of the cosmos, the development of life-forms and the appearance of man. These discoveries invite us to even greater admiration for the greatness of the Creator, prompting us to give him thanks for all his works and for the understanding and wisdom he gives to scholars and researchers" (CCC 283)

God was behind Big Bang, universe no accident: Pope

REUTERS

Buzz up! 0 votes | Share 30 | retweet 10 | Email | Print

By Philip Pullella – 54 mins ago

VATICAN CITY (Reuters) – God's mind was behind complex scientific theories such as the Big Bang, and Christians should reject the idea that the universe came into being by accident, Pope Benedict said on Thursday.

"The universe is not the result of chance, as some would want to make us believe," Benedict said on the day Christians mark the Epiphany, the day the Bible says the three kings reached the site where Jesus was born by following a star.

"Contemplating it (the universe) we are invited to read something profound into it: the wisdom of the creator, the inexhaustible creativity of God," he said in a sermon to some 10,000 people in St Peter's Basilica on the feast day.

While the pope has spoken before about evolution, he has rarely delved back in time to discuss specific concepts such as the Big Bang, which scientists believe led to the formation of the universe some 13.7 billion years ago.

Researchers at CERN, the nuclear research center in Geneva, have been smashing protons together at near the speed of light to simulate conditions that they believe brought into existence the primordial universe from which stars, planets and life on earth -- and perhaps elsewhere -- eventually emerged.

Some atheists say science can prove that God does not exist, but Benedict said that some scientific theories were "mind limiting" because "they only arrive at a certain point ... and do not manage to explain the ultimate sense of reality ..."

He said scientific theories on the origin and development of the universe and humans, while not in conflict with faith, left many questions unanswered.

"In the beauty of the world, in its mystery, in its greatness and in its rationality ... we can only let ourselves be guided toward God, creator of heaven and earth," he said.

Benedict and his predecessor John Paul have been trying to shed the Church's image of being anti-science, a label that stuck when it condemned Galileo for teaching that the earth revolves around the sun, challenging the words of the Bible.

The Morality of Science

- There are **NOT** two equal sides to every question in science. Typically, there is an overarching theory that is well accepted, with a lot of work being conducted on the details of that theory. Then, ever so often, a dramatic shift in viewpoint will improve on the basic theory.

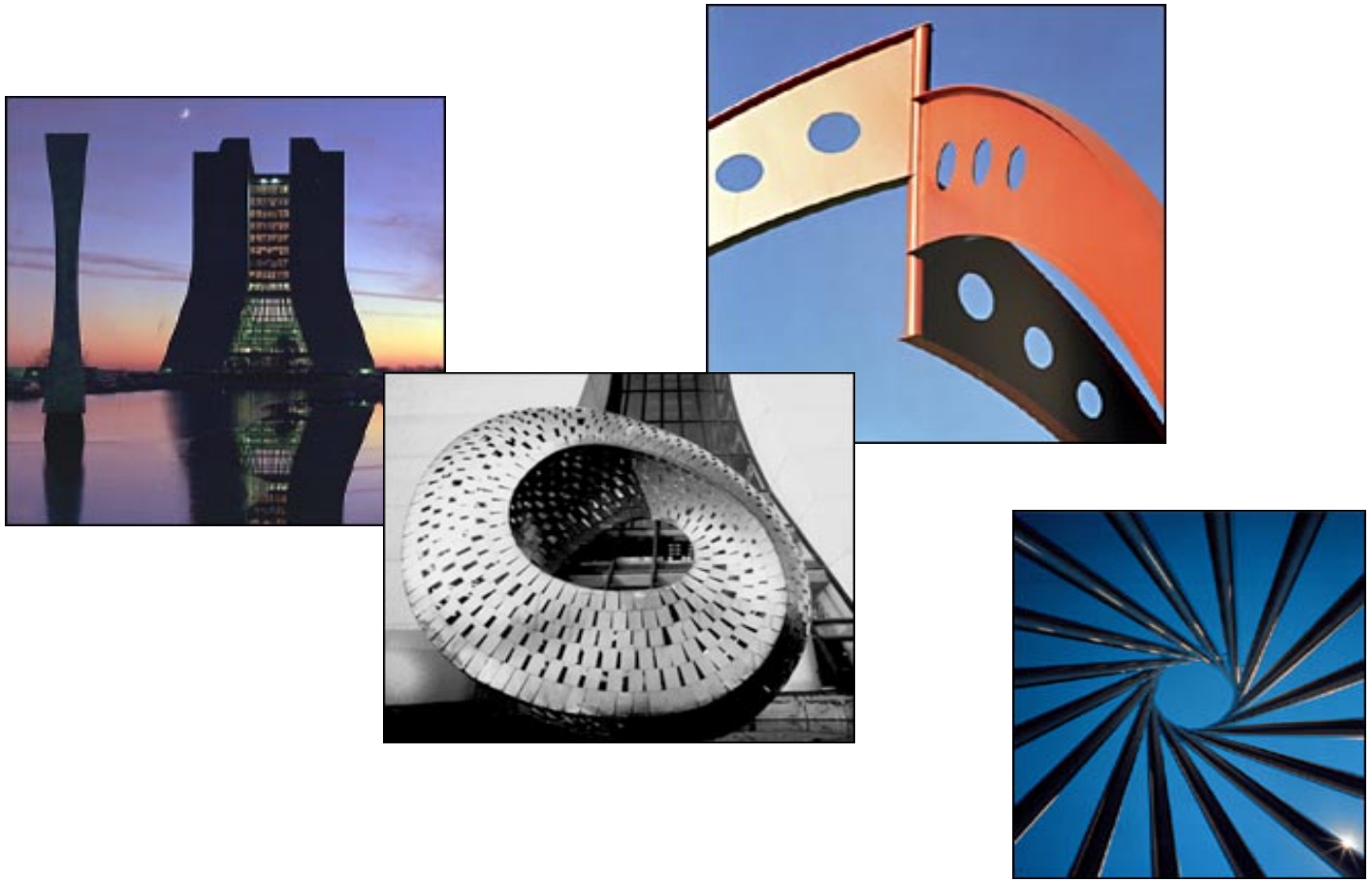
- The tendency of people to consider alternative viewpoints with equal weight is not scientific if there is a vast preponderance of evidence for only one of them.

- This can give the appearance of harshness and rigidity and even perhaps amorality.

- However, science is indeed a "moral" endeavor in that it requires a person to change his deeply held beliefs if the evidence demands it. It demands of its adherents that they be able to say "I can be wrong" and "Your viewpoint is better than mine". Can this be said of politics, religion, business, art, sports?

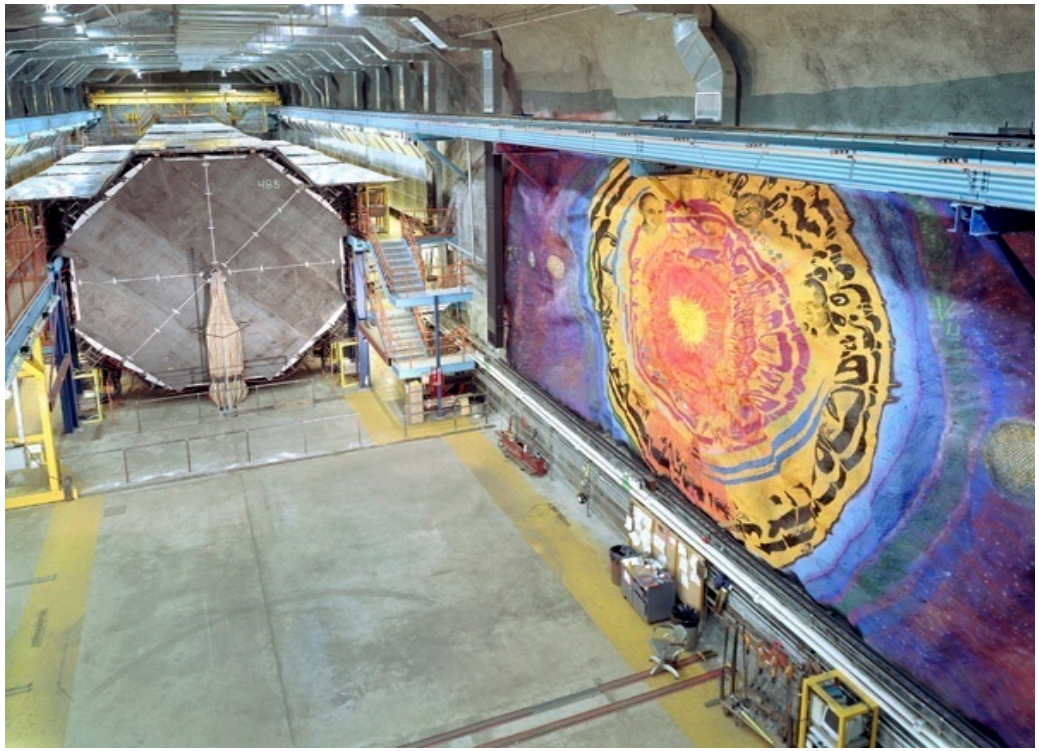
- Science can undoubtedly be used for amoral or immoral purposes. As can politics, religion, business, art, sports, entertainment, etc, etc.

Art – the crucial link between Science and Society



Fermilab may well be the world's premier nexus between physics and art.

→ Due to the influence of a single man – Robert Wilson, the founder of Fermilab



This appreciation for art has been translated into other laboratories.
Shown here is the Soudan Underground Laboratory in Minnesota.

Does Science Interfere with an Artistic Sensibility?

- Artists see the world differently than scientists. They are concerned with the emotional response to nature or representations of nature. The world doesn't have to 'make sense' – it can just as easily be nonsensical, or sometimes one and sometimes the other.

- Artists sometimes push away rigorous scientific thinking, assuming that it limits the range of emotions. Witness the rise of deconstructionist literary theories, which are an attempt to portray the world as having no fixed truths.

- But it is absolutely wrong to think that pursuing scientific knowledge of the world destroys ones ability to have an emotional response to it. Everything we do at Fermilab denies that viewpoint. Most of my colleagues are involved with the arts in some way.

Battle of the Poets!

(Which viewpoint do you want to live by?)

SONNET- TO SCIENCE
by Edgar Allan Poe

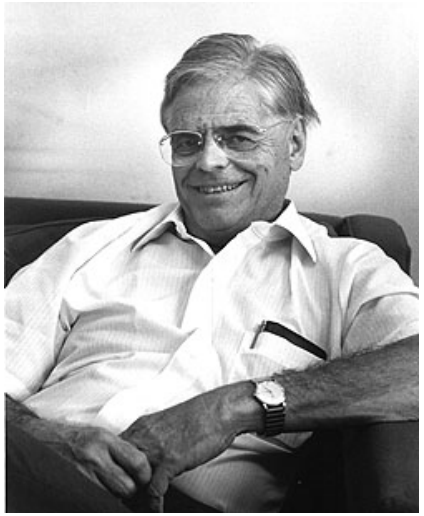
Science! true daughter of Old Time thou art!
Who alterest all things with thy peering eyes.
Why preyest thou thus upon the poet's heart,
Vulture, whose wings are dull realities?

WATCHERS OF THE SKY
by Alfred Noyes

Fools have said
That knowledge drives out wonder
from the world;
They'll say it still,
though all the dust's ablaze
With Miracles at their feet.

In 1969, when Wilson was in the hot seat testifying before the Congressional Joint Committee on Atomic Energy, Sen. John Pastore demanded to know how a multimillion-dollar particle accelerator improved the security of the country.

Wilson said the experimental physics machine had "nothing at all" to do with security, and the senator persisted.



"It has only to do," Wilson told the lawmakers, **"with the respect with which we regard one another, the dignity of men, our love of culture. It has to do with: Are we good painters, good sculptors, great poets? I mean all the things we really venerate in our country and are patriotic about. It has nothing to do directly with defending our country except to make it worth defending."**