Scientific Ethics and the Signs of Voodoo Science

July 6, 2007

What is Science?

- Systematized knowledge derived from observations, experimentation and study with the objective of
- Describing the physical universe and the underlying principles that govern activities therein
- Deals with phenomena that can be examined empirically

Pseudoscience

- Appropriation of the prestige of genuine science and its outward trappings and protocols but lacking the accepted standards of practice and verification
- Typically, pseudoscience does not value debate and criticism and rarely shows genuine progress

What are the ethical standards of science?

- Honesty is its foundation.
- An implicit social contract between scientists.
- “Science is a set of rules that keep the scientists from lying to each other” - Kenneth S. Norris, U. Cal. Santa Cruz

Characteristics of Scientists

- Make judgment of truth in terms of intellectual criteria.
- Disinterestedness
  - Direct efforts towards extension of knowledge
- Skepticism
  - Do not accept results on the basis of authority
- Sharing of information
- Emotional neutrality

APS Statement on Integrity in Physics - 1987

“The physics community has traditionally enjoyed a well-deserved reputation for maintenance of high ethical standards and integrity in its scientific activities. Indeed, the American Physical Society is one of the few professional societies which has not felt the need for a formal code of ethics.”

The APS statement went onto exhort physicists not to take its good reputation for granted.

The Scope

- Outright fraud to “grantsmanship” and negligence.
- How serious a problem?
- Important falsehoods will be found out.
  - Inability to reproduce results
  - Insider disclosure

Physics Today - Nov. 2004 p. 42

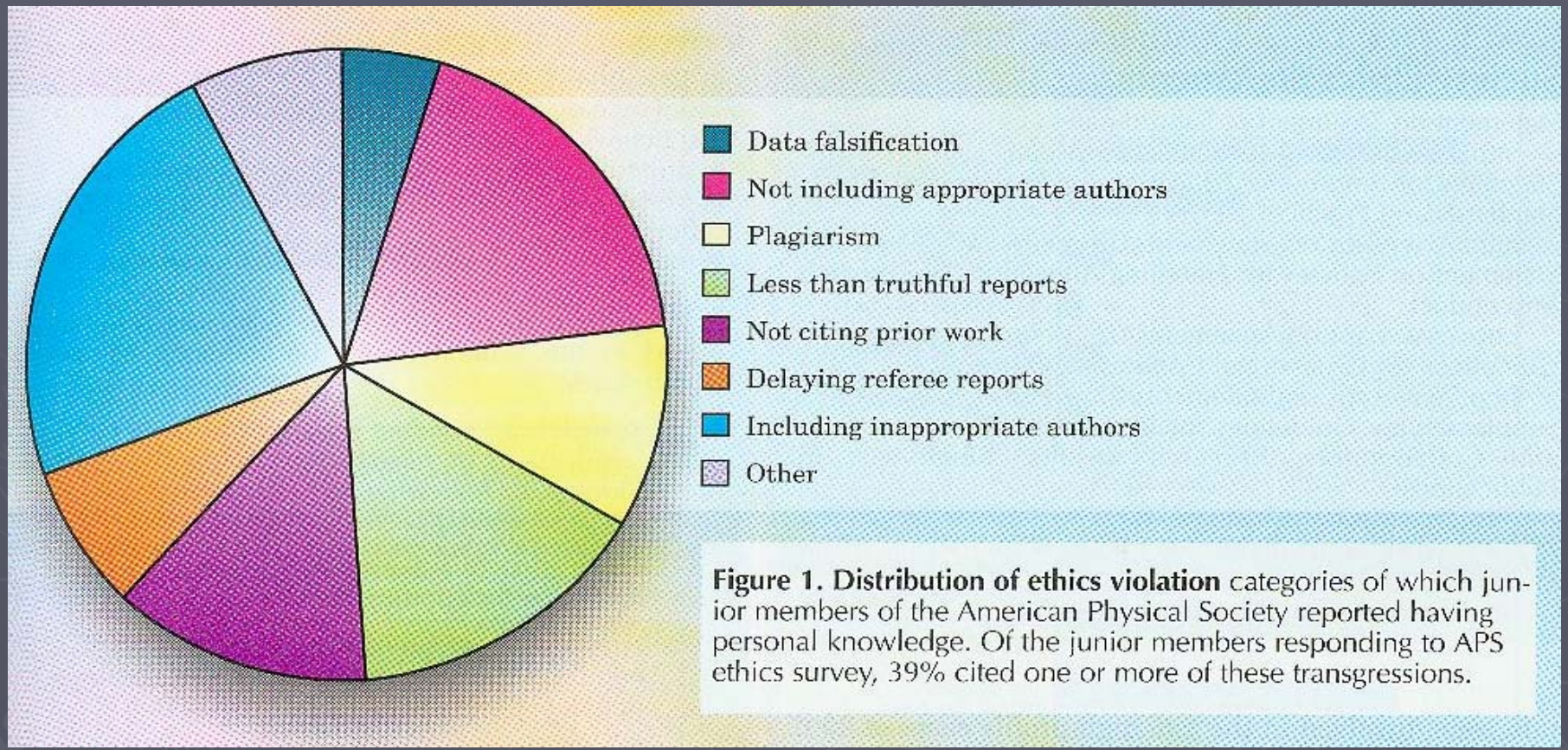


Figure 1. Distribution of ethics violation categories of which junior members of the American Physical Society reported having personal knowledge. Of the junior members responding to APS ethics survey, 39% cited one or more of these transgressions.

Responses of Junior APS Members

Survey of NIH-funded Scientists

Table 1 | Percentage of scientists who say that they engaged in the behaviour listed within the previous three years ($n = 3,247$)

Top ten behaviours	All	Mid-career	Early-career
1. Falsifying or 'cooking' research data	0.3	0.2	0.5
2. Ignoring major aspects of human-subject requirements	0.3	0.3	0.4
3. Not properly disclosing involvement in firms whose products are based on one's own research	0.3	0.4	0.3
4. Relationships with students, research subjects or clients that may be interpreted as questionable	1.4	1.3	1.4
5. Using another's ideas without obtaining permission or giving due credit	1.4	1.7	1.0
6. Unauthorized use of confidential information in connection with one's own research	1.7	2.4	0.8 ***
7. Failing to present data that contradict one's own previous research	6.0	6.5	5.3
8. Circumventing certain minor aspects of human-subject requirements	7.6	9.0	6.0 **
9. Overlooking others' use of flawed data or questionable interpretation of data	12.5	12.2	12.8
10. Changing the design, methodology or results of a study in response to pressure from a funding source	15.5	20.6	9.5 ***
Other behaviours			
11. Publishing the same data or results in two or more publications	4.7	5.9	3.4 **
12. Inappropriately assigning authorship credit	10.0	12.3	7.4 ***
13. Withholding details of methodology or results in papers or proposals	10.8	12.4	8.9 **
14. Using inadequate or inappropriate research designs	13.5	14.6	12.2
15. Dropping observations or data points from analyses based on a gut feeling that they were inaccurate	15.3	14.3	16.5
16. Inadequate record keeping related to research projects	27.5	27.7	27.3

Nature, **435**, June 2005, p. 737

“Our evidence suggests that mundane ‘regular’ misbehaviors present greater threats to the scientific enterprise than those caused by high-profile misconduct cases such as fraud.”

Federal Policy on Research Misconduct

- **Fabrication of data**
  - Making up data or results.
- **Falsification of data**
  - Manipulating data such that the research is not accurately represented in the research record.
- **Plagiarism**
  - Appropriation of another person's ideas or words without giving appropriate credit.

Findings of Research Misconduct

- Significant departure from accepted practices of the relevant research community; and
- Misconduct committed intentionally, knowingly, or recklessly; and
- The allegation must be proven by a **preponderance** of evidence.

Responsibilities of Federal Agencies and Research Institutions

- Federal agencies have ultimate oversight and authority for Federally funded research
- **Research institutions** bear primary responsibility for prevention and detection of research misconduct and for the inquiry, investigation, and adjudication of research misconduct alleged to have occurred in association with their own institution.

Some Famous (or Infamous) Case Studies

N-Rays

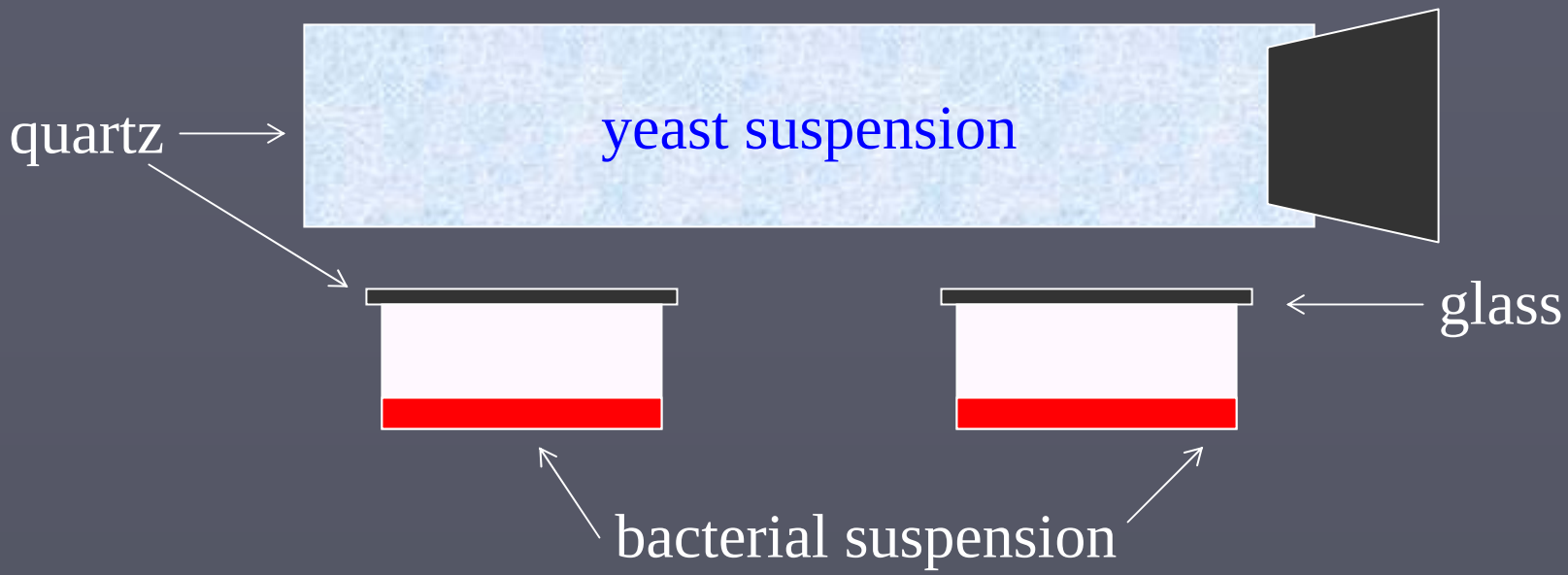
- Discovered by René Blondlot, Prof. of Science. Univ. Nancy, 1901-04
  - New type of radiation emitted by a hot platinum wire
  - Could increase the luminosity of a flame or a white calcium sulfide screen
- X-Rays had been previously discovered and were all the rage!

N-Rays

- Publication by Wood in Nature (1904) killed the field but…
- Did not dissuade the French Academy of Sciences from awarding Blondlot the Le Conte Prize…
- Even though the leading candidate was Pierre Curie who had just won the 1903 Nobel Prize

The Myth of Mitogenetic Rays

- 1920's and 1930's - 500 publications
- First reported by Alexander Gurwitch
  - UV rays below 2500 A
  - Filtered by glass but not quartz
  - Emitted by animal and plant cells when dividing
  - Very low flux of quanta (10-100/cc/sec)


quartz
yeast suspension
glass
bacterial suspension

Mitogenetic Rays - Cont.

- All attempts to directly detect the UV rays failed.
- Response was that the energy was too small for detection on short exposure.
- Even months of exposure failed to detect the rays.
- Photoelectric cells sensitive to < 1/3 the intensity of rays required for the biological effect failed to detect them!
- Editorial in Nature, 1931: the new experimental field failed to produce any evidence of mitogenetic rays.

Polywater

- 1962 - N. N. Fedyakin reported discovery of a water-like liquid, formed during condensation of water vapor in quartz capillaries.
- Peculiar properties:
  - Density 40% higher than water
  - Freezing point of -40 C
  - Consistency of petroleum jelly

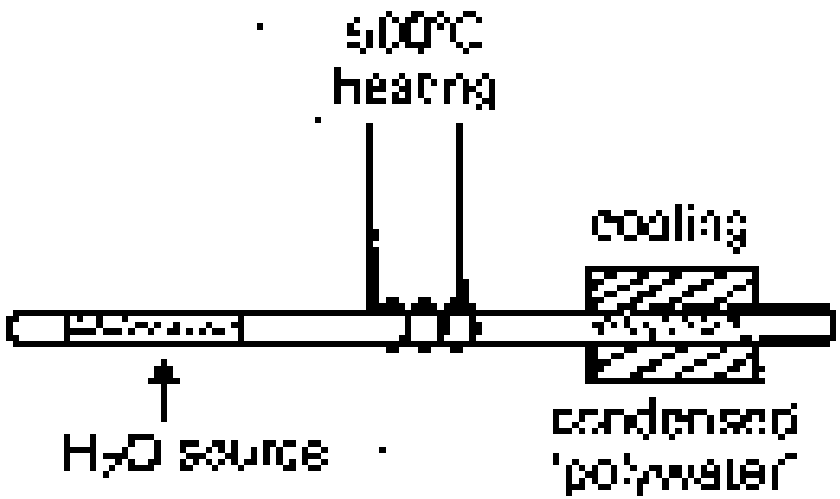


Figure 4. The apparatus used in the preparation of polywater (From Kuhn, A. 1978: *Perspectives in Biology and Medicine*, 21: 520).

Polywater - Cont.

- By 1971, hundreds of papers had been published.
- The entire edifice began to collapse.
- Fatty contaminants were detected, then sodium and carbonate.
- Most of the contaminants were introduced during the handling of the silicon (quartz) capillaries.

Cold Fusion - Fleischmann & Ponds

- March 23, 1989 - Press conference announcement of sustained nuclear reaction at room temps via simple electrochemical process.
- Claimed excess heat, leading to inexhaustible source of power and immense financial awards to U. of Utah.

Cold Fusion

- 2 weeks prior to press conference, paper was submitted to J. of Electroanalytical Chemistry.
  - Published in only 4 weeks.
  - A long list of errata soon followed, including the name of M. Hawkins, a coauthor!!

Cold Fusion

- Over next 6 months, attempts to reproduce the effect were conducted at many labs around the world.
- Hastily announced confirmations were followed by equally swift retractions.
- Nov. 1989 DoE Panel report
  - "…no convincing evidence that useful sources of energy will result from the phenomena attributed to cold fusion."

Cold Fusion*

- “The U. of Utah’s handling of cold fusion is a striking illustration of what happens when scientists circumvent the normal peer-review process, when scientists use the press to disseminate information about a claimed discovery in an unrealistic and overly optimistic tone, when scientists require too many miracles to account for their results, when research is done in isolation by scientists who are outside their field of expertise, …

* John Huizenga, Cold Fusion: The Scientific Fiasco of the Century

Cold Fusion

- …when data are published by private communication rather than by those responsible, when administrators use potential royalties to force premature publication and when university administrators lobby for large federal funds before the science is confirmed.”

7 Signs of Voodoo Science - Robert Park -*What's New* - APS

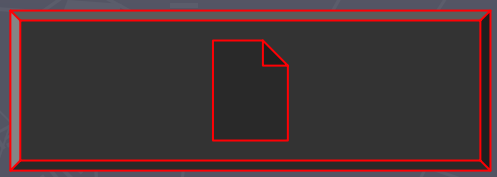
- Discovery is pitched directly to the media.
- A powerful establishment is said to be suppressing the discovery.
  - Cold Fusion - physicists responsible for negative reports
- An effect is always at the very limit of detection.
  - Parapsychology - nothing can be done to strengthen paranormal effects
- Evidence for a discovery is anecdotal.
  - Randomized double-blind test is most important discovery in modern medicine

7 Signs of Voodoo Science - Robert Park

- A belief is said to be credible because it has endured for centuries.
  - Science is conditional - when better information becomes available, textbooks are rewritten.
- An important discovery is made in isolation.
  - BlackLight Power
- New laws of nature are proposed to explain incredible observation.
  - Extraordinary claims require extraordinary evidence.

Additional recent “discoveries”

- Anomalons
- The 17 KeV neutrino
- LBL Heavy Elements
- Bell Labs



Lucent Committee Rpt

REPORT OF THE INVESTIGATION COMMITTEE ON THE POSSIBILITY OF SCIENTIFIC MISCONDUCT IN THE WORK OF HENDRIK SCHON AND COAUTHORS

September 2002

Property of Lucent Technologies

Hendrik Schon-Bell Labs Case

These Final Allegations can be grouped into 3 classes:

· Substitution of data (substitution of whole figures, single curves and partial curves in different or the same paper to represent different materials, devices or conditions)

· Unrealistic precision of data (precision beyond that expected in a real experiment or requiring unreasonable statistical probability)

· Results that contradict known physics (behavior inconsistent with stated device parameters and prevailing physical understanding, so as to suggest possible misrepresentation of data)

Hendrik Schon-Bell Labs Case

The Committee's main findings and conclusions can be summarized as follows.

By all accounts, Hendrik Schön is a hard working and productive scientist. If valid, the work he and his coauthors report would represent a remarkable number of major breakthroughs in condensed-matter physics and solid-state devices.

Hendrik Schon-Bell Labs Case

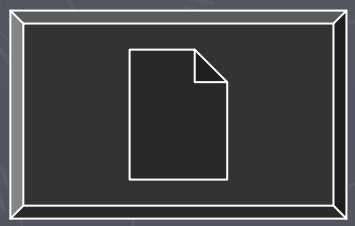
Except for the provision of starting materials by others, all device fabrication, physical measurement and data processing in the work in question were carried out (with minor exceptions) by Hendrik Schön alone, with no participation by any coauthor or other colleague. None of the most significant physical results was witnessed by any coauthor or other colleague.

Hendrik Schon-Bell Labs Case

Proper laboratory records were not systematically maintained by Hendrik Schon in the course of the work in question. In addition, virtually all primary (raw) electronic data files were deleted by Hendrik Schon, reportedly because the old computer available to him lacked sufficient memory. No working devices with which one might confirm claimed results are presently available, having been damaged in measurement, damaged in transit or simply discarded. Finally, key processing equipment no longer produces the unparalleled results that enabled many of the key experiments. Hence, it is not possible to confirm or refute directly the validity of the claims in the work in question.

Issues

- The role of reviewers.
- Authorship within large collaborations.



Click here to see an author list for a publication from a high energy nuclear physics experiment!

Question #1

Question #2