

# Scientific Ethics: Issues and Case Studies

Lance Cooper and Celia Elliott

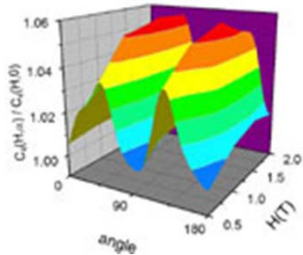


*Each physicist is a citizen of the community of science. Each shares responsibility for the welfare of this community.*

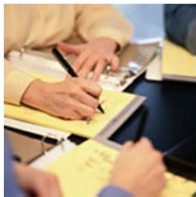
- Statement by the APS

<http://www.aps.org/statements/02.2.html>

# Ethical considerations usually fall into four major categories:



Integrity of research results



Publication and authorship issues



Integrity of peer review



Conflicts of interest

# Ethics associated with research results\*:

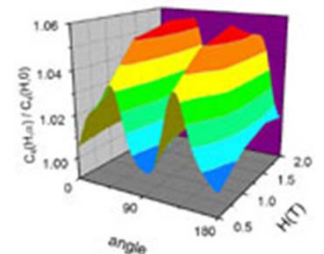
The results of research should be recorded and maintained in a form that allows analysis and review, both by collaborators before publication and by other scientists for a reasonable period after publication.

‘Egregious’ departures from the expected norms of scientific conduct:

- Fabrication of data
- Selective reporting of data with the intent to deceive
- Theft of others’ data

\*From AIP statement of ethics and responsibilities of authors:

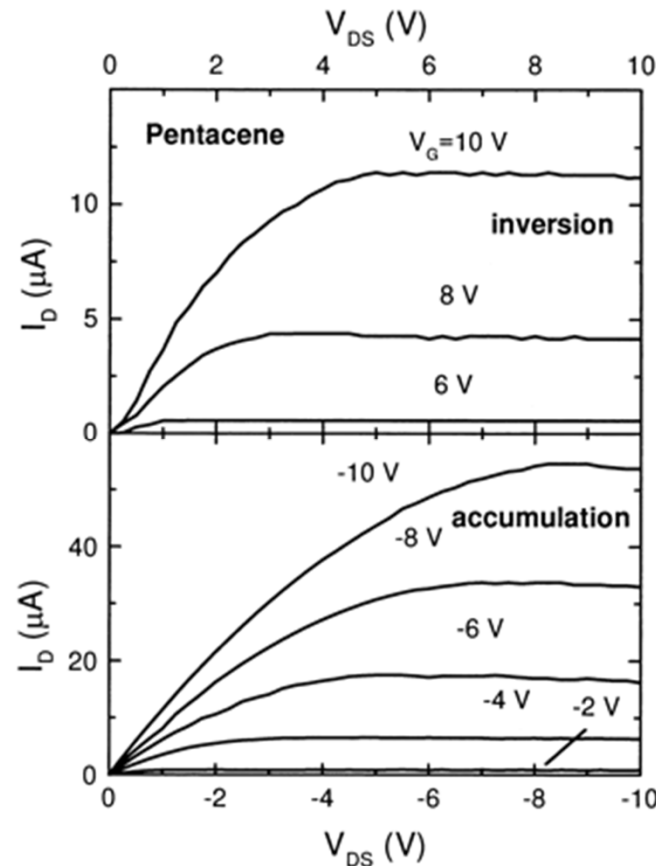
[http://www.aps.org/policy/statements/02\\_2.cfm](http://www.aps.org/policy/statements/02_2.cfm)



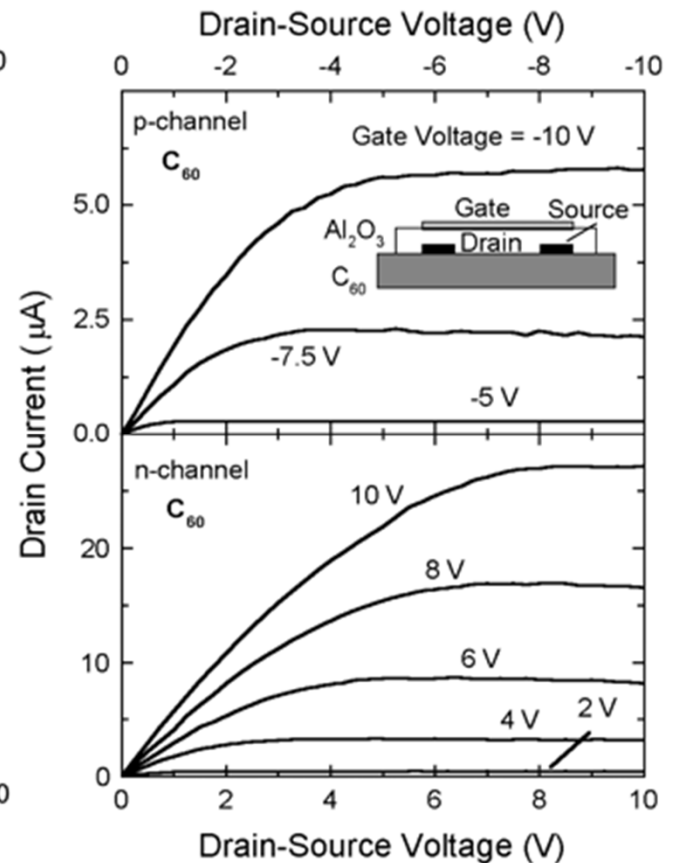
# Obviously, data fabrication is a serious breach of scientific ethics\*

Forged or fabricated data

Falsified or invented results



J. H. Schön, et al., Ambipolar Pentacene Field-Effect Transistors and Inverters,” *Science* **287**, 1022 (2000).



J. H. Schön, et al., “A Superconducting Field Effect Switch,” *Science* **288**, 656 (2000).

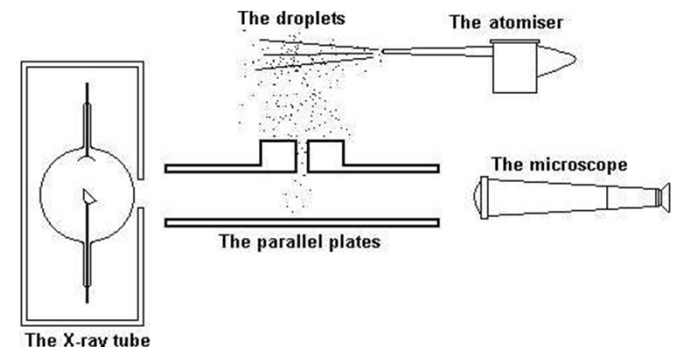
\*The Hendrick Schön case: [http://www.lucent.com/news\\_events/researchreview.html](http://www.lucent.com/news_events/researchreview.html)

# Data fabrication is clearly wrong; what about more-subtle data “selection”?

In 1910, R.A. Millikan measured the charge  $e$  of the electron in his famous “oil drop” experiment and published his results in a number of papers. In 1923, he won the Nobel Prize in physics for this work.

In his 1913 paper<sup>‡</sup>, the most complete account of his measurements of  $e$ , Millikan stated, “It is to be remarked, too, that this is not a selected group of drops *but represents all of the drops experimented upon during 60 consecutive days.*” [emphasis added]

Millikan’s own notebook appears to contradict this statement. Of 175 observations during the period in question, only 58 are reported in the paper.



<sup>‡</sup>“On the Elementary Electrical Charge and the Avogadro Constant,” *Phys. Rev.* **2**, 109 (1913).



## Marginalia from Millikan's notebooks:

*“Good one. Keep this!”*

*“Publish. Fine for showing two methods...”*

*“Won't work”*

In science, it is generally accepted that certain data may be rejected, but under what conditions?

Reality of the experimental method: Things go wrong; equipment malfunctions; people make mistakes.

Was Millikan's data selection blatantly unethical data manipulation or the application of good scientific intuition?

# Data may be excluded for several reasons, but the reasons must be sound!

- Use accepted statistical tests, but *data exclusion must be disclosed* in reported results, for example
  - ❖ Chauvenet's criterion<sup>§</sup>: the outlier is more than  $t\sigma$  from the mean of  $N$  measurements
  - ❖ Kolmogorov-Smirnov tests, designed to compare runs against a standard data set in a result-independent manner
- Decide *before the experiment* what your criteria are for accepting or excluding data. Make sure all collaborators know and are in agreement with these criteria
  - ❖ “Result-unbiased” algorithm
- More difficult ... after the experiment you discover biases based on something you monitored but you did not “pre-reject” data. Now what?
  - ❖ Ideal, and gaining popularity, cast analysis in a result-blind manner. Then, make cuts without physics implication.

<sup>§</sup> J.R. Taylor, *An Introduction to Error Analysis* (Mill Valley CA, Univ Science Books,<sup>7</sup>1982).



# **Record *everything!***

Make a permanent record—in a bound log book, in ink, as the data are being taken

Record everything that could affect the measurement (temperature, humidity, ambient light, exhaust hood open or closed, power surges, diagnostic “drift”)

Record data electronically if at all possible to minimize bias or human error

Keep raw data intact; you may have to reanalyze it or refer to it later



# Ethics of publication and authorship\*:

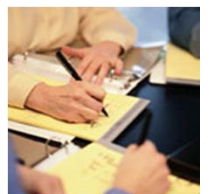
A paper should contain sufficient detail and references to public sources of information to permit others to repeat the work.

Proper acknowledgment of the work of others used in a research project must always be given. Authors should cite publications that have been influential in determining the nature of the reported work.

Authorship should be limited to those who have made a significant contribution to the concept, design, execution, or interpretation of the research study.

**\*From AIP statement of ethics and responsibilities of authors:**

[http://www.aps.org/policy/statements/02\\_2.cfm](http://www.aps.org/policy/statements/02_2.cfm)



# Ethics of publication and authorship\*:

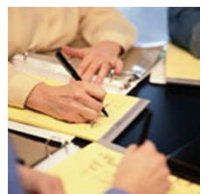
All those who have made significant contributions should be offered the opportunity to be listed as authors. Other individuals who have contributed to the study should be acknowledged, but not identified as authors.

The sources of financial support for the project should be disclosed.

Plagiarism constitutes unethical scientific behavior and is never acceptable.

**\*From AIP statement of ethics and responsibilities of authors:**

[http://www.aps.org/policy/statements/02\\_2.cfm](http://www.aps.org/policy/statements/02_2.cfm)



# Plagiarism:

Submitting another's published or unpublished work, in whole, in part, or in paraphrase, as one's own without properly crediting the author by footnotes, citations, or bibliographical reference

Submitting material obtained from an individual or agency as one's own original work without reference to the person or agency as the source of the material

Submitting material that has been produced through unacknowledged collaboration with others as one's own original work without written release from collaborators

## Tips for avoiding plagiarism when referring to other's work:

- (1). Study the original text you want to summarize until you *fully* understand its meaning
- (2). Set aside the original and write a summary of the text in your own words
- (3). Check your version with the original to ensure that the meaning has been retained
- (4). Enclose any text or phrase that you have borrowed exactly in quotation marks

**Cite the source!**

# Ethics of publication and authorship\*:

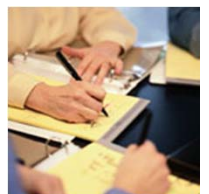
It is unethical for an author to publish manuscripts describing essentially the same research in more than one journal of primary publication.

Submitting the same manuscript to more than one journal concurrently is unethical and unacceptable.

When an error is discovered in a published work, it is the obligation of all authors to promptly retract the paper or correct the results.

**\*From AIP statement of ethics and responsibilities of authors:**

[http://www.aps.org/policy/statements/02\\_2.cfm](http://www.aps.org/policy/statements/02_2.cfm)



# Ethics in collaborations\*:

All collaborators share some degree of responsibility for any paper they coauthor.

The author who submits the paper for publication should ensure that all coauthors have seen the final version of the paper and have agreed to its submission for publication.

All coauthors have an obligation to provide prompt retractions or correction of errors in published works. Any individual unwilling or unable to accept appropriate responsibility for a paper should not be a coauthor.

**\*From AIP statement of ethics and responsibilities of authors:**

[http://www.aps.org/policy/statements/02\\_2.cfm](http://www.aps.org/policy/statements/02_2.cfm)



# Ethics in peer review\*:

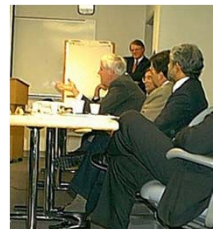
Review by independent scientists provides advice to editors of scientific journals concerning the publication of research results. It is an essential component of the scientific enterprise, and all scientists have an obligation to participate in the process.

Privileged information or ideas obtained through peer review must be kept confidential and not used for competitive gain.

Reviewers must disclose conflicts of interest...and avoid cases in which such conflicts preclude an objective evaluation.

**\*From AIP statement of ethics and responsibilities of authors:**

[http://www.aps.org/policy/statements/02\\_2.cfm](http://www.aps.org/policy/statements/02_2.cfm)





# Ethics in peer review\*:

Reviewers should judge objectively the quality of the research reported and respect the intellectual independence of the authors.

**\*From AIP statement of ethics and responsibilities of authors:**

[http://www.aps.org/policy/statements/02\\_2.cfm](http://www.aps.org/policy/statements/02_2.cfm)



# Ethics in the laboratory\*:

The Council of The American Physical Society has long been concerned with the serious under-representation of women and minorities in the profession of physics and, over the years, has established a number of programs that attempt to counter this trend. The Council now urges each member of the Society to help in this effort by being sensitive to all matters that affect the atmosphere of the physics workplace.

In particular, actions that create a hostile, intimidating, or offensive work environment for any group undermine the affirmative action efforts of the Society and should be eliminated. These actions include the public posting of materials that are insulting, derogatory, or exclusionary to a particular group.

We call upon all members of the Society to help ensure that persons of every race, gender, and ethnic origin may feel a welcome part of the physics community.

**\*Statement 88.1 from American Physical Society**



# Treatment of Subordinates:

Subordinates should be treated with respect and with concern for their well-being. Supervisors have the responsibility to facilitate the research, educational, and professional development of subordinates, to provide a safe, supportive working environment and fair compensation, and to promote the timely advance of graduate students and young researchers to the next stage of career development. In addition, supervisors should ensure that subordinates know how to appeal decisions without fear of retribution.

Contributions of subordinates should be properly acknowledged in publications, presentations, and performance appraisals. In particular, subordinates who have made significant contributions to the concept, design, execution, or interpretation of a research study should be afforded the opportunity of authorship of resulting publications, consistent with APS Guidelines for Professional Conduct.

Mentoring of students, postdoctoral researchers, and employees with respect to intellectual development, professional and ethical standards, and career guidance, is a core responsibility for supervisors. Periodic communication of constructive performance appraisals is essential.



# Many ethics resources are available

## APS “Ask the Ethicist”

<http://www.aps.org/publications/apsnews/features/ethicist.cfm>

## Online Ethics Center for Engineering and Science

<http://onlineethics.org/>

## Applied Ethics “Case of the Month” Club

<http://www.niee.org/case-of-the-month/>

## Engineering Ethics

<http://repo-nt.tcc.virginia.edu/ethics/home.htm>

*Fundamentals of Ethics for Scientists and Engineers*, E.G. Seebauer and R.L. Barry (Oxford, Oxford University Press, 2000).

*On Being a Scientist: Responsible Conduct in Research*, 2<sup>nd</sup> ed., NAS Press

<http://www.nap.edu/readingroom/books/obas/>