Ethics for Young Scientists and Engineers

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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

With thanks to David Hertzog, Lance Cooper, Alan Nathan, and Brian DeMarco, who contributed ideas and insights

You are now "scientists."

Science requires its practitioners to be:

Honest—do not fabricate, misrepresent, manipulate, or destroy data.

Careful—apply rigorous standards.

Skeptical—don't want to believe so much in some result that you lose your objectivity and critical thinking.

Open—share data, methods, theories, equipment; allow others to see your work; be open to criticism.

Generous—give credit to others; do not plagiarize others' work; help others.

Socially responsible—anticipate the consequences of research; prevent harm to the public and promote social welfare.

Scientific progress depends on …

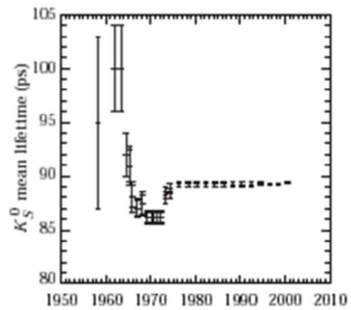
Truthfulness and full disclosure

Accurate and complete record-keeping

Free and open exchange of data and interpretations

Skepticism

…but honest error is inevitable



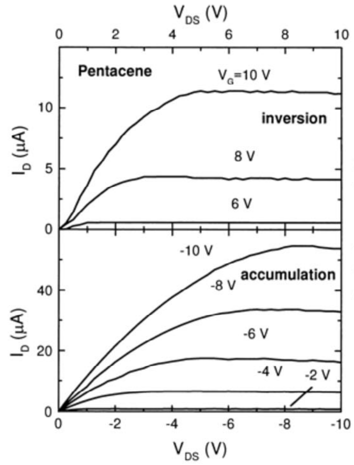
Experimental measurement of the mean lifetime of the kaon, in ps, from 1950 to 2005.

Science, if it is allowed to function as it should, is self correcting. That's why honesty and openness are essential.

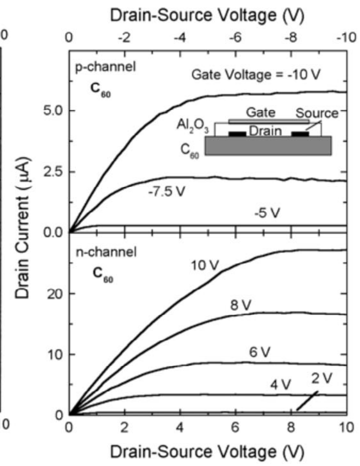
Sometimes there's a thin line between honest error and misconduct, just as there is a line between being bold and being reckless. Ethical issues are often decided "on the margins."

Everyone* recognizes that deliberate dishonesty is wrong

- Forged or fabricated data
- Falsified or invented results
- Plagiarism
- Piracy
- Hoaxes



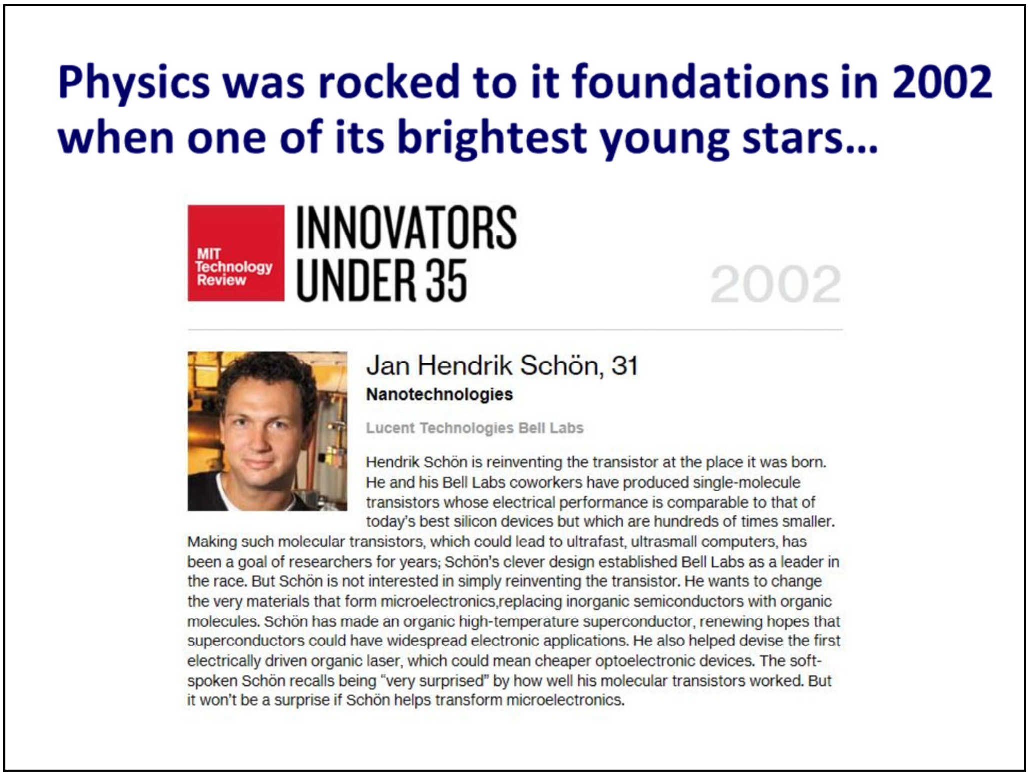
J. H. Schön, et al., Ambipolar Pentacene Field-Effect Transistors and Inverters," *Science* **287**, 1022 (2000).



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

*Well, *almost* everyone…

In May 2002, a Bell Labs postdoc, Hendrik Schön, was accused of fabricating, manipulating, and destroying data from a number of experiments that had been published in leading scientific journals, including *PRL, Science,* and *Nature*. The scandal shook physics to its foundations.



The Schön case followed shortly after Victor Ninov was fired from LBL for fraud after analysis showed that he had fabricated data used to claim the creation of Element 118, and may have altered original data involved in the discovery of Elements 111 and 112. That Ninov case did not create the widespread consternation that the Schön case did, because it was believed to be the misconduct of one misguided individual. But the Schön episode involved so many co-authors, so many prestigious journals, so many reviewers, and had gone on for so long that it was much more shocking.

In all, between 31 Oct 2002 and 2 May 2003, *Science* withdrew 9 Schön papers, *PRL* withdrew 6 papers, *Appl. Phys. Lett.* withdrew 4 papers, *Adv. Materials* withdrew 2 papers, and *Nature* withdrew 7 papers. Retraction notices by *Appl. Phys. Lett.* raised concerns about an additional 7 papers by Schön, and *Adv. Materials* issued a retraction notice about an additional Schön paper, in addition to the ones that were formally withdrawn.

The aftermath: In 2004, the University of Konstanz revoked Schön's PhD based on a state law that allows degrees to be revoked if the degree holder is found to be "unworthy." Schön sued the university, and in 2010, a court ruled in his favor. The University appealed, and in September 2011, the Administrative Court of Baden–Württemberg in Mannheim ruled that the University was correct in revoking Schön's degree. The German Federal Administrative Court (equivalent to the US Supreme court) upheld the state court's decision on 13 July 2015.

For more on the Schön subject: http://nanoscale.blogspot.com/2007/01/internet-memory-hole-and-jan-hendrik.html. Do you agree with Professor Natelson? Does Alcatel-Lucent have any obligation to keep the Beasley Commission Report posted publicly?

Scientific misconduct is drawing increasing federal scrutiny

NATIONAL SCIENCE FOUNDATION
OFFICE OF INSPECTOR GENERAL
OFFICE OF INVESTIGATIONS

CLOSEOUT MEMORANDUM

Case Number: A07100053	Page 1 of 1

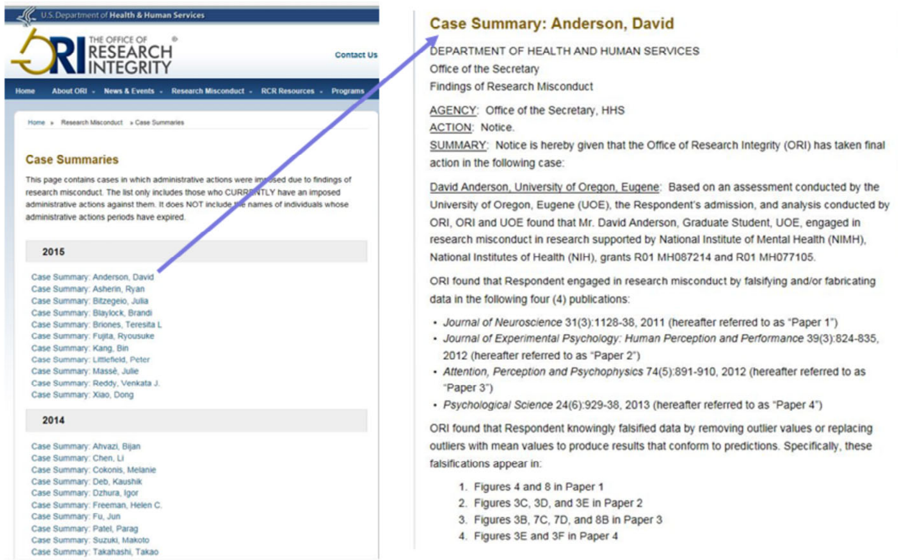
We referred allegations of fabrication and falsification of data to a university[1] following our inquiry into the allegations against a former post-doctoral researcher (post-doc)[2] and his mentor.[3] During the period of the alleged misconduct the mentor was a CAREER awardee[4] and provided acknowledgement to that award in some of the publications involved. The university conducted a full investigation in which it determined that both the post-doc and his mentor had committed research misconduct. The university found that the post-doc had hands-on responsibility for the misconduct. It also found that the mentor, once he had substantial reason to know of the misconduct, continued to use the suspect results to the point of committing research misconduct himself.

We concurred with the university investigation and identified additional allegations based on the admissions of both the post-doc and mentor in their interviews, specifically the knowing falsification of the methodology reported in a published article. We recommended NSF make findings of research misconduct (report attached) and recommended debarments. Because of the ongoing risk to federal funds during the adjudication, NSF implemented our recommendation for government-wide suspensions for both pending a final determination.

NSF made findings of research misconduct (attached) to which both the post-doc and the mentor appealed. Following the appeals, NSF modified its imposed actions in its final notice of debarment to both (attached).

Accordingly, this case is ***closed***.

Scientific misconduct is drawing increasing federal scrutiny



U.S. Department of Health & Human Services

THE OFFICE OF RESEARCH INTEGRITY

Contact Us

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Home » Research Misconduct » Case Summaries

Case Summaries

This page contains cases in which administrative actions were imposed due to findings of research misconduct. The list only includes those who CURRENTLY have an imposed administrative actions against them. It does NOT include the names of individuals whose administrative actions periods have expired.

2015

Case Summary: Anderson, David
Case Summary: Asherin, Ryan
Case Summary: Bitzegeio, Julia
Case Summary: Blaylock, Brandi
Case Summary: Briones, Teresita L
Case Summary: Fujita, Ryousuke
Case Summary: Kang, Bin
Case Summary: Littlefield, Peter
Case Summary: Massè, Julie
Case Summary: Reddy, Venkata J.
Case Summary: Xiao, Dong

2014

Case Summary: Ahvazi, Bijan
Case Summary: Chen, Li
Case Summary: Cokonis, Melanie
Case Summary: Deb, Kaushik
Case Summary: Dzhura, Igor
Case Summary: Freeman, Helen C.
Case Summary: Fu, Jun
Case Summary: Patel, Parag
Case Summary: Suzuki, Makoto
Case Summary: Takahashi, Takao

Case Summary: Anderson, David

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Office of the Secretary
Findings of Research Misconduct

AGENCY: Office of the Secretary, HHS
ACTION: Notice.
SUMMARY: Notice is hereby given that the Office of Research Integrity (ORI) has taken final action in the following case:

David Anderson, University of Oregon, Eugene: Based on an assessment conducted by the University of Oregon, Eugene (UOE), the Respondent's admission, and analysis conducted by ORI, ORI and UOE found that Mr. David Anderson, Graduate Student, UOE, engaged in research misconduct in research supported by National Institute of Mental Health (NIMH), National Institutes of Health (NIH), grants R01 MH087214 and R01 MH077105.

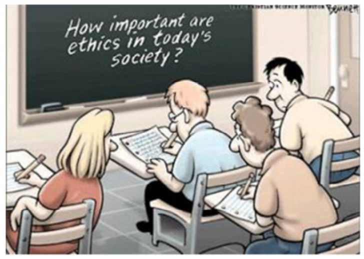
ORI found that Respondent engaged in research misconduct by falsifying and/or fabricating data in the following four (4) publications:

- *Journal of Neuroscience* 31(3):1128-38, 2011 (hereafter referred to as "Paper 1")
- *Journal of Experimental Psychology: Human Perception and Performance* 39(3):824-835, 2012 (hereafter referred to as "Paper 2")
- *Attention, Perception and Psychophysics* 74(5):891-910, 2012 (hereafter referred to as "Paper 3")
- *Psychological Science* 24(6):929-38, 2013 (hereafter referred to as "Paper 4")

ORI found that Respondent knowingly falsified data by removing outlier values or replacing outliers with mean values to produce results that conform to predictions. Specifically, these falsifications appear in:

1. Figures 4 and 8 in Paper 1
2. Figures 3C, 3D, and 3E in Paper 2
3. Figures 3B, 7C, 7D, and 8B in Paper 3
4. Figures 3E and 3F in Paper 4

But, apart from what you learned in kindergarten, what ethics situations might you encounter early in your career?



Using and referencing others' scholarly work
Data selection/rejection and treatment of data
Intellectual property "ownership"; authorship
Human relationships
Impact of research on society

Human relationships—science is a social, collaborative endeavor. Friction and conflicts are inevitable.

Using others' work:
What has to referenced?

Using and referencing others' work: Plagiarism is scientific misconduct

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

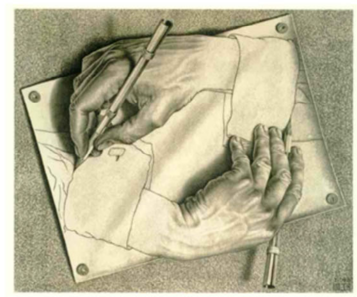
Submitting material that has been produced through unacknowledged collaboration with others as one's own original work without written release from collaborators

It is also scientific career suicide

Credit should always be given for others' work—in references, acknowledgments, and authorship.

At first, it seems straightforward, but sometimes the lines are hard to draw

Using another author's ideas or words without proper documentation; representing someone else's creative work (ideas, words, images, etc.) as one's own, *whether intentional or not.*



M. C. Escher, *Drawing Hands*, 1948

Now, let's look at a real example…

Plagiarism: Case Study*

While classical melting in two-dimensional systems is reminiscent of the phase behavior observed as a function of pressure in this material, an important qualification should be made with respect to this comparison. In contrast to the examples described above, the melting process observed in *1T*-$TiSe_2$ is quantum mechanical in nature, in that it is driven near $T = 0$ K by pressure tuning the competing interactions in this system. To understand the nature of this competition, note first that the zero-pressure charge density wave (CDW) state in *1T*-$TiSe_2$ is unconventional, as it arises from an indirect Jahn-Teller interaction that splits and lowers the unoccupied conduction band. As a result of the electron-hole interaction between the conduction and valence bands, the lowering of the split conduction band "repulses" and flattens the valence band, resulting in a lowering of the system's energy, and the formation of a small gap CDW state.

From: C.S. Snow et al., Phys. Rev. Lett. 91, 136402 (2003)

*S.L. Cooper, PHYS 496, 2008.

Original:

While classical melting in two-dimensional systems is reminiscent of the phase behavior observed as a function of pressure in this material, an important qualification should be made with respect to this comparison.

In contrast to the examples described above, the melting process observed in $1T$-$TiSe_2$ is quantum mechanical in nature, in that it is driven near $T = 0$ K by pressure tuning the competing interactions in this system.

To understand the nature of this competition, note first that the zero-pressure charge density wave (CDW) state in $1T$-$TiSe_2$ is unconventional, as it arises from an indirect Jahn–Teller interaction that splits and lowers the unoccupied conduction band.

As a result of the electron-hole interaction between the conduction and valence bands, the lowering of the split conduction band "repulses" and flattens the valence band, resulting in a lowering of the system's energy, and the formation of a small gap CDW state.

My version:

The phase behavior observed as a function of pressure in $1T$-$TiSe_2$ is similar to classical melting in 2D materials.

However, in contrast to classical melting, the melting process seen in $1T$-$TiSe_2$ is governed by quantum mechanics, as it the result of tuning the competing quantum mechanical interactions with pressure near $T = 0$ K.

An examination of the unconventional charge density wave (CDW) in $1T$-$TiSe_2$ state helps elucidate this competition—the CDW state in $1T$-$TiSe_2$ is caused by an indirect Jahn–Teller interaction that lowers the unoccupied conduction band relative to the filled valence band.

Because there is a strong electron-hole interaction between the conduction and valence bands in this material, this lowering of the conduction band causes a "repulsion" and flattening of the valence band, which results in a lowering of the system's energy and the formation of a small CDW small gap.

Is it plagiarism?

Tips for avoiding plagiarism:

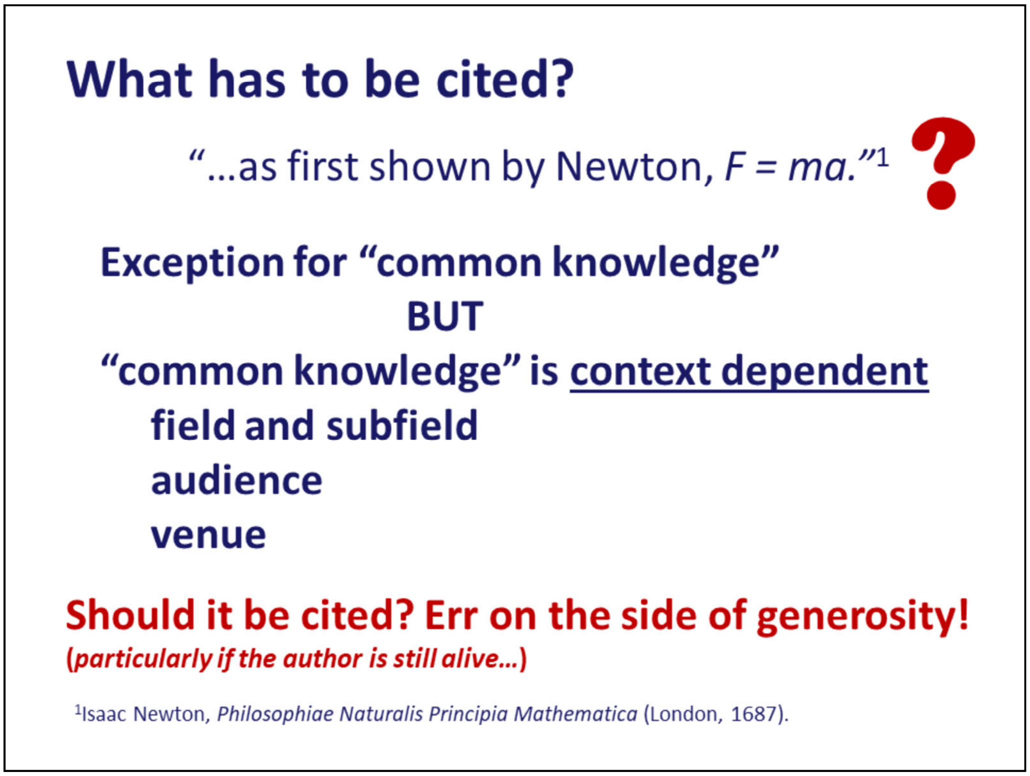
Study the original text until you *fully* understand its meaning

Set aside the original and write a summary of the text *in your own words*; label it so you know it's *your* words

Check your version with the original to ensure that the meaning has been retained

Enclose any text or phrase that you have reproduced exactly in quotation marks

Cite the source!



When to cite?
Is the fact readily available from numerous sources (textbooks) and generally known to the public? (no citation needed)
Is the idea or fact a result of unique individual research? (must cite)
If I change the words, do I still have to cite the source? **YES**!

Which source should be cited?

Cite original, not derivative work, if possible—minimizes risk of misinterpretation or error in the secondary source

Cite the final, peer-reviewed, published version, not the preprint (*Phys. Rev. D*, not arXiv)

Bad citation practices:

- Selective citation—incomplete, biased
- Citing inaccessible sources
- Citing papers you haven't actually read (!)
- Misrepresenting the cited paper
- Citing indiscriminately (the "core dump")

"Literature references should not be tacked onto a manuscript …instead, they need to be used with taste and judgment. Although some may consider references mere "window dressing"—something added to a manuscript to make it look scholarly—their misuse speaks loudly for itself…Such citations become annoying rather than illuminating."

—Herbert B. Michaelson
How to Write & Publish Engineering Papers and Reports

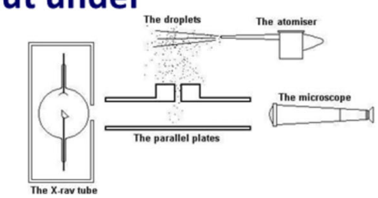
Data selection:
What if you have "bad" data?

Although data falsification or fabrication is clearly wrong, what about more-subtle data "selection"?

Example: In 1909, Millikan measured the charge *e* of the electron in his famous "oil drop" experiment … there have been raging scholarly debates since then about his use of "selected" drops, given his claim that *all* drops were included in his published results

- Too bad there remains a kind of doubt hanging over it
- An important and highly scrutinized result (Nobel Prize),
- We won't debate that here, but you can read about it http://www.its.caltech.edu/~dg/MillikanII.pdf

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, and people make mistakes

Manipulation or enhancement of images is becoming is huge issue

From the Council of Science Editors*:

1. No specific feature within an image may be enhanced, obscured, moved, removed, or introduced
2. Adjustments of brightness, contrast, or color balance are acceptable if they are applied to the whole image and do not obscure, eliminate, or misrepresent any data present in the original
3. The grouping of images from different parts of the same image or from different images must be made explicit
4. If the author cannot produce the original data, acceptance of the manuscript should be revoked

*http://www.councilscienceeditors.org/resource-library/editorial-policies/white-paper-on-publication-ethics/3-4-digital-images-and-misconduct/

Data may be excluded or manipulated but must be disclosed

Use accepted statistical tests [§]

Decide before the experiment what criteria will be used to accept or exclude data

More difficult … after the experiment you discover biases based on something you monitored but you did not "pre-reject" data. Now what?

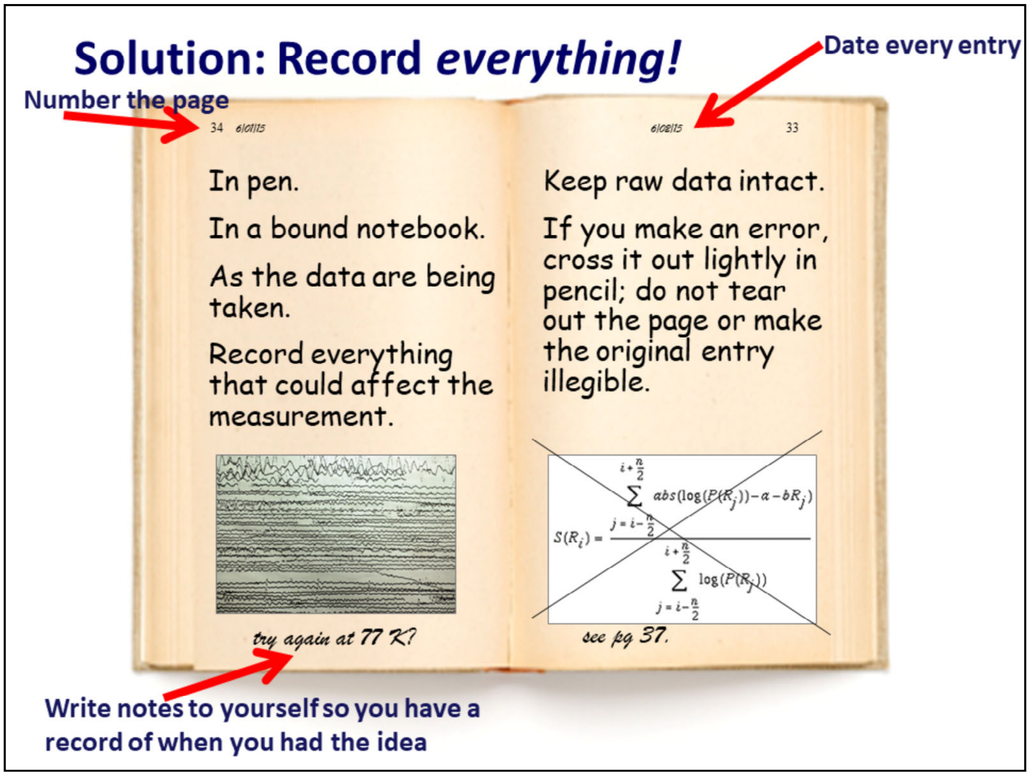
If images are enhanced, you must do the same to everything in the image; no selective enhancement

[§] J.R. Taylor, *An Introduction to Error Analysis* (Mill Valley CA, University Science Books, 1982).

Data selection or treatment is okay,

1) as long as it is disclosed.
2) as long as the original data are kept permanently and made available to other researchers.

Ideally, decide ***before*** you do the experiment what your criteria are for rejecting data, so any data selection is results-neutral.



Research results should be recorded and permanently maintained to allow for analysis and review.

Data should be immediately available to supervisors and collaborators.

After publication, original data records must be maintained completely and made available to other scientists.

Collaborations must have a mechanism to respond to questions about the joint work and share information with other scientists.

Falsification or fabrication of data is an egregious breach of ethical conduct.

Selective reporting of data with the intent to mislead or deceive is an egregious breach of ethical conduct.


Who owns
your data?

NOT you—your employer owns all data produced during your employment

At universities, the university owns all research data

Your notebooks are the property of the lab

You may not disseminate data in *any* way without your supervisor's permission

The "principal investigator" (PI) is responsible to the agency who funded the work for the proper acquisition, recording, analysis, protection, management, curation, preservation, and sharing of all data arising from the funded research

Authorship:
Who gets to be an author?
What about priority in the author list?

Conflicts can arise over authorship

Authorship should be limited to those who contributed *meaningfully* to the concept, design, execution, or analysis of the work

- ✓ Each person who contributed to the work should be offered authorship
- ✓ Every co-author should have an opportunity to examine a manuscript prior to publication
- ✓ Each author is obligated to promptly disclose errors and provide corrections for published work
- ✓ Other contributors should be acknowledged
- ✓ Credit should ***always*** be given for others' work

Who decides?

The leader of the research group (professor)

In large collaborations, a committee

As a student, you <u>may</u> <u>not</u> "publish" anything without your research adviser's *explicit* permission

- ✓ **Journal articles**
- ✓ **Posters**
- ✓ **Talks**
- ✓ **Interviews**

Coauthors and collaborators share responsibility for published work

Some coauthors are responsible for accuracy and verifiability of the *entire paper*

Built the apparatus, recorded the data, analyzed the data, supervised junior researchers, wrote the paper

Coauthors who make specific, limited contributions may have only limited responsibility

Fabricated the thin films that others tested

All collaborations should have a process for reviewing and ensuring the accuracy and validity of reported results

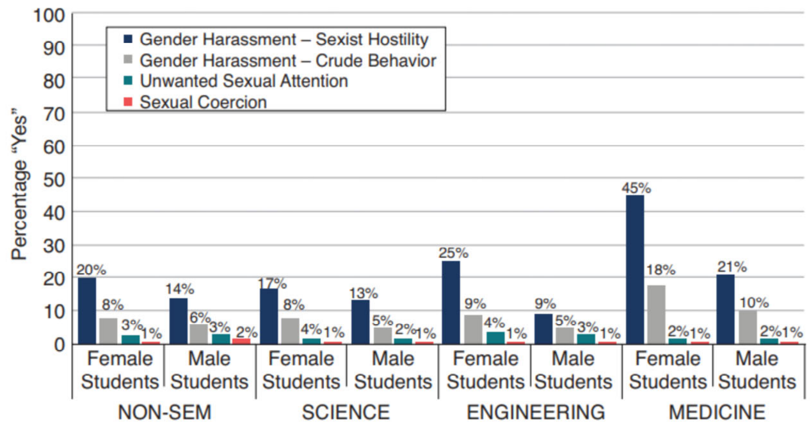
Anyone unwilling or unable to accept appropriate responsibility for a paper should not be a coauthor

Interpersonal relationships:

What are your rights and obligations?

Sexual harassment—it's still happening

Marcy (Berkeley), Ott (Caltech), Slater (Arizona/Wyoming), Lieb (Chicago) ...



National Academies of Sciences, Engineering, and Medicine. 2018. Sexual Harassment of Women: Climate, Culture, and Consequences in Academic Sciences, Engineering, and Medicine. Washington, DC: The National Academies Press., p. 60. https://doi.org/10.17226/24994.

Be aware of your *other* ethical responsibilities as a scientist

Don't claim expertise or credentials you don't have*

Be proactive about avoiding conflicts of interest or commitment

Always disclose funding

Promote openness and collegiality

Treat colleagues and subordinates with respect

*William Shockley and "dysgenics"
https://www.youtube.com/watch?v=UaoEWR2ndvA

Being an ethical scientist goes beyond "don't cheat" and "don't make things up."

Represent yourself as an expert only in your field of competence and only to the extent that your formal qualifications, credentials, and relevant experience allow.

A variety of activities and relationships in science may lead to conflicts

- Financial support of research
- Adviser/student, collegial, and collaborative relationships
- Competitive relationships

Always disclose sources of funding

Science is a social, collaborative effort; it's not all about YOU.

Every scientist has an ethical obligation to disclose scientific misconduct.

That said, you also have an obligation to promote a supportive, collegial, cooperative environment. Don't make an accusation until you have all the facts and have considered all options. Talk the situation over with someone you trust and who can give you objective advice.

Title IX: Education Amendments (1972)

"Title IX of the Education Amendments of 1972 ("Title IX"), 20 U.S.C. §1681 et seq., is a Federal civil rights law that prohibits discrimination on the basis of sex **in education programs and activities**. All public and private elementary and secondary schools, school districts, colleges, and universities (hereinafter "schools") receiving any Federal funds must comply with Title IX. Under Title IX, discrimination on the basis of sex can include sexual harassment or sexual violence, such as rape, sexual assault, sexual battery, and sexual coercion."

http://studentcode.illinois.edu/article1_part1_1-111.html

Note: professors and staff are "required reporters"

To recap:

- Science ethics rest on six fundamental principles—honesty, carefulness, objectivity, openness, giving credit, social responsibility
- Science is a human endeavor, and ethical issues are likely to arise over your career
- Use your own personal ethical values to inform your behavior
- Ask for help if you need it—you are not alone
- Your reputation is your most valuable scientific asset—protect it

cmelliot@illinois.edu
http://physics.illinois.edu/people/Celia