Ethics for Young Scientists and Engineers

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University of Illinois

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

The image shown on this slide illustrates a deeply held belief among US schoolchildren, i.e., that if you "cross your fingers" behind your back when you tell a lie, the lie somehow magically doesn't "count" as a lie and you will be exempt from punishment. Never worked with my parents—*cme.*

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 your co-workers; promote social welfare.

Scientific progress depends on …

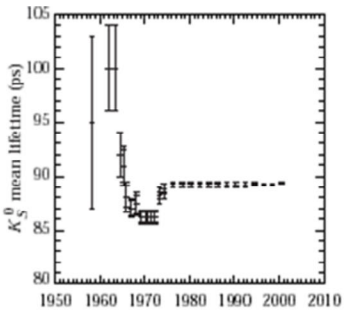
Truthfulness and full disclosure

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.

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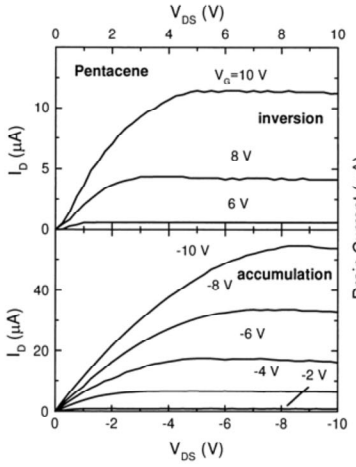
Science, if it is allowed to function as it should, is self correcting. That's why honesty and openness are essential.

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."

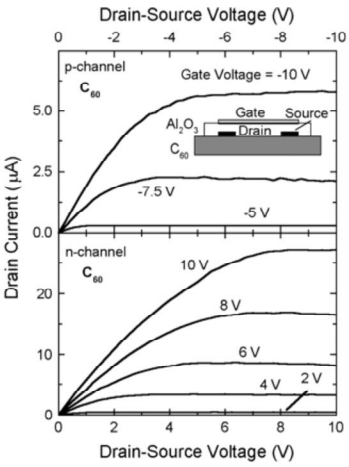
The figure shown on this slide charts the measurement of the kaon lifetime in picoseconds, from 1950 to 2005. The changes in the measurement over time are not the result of careless or deceptive earlier researchers; they are the result of increasing powerful accelerators and precise instrumentation. The plot is a perfect example of how science is supposed to work.

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).

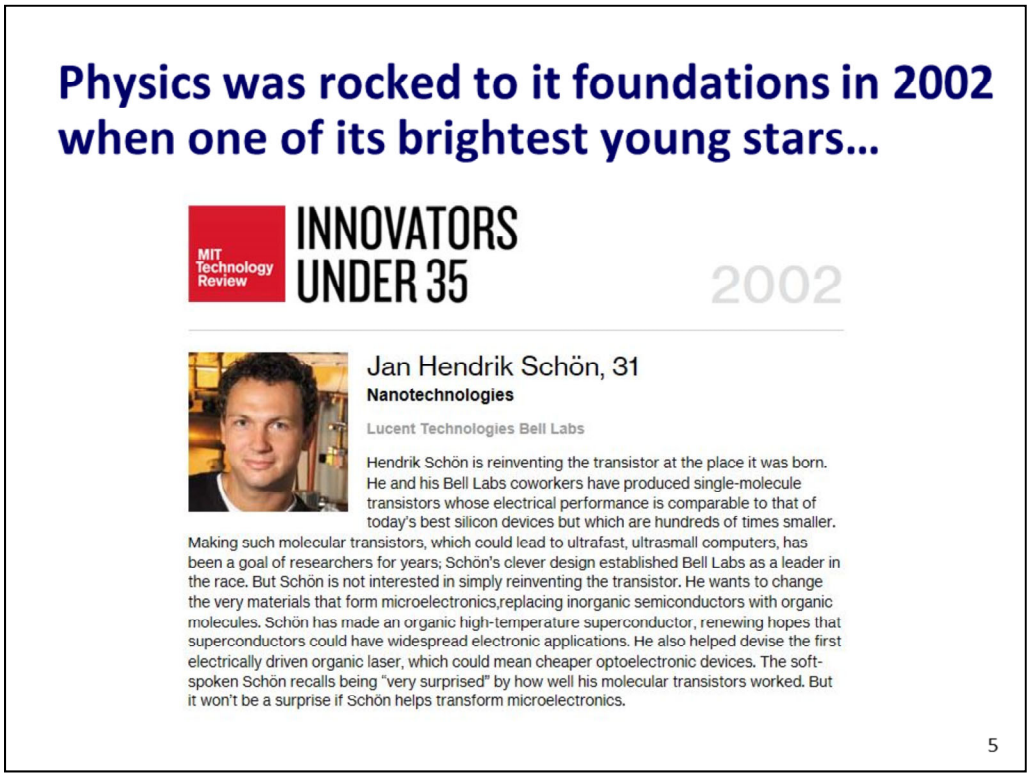


J. H. Schön, et al., "A Superconducting Field Effect Switch," *Science* **288**, 656 (2000).

***Well, *almost* everyone...**

4

In May 2002, a Bell Labs postdoc, Jan 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 Lawrence Berkeley National Laboratory 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. The 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.

Not the Schön case, but an example of what happens when a paper is retracted

Signal Processing
Volume 152, November 2018, Page 83

Retraction notice

Show more

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https://doi.org/10.1016/j.sigpro.2018.05.013

This article has been **retracted**: please see Elsevier Policy on Article Withdrawal (https://www.elsevier.com/about/our-business/policies/article-withdrawal).

The authors have plagiarized part of a paper that had already appeared in the PhD Thesis: Complexity Reduction In Multiple Input Multiple Output Algorithms by Leon Gor, March 2007, University of Victoria, Melbourne, Australia (vuir.vu.edu.au/1409/1/gor.pdf). One of the conditions of submission of a paper for publication is that authors declare explicitly that their work is original and has not appeared in a publication elsewhere. Re-use of any data should be appropriately cited. As such this article represents a severe abuse of the scientific publishing system. The scientific community takes a very strong view on this matter and apologies are offered to readers of the journal that this was not detected during the submission process.

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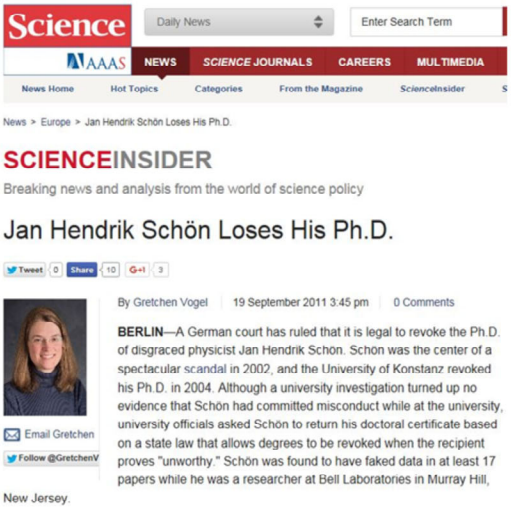
Journals don’t make any attempt to soften the blow when they retract a paper.

After 13 years of rulings, appeals, and new rulings, the German Supreme Court finally revoked Schön's PhD in 2015


Science
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News > Europe > Jan Hendrik Schön Loses His Ph.D.
SCIENCEINSIDER
Breaking news and analysis from the world of science policy
Jan Hendrik Schön Loses His Ph.D.
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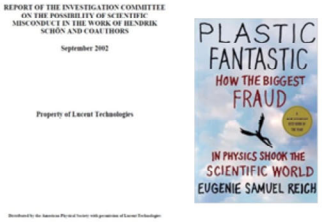
By Gretchen Vogel | 19 September 2011 3:45 pm | 0 Comments
BERLIN—A German court has ruled that it is legal to revoke the Ph.D. of disgraced physicist Jan Hendrik Schön. Schön was the center of a spectacular scandal in 2002, and the University of Konstanz revoked his Ph.D. in 2004. Although a university investigation turned up no evidence that Schön had committed misconduct while at the university, university officials asked Schön to return his doctoral certificate based on a state law that allows degrees to be revoked when the recipient proves "unworthy." Schön was found to have faked data in at least 17 papers while he was a researcher at Bell Laboratories in Murray Hill, New Jersey.
Email Gretchen
Follow @GretchenV

For further reading:
Beasley Report
*publish.aps.org/**reports/lucent**rep.pdf*

Plastic Fantastic, E.S. Reich
(St. Martin's Griffin, 2010)


REPORT OF THE INVESTIGATION COMMITTEE ON THE POSSIBILITY OF SCIENTIFIC MISCONDUCT IN THE WORK OF HENDRIK SCHÖN AND COAUTHORS
September 2002
Property of Lucent Technologies

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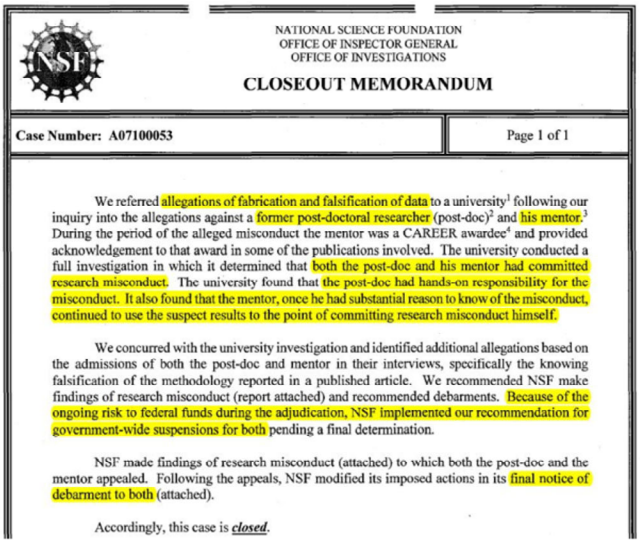
The aftermath: In 2004, the University of Konstanz revoked Schön's PhD based on a state law that allows degrees to be revoked if the degree holder is found to be "unworthy." Schön sued the university, and in 2010, a court ruled in his favor. The University appealed, and in September 2011, the Administrative 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 and comments therein. Do you agree with Professor Natelson? Does Alcatel-Lucent have any obligation to keep the Beasley Commission Report posted publicly? As shown on the slide, the American Physical Society has posted the Beasley Commission Report on its website. The report is very interesting reading.

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***.

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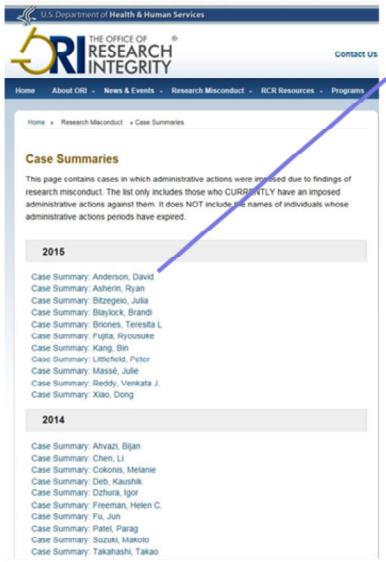
The National Science Foundation reports to Congress semiannually on its investigations of scientific misconduct among its proposers and grantees; q.v. https://www.nsf.gov/oig/reports/semiannual.jsp.

In particular, read the report of scientific misconduct by a graduate student, “Graduate Student Plagiarized from a Manuscript He Reviewed for a Journal,” on page 13 (printed page 11) of the March 2021 Report of the NSF Inspector General (q.v. https://www.nsf.gov/oig/_pdf/NSF_OIG_SAR_64.pdf).

Scientific misconduct is drawing increasing federal scrutiny



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

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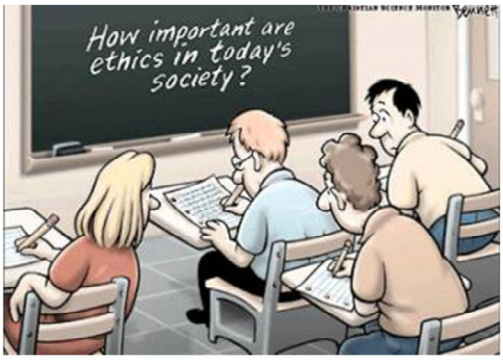
NIH goes one step further—it publishes the names of miscreants.

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
Intellectual property "ownership"; authorship
Human relationships

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

Using others' work: What has to be referenced?

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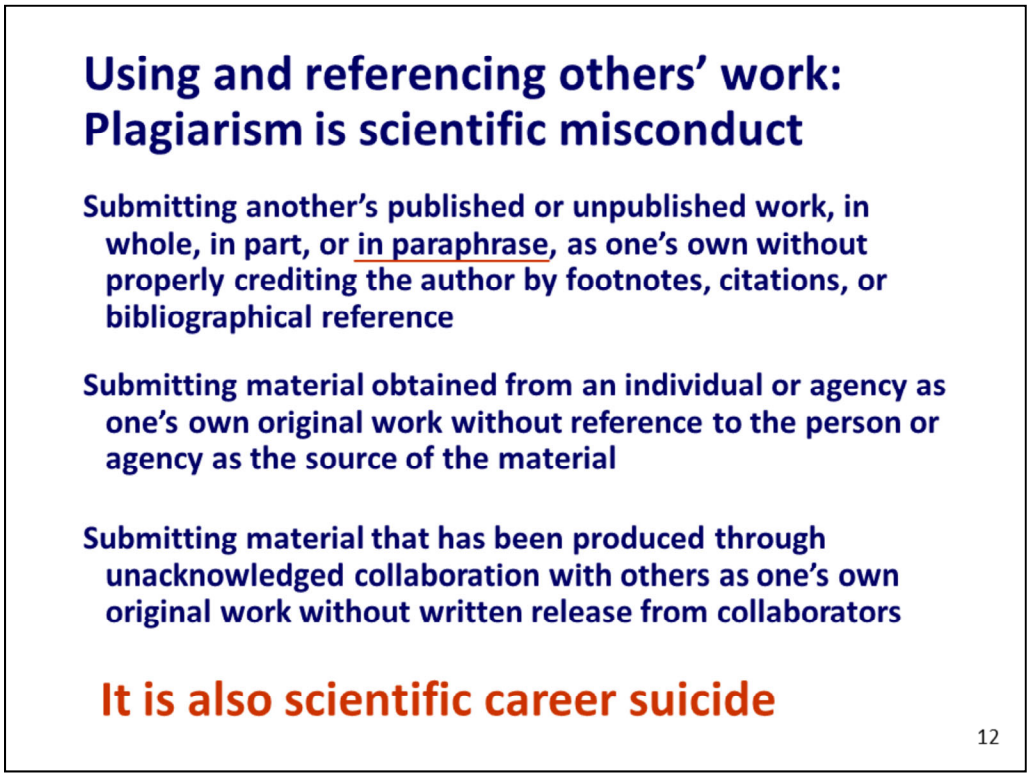
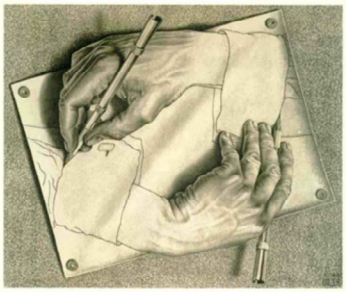


Credit should always be given for others' work—in references, acknowledgments, and authorship.

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…

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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.

14

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.

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Is it plagiarism?

Yes it is plagiarism! Although the original language has been paraphrased, the ideas and the order they are presented in have not changed, and the plagiarizing author has not cited the original source anywhere.

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!

16

What has to be cited?

"…as first shown by Newton, *F = ma.*"[1] 

Exception for "common knowledge"

BUT

"common knowledge" is <u>context dependent</u>

- **field and subfield**
- **audience**
- **venue**

Should it be cited? Err on the side of generosity!

(particularly if the author is still alive…)

[1]Isaac Newton, *Philosophiae Naturalis Principia Mathematica* (London, 1687).

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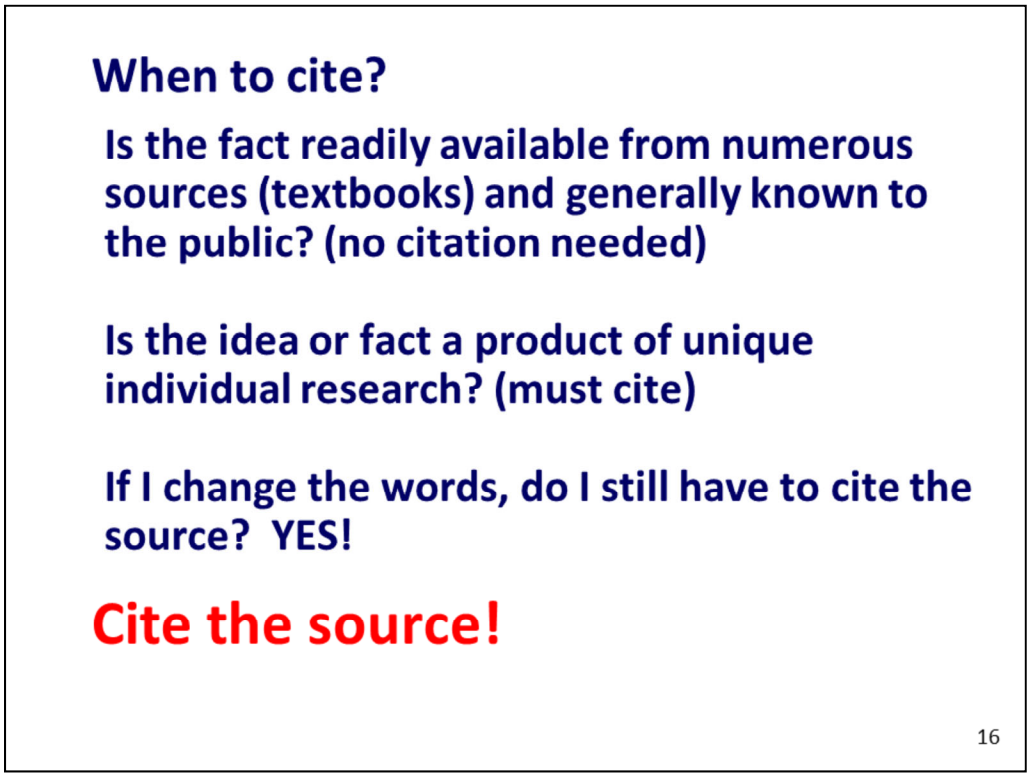

If you have *any* question about whether a source should be cited, consult your instructor, your research supervisor, or a faculty member. DO NOT just assume it is okay and hope for the best. Being accused of plagiarism is career suicide.

Which source should be cited if multiple iterations exist?

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)

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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

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

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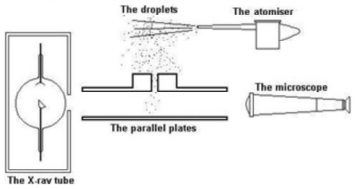
Although data falsification or fabrication is clearly wrong, what about more-subtle data "selection"?

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



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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

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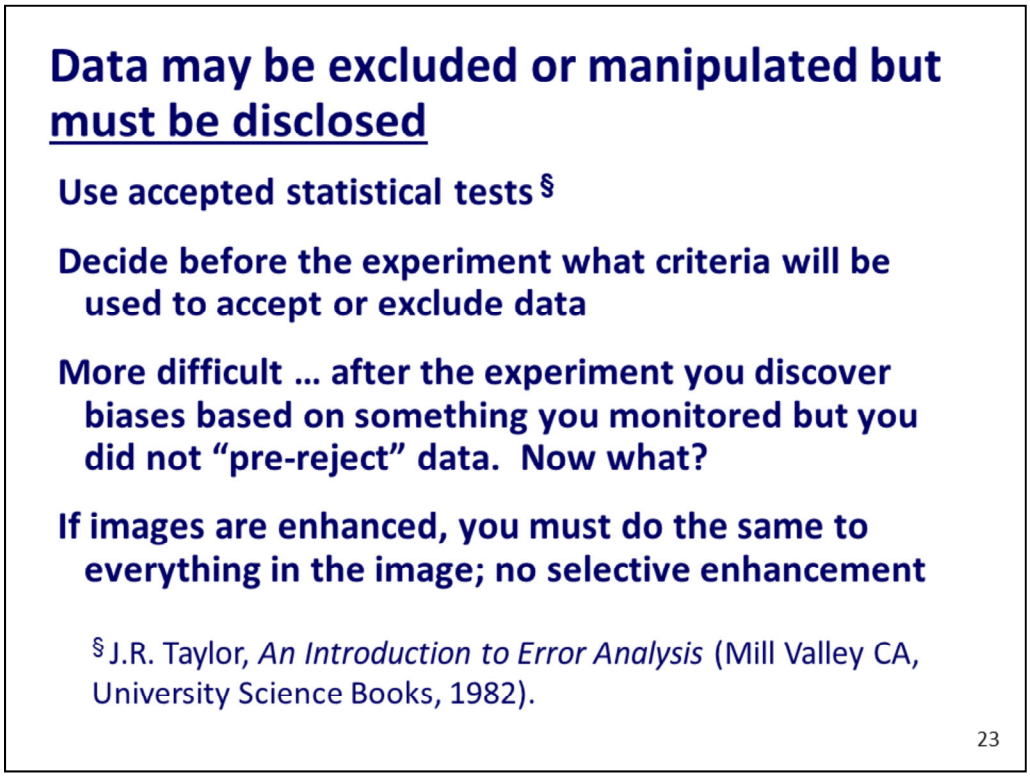
*http://www.councilscienceeditors.org/resource-library/editorial-policies/white-paper-on-publication-ethics/3-4-digital-images-and-misconduct/

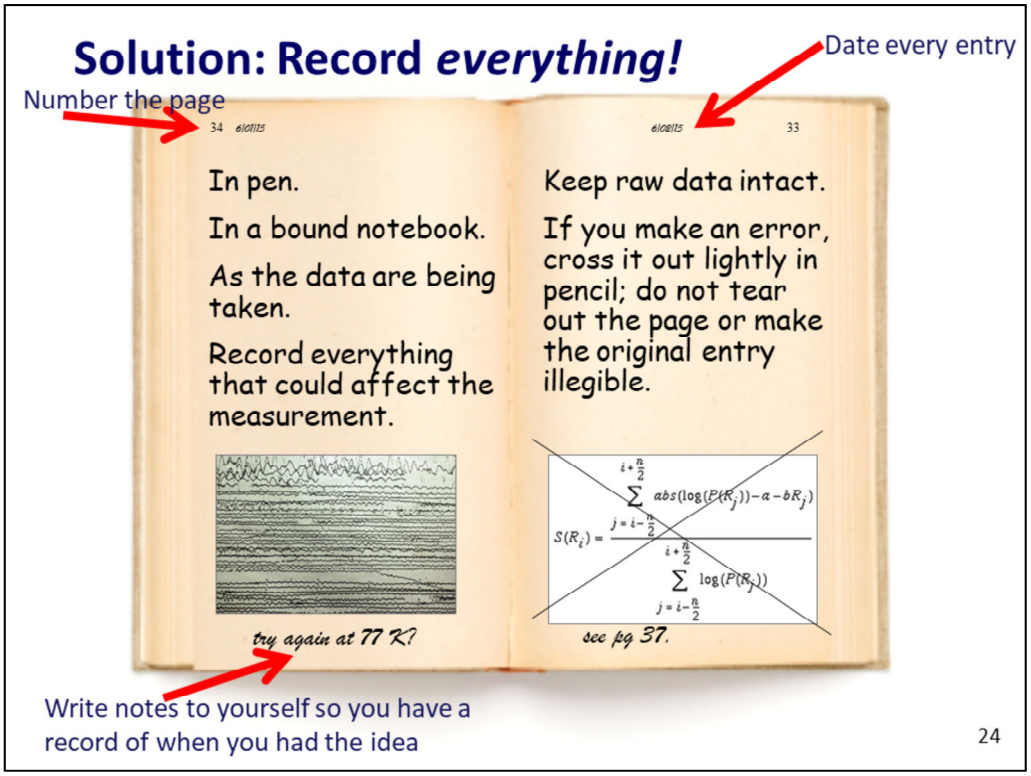
If you "enhance" images, you must retain the original, unenhanced images in the research record.



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.

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

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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

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Who decides?

The leader of the research group (professor)

In large collaborations, a committee

If your supervisor says "No" to publication, you cannot go off on your own and write a paper and submit it for publication

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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

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Intellectual property: all intellectual property you create is “owned” by your employer, in this case, the University of Illinois.

Your notebooks and any other “work product” belong to the lab; you must leave them here at the end of your project. If you want to follow up on your research when you go to another institution, discuss it with your faculty supervisor now.

Don’t keep a separate, “personal” notebook; everything goes in the lab notebook. Your adviser will probably allow you to make copies to take with you, but ask permission.

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

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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.

Sexual harassment—it's still happening

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

What are your rights and obligations?

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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"

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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

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NOTES: