Introduction to Responsible Conduct of Research for Physics Students

> ***Each physicist is a citizen of the community of science. Each shares responsibility for the welfare of this community****. Science is best advanced when there is mutual trust, based upon honest behavior, throughout the community. Acts of deception, or any other acts that deliberately compromise the advancement of science, are unacceptable. Honesty must be regarded as the cornerstone of ethics in science. Professional integrity in the formulation, conduct, and reporting of physics activities reflects not only on the reputations of individual physicists and their organizations, but also on the image and credibility of the physics profession as perceived by scientific colleagues, government and the public. It is important that the tradition of ethical behavior be carefully maintained and transmitted with enthusiasm to future generations.*
>
> —Statement by the American Physical Society
> http://www.aps.org/policy/statements/02_2.cfm

As you prepare yourself to join the world-leading research effort at the University of Illinois, you should understand that the university and your research colleagues expect you to maintain the highest standards in the responsible and ethical conduct of your research. As Nobel Laureate Max Delbrück put it, "In the cathedral of science, every brick is important."[*] The work you do as an undergraduate researcher will contribute to the work done by others who will follow you, and they must be able to rely on the honesty and soundness of your work. The University's statement on research integrity spells out in detail what is expected of you, and we urge you to familiarize yourself with the institution's formal policies and procedures.

The guidance about the responsible conduct of research that you receive from your research supervisors and mentors is fundamental to your training as a scientist or engineer. However, you cannot expect your research supervisor to anticipate every problem or preemptively address every issue. As a responsible researcher, you have an obligation to inform yourself of the professional obligations and legal requirements involved in carrying out research. Do not hesitate to ask questions to help you gain an instinctive feel for what is proper and to develop deeper insight into the issues involved in conducting research.

Responsible conduct of research

Science ethics rests on six fundamental principles—honesty, rigor, skepticism, openness, generosity, and social responsibility.

- Science requires its practitioners to be **honest**—do not fabricate, misrepresent, falsify, manipulate, or destroy scientific data, calculations, or analysis. The results of your work must be maintained in an unbiased, permanent record that is available for others to see and evaluate. You are obligated to correct errors in the scientific record as soon as you become aware of them. You must also refrain from claiming expertise or credentials that you do not have.
- Science requires its practitioners to be **careful**—follow protocols exactly and apply rigorous standards to all work that you do. Take no shortcuts and change no procedures without the knowledge and explicit permission of your research supervisor.

[*] James Woodward and David Goodstein, "Conduct, misconduct and the structure of science," *American Scientist* **84**, 479 (1996).

- Science requires its practitioners to be **skeptical**—do not want to believe so much in some result, yours or someone else's, that you lose your objectivity and critical thinking.
- Science requires its practitioners to be **open**—you must be willing to share data, methods, theories, insights, and equipment with other members of your research group. You must allow them to see your work and evaluate it. You must respond promptly and constructively to questions about your work. You must be open to criticism and accept it graciously.
- Science requires its practitioners to be **generous**—you must give credit to others for their ideas and prior work and be scrupulous to avoid even inadvertent piracy or plagiarism. You should recognize that science is a cooperative social endeavor and assist other members of your research group when they ask for your help. You must always treat others with respect and candor.
- Science requires its practitioners to be **responsible**—you must anticipate the social consequences of your research and prevent harm to the subjects of experiments and to the public at large. You must safeguard the wellbeing of your labmates and be mindful of the social welfare of anyone affected by your research.

Scientific progress depends on truthfulness and full disclosure, accurate and complete record-keeping, and free and open exchange of data and interpretations, but honest error is inevitable. If science is allowed to function as it should, it is self-correcting, as new methods and ideas supplant previous inaccuracies and errors.

But sometimes there's a thin line between honest error and misconduct, just as there is a thin line between being bold and being reckless. If you are uncertain about any aspect of your obligations as a researcher, you should seek the guidance of your professors, research supervisors, and mentors. It is their responsibility to assist you as you undertake research and learn to fulfill your duties as an ethical physicist. They can answer your questions about your responsibilities and the practices in place at the University of Illinois to ensure the integrity of the research enterprise and to safeguard the knowledge that research produces. Contact information for people outside your research group who can help you resolve problems is given at the end of this document.

What sorts of ethical dilemmas might you encounter as a young scientist? In the next sections, we'll look at five areas where beginning researchers often have questions.

Data selection, rejection, and treatment

Forging or fabricating data and falsifying or inventing results clearly constitute egregious scientific misconduct. In some physics research, however, certain data are routinely excluded or selected for further analysis. This practice is entirely acceptable, *provided all original data are retained and any selection, treatment, or exclusion of data is disclosed*. Thus it is imperative for you to preserve all data that you take in a permanent record. As soon as you begin working with a research group, ask your research supervisor to show you the proper way to record data and document all your work.

The manipulation or enhancement of digital images is becoming a huge issue in the ethical reporting of research results, and scientific societies and journal editors are working to clarify what are acceptable practices and what constitutes misconduct. As in all other kinds of data selection or treatment, the original pre-enhancement images must be preserved in the research record.

If you have questions about why certain data are selected or excluded, or how and why images are enhanced, ask your research supervisor for clarification.

Using and referencing others' scholarly work

In the course of your studies, you have learned that plagiarism, the reproduction or close imitation of the ideas or language of others in your written work without attribution, is academic misconduct. A related form of research misconduct is *piracy*, the theft or unauthorized reproduction or use of the

ideas, data, or methods of others without adequate permission or acknowledgment. Both plagiarism and piracy are egregious breaches of the responsible conduct of research.

Plagiarism is generally thought to apply to the written misuse of others' ideas, images, figures, or tables, but some scientists believe it can also apply to researchers' reuse of their own previously published reports or papers without proper acknowledgment of the source. This practice is referred to as *self-plagiarism* or *duplicate publication*. Research-based writing is filled with rules of which you may not be aware or know exactly how to follow. Sometimes you may not know what must be cited and what is considered "common knowledge." You should always seek guidance from your research supervisor about proper citation practices in your field.

Piracy is the unauthorized use of others ideas, materials, data, or methods without permission in the deceitful attempt to pass them off as one's own. Particular care must be taken to avoid personal benefit from participating in peer review of the work of others.

Ownership of intellectual property and authorship practices

Much of the physics research that is conducted at the University of Illinois is paid for by grants from federal agencies—the National Science Foundation, the National Institutes of Health, the US Department of Energy, NASA, and several US Department of Defense agencies. Federal regulations require the recipients of federal funding to adhere to the highest standards of ethical conduct, to preserve and protect the research record, and to share their results with the research community and the general public.

Generally, any results or data obtained by University of Illinois researchers, including those paid from federal grants, are the property of the university.[†] When you leave your research group, all your original research records must be left with your research supervisor, who will maintain the data on behalf of the university and the sponsors of the research. Copies may be taken, with your supervisor's permission, but you may not remove the original data and records.

Disagreements on attribution of credit and responsibility for collaborative work cause many complaints among researchers. You should discuss any of these concerns with your research supervisor early in your project and reach an understanding of the role and responsibilities of each person in the research group and the group's authorship practices.

The American Physical Society has articulated professional standards on the responsibility of authors, but different research groups have differing practices on the assignment of co-authorship and the listing of authors' names in publications. The research supervisor has the responsibility to decide what is published, when it is published, and who should be listed as a co-author. The decision of the research supervisor is final; a student may not independently disseminate research results *in any form* without the explicit written permission of the research supervisor.

Conflicts of interest

Conflicts of interest arise when other considerations interfere with the objective conduct of research and accurate and full reporting of results. Sources of conflict may be personal obligations, professional or financial relationships, and philosophical or intellectual predispositions. Part of your duty as a responsible researcher is to be aware of and avoid potential conflicts that could affect your objectivity and independence.

[†] In some very limited cases, private entities contract with University researchers to perform certain experiments or testing or to deliver a specific product. In those cases, the data and other research products are "owned" by sponsor of the research. If you have any questions about who owns the data and products of your research, consult your research supervisor.

Communications and human relationships

Physics is increasingly an international, collaborative enterprise, and you may find yourself working side by side with people whose backgrounds and experiences are very different from your own. The American Physical Society has made strong statements that "full participation by everyone…is important to the health and future achievements in our discipline." In addition, the University of Illinois' Student Code, Article 1, articulates clear expectations that students adhere to the university's fundamental commitment to academic freedom, equality of opportunity, and human dignity.

We are very proud of the longstanding supportive, collegial atmosphere of Physics Illinois, and we expect you to do your part to maintain and strengthen this essential intellectual environment. Treat everyone in your research group with courtesy and respect. Learn from them. Be welcoming and inclusive of all members, regardless of their roles. Be aware of your own unconscious biases and the unintended consequences of thoughtless actions and strive to overcome them. If you encounter problems, address them early and objectively. Seek help if you need it to resolve misunderstandings or differences of opinion.

Next steps

Welcome to the world of physics research—we are glad you have chosen to join our community! We expect you to fulfill your duties in accordance with the highest standards of integrity. We encourage you to learn more about the responsible conduct of research through discussions with your research supervisors and mentors, through additional readings and training, and through self-reflection. Do not hesitate to ask questions or request assistance in resolving problems—it is the obligation of all physicists to help you and to ensure the wellbeing of our community.

Where to go for help

Physics Department Head, Matthias Grosse Perdekamp, Room 211, Loomis Laboratory

Associate Head for Undergraduate Programs, Brian DeMarco, Room 231, Loomis Laboratory

Associate Head for Graduate Programs, Lance Cooper, Room 227B, Loomis Laboratory

University Research Integrity Office, Kyle Galbraith, Swanlund Administration Building, 4th Floor, rsofficer@illinois.edu

Additional Resources

University Ethics and Compliance Office

University of Illinois Policy and Procedures on Integrity in Research and Publication

University of Illinois Student Code of Conduct

Office of the Vice Chancellor for Research's Resources for Research Integrity and Ethics

The Office of Technology Management at Illinois' *Inventors Handbook* (pp. 6-11 on intellectual property)

For further reading:

Committee on Science, Engineering, and Public Policy; Institute of Medicine; Policy and Global Affairs; National Academy of Sciences, National Academy of Engineering, *On Being a Scientist: A Guide to Responsible Conduct in Research*, 3rd ed. (Washington DC, The National Academies Press, 2009).

Office of Science and Technology Policy, Executive Office of the President, "Federal Policy on Research Misconduct," *Federal Register* **65**, No. 235, Wednesday, December 6, 2000/Notices.

D. Scott-Lichter and the Editorial Policy Committee, Council of Science Editors, *CSE's White Paper on Promoting Integrity in Scientific Journal Publication, 2012 Update*. 3rd revised ed. (Council of Science Editors, Wheat Ridge, CO, 2012). (accessed 02/23/2016).

Adil E. Shamoo and David B. Resnik, *Responsible Conduct of Research*, 2nd ed. (Oxford University Press, Oxford, 2009); doi:10.1093/acprof:oso/9780195368246.001.0001.

"Report of the Investigation Committee on the Possibility of Scientific Misconduct in the Work of Hendrik Schön and Coauthors," Lucent Technologies (2002); doi:10.1103/APS.Reports.Lucent.

James Woodward and David Goodstein, "Conduct, misconduct and the structure of science," *American Scientist* **84**, 479 (1996).

Natasha Gilbert, "Science journals crack down on image manipulation," *Nature News*, published online 9 October 2009; doi:10.1038/news.2009.911.

Brian C. Martinson, Melissa S. Anderson, and Raymond de Vries, "Scientists behaving badly," *Nature* **435**, 737–738 (2009); doi:10.1038/435737a.