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SOME ETHICAL CONSIDERATIONS IN ASTRONOMY RESEARCH AND PRACTICE

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Abstract. Research ethics as an applied field has evolved due to a number of contentious and public lapses in ethical judgment over the past hundred years. But the main principles underlying good, ethical behavior in all of the sciences are rooted in what Robert Merton calls the ethos of science. Values and virtues, including the universal nature of its underlying objects, communal nature of scientific research, the necessity for individual disinterestedness on the part of researchers, and science's nature as organized skepticism, provide a foundation for conducting ethical research. Scientific integrity, the relation between basic science and the general public, and the social role of science all argue for adopting virtues, guiding behavior, and pursing science in ways we can now characterize as ethical in themselves. Being a good scientist and doing good science overlaps significantly with being a good person.

1. Introduction

Science was once deemed to be a field apart from ethics, having little-to-no nexus between the two. Science, after all, looks into objective reality, uncovering natural phenomena by measurement, experiment, and the accumulation of corroborating evidence. Ethics, on the other hand, seems to change according to the age, differs among cultures, and cannot be measured, observed, or quantified with any known precision or instruments. But science has suffered at times for these conceits, and for individual and collective groups of scientists who have in some cases flouted social conventions, ethics, or morals. Prominent cases in which scientists have engaged in academic fraud, waged public disputes with colleagues or competitors, plagiarized, falsified, or otherwise damaged their reputations and that of science itself, become etched upon the public's images of science as a field, and upon sub-fields within it. Yet science is a public pursuit, largely dependent upon the public's support, either directly or indirectly, and impacting the public in many ways as its discoveries filter up into our institutions and technologies.

Ethics is the study of "the good" and applied ethics has evolved most recently as a response to lapses in ethical judgments by those involved in sciences most directly impacting upon humans. Despite long standing philosophical disputes about the nature of the good, and its theoretical origins, in medical and research ethics, some basic guiding principles have emerged to guide and judge conduct or misconduct when it occurs. Included among these principles are a general value of beneficence, or the desire to help rather than harm, the preservation of human autonomy and dignity, the pursuit of justice, and avoiding ill intent. In other fields of research, not directly involving human subjects, these and other basic principles can help to ensure that not only does good science gets done, but science gets done in accord with the good[1].

Over the past few decades, numerous rather public and embarrassing lapses of ethics on the part of scientists, engineers, and other professionals and academics charged with academic study on the public's dime have encouraged the development of standards and norms that help to regulate and discourage bad behavior. Fields such as chemistry, physics, and basic sciences once thought immune to the errors of applied sciences like medicine and engineering, have faced the need for soul-searching in light of ethical lapses. No professional or academic endeavor, it seems, is entirely immune from errors or even evils. Conflicts of interest, the cut-throat nature of academic departments and projects, or just bad judgment can result in real harms to both the public and professions (Macrina 2005).

While most of the ethical issues that confront researchers in astronomy are similar or identical to those of other academic fields, there may be unique issues that confront astronomers. But sound ethical principles, tried and tested, and applied in courses and reviews regarding research integrity, can help guide most of those conducting astronomical research to avoid ethical pitfalls. While many might question the value of such study, or the use of such principles, consider the nature of basic science, its dependency upon the public's largess, and the duties owed to other members of the profession to maintain high ethical standards and to support its continued honor and virtue. Moreover, astronomy as a field overlaps with a number of

[1]See generally Koepsell (2009).

other fields and practices, including space exploration and commercialization, climate science, and applied physics. Researchers doing work in any basic science must consider the impact and role their research plays in a broader economic and social sphere, and gauge their actions and intentions accordingly.

Policy-makers, investments, and individual choices outside of academia depend upon work within the academy. We are all thus obliged to be mindful not only of conducting ourselves according to good ethical research practices for their own sake, but also because it matters to the world at large. Let's consider below some of the core issues involved in maintaining scientific integrity, and look at a few examples of how they may apply to research in astronomy. As well, we will look more generally at some unique duties or values associated with astronomical research and practice.

2. Scientific Integrity

Over the past few centuries, scientific practice has developed institutions and norms that are meant to collectively advance the conduct of research, and enrich the public store of knowledge. The scientific method depends upon some core values, including honesty and openness regarding the outcome and methods of research. According to Robert Merton, science is an inherently democratic institution, and embodies the following values: universalism, communalism, disinterestedness, and organized skepticism[2].

These values are necessary elements of the scientific method. Universalism respects that the objects of science are the same everywhere. There is no special science of the US, vs. other nations, nor of one race over another. Science seeks to uncover universal truths. It is also a necessarily communal activity. Even while research programs pursue their research sometimes behind closed doors, to enter into the scientific realm, results and methods must eventually be shared, and thus become subject to testing. Scientists must remain disinterested in the results of their study, lest they be emotionally vested in such a way that their reporting becomes skewed, either intentionally or unintentionally. Finally, scientists must constantly challenge and doubt the finality of their searches for the truths underlying nature, and be prepared to overturn cherished and accepted beliefs about past studies. Science depends upon these values, which have been said to make up the ethos of science itself.

Even before codes of ethics were developed and adopted by universities, institutes, and professions, the ethos of science, generally accepted and understood, pushed scientists to behave honestly and openly. Without these cornerstones of research integrity, a scientist's discoveries were suspect, and

[2]See Chap. 13 of Merton (1973): "The Normative Structure of Science".

his or her reputation prone to challenge. Being a good scientist, whose discoveries were useful and respected, and whose contributions to the body of scientific knowledge would endure, meant necessarily being a good scientist ethically-speaking. This is true today, but we have more concrete historical examples than a hundred years ago that help to illustrate this point, and we have codified the ethos into an ethics.

Being a good researcher and being a good human being often overlap, but there are some particular duties that arise out of the institutions of science, that we will look into more deeply in the pages ahead. Specifically, science is a socially-constructed institution that has no governing body, no central oversight, and no real codified or legal rules that apply to all scientists (although recently, some have attempted to promote such a universal code, it has only been sporadically adopted[3]).

While various fields have developed their own professional organizations, accrediting bodies, and other means of providing some direction to their "members", science as a whole remains more or less self-governing, and scientists, who conduct their research generally due to the largess of states and their citizens, may yet be guided (and generally are) by what we will call the ethos of science. As the most successful endeavor yet undertaken by humans to uncover the laws and parts of the universe, this ethos has been implicit in the methods and history of the sciences for centuries. Today, we can use it as a foundation also for discussing the ethical duties and implications of scientific research in general, and in the following pages, astronomical research in particular.

3. Research Conduct

Scientific programs are typically not conducted by isolated individuals. Rather, research is conducted in teams, or at least by individuals loosely connected through broader social and political networks. Ethical conduct depends upon a number of tacit virtues, collectively agreed upon, and manifest by some of the ethos described by Merton. Namely, researchers should be forthright about the bases for their "own" work, where it depends (as most research does, as even Newton acknowledged long ago) upon the work of others. Research misconduct can occur whenever researchers do any number of obviously unethical things, such as misrepresent data, fail to properly acknowledge sources or methods, etc. indeed, any actions that tend to undermine the confidence that an objective peer would have in the research or findings of another, were those actions known, ought to be avoided merely

[3]See, e.g., "A Universal Ethical Code for Scientists", 2007, UK Govt. Office for Science, `http://www.berr.gov.uk/files/file41318.pdf`. See also "The Great Beyond: Hippocratic Oath for scientists" (*Nature*, 12 Sep 2007).

as a practical matter. Of course, the motivations for misconduct, and the degrees to which certain acts may arise to unethical as opposed to merely negligent, differ from case to case. Allegations of manipulating or improperly referencing the source of data date back even to the time of Ptolemy. Up through the middle ages, Ptolemy's catalogue of stars and constellations was referenced and relied upon by generations of astronomers, navigators, and scientists. Yet the accuracy and originality of his contributions have since been cast into doubt (Evans 1987).

Critics as long ago as Sir Isaac Newton recognized that observations claimed to have been made by Ptolemy could not have been made where he claimed they were made. Thus, the accuracy of the observations themselves were cast into doubt. While there are clearly many grounds on which to challenge Ptolemy's inferences, including for instance his geocentric theory of the solar system, mere observations of the positions of stars ought to be uncontroversial. Yet his reliance upon unnamed sources clouds the veracity of his work in general, and tarnishes his work as a scientist. It also may have adversely affected generations of those who relied upon his observations. If, as seems likely, Ptolemy merely borrowed some likely reliable observations from another, attribution would have been the appropriate scientific and ethical course.

This is important because not only is it ethically wrong to claim as one's own work the work of another, but because scientists must leave a clear research trail for other researchers to check their work. Without such a trail, many countless hours of work may be duplicated or wasted.

Of course, the modern astronomer is in a much more precarious position when it comes to misappropriating or faking sources or data. It may have taken centuries for Newton *et al.* to catch onto various discrepancies in Ptolemy's accounts, but modern science moves much more quickly. The pressures of academic tenure and promotion, the need to publish, to achieve quickly, and the achieve security tend to impel researchers even now to cut corners, and in the worst cases, to commit fraud, but prominent cases of getting caught, as well as the impact such fraud has upon the ethos and perception of the sciences, ought to steer modern scientists away from such risks.

Even failure to abide by a minimal standard of care, as opposed to outright fraud, risks undermining one's own and the profession's integrity. Witness, for example, the failure of NASA scientists to covert from metric to English measurements when transferring data to the Mars Climate Orbiter resulted in the total loss of the USD 125 million spacecraft in 1999. This sort of negligence reflected badly upon NASA, wasted taxpayer dollars, and meant that valuable scientific data would not be obtained for years. Failing to properly abide by the findings of various calibration instruments during the construction of the Hubble Space Telescope's primary mirror meant a costly, and dangerous repair mission.

The stresses of due dates, monetary constraints, the pressure to publish, demands of various stakeholders, and other similar common stresses in academic research can strain the judgment of any researcher. Remaining true to the principles and duties of good research, and the virtues of a good researcher, in the face of these pressures, can help to avoid future harms. Among these principles and virtues are those associated with the ethos of science discussed above. Being open about one's sources and attributing correctly, leaving a clear trail, being honest, cooperative, and careful. Below we will discuss some specific and touchy areas of research etiquette and conduct that have ethical implications, and about which a fair amount of angst can arise.

4. Authorship

A frequent issue that arises in academia with ethical implications and impact regards the issue of authorship. Who counts as an author? All too frequently, authors are named on papers where no overt acts of authorship occurred. This may be because the named person was responsible for securing funding, or because of a sense of duty within a hierarchy to name the person who provides some oversight in a department, or for other understandable but insufficient reasons to grant authorship.

A good measure, however, is asking whether the named person actually contributed to writing the paper, either through developing the ideas, doing critical research and analysis, or the nuts and bolts of stringing the words together in a meaningful way. Mere copyediting does not amount to authorship, nor does a discussion around a water cooler regarding the progress or scope of the research. Rather, ask whether without the person to be named would the paper as conceived and written be possible. Some hand in both the conception and realization of a paper warrants a claim of authorship. The order of authorship differs according to professional custom, but typically first authors do most of the actual writing, middle-named authors are involved in the research, drafting and editing, and last named authors are conceptually responsible for the paper, even if they haven't written most of it. All authors ought to be involved in the drafting process to some degree, combing through it, providing corrections, actually writing parts, but at the very least reviewing it.

The ethics of authorship revolves around the notion of responsibility. If one benefits by being a named author, in that authorship typically promotes a career, bolstering a CV, leading to promotion or tenure decisions, etc., then one ought to have a vested interest in the accuracy or the paper and its impact upon the field. Recent controversies that ended up in shame and discrediting of various researchers could have been avoided had the named authors been actually, conceptually, or editorially involved in authorship. The stem cell scandal involving South Korean scientist Hwang Woo-suk resulted in jail time, loss of licenses, fines, and of course lost time and money due to research fraud (Rusnak & Chudley 2006). An apparently ground-breaking research paper published in Science had to be rescinded, and doubts were cast upon his previous papers in that and other journals. Researchers with only the most tangential connections to the study itself were named as co-authors, and had to clear their names, explain their lack of oversight and knowledge, and disclaim responsibility for the fraud. Had all named authors been actually involved as discussed above, reputations would not have been jeopardized, and the chain of responsibility for the fraud would have been more clear.

Ultimately, the decision to name someone as an author imports presumptive responsibility for that author. The reward for publishing includes a duty to stand by what is published, and the responsibility to account for any failures, intentional or otherwise, that result from published research. Researchers pressed with naming a dubious collaborator as a co-author must ask themselves and the person to be named not only whether they played a conceptual or editorial role in the paper, but also whether they can take actual responsibility in case of some failure. The public and other scientists have a right to expect no less from those who benefit through the institution of scientific publishing.

Aside from the issue of authorship itself, those engaged in any form of research ought to credit others where credit is due. Authorship decisions may have long-standing implications, and disputes have waged for generations about the roles of co-researchers, and whether they were properly credited. These disputes become especially important when Nobel Prizes are at stake, as in the case of Watson, Crick, Wilkins, and Franklin. While everyone knows who Watson and Crick were, and some know of Wilkins, Rosalind Franklin has recently been argued to have been just as critical in the discovery of the structure of DNA as the other three, and was perhaps just as deserving of Nobel recognition. In astronomy, a similar dispute continues to brew regarding the discovery of the very first pulsars, and whether Jocelyn Burnell-Bell, who was a graduate student working for Antony Hewish and who made the first actual observation of a pulsar, should have shared in the Nobel Prize with her advisor Antony Hewish (Overby 2008).

5. Conflicts of interest

Another issue that either raises or precipitates ethical issues in modern research concerns conflicts of interest. Where a researcher may be beholden not just to the virtues and aims of the ethos of science, in other words when he or she is not "disinterested" in the outcome of the research, a conflict of interest may result. Conflicts of interest may not necessarily impede research, nor cause it to go astray or wrong, but they run the risk of undermining the confidence of the public or other members of the profession. The nature of modern science inevitably raises more frequent potential conflicts as scientists and academics, forced to seek funding and support beyond their institutions, are often in the position now of serving multiple masters. While ideally maintaining a clear idea of the researchers disinterest in the outcome of the research would help alleviate potential conflicts, in the real world we all have interests in more mundane matters, like remaining employed, keeping funders happy, advancing our careers, and feeding our families. Remaining mindful of the potential for conflicts, however, and keeping the sources of money and trail of overlapping or conflicting duties transparent, can help maintain confidence in results and professional integrity.

Just as most institutions do not require avoiding such conflicts entirely, so too it is clear that good ethical practice in the real world may at best only require openness. Impartial arbiters, once apprised of the various potentially conflicting duties, can sort out whether, if something goes wrong, the source of the error or fault lies with the conflicts. A prominent example of how complex endeavors may lead to conflicts is the oft-cited instance of the Challenger disaster. Because NASA was answering to the executive branch, under various political pressures for a timely launch, and because Morton Thiokol was under similar political pressures, the decision to launch may have been predicated upon the wrong interests, rather than the most clear ethical duty to maintain the safety of the crew and integrity of the system.

Ultimately, researchers wishing to avoid the perils of conflicting interests need firstly to be aware of their potentially occurring. Be mindful of how owing duties to various parties may affect the production, translation, or dissemination of research. Be aware of the existence of various interested parties, and be transparent about them. In the long term, the methods of science itself will sort out whether conflicts have skewed results, or prejudiced a study. A researcher can best avoid the taint of future possible findings by being open about his or her awareness of the potential conflict, and taking pains to avoid even the appearance of bias due to potentially conflicting duties.

6. IP and Data

Intellectual property (IP) and rights and responsibility related to data are incompletely overlapping issues. Ordinarily, intellectual property rights do not attach to data sets since copyright and patent are meant to protect original expressions of ideas. The data accumulated through scientific study is observational. In its best instances, it reflects the world that exists, even while researchers might then go on to represent that data in new and original manners. Natural laws and phenomena themselves cannot be protected by IP, but the original uses and depictions of those laws and phenomena may be. Even so, researchers must be mindful of existing protections on such original expressions, either in publications or in the form of patented methods or machines, and ensure that they do not violate any legal rights that might exist. IP cases are costly and difficult to defend, and may hinder research for years while they are sorted out[4].

The use and misuse of data itself poses another sort of challenge. Aside from legal issues such as non-disclosure agreements, privacy concerns, and contractual restrictions that may arise in complex research scenarios, data itself must at some point be revealed in accord with the proper methods and ethos of science. It must be handled carefully, and attempts to massage, obfuscate, or otherwise manipulate data are treated harshly if uncovered by the scientific community at large. Claims of rights and restrictions over the dissemination of data or other attempts to prevent full access and investigation of data sets ultimately reflect poorly on those who choose less open paths in their research.

But being a good researcher also means respecting the need for some secrecy and not disclosing during the course of a research project, motivated by the perfectly reasonable desire to be the first to publish on a topic. Researchers who steal or destroy data in order to get ahead, to promote their careers or destroy those of others, not only violate the most basic tenets of the ethos of science, but also behave unethically. Science is a meritocracy, and sometimes luck helps. But good research and discovery is rewarded by status in the profession. Academic environments have too often been poisoned by competitiveness of the worst sort, where merit is attacked by guile, rather than competing in the open realm of discovery and invention.

Originality of thought and scientific rigor in experiment are the mechanisms for moving ahead in science, and these move us ahead as communities not only of similarly-minded researchers, but also as a species. Theft, misappropriation, or excessive secrecy, mistrust or guile, may result in temporary personal advances, but ultimately hinder our progress both materially and

[4]See generally Koepsell (2011).

ethically. Data can be reasonably concealed or otherwise protected during the course of a research project, but must be reported honestly at its conclusion. Without this sort of transparency, the scientific method itself is undermined.

7. Duties to Society

Increasingly, we are becoming aware that no area of science is an island unto itself. Even the most theoretical fields of research have some broader impact, if only because most basic research remains publicly-funded, and the pot of public money available for such research is increasingly threatened. Scientists doing research on the heavens are not immune from social considerations inherent in their research. Space observation and exploration take their toll not only upon the taxpayer's wallets, but also pose issues for our daily lives both now and into the future. With each launch of space-based telescope, or construction of earth-bound observatories, there is, for instance, not only generally some public expenditure, but also some environmental consequence. Whether it's contaminants from rockets or clearing land for construction, astronomical science makes an impact upon the environment. Our duties to others in general, as expressed by centuries of ethical theory, are typically recognized as including avoiding conscious harms, or at least minimizing them where harm is necessary for some other, more important reason.

While scientists sometimes work oblivious to societal repercussions, increasingly various fields are adopting codes of behavior that recognize their wider societal impact. Mindful that they work largely at the whim of the public, a sense of a reciprocal duty to others upon whom they ultimately depend, as well as guarding of reputations, help to motivate modern researchers to heed the impact of their work on their neighbors and society at large. While codes and rules are certainly helpful, a well nurtured sense of moral or ethical duty properly heeded can help avoid unnecessary and painful harms and their repercussions.

Astronomical research has a direct impact on areas of growing societal concern, and environmental consequences may come from or be influenced by the proper conduct of the study not only of other bodies in the solar system, but of earth itself. Political disputes about global warming affect us all, and these disputes depend upon accurate and responsible collection and interpretation of data, modeling of planetary climates, and analogies to other planetary climates both past and present. While many might wish to stay out of the political fights, good science warrants thorough and dispassionate research and theory free from political or emotional pressures. Misuse or manipulations of science for political ends, no matter their placement upon the political spectrum, offends the ethos of science, and degrades the nature of scientific research. It may also harm people.

Whatever the truth of the premise of anthropogenic climate change, current and future generations deserve the highest degree of scientific work in uncovering and interpreting data. Policy-makers are often politically motivated, and corporations are driven by profit, but scientists must be guided by a passion only for the truth, regardless of profit or politics. Recent stories regarding the discussion and possible manipulation of climate data, by scientists with clearly-expressed motivations to influence the public debate, have undermined public confidence in climate scientists, and perhaps set back attempts to curb behaviors that may contribute to climate change. In so doing, these researchers, by failing to remain disinterested, have hurt their cause. If they are right about the nature of climate change, they have harmed much more than a cause.

Astronomical research may also have implications for peace and justice. The exploitation of natural resources in space involves issues of fair distribution. International treaties already prohibit "owning" parts of the Moon, and future exploration of the solar system will likely involve the cultivation of valuable mineral resources, harvesting of strategic elements, or other similar goals. On Earth, we have attempted to define parts of the world that cannot be freely exploited, noting that there are things that we call "the commons" whose use impacts the potential or even right to use by everyone. Astronomers will be essential in future plans to locate and exploit the solar system's natural resources, and may well be drawn into debates regarding the existence of some extraterrestrial commons, and the justice of awarding exploitation rights to some while denying them to others.

The development of astronomical instruments may also have so-called "dual use" implications, as extremely powerful mirrors and lenses can possibly be used in space-based weapons, or sensing devices can pose a threat to our privacy or individual liberties. Just as nuclear technologies have both benign and belligerent uses, so too do many of the essential technologies behind space observation and exploration. These potential dual uses must be recognized, and scientists and engineers pursuing them should take responsibility for guarding against their harmful use, even while vigorously pursuing and realizing their scientifically valuable uses. Individual responsibility taken today can help to avoid future legal and moral culpability for the harmful uses of technology gone astray.

Finally, astronomy has long had an impact upon religious belief, and societies have had to confront, sometimes rather violently, the challenge that astronomical truths have posed to long-cherished beliefs and faiths. Galileo's famous prosecution and sequestration resulted from his accurate account of astronomical observations. Copernicus's studies and the eventual uncensored publication and dissemination of confirming study ultimately led the Catholic Church to back down and admit that the Earth was not the center of the solar system. Believers were shaken, faiths challenged, and society tested. But society has survived, and moved forward, and faiths remain. Added to the list of sciences that challenge religious faith is biology, and even now disputes rage in politics regarding the implications of Darwin's theory of evolution. Some continue also to challenge the observation that the universe and Earth are more than 6000 years old.

How should a scientist respond to those who argue that science undermines their right to religious freedom, or merely unfairly challenges their faith? Is there a duty to respect everyone's beliefs, or to tread lightly when it comes to revealing observations or studies that impact cherished belief systems? The ethos of science says no. Science and faith must at some point conflict where observations do not agree with revelation. Disinterested scientists must separate their own faith systems from observation and interpretation of empirical data if they are to remain true to the methods of science.

Similarly, they must remain disinterested in the effect of their study on the beliefs of others. Even while there is a duty to not discriminate against others due to their differing faiths, and to respect the rights of others to believe whatever they want consistent with John Stuart Mill's "liberty principle" (the right to freedom ends where it causes harm to others), there is no right to hold a belief without the inconvenience of challenge (Mill 1910). Challenging one's faith because it does not hold up against evidence causes no harm to the believer. Faith properly construed does not depend upon evidence. This is what makes it faith rather than science. Science, on the other hand, recognizes its fallibility and its mutability in light of the evidence, and depends upon constant challenge[5]

Respect for others means that challenges to faith must be civil, backed by evidence, and done only with the intention to pursue science, as opposed to the intent to cause harm. But adherence to the ethos of science, and scientific integrity and ethics demands that truths be revealed, despite their potential effects on believers. We are all entitled, after all, to our own opinions and beliefs, but we are not entitled to our own truths.

Truth is itself a good, and the uncovering of the truths underlying nature is the fundamental goal of science. Other fields may seek the exploitation of those truths to various ends, involving their own ethical duties and responsibilities, but scientists observing nature must seek to hone their models of the universe, its laws and phenomena without regard for political or religious ends. In their roles as researchers, at least, the values expressed by

[5]Elegantly argued by Stephen J. Gould (1997) who described science and religion as "non-overlapping magesteria".

Merton in delineating the ethos of science may serve as a useful guide for ethical conduct.

Ultimately, science is a social phenomenon, and scientists are a part of a broader society. The proper conduct of scientific research in every one of its branches reflects upon its role in society, and effects its perception by the broader public. Ethical conduct can be complicated as duties and obligations multiply, and as motivations become cloudy or conflict. Remembering the ultimate role of science in society, and the manner by which it best proceeds, can help to sort out some if not all of the ethical issues that may arise, and will help to ensure the smooth progress not only of individual subfields in science, but of science in general as a means to achieving human progress.

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