# The Ethics of Exploration: Planetary Astronomy

Brother Guy Consolmagno SJ
Specola Vaticana

Presented at the Manresa Symposium
Dobogoko, Hungary
2008

## Ethics in Astronomy?

Most of the focus on ethics in science has been placed on the biological sciences, where life, especially human life, can at times be at risk; and because the stakes for being first with an important result are also quite high in terms of prestige and financial gain. By contrast, it seems odd at first for me, an astronomer, to be thinking about ethics. Astronomy is a remote and passive field, with little immediate relevance for the lives of most people. How can we worry about doing the wrong thing, when we basically aren't doing anything at all... except observing far distant objects?

And certainly it is hard to imagine a possible commercial value to the work we astronomers do. Indeed, I find that there is not very much need to worry about plagiarism or falsification in my science — the stakes are too small to make it worth anyone's while. If I turn out to be right in some theory or observation, there are few financial windfalls coming my way; if it turns out I am wrong, no one is hurt but myself. Our real reward is in our reputation, the one thing that we put most at risk by trying to fake our data. And it takes longer to build a reputation than it does to be caught cheating!

And yet, ethical issues can arise even in a passive science like planetary astronomy.

## Planetary Sciences and Global Warming

In order to be tempted to unethical behavior, there has to be a forbidden fruit worth grasping for… a temptation like worldwide fame, or an issue that will actually matter to more people than just our fellow astronomers. And I can think of one current field of research where planetary sciences do have a temptation toward unethical behavior. In their contribution to environmental studies, in particular global warming, planetary sciences do have such an issue. In this, it is unlike our neighbors who work in stellar or extra-galactic astronomy. Our studies are close to home.

Is the Earth experiencing a global increase in temperature? And if so, are the causes of this increase anthropogenic – caused by human activity? This is, at one level, a question of planetary sciences. What is an appropriate measure of the mean temperature of the Earth? What are the trends in the data when local variations are accounted for? What are the possible causes for such warming, and how important among these causes are human activities?

The answers to these questions have serious economic implications for many industries, and many nations. Getting the answer wrong could mean risking, on one hand, the fortunes of individuals, corporations, and societies; or, on the other hand, the fate of life on the planet itself.

The risks are certainly high. And various political entities have come out strongly on both sides of the issue, representing the interests of those who are most likely to suffer if, on the one hand, extreme but unnecessary measures are mandated against carbon emissions (for instance); or if, on the other hand, the rising temperatures produce cataclysmic effects in the absence of extreme measures that turn out to actually be quite necessary!

In the absence of scientific certainty – and, alas, scientific certainty never occurs – society must make choices now. Indeed, it seems that all of life is the challenge of making difficult choices in the absence of adequate data.

But the consequences of making those choices can be quite serious to those making the choices long before the consequences of global warming itself appears.

In many situations, a scientist who states publicly that global warming is caused by human activity can be punished by funding agencies who find that message unwelcome, and those who debunk global warming can be rewarded with financial support from oil companies and the like. On the other hand, those same debunkers are liable to experience being ostracized, or at the least suffer a severe loss of status, from the majority of their peers who might accuse them of caving in to such pressure or being "bought off" by such funding. I have seen both effects take place with colleagues of mine.

To give but one example, a scientist of my acquaintance has found evidence of an apparent increase in the temperatures of the outer planets over the past thirty years. This is an increase that parallels the warming of the Earth, but which obviously could not be blamed on human activity, absent the presence of cars and factories on Uranus and Neptune! But my colleague has had great difficulty in getting her work published because referees are afraid that its publication will weaken the sense of urgency to limit the human pollution on our planet. And they may be right.

The astronomer in question does not think that global warming is entirely explained by a change in the Sun's output. And in any event, she recognizes that reducing pollution is a good goal in and of itself. She is herself worried that her work might be misused by those who would completely discount any human effect on global temperatures. But her ability to publish a straightforward scientific paper has become entangled in the larger politics of global warming.

**Mineral Exploitation of the Asteroid Belt**

Other and perhaps more surprising examples exist of where ethical issues impinge on planetary science. Some of the work in planetary sciences is laying the groundwork for a perhaps still distant future when humanity will be actively working beyond Earth orbit, and the eventual raising of serious ethical issues.

For example, my own work has contributed to our understanding of the connection between asteroids and meteorites. There are many lines of evidence suggesting that ordinary chondrite meteorites can be derived from a particular spectral class of asteroid, the "S-class." We also know that many such asteroids are in orbits that pass near the Earth. Through 2008, about 5500 such asteroids have already been discovered; 750 of them are larger than one kilometer in diameter. Many of them may at one time or another pass as close to the Earth as Earth's Moon orbits now, a distance that we know we can traverse with manned spacecraft.

Consider an asteroid of 10-kilometer radius. The typical S-class asteroid has a density of about 2500 kilograms per cubic meter; so, the total mass of one such asteroid is roughly $10^{16}$ kilograms. If its composition is the same as an ordinary chondrite, it will be about ten percent metallic iron and other siderophile (metallic) elements.

Ten to the fifteenth kilograms of iron – one trillion metric tons – is a thousand times greater than the entire annual output of iron ore everywhere on Earth. The other metallic elements present in such an asteroid, such as gold or platinum, would likewise overwhelm domestic demand for such metals. Will the exploitation of mineral wealth from the asteroid belt lead to devastating disruptions in the economies of resource-exporting nations – which are, usually, poorer nations?

**Terraforming Other Planets**

The science-fictional dream of living on other worlds will eventually become a reality, even though today, forty years after the Apollo Moon landings, we must admit it is a rather more distant reality than we once might have dreamt. But as we can see in the history of settling the Americas, the availability of new land for colonization will inevitably lead to social disruptions in the "old" world. Presumably this will not include the displacement of indigenous peoples, thus avoiding the ethical issues that came with colonization in the Americas, Africa, and Australia. But such colonization of these New Worlds, unlike that of previous centuries, will only be able to occur if those planets are significantly altered to allow for the sustainable presence of human and other life. The dream of colonizing Mars usually includes creating ways of increasing its atmospheric pressure and temperature, a process called "terraforming." But under what conditions is it ethical to "terraform" a planet? Can we be certain there is no life on Mars now? Can we be sure that no life would ever arise on another planet in some future date if we did not terraform there? Do we have a responsibility to non-intelligent indigenous life, or to the potentiality of future life that does not yet exist?

**The Environmental Impact of Observatories**

Such issues are, admittedly, in the realm of science fiction. Other issues, however, are more immediate. Even an activity as passive as astronomy requires expensive equipment and telescopes in remote, often wilderness, sites. Does astronomy's need for clear, dark skies impede on other human values, including security and economic well-being?

The International Dark Sky Association works hard to restrict lighting in populated areas that impedes our ability to see the nighttime sky. But the very fact that they must work so hard indicates that there is significant resistance to their efforts. For a number of reasons, economic and psychological, many people do not want their cities to be dark. And rural property owners are often adamant in the defense of their perceived right to control the use of their own land, including the lighting on that property. To insist on dark skies for a few astronomers a hundred kilometers away is justifiable only if one sees the work of astronomy as having an intrinsic value, which is a judgement that not everyone accepts.

Telescopes on top of mountains inherently infringe on other uses of those mountaintops. In Arizona, conflicts have arisen between the desires of astronomers and those who, on the one hand, want to keep the mountaintops completely untouched by human presence, and on the other hand those who want to be able to exploit those mountaintops for logging or to build ski resorts. And in many places, including not only Arizona but also Hawaii and Chile, issues have arisen between the astronomers and the local peoples who have a traditional or religious association with the mountains on which the telescopes are posted. Resolving these conflicts is no trivial task.

Radio astronomers have encountered another sort of problem in attempting to keep clear certain parts of the radio spectrum that are in demand by commercial or navigational users. Many of those uses might involve public safety. There is a necessary ethical balance that must be resolved in such issues.

**The Legal Collection of Samples**

Many years ago, a popular song proclaimed that "the Moon belongs to everyone, the best things in life are free." But Moon rocks, at least those which have found their way to Earth, are anything but free. A thriving trade — and not always a legal trade — has arisen in the collection and distribution of meteorites, fueled by the high value placed on lunar meteorites or those of the classes which are widely believed to have come from Mars. Typical ordinary chondrite or iron meteorites generally sell for a few US dollars per gram; lunar and Martian meteorites may fetch in excess of US $1,000 per gram. With such amounts of money changing hands, shady practices are inevitable.

Some of those practices are obviously unethical, and don't require a philosopher to condemn. To steal a sample; to misrepresent a sample; to fake the provenance of a sample; all are clearly problems that anyone dealing in a collectable item, be it artwork or meteorite, will have to encounter. But in the meteorite collection business, which is the core of my own research, there also exist certain ethical issues that are more difficult to sort out.

Meteorites fall indiscriminately everywhere on Earth, but some locations are more amenable to their recovery than others. A typical meteorite, at first glance, is hard to distinguish from a terrestrial rock to the casual observer; and so falls in areas where rocks are already common can be very difficult to find. Furthermore, meteorites (as we noted above) are rich in metallic iron. This iron is general present in the form of tiny flecks, less than a millimeter across, packed inside a rock that is permeated with thin cracks. Terrestrial water vapor easily enters those cracks and attacks the metal, turning it into rust, which then expands and eventually turns the rock into powder. Thus the most fruitful places to look for meteorites are dry desert regions, and Antarctica, where the presence of any rocks is easy to spot and where this weathering process is greatly slowed down.

But both Antarctica and desert regions are subject to national and international laws that may limit or control the removal of samples.

In the case of Antarctic meteorites, the problem of "poaching" is not acute. The difficulty of getting to the meteorite-rich regions is sufficiently acute that only large scientific expeditions organized by government-sponsored science foundations can reach these samples. Such expeditions all operate under well-recognized rules that determine what materials can be removed from Antarctica, and how other scientists may access those materials.

In the case of dry desert meteorites, however, the situation is quite different. Some nations have specific laws against removal of material, including specifically meteorites, from their deserts. These laws vary from nation to nation, however, and change with time. In the United States, the meteorite is considered to be the property of the person who owns the land on which is was found; but since many meteorites are found in remote areas by collectors and dealers, it is quite easy for them to claim they found the samples wherever it is most convenient for them. For example, a sample could be said to have been found on private land where the collector has already made a deal with the owner, rather than on public parkland where the sample would, by

law, belong to the state. North African nations have only recently recognized that meteorites have a commercial value and have begun to restrict their export as "national treasures."

But most meteorites do not have any intrinsic monetary value, in terms of their mineral wealth. And scientific value is impossible to quantify monetarily. Since in fact the value of the meteorite is only what the collector market will bear, the value of such meteorites can thus be manipulated by dealers and by governments who have the power to make these samples more or less readily available to the public.

One obvious question for the meteoriticist, is if it ethical to do research on meteorite samples that may have been collected or transferred from their countries of origin in a manner contrary to local laws. The scientist in question may have had no role at all in violating the law; the law may have changed during the time the sample was obtained and so its legality may be impossible to determine. But even if the sample was clearly obtained contrary to law, there is valuable science that can be obtained by studying that sample. What is the ethical practice for a meteoriticist in such a situation?

Furthermore, that research may itself alter the value of the sample, and raise the risk of further illegal (or immoral) practices. In 1996, the possibility of fossil life was first suggested in a particular meteorite (Allan Hills 84001, found in Antarctica). This publicity caused the value of the Martian meteorites to jump by about a factor of ten, and inspired the widescale search for meteorites in the dry deserts of Africa. By showing the scientific value of these meteorites, the researchers also affected their monetary value. Indeed, nowadays meteoriticists who are called upon to certify the authenticity, and type, of purported new meteorites have found themselves facing lawsuits when the owners of the rocks don't get the answers they want to hear!

**Astronomy in a Starving World**

I end with one more personal story. Twenty-five years ago, before I was a Jesuit, I worked as a researcher at the Massachusetts Institute of Technology, modeling the interiors of the icy moons of Jupiter and Saturn. But late at night, pondering my life, I was troubled; why was I spending so much time and effort on what was, essentially, a meaningless study when people were starving in the world? Eventually I decided to leave the world of science and join the US Peace Corps. I volunteered to go anywhere in the world, and do anything they asked me to do.

The Peace Corps sent me to Africa, and they took me at my word when I insisted I was available for whatever the local populace most wanted from me. Within a few short months, I was at the University of Nairobi… teaching astronomy! And every weekend I found myself traveling upcountry to remote villages with a small telescope, showing off the stars and planets to everyone in the town.

They taught me an important lesson. Doing astronomy, wondering about what is in the universe and how it came to be that way, is a desire that is common to every culture and every race. It is part of what makes us human. Yes, there was hunger in Kenya. But there was also hunger in the soul, hunger for knowledge, hunger to be assured that they, too, could participate in the great adventure of studying the stars and planets. The Biblical phrase "man does not live by bread alone" is not a vague theological principle, but a very practical admonition to us all.

To deny people the chance to study astronomy just because of where they were born or how much they earn, is to deny them their humanity. To deny the arts and sciences that make us human, is itself a crime against morality.

## Conclusion

The point of this short paper is not to provide definitive answers to any of these thorny problems. In many cases, there is no simple answer, and local circumstances can shift the ethical balance in one direction or another.

Indeed, one can see a pattern of ethical issues that stays the same from field to field. The question of researching meteorites gathered illegally is essentially the same (though with lower stakes) as the question of doing biological research on stem cells. The question of enacting and enforcing anti light pollution ordinances is similar to the issue of mandatory vaccinations.

My intent has been merely to remind ourselves that every scientific action has a moral dimension that cannot be ignored. But that also includes the decision not to proceed with a scientific action. The choices are never easy. We will inevitably make mistakes. But to refuse to face the choices is itself always a mistake.