PHYSICS AND THE CLASSIFIED COMMUNITY

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The goals of a working physicist include making major scientific discoveries and disseminating results as widely as possible throughout the community in order to obtain the maximum recognition for one's work from one's peers. If the results of one's work are the basis for many other experiments and ideas, one is regarded as successful.

In doing physics, there are several accepted norms of behavior. Among them are:

•Share results with a peer group.

•Encourage open discussion of methods, materials and ideas.

•Familiarity with existing literature in a field and care in citing sources in all published work are the hallmarks of a good physicist.

•New ideas are validated by comparison with others' work.

•Crediting colleagues with ideas and designs is essential.

•Carefully delineating uncertainties in work is part of physics.

Any physicist who does not conform to these norms (among others, of course, such as making reliable, precise and repeatable measurements--this list is selected for purposes of this paper) finds himself isolated from the community. His work is subject to intense doubt even when it may be physically correct, and his colleagues are reluctant to talk to him about their work and their ideas.

Members of the uniformed military have different goals. Their job is to take an order and successfully conduct a mission. Discussion of orders is out of line, and secrecy is imperative since its violation may have a direct cost in human lives.

The military establishment traditionally plays by a very different set of rules from physicists. In part:

•Loose lips sink ships--talk as little as possible about your work.

•The fewer people who know a secret, the better.

•Detailed discussion of methods and materials can compromise sources.

•Splitting a project into compartments protects the enterprise from enemy espionage.

•The commander always takes both credit and blame for work of the entire group.

•Don't bother me with excuses, what is the answer?

Obviously there is an inherent tension between the military objectives and those of the physics community. The picture is incomplete without adding in the defense contractors and national labs who actually conduct much of the research done by the classified community. In this case, the physicists involved actually do the traditional type of physics; however their success is measured in patents obtained, contracts gained and competitive advantage for the organization. Their rules of behavior might read something like this:

•Talk only about those aspects of your work that can't be patented.

•Don't give information away for free if you can sell it.

•Be sure to get credit for what you have produced.

The most cursory consideration of these varying goals leads one to the realization that physics and classified work are not happy bedfellows. The problem is certainly as old as the Manhattan Project. One of the early points of contention between physicist Robert Oppenheimer and General Leslie Groves concerned technical seminars. Oppenheimer insisted that all scientific staff members needed to understand the scope of the project on which they were working. Groves wished to inform individuals of only those details that they were required to use in their daily work.

Today, Department of Energy clearances are given generically and information is released on a need to know basis. Military clearances are considerably more complex, ranked secret and top secret. Much information is compartmented data which means that you have to have a special clearance to know. This is frustrating when a job overlaps compartments and you are not cleared to enter one of them.

Working within the classified community poses a problem for those of us who are accustomed to the freedom of academia. First of all, academia is intrinsically horizontal. A full professor, can argue with anyone in the university system. Faculty opinions are understood to be their own, and professors express them freely to whomever they desire. The president of a university may be unhappy with a professor, but he can't fire one for presenting his ideas.

In the federal bureaucracy, it is imperative that the national government speaks with a single voice. Any employee of the government may be interpreted as speaking for the government. Therefore all employees must speak the party line in public whether they agree with it or not. Arguments are behind closed doors, and any eruption into public is apt to get someone fired.

There is no such thing as a good library of classified information. What exists on the data bases is usually out of date. Information exists in people's minds and their safes. To find out what is known about a problem, one must access a network of friends who may or may not take your phone calls and provide answers. From time to time, one agency will effectively forbid its members to talk to members of another agency. The rule of thumb is that if you cite your sources, you lose them.

The work in progress is swamped in a formidable bureaucracy. The top management--Congress, the White House etc. decides that the U.S. needs a position on an issue. An Interagency Group is formed usually at the assistant secretary level. The IG in turn forms an Interagency Working Group at the next level down. The Working Group tasks aspects of the problem out to each of its member agencies. The agencies involved depend on the problem under consideration: the State Department, the Department of Defense, the Arms Control and Disarmament Agency, and the Joint Chiefs are almost always involved with input from the CIA. NASA joins if the discussion has anything to do with space; the Department of Energy if it involves nuclear weapons; and the Commerce Department if it involves technology controls.

The agencies in turn task their issues out to divisions that in turn assign individual staff members the task of preparing a draft position. Writing a draft position is a little like preparing a term paper without benefit of a library. The draft position is circulated in the division, argued over and changed to suit the director of the division. The revised draft then circulates throughout the top bureaucracy of the agency. As modified, it becomes the agency position in the working group. The working group wrangles over agency positions and produces a draft that then travels to the IG.

At each step, the draft gets shorter and shorter. Options drop out and disagreements are resolved. It is axiomatic that the more power one exercises, the less time one has to study individual issues. The IG completes a draft that then goes to the National Security Council for action. The NSC, in turn, sends the document or a summary of it to the President for signature. By the time it reaches this level, the position is simple and clear. There is no room for discussion of confidence levels or error bars.

Technical issues clearly involve ambiguity. Equally clearly, this process has little tolerance for this sort of ambiguity.

The ethical guts of the issue arise when you, a physicist in the system, feel that scientific results are being distorted by your superior. If you flout the system, you run the risk of being simply ignored while taking the consequences of your disobedience at a professional level.

There is no such thing as peer review within the system. Contracts are let by agencies such as ARPA, the Advanced Research Projects Agency. ARPA is staffed with bright, young military officers, many of whom hold advanced degrees in technical areas. These young people award large sums of money and are responsible for overseeing the work of many of the best working physicists going. They do a conscientious job at their work. However, they haven't got a chance against a senior and successful working physicist, since by definition these senior people are excellent sellers of their own ideas

and very confident that they are right. Without involving an immoral act, the system allows scientific blunders of major magnitude to enter the system and even cost the government millions of dollars. Technical work produced by and for the government thus varies in quality from the sublime to the laughable.

The above analysis assumed that there were no villains in the system. It is easy to see how falsified results, lucrative job offers to contract monitors, or even over-optimistic assessments of progress can badly distort the system.

There is probably no better example of the ethical problems involved in this type of classified work than the cautionary tale of the X-ray laser. Most of the detail here comes from the excellent book *Teller's War* by William Broad (New York: Simon and Schuster, 1992) which is both very readable and very thorough. The attached table, which is also based on Broad's data, summarizes the story.

Essentially, in the early 1980's Edward Teller, a physicist with a long track record of military research and development including invention of the hydrogen bomb, used his direct access to President Reagan to promote the x-ray laser pumped by a nuclear explosion as the answer to the nation's need for a defense against intercontinental ballistic missiles. Teller's optimism was based on early tests of the system that seemed promising. Further analysis of these same tests showed that the results might not be as encouraging as they seemed at first.

More conservative physicists within the system who studied the tests felt that Teller's assessment of the potential for the x-ray laser were over-optimistic. In particular, Roy Woodruff, a physicist who was associate director of Livermore National Laboratory for Nuclear Design, feared that the President would be misled by Teller's statements if they were not qualified by the judgment of other physicists in the system. Woodruff at first tried to work within the system to bring about a reevaluation of the x-ray laser without embarrassment to Teller, who was after all the founder of Livermore. The system listened and did nothing.

In March, 1983, President Reagan committed the United States to a massive research program aimed at the construction of working defenses against ICBMs. The Strategic Defense Initiative or SDI was funded heavily, and the x-ray laser formed a major element in early discussions of defenses. Teller and his deputy Lowell Wood continued to present optimistic briefings on experimental progress with the x-ray laser to the highest levels of government.

Meanwhile a variety of experimental results seemed to Woodruff and others to question the validity of even the initial experimental results. In particular, the brightness of the laser was measured by reflecting x-radiation off mirrors to protect sensors from the effects of the nuclear explosion used to pump the x-ray laser. New results indicated that the mirrors themselves were radiating because of their interaction with the effects of a nuclear explosion so that the brightness measurements for the laser were much higher than they should have been. In addition, Teller's briefings used preliminary results from tests and slanted the results in favor of the x-ray laser. Woodruff became increasingly frustrated with his inability to correct what he felt was the mistaken impression of the x-

ray laser's success that Teller presented. Teller used his direct access to President Reagan to block Woodruff's corrections at every turn and was supported by the director of Livermore, Roger Batzel.

In October, 1985, Woodruff felt he had no option except to resign his position as associate director in protest. His resignation was accepted. At this same time, the press finally broke the story that there were questions about the success of the x-ray laser. Woodruff found himself facing a major reduction in salary. He was given no meaningful work and an office the size of a broom closet, known in-house as Gorky West. Finally in April, 1987, Woodruff filed two protests against his treatment with the University of California which operates Livermore National Laboratory. A university panel upheld one grievance, but the General Accounting Office supported the laboratory and accused Woodruff of taking secret letters home and claiming membership in Phi Beta Kappa falsely. In May, 1990, Woodruff left Livermore to work at Los Alamos National Laboratory.

The complex history of the x-ray laser illustrates three major issues in the ethics of doing physics within the classified community. First, the data under debate cannot be presented to the physics community at large for a judgment of their validity. As long as the data can't be checked, the argument over what they mean will necessarily be clouded by uncertainty. After all, any physicist who advances an argument without seeing the data is just presenting a good guess at what the data show. Because the participants in the debate can't present data, they say to the public, "Trust me. I'm the smart, good guy here!" Political decision makers are generally not scientists, and their reactions to such a debate depends on whom they trust. President Reagan has never been accused of possessing an in-depth understanding of nuclear physics. There is no provision for peer review within the classified system.

Second, a physicist within the classified community is torn by divided loyalties. Scientists working on weapons development are loyal to their colleagues and the teams for which they work. To publicly accuse another member, particularly a leading member of your own team of making mistakes, damages your team in the vital game of securing funds for its operation. Thus such an action violates the principle or loyalty and involves an intrinsic ethical conflict. Of course the professional consequences for whistle blowers are frequently severe. Thus the watchdog must face his own divided loyalties as well as the probable damage to his professional status arising from his actions.

Last, the history of the x-ray laser illustrates the difficulty in telling a mistake in science from a deliberate fraud. Teller had little to gain except prestige from his position on the x-ray laser. Could he really have misinterpreted the results of the tests? As in many other case studies in scientific ethics, this question remains both critical and unanswered.

Issues of scientific ethics become even more complex within the classified community because of the intrinsic conflict between the openness demanded by science and the secrecy needed for military operations. The ordinary processes for scientific decision-making are suspended by the need to keep data from the scientific community and the discouragement of open debate and argument. Because these technical issues

impact both political power and enormous sums of money, the temptations to falsify or distort results can be very great. A system is needed to police the classified technical community, but as yet, no one has been able to devise one that meets the needs of all the constituencies involved.

A History of the X-ray Laser

March 1968	Spartan Interceptor tested at Kwajalein
1969	First antimissile debate (Safeguard)
1975	Grand Forks completed ($7 billion)
1976	Grand Forks mothballed
1978	Diablo Hawk--failed test of x-ray laser
1980	Woodruff associate director of Livermore for nuclear design
November 1980	Dauphin-test including Hagelstein's design--Wood declares immediate success--Excalibur-data ambiguous
1981	R Program established to develop x-ray laser
September 1981	High Frontier Group formed
January 1982	Briefing to Reagan supporting x-ray laser + antimissile defenses
June 1982	R Program officials present conservative briefing to Frieman panel-6 years & $1 billion to feasibility + decade of engineering development
September 1982	Teller gives private briefing to Reagan: x-ray laser deployed by 1989 or earlier
December 1982	Teller and Woodruff clash on timetable
February 1983	Joint Chiefs endorse antimissile defense but not major strategic shift
March 1983	Reagan's Star Wars Speech
March 1983	Cabra x-ray laser test-failure because data garbled
October 1983	Fletcher Report delivered-$1 billion for x-ray laser but showed it had major problems with deployment; funding to determine feasibility

December 1983	Romano test-length of rods vs. gain showed x-ray lasing One week later, Teller writes very optimistic assessment to Keyworth claiming quantitative agreement with theory--no copies to others Woodruff challenged-qualitative not quantitative-drafted follow-up letter--Batzel scrapped letter
January 1984	Woodruff sends "results letter" to Keyworth--Laser's shape and color in quantitative agreement--brightness only qualitative
February 1984	Woodruff meets with Keyworth-Maenchen questions interaction of sensors with bright laser beams-glowing reflectors
August 1984	Correo Test by Los Alamos-false brightness from interaction of sensors with bomb--Maenchen presents secret theory describing false brightness from interaction
October 1984	Wood presents Super Excalibur to Abrahamson
December 1984	Teller writes Nitze and Macfarlane stating that they have made a breakthrough--Woodruff out of loop Woodruff drafts clarification: more technical breakthroughs + antisatellite problem + time Batzel blocks because nothing in Teller's letter violated physics
January 1985	Kerr (Los Alamos) would fire Teller Batzel and Woodruff defend Woodruff ordered to increase x-ray laser budget at expense of other weapons programs
February 1985	Woodruff goes public protesting funding and wins
March 1985	Bethe and Drell not impressed
March 23, 1985	Cottage test-one sensor modified to look at brightness problem-Teller hailed as success
April 1985	Wood gives series of briefing extolling x-ray laser

June 1985	Teller visits White House Los Alamos report on glowing beryllium reflectors
September 1985	Teller overrules Woodruff at Pentagon meeting-scientists leave R program
October 1985	In letter to Batzel, Woodruff charges Teller with distorting facts to sell x-ray laser--does not send letter--situation beyond repair
October 31, 1985	Woodruff resigns-publicity on brightness breaks
December 1985	Goldstone test in spite of bent canister showed brightness less than expected by factor 10
February 1986	Batzel suggests reduction in Woodruff's salary--Gorky West days
September 1986	Labquark-focusing seemed to work
April 1987	Delamar-focusing really edge of annulus Woodruff files two protests with University
September 1987	University panel upholds second grievance
October 1987	Woodruff story leaks to the press
December 1987	Woodruff promoted to treaty verification
February 1988	Nuckolls appointed Livermore director supports Teller
July 1988	GAO Report supports Teller's position. Substantial agreement between Teller and Woodruff
1989	Attacks on Woodruff for false claims of Phi Beta Kappa and secret letters at home
May 1990	Woodruff to Los Alamos

DISCUSSION

Some indicated that the Strategic Defense Initiative was clearly useful only in adding to the offensive capabilities of the United States while adding little of significance to the defensive capabilities. Others suggested that these issues were not so obvious, pointing to the amount of work that was required for the American Physical Society's Directed Energy Weapons study.

Was the idea of an impenetrable shield ever a defensible idea? Was the shield concept originally a physicist's idea or did it come from a politician? These two questions address the role of physicists as technical advisors. First, there is the desire among physicists to provide sound technological advice, where required. It may be that this advice was not solicited or was overlooked in formulating the impenetrable shield concept. Second, when physicists do offer advice to elected officials, one would assume that the advice is based on technical analysis. However, is it possible to be entirely scientifically objective in delivering such advice, or will political opinions necessarily color one's analysis? How often are technical opinions tempered by the desire not to make waves so as to maintain one's position of influence? To what extent is an advisor responsible for trying to purge political bias from technical advice?

How many physicists compromised their personal beliefs regarding SDI to accept funding from that program? Does one need to agree with the long term objectives of a program such as this one in order to pursue funding from it? One could argue that it is up to our elected government officials to make decisions regarding objectives, and that scientists are responsible for providing technical services as requested by the government. On the other hand, even decisions made by an elected government do not always represent the will of a majority of the population. Furthermore, it is not clear that a scientist, who may be familiar with the technical details of a particular program, should use popular opinion as an excuse to avoid an examination of the implications of the program.

If a physicist believes money is being improperly allocated to a program such as SDI, is it ethical to solicit such funding with the intent of redirecting it to other more palatable uses? Although such a misdirection is likely to be the result of the scientist misleading the agency providing the funding, the scientist may view this misdirection as a service to the country by promoting better uses of its limited resources. Is this approach undemocratic?

Given that the principle of openness seems to be fundamental to the academic setting, is there an inherent problem in the University of California managing a lab such as Livermore where so much of the research is classified?

It would appear that in the present state of affairs it is quite easy for technical advice from a physicist to the government to be altered, ignored, or misrepresented. If the physicist is employed by the government, there seem to be just two choices: shut up or resign (and then speak out to the extent that classification requirements are not compromised). Are there any other choices?