Congratulations to J. Murray Gibson for his much needed comments on the arrogance of some physicists. Let me give a specific example of such arrogance, heard during a lunch conversation at Bell Labs in the good old days. A very senior administrator of research commented about the Nobel Prize–winning chemist Peter Debye: "He could not have been that good a scientist or he would have become a physicist."

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To have, in the same issue, articles about the joy of physics and the privilege of being a physicist, on the one hand, and even a hint of the glorification of arrogance in physicists, on the other hand, represents a cruel irony. Victor Weisskopf would not be happy with that juxtaposition! There is nothing positive about arrogance. For every putdown artist among the greats of physics, such as Wolfgang Pauli, there were warm and humane greats, such as Enrico Fermi and Albert Einstein.

Arrogance is not a sine qua non for great accomplishment. In my own career, I have had wonderful experiences with great scientists who were kind, mentoring, and supportive, as well as unpleasant, and even shattering experiences with others, ruthless prima donnas whose behaviors have been very destructive. There is a close connection between arrogant wunderkinder and the incidents of fraud that have recently plagued physics research.

Many physicists have bemoaned the reduction in funding and prestige in our field during the past decade or so. For a premier physics magazine to print an article extolling the value of arrogance does not constitute good public relations in the battle to maintain the health of our science.

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Physics is not as arrogant a trade as J. Murray Gibson claims. My dictionary calls arrogance "unwarranted pride," and I warrant that our trade is somewhat justified in being proud of its accomplishments.

In Drexel University's course on science and religion, taught by a trinity of one campus minister, one physicist-philosopher, and one humble physicist, I emphasize what I call the principle of scientific humility—that integral to science is our express lack of knowledge. That lack is clear in physical measurements, each one of which has an attached uncertainty, colloquially called an "error." In precision work, two errors are often given for a measurement: one covering experimental errors and one covering systematic errors. We ask students to find other areas of human endeavor in which uncertainties are similarly openly displayed.

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Although I am impressed with J. Murray Gibson's courage to abjure humility and lecture us on the evils of misplaced arrogance, I hold that there is a little more, and very much less, to be said on that topic. Even as we physicists must be arrogant to box with God as we do in our exploration of His creation, we have to be humble in considering possible errors in our conclusions. Our answers must be correct; our colleagues are—properly—unforgiving of error.

Contrary to Gibson, I don't find that the "me teacher, you student" arrangement that goes back at least 5000 years to Ur of the Chaldees is insufferably arrogant. Nor is it arrogant to hold that a particular formal mentoring program that Gibson espouses, one that extends beyond our present traditions, might do more harm than good.

Then Gibson confuses political correctness with humility and considers that our arrogance contributes to our "severe underrepresentation of women and minorities" and adds "Since I do not believe that white males have an intrinsically higher ability in physics than other groups have, I think we might have a problem in our profession." Years ago, at a small conference held to address the barriers women meet in science, a prominent astrophysicist suggested that we should regard those barriers as dismantled only when 50% of scientists were women. Ruth Bader Ginsburg then asked if, at that time, we should expect that only 3% of scientists be Jewish!

The varying representations of different races, genders, and ethnic groups in science, arts, sports, commerce, and other fields surely follow from causes outside of physics or any perceived arrogance of physicists.

Overall, one must not equate arrogance with disagreement with Gibson—or even with me.

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I use my own arrogance to criticize J. Murray Gibson's Opinion on arrogance. Gibson misses one important point: Never ascribe to arrogance what is more properly described as stupidity.

Gibson quotes otherwise "rational and intelligent scientists" as saying, "Just show me a well qualified XXX [woman or minority] and I will hire him or her on the spot—I have no bias." He calls such a statement classical arrogance. I use my arrogance to claim that anyone who says such a thing cannot be a good scientist. A good scientist does not dismiss a question by claiming to know the answer; he answers the question by asking another question. Science progresses when people find the right questions.

The right question with regard to groups underrepresented in physics is, Why are there no qualified XXXes available?

I started asking questions about women in physics after being annoyed by Steven Goldberg's article, "Numbers Don't Lie: Men Do Better Than Women," in the 5 July 1989 *New York Times*. The author noted that men do better than women on the mathematics portion of the Scholastic Aptitude Test and jumped to conclusions about a possible physiological basis.

I recalled an arrogant old saying, "Figures don't lie, but liars can figure," and I started asking relevant questions.

Why are so very many of the successful American women scientists and mathematicians born outside the US? Why is it hard to find American-born women in nuclear and particle physics of comparable stature to the enormous number of successful American women in those fields who were born outside the US?

I noted Maria Goeppert-Mayer, C. S. Wu, Gertrude Scharff-Goldhaber, Fay Ajzenberg-Selove, Noemie Koller, Sulamith Goldhaber, Juliet Lee-Franzini, Sau Lan Wu, Inga Karliner, and so on. There are exceptions: Nina Byers and Glennys Farrar are American-born. I may have missed some others, but the asymmetry is still striking. I thought that I had finally found a top American-

born woman particle theorist in Helen Quinn, until I learned that she was Australian.

Why is the ratio of women to men in physics much higher in France, Italy, and Poland than in the US? Do European women do better in primarily Roman Catholic countries than in Protestant ones? Is the greater success of European women because they had Marie Curie as a role model, or because the Virgin Mary is so important in Roman Catholic culture?

Why is there apparently such a large number of women mathematicians and engineers among the Soviet Jewish immigrants to Israel and the US? Why was one of those the only woman with a tenure position in a large leading American university mathematics department?

Perhaps one must look back much earlier than university or graduate school to understand the problem. Are subtle prejudices and sociological factors in American culture crucial at high-school and perhaps even at elementary school levels?

These are the questions to ask; they will lead us to serious thinking and perhaps to finding some answers. It is a copout and a deflection to say, "Just show me a well qualified XXX and I will hire him or her on the spot." Bias is not the problem.

Some of my women physicist friends who were born outside the US confirm that the problem begins quite early. One who immigrated from Europe to America when she was in high school said that she was considered peculiar in the US, because "girls were not supposed to be smart." Another said that the best road to success for a woman physicist would be to start her education in Europe and move to the US at a later point in her career. Girls who wanted to be physicists had a much easier time in Europe until they hit a point on the academic ladder where there was real discrimination. At that point, they could do much better in the US.

The moral: Be arrogant. But ask the right questions. If you are sure you know the right answer, you are probably stupid, not arrogant.

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Gibson replies: I appreciate the healthy response to my Opinion piece. The writers added many valuable insights, and several echo my sentiments. My original piece was intended as a condemnation of the behavior that most of us would identify as arrogant. Most of the disagreement is due to semantics concerning the meaning of the word *arrogance*. I came not to praise arrogance, but to bury it.

Admittedly, the word arrogance is technically inaccurate to describe the positive behavior that I defended. My poetic license may have confused some readers. The dictionary definition of arrogance suggests overbearing behavior based on inappropriate views. "High degree of self-confidence"—Richard Noer's phrase—or even *assertive* may well be more accurate to describe the positive side of arrogance. Because arrogance and self-confidence seem intimately related even though one is bad and the other is good, I chose to blur the distinction.

Physicists are, as Leonard Finegold observes, more open than other professions to admitting uncertainties. We physicists have much to be proud of, but for our own sake, we need to admit our weaknesses.

I disagree with Robert Adair's comment that the varying represen-