

# PHYSICS

## Modern Physics in the Spirit of the Jesuit Tradition

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Modern science has a tendency of being presented as the existence of facts found in nature. The pursuit of knowledge for the sake of the greater good is often not considered in the light of the search for fundamental truth. As technology continues to grow, impressively opening windows to new areas of research not previously realized, one must take into consideration the impact on society as a whole. It is here at Xavier University that we can create the environment that is “dedicated to engaging and forming students intellectually, morally and spiritually, with rigor and compassion, towards lives of solidarity, service and success.” With the topics presented in Modern Physics, excellent opportunities arise to illustrate the ethical and moral implications inherent in this pursuit of knowledge.

Modern Physics (Phys 330 & 340) is a year-long course typically consisting of sophomore physics majors. The course addresses the important physical discoveries from 1890 to the present. Topics covered include Einstein’s Special Relativity, Bohr’s model of the hydrogen atom, quantum physics phenomena, radioactivity, nuclear reactions, high-energy physics, and fundamental particles. Due to the exponential growth of technological advances, there have been more breakthrough physical discoveries in the last century than there has been in previous millennia. The rigorous and ambitious objectives set in the course description truly limit the available time to have quality in-depth discussions concerning all of the moral repercussions involved in Modern Physics. As a result, the current international heated topic of nuclear power, both in electrical supply and weaponry, was the focus of our discussions.

Text books for the modern sciences thoroughly cover the scientific aspects of nuclear power but fail to address any moral implications, therefore, class discussions are included to increase the scope of the course. The time allotment for such discussions was originally set for one fifty minute class period. Due to the enthusiastic response from the students and excellent discussion, several class periods were required for the exercise. Before any such discussions began, the issue of respect was thoroughly emphasized due to the heated topics addressed. The students were also instructed to put themselves in the shoes of the scientists working on the projects, not as outsiders looking in. This point of view gained by such instruction lead to extremely insightful discussion. As the facilitator of the discussion, I played the role of devil’s advocate trying to challenge the students to critically think about their comments in the discussion. It is with this challenge that the students appeared to dive deeper into the topics.

The first topic addressed was the use and control of nuclear energy. To begin the discussion, several challenging questions were posted for all to review and consider. The questions were as followed:

- Is nuclear energy a safe and viable option?
- What is the environmental impact of nuclear energy?
- As nuclear power facilities reach their life expectancy, should they be allowed to continue to operate?
- Would you want a nuclear power plant in your city?
- Can nuclear power assist the socioeconomic status of troubled countries?
- Can we responsibly supply the technology needed to these countries?

These questions were not intended to inject my personal opinion, merely to ask the hard questions that the students must address and consider. Each question stimulated more in-depth responses but the attitude of the class changed significantly when discussing the last three questions. In order to have the students understand the significance of this topic, I introduced them to the nuclear facilities close to Xavier. Discussing facilities such as the Davis-Besse Power Plant in Toledo and the Perry nuclear power plants located in Cleveland illustrated that these issues are relevant to each and every student’s lives. To bring the issue even closer to home, we discussed the history of the Zimmer Power plant and how it related to the mistakes made at Chernobyl and Three Mile Island. The implications of the new Piketon Nuclear Power Plant, which is only 90 miles away from Xavier University, were also discussed. The overall sentiment of the students was that nuclear power plants have an overall good effect but they didn’t want them in their back yards.

The final two questions of the topic brought forth intriguing discussions. At the time of the discussions, the United Nations was attempting to control the Iranian procurement and control of nuclear enrichment facilities for the purpose of nuclear power and potentially weaponry. It became clear that most of the students had not critically thought about the implications or moral justifications for or against Iran obtaining the nuclear technology. Some students believed that the best solution was for the United States to build the facilities and control them at all costs. It soon became evident that this may not be a viable option and the complexity of the situation frustrated the students. This discussion was finalized at the end of the class period and nuclear weaponry was resumed in the following class.

The use and control of nuclear weaponry was the second topic addressed. To begin the discussion, three short video clips were shown to prepare the students for the discussion. The first two clips were that of the Nagasaki bomb explosion, and the released military video of the aftermath of the Hiroshima bombing. The final video clip was that of J. Robert Oppenheimer discussing the attitude of the scientists on the Manhattan project after the first successful test of a controlled nuclear explosion. These clips visibly upset the students and illustrated to them the severity of the nuclear weapon discussion. Just as before, the same discussion technique was used and the questions were as follows:

- Do you, as a scientist, need to consider the moral implications of your scientific research?
- Placing yourself in the shoes of the scientists of the Manhattan project, would you have completed the work on nuclear weapons?
- Is the use of nuclear weapons necessary?
- Do we still need to build more nuclear weapons?
- Do other countries have a right to advance their nuclear weapon programs?
- Do we have an obligation to share the technology with other countries?

These topics were by nature much more controversial and this fact showed in the discussions. The students quickly came to a heated discussion on the use of nuclear weapons and the building of the nuclear arms race. Being of the generation where the Cold War is something of the past and only discussed in text books, several students did not understand the need for the building of our own nuclear weapon stock pile. I personally found this rather eye-opening and was happy to hear the responses from other students. One student went as far as to research the topic and was happy to supply the class with several uncommon facts behind the fight for the first nuclear weapon. The last two questions introduced to the students once again challenged them to discuss the current events.

At the end of the two-class exercise, the students were presented with two comments from the father of the Manhattan project J. Robert Oppenheimer. After the end of WWII, he stepped down from the nuclear arms program due to his moral convictions, and the project went on without him to develop the hydrogen bomb. I personally believe that these two statements truly brought home the message to the students.

“If you are a scientist you believe that it is good to find out how the world works; that it is good to find out what the realities are; that it is good to turn over to mankind at large the greatest possible power to control the world and to deal with it according to its lights and values.”

“[W]e have made a thing, a most terrible weapon, that has altered abruptly and profoundly the nature of the world. We have made a thing that, by all standards of the world we grew up in, is an evil thing. And by doing so, by our participation in making it possible to make these things, we have raised again the question of whether science is good for man, of whether it is good to learn about the world, to try to understand it, to try to control it, to help give to the world of men increased insight, increased power. Because we are scientists, we must say an unalterable yes to these questions; it is our faith and our commitment, seldom made explicit, even more seldom challenged, that knowledge is a good in itself, knowledge and such power as must come with it.”

By the end of the two-day discussion, several comments truly exhibited the significance of this effort. Student comments such as: “If we don’t do it, who will?”, “Who would be better to do the job than those who have morals and consider the ethical implication of the research” and “If we were in the shoes of those working on the Manhattan project, if we quit to demonstrate our vested interest in the nuclear weapons program, the program would still go on without us and those who continue the work may or may not consider the impact on society.” These comments alone highlighted the importance and significance of our jobs as Xavier University professors to ask the hard and challenging questions to our students. These discussions emphasized the need for us to continue to be “dedicated forming students intellectually, morally and spiritually, with rigor and compassion, towards lives of solidarity, service and success.”