Spring 2009 CORE 103 - The Process of Change in Science

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Lectures: Tuesdays & Thursdays 9:30-10:50, THH 114
Recitations: Fridays 10:00-10:50 or 12:00-12:50 (pick one), THH 112
Office Hours: Tuesdays 3:30-5:00

Course Summary

Welcome to CORE 103. The aim of this course is to investigate how scientific revolutions come about, understand their historical and philosophical context, learn how they impact society and technology, and examine the resulting shift of boundaries between science and our world view.

In contrast to more conventional introductory courses to the sciences, here we take a much broader view, however with an emphasis on the physical sciences, since my own training is in theoretical physics. In order to fully appreciate scientific developments, we will start with a crash course in physics, based on the self-study guide by Kuhn, and we will try to do everything with as little mathematics as possible.

In this first part of the course, we will discuss the main concepts of physics, so that when your kids ask you why the sun is so hot or how hard is it to make an atomic bomb you'll be able to give them a reasonably coherent answer. Your kids will then have more respect for you and might not lie to you as often. We will study the emergence of mechanics in the 18th century, electromagnetism and thermodynamics during the 19th century, and relativity and quantum mechanics in the 20th century, which mark some of the most important moments in the history of science. And of course we will take a close look at topics of current interest, such as nanoscience, chaos and quantum information theory.

In the second part of the course, we will examine the interfaces of science with other realms, such as religion, art, philosophy, engineering and society. The four assigned books are selected among the finest popular-science writing. Two of them are by experts in their own fields (Aczel; Lorenz), the two others are by brilliant science writers (Bryson; Sagan), who write about many other things as well. This will help us to gain a perspective on the boundaries between disciplines, how they move over time, and how science nerds look at the rest of society.

Since there is no shortcut around the hard work of properly studying science, the implicitly given crash course and the assigned popular-level reading material can of course not replace the serious stuff! The reading could rather be compared with phrase books for a foreign language. One should not underestimate the power of good phrasebook! During a trip, it opens many doors, leads to cultural insight, and above all, it can give immense pleasure. Similarly, in this class we will encounter and learn about real science. The experience will not be easy, but it should be interesting and enjoyable. And most importantly, your instructor is here to help!

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Required Reading

Karl F. Kuhn. Basic Physics: A Self-Teaching Guide. New York: John Wiley & Sons, 1996. (Paperback). ISBN: 0-471-13447-3 (Estimated Price, new: $ 15)
Amir D. Aczel. entanglement: the greatest mystery in physics. London: Plume (Penguin), 2003. (Paperback). ISBN: 0-452-28457-0 (Estimated Price, new: $ 15)
Edward N. Lorenz. The Essence of Chaos (The Jessie and John Danz Lecture Series). Seattle: University of Washington Press, 1996. (Paperback). ISBN: 0-295-97514-8 (Estimated Price, new: $ 15)
Bill Bryson. A Short History of Nearly Everything. New York: Broadway Books (Trade Paperback) ISBN: 978-0-7679-0818-4 (0-7679-0818-X) (Estimated Price, new: $ 15)
Carl Sagan. The varieties of scientific experience : a personal view of the search for God. Penguin, ISBN 1594201072 (Estimated Price, new: $6)

Detailed Schedule & Reading Assignments

January 12 – 18	What is Science? Is the "scientific method" they teach you in school the way it really works? What has your exposure to science been so far? How do you view scientists and how do they see themselves? Mechanics: Forces & Newton's Laws of Motion. (Kuhn pp. 1-23)
January 19 – 25	The search for symmetry. Is there a formula for the Universe? Elements of science: reductionism, predictivity, quantitative vs. qualitative understanding of processes in nature. Conservation Laws, Gravity. (Kuhn pp. 24-40)
January 26 – February 1	The Relativity Revolution. How did Einstein come up with it? Was the time ripe for it, or did he pull it out of a hat? How about scientific revolutions in general – are they driven by individual or collective efforts? Special & General Relativity. (handouts)
February 2 – 8	Particles and Astronomy. What is everything made of? Let's take a historical view of how our current picture of nature evolved. What is the evidence for heliocentric astronomy? What is the evidence for the Big Bang? Wave motion, sound, light (Kuhn pp. 103-137,270-288)
February 9 – 15	The Quantum Revolution. Is it a particle or a wave? Experimental evidence for the quantum nature of matter. Which aspects of quantum mechanics are relevant for everyday life? How was early quantum theory received by the scientific community? Light and quantum mechanics. (Kuhn pp. 197-230)
February 16 – 22	The High Tech Revolution. Gizmos. How I grew up (radio, black & white TV) vs. how you grew up (video games, PCs and such). How do these things actually work? Can you fix it, or do you just buy a new one when it's broken? Electricity. (Kuhn pp. 138-163)
February 23 – March 1	We will keep this week as a buffer, in case some of the previous topics take a little longer to cover than anticipated.
March 1 – 8	Midterm Preparation & Midterm March 5.
March 9 – 15	The end of scientific disciplines as we know them. When is it Science and when do you call it Engineering? Healing cancer vs. understanding string theory. Nanoscience and quantum information theory.
March 16 – 22	Spring Break – Yeah!
March 23 – 29	Science and Society. How is science perceived by society? What is the image of scientists, and how realistic is it? What is the political impact of scientists? And how do scientists view society?
March 30 – April 5	Philosophical aspects of science. Introduction to quantum mysticism relativity and ether garble. The rift between philosophy of science and actual science.

April 6 – 12	Religion and Science. The question of why. How do various religions view science in general and particular aspects of it? And how scientists view religion?
April 13 – 19	Science Fiction. Do you know how many scientists got into what they are doing because of Star Trek? How much does the science part matter in books and movies? What common stereotypes are used for scientists, and how much are they rooted in reality?
April 20 – 26	The Arts and Science. We will look at examples of science inspired art and music, and examine how scientific content can be represented in non-verbal forms.
April 27 – May 3	We will keep this week as a buffer, in case some of the previous topics take a little longer to cover than anticipated.
May 4 – 10	no class
May 11 – 17	Final Exam May 12, 8am

Grading

Your course grade will be determined according to your performance on:

Homework (25%)
Midterm exam (25%)
Final exam (25%)
Term paper (25%)

Homework

There will be weekly homework assignments posted on our course website. You are encouraged to work together on the problem sets. (In fact, the best way to make sure you understand how to answer a question is to see if you can explain it to someone else.) However, the final submission must be your own. Don't submit work that is not yours.

Other Resources

- Our class has its own web site at http://blackboard.usc.edu. The site will contain homework assignments, solutions, scores, and other information. You can log into that site with your USC username and password.
- For additional help, TAs are available in SGM 412, 9 am to 4 p.m., Monday -Thursday. See the schedule at http://physics.usc.edu/Undergraduate/TAofficehours.html.
- Your TA also has office hours; ask him for details.

Students with Disabilities

Students who need accommodations based on a disability are required to register each semester with Disability Services and Programs. In addition, a letter of verification to the instructor from Disability Services and Programs is needed for the semester you are enrolled in this course. If you have any questions concerning this procedure, please contact the course instructor and Disability Services and Programs at 740-0776, STU 301.

Important Dates for Spring 2009

January 9	**Last day to register and settle without late fee**
January 13	First class for CORE 103
January 12-16	Late registration and change of program
January 30	**Last day to register and add classes and last day to drop with mark of "W"**
January 30	**Last day to drop a class without mark of "W," except for Monday-only classes, and receive 100% refund**
March 5	**Midterm**
April 10	**Last day to drop a class with mark of "W"**
March 16-21	Spring recess
May 1	Spring semester classes end
May 2-5	Study days
May 8	**Final exam – Tuesday, May 12, 8:00 a.m. – 10:00 a.m.**