Course Summary: "Einstein for Everyone"

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http://strangebeautiful.com/lmu/2014-summer-lmu-einstein.html

Summer, 2014
Th. 14:00–16:00 C.T.
Ludwigstr. 31, 021

Contents

1 Course Description

This course considers the work of Albert Einstein, focusing on the theories of relativity. Mathematics will be kept to a minimum, and no physics background will be assumed. The course starts with special relativity, as formulated by Einstein in 1905. We will discuss Einstein's two postulates and explore their strange consequences for the behavior of measuring rods and clocks, and explain the meaning and importance of the relativity of simultaneity. In order to answer the question of how Einstein discovered special relativity, we will look at the historical context of his work, showing how it related to 19th century physics. We will also consider various consequences of the theory, such as $E = mc^2$, and alleged paradoxes (such as the twin paradox). We then turn to Einstein's most striking achievement, the general theory of relativity (1915). This theory is based on the remarkable idea that spacetime is curved. We will develop the background needed to understand this concept and the other basic ideas of the theory, and consider consequences of the theory related to cosmology and black hole physics. We will also consider Einstein's innovative path to general relativity as exemplifying an effective critical analysis of a physical theory. The course will close with a brief discussion of Einstein's important contributions to the theory of statistical mechanics and Brownian motion, and to the development of quantum theory and his later criticisms of it.

This course has two main objectives. The first is to give students the background needed to appreciate Einstein's contributions to physics and the broader implications of his theories. The course is structured to introduce students, using a minimum of physics and mathematics, to the basic conceptual puzzles of 19th century physics that Einstein confronted and resolved. The second goal is to provide students with an example of creative achievement in science, and an understanding of how Einstein discovered relativity. The course will characterize Einstein's philosophical approach to physics.

2 Texts

The following texts are required.

1. Mermin (2005), *It's About Time: Understanding Einstein's Relativity* (available at any decent academic bookstore or online bookseller)

2. Geroch (1981), *General Relativity from A to B* (available at any decent academic bookstore or online bookseller; there is a scanned copy for download on the course website)

3. Norton (2013), *Einstein for Everyone* (available online for free download, see References section for URL)

Some further required reading will be posted on the course website. Suggested readings will be available in reserved books at the university library or by looking up the articles in journals on your own.

3 Requirements, Expectations and Evaluation

The course is worth 9 ECTS. The grade for the course will be determined by a 12–15 page term paper due September 19. I will give out suggested topics for the paper near the end of the term. Students are free to write on toics other than the ones I suggest, so long as they come talk to me about it first.

I will assign 10 sets of homework problems over the course of the term, and I strongly encourage students to complete them, but they will not count towards final evaluation of the grade.

Finally, while I allow the use of laptops and other such devices in the class room for the purposes of reading texts and taking notes, if I ever catch a student using such a device during lecture for any reason not directly related to the course (*e.g.*, email, browsing the web, playing a game, and so on), that student will be summarily ejected from the class room and will automatically fail the course.

Students wishing to audit the course should consult with the instructor prior to or during the first week of classes.

References

Geroch, R. (1981). *General Relativity from A to B*. Chicago: University of Chicago Press.

Mermin, D. (2005). *It's About Time: Understanding Einstein's Relativity*. Princeton, NJ: Princeton University Press.

Norton, J. (2013). Einstein for everyone. http://www.pitt.edu/~jdnorton/teaching/HPS_0410/chapters_2013_Jan_1/index.html.