Course Summary
"The Philosophy of Space, Time and Spacetime"

Dr. Erik Curiel
Erik.Curiel@lmu.de
office: Ludwigstr. 31, R126
office hours: by appointment

course website:
http://strangebeautiful.com/lmu/2015-winter-space-time-st.html

Winter, 2015–2016
Wednesdays, 12:00–14:00 C.T.
Ludwigstr. 31, 021

1 Course Description

Space and time are among the most basic concepts in humans' shared intellectual equipment. Space is what we live in moment by moment and move through. Time is composed of those moments, and those moments pass sequentially, flowing equably forward. What could be simpler? The answer to that question, I will try to convince you in this course, is: almost everything else. St. Augustine himself gestured at this when he famously remarked about time (*Confessions*, book XI), "What, then, is time? If no one ask of me, I know; if I wish to explain to him who asks, I know not."

Space and time (and their love-child in relativistic physics, spacetime) are exquisitely complex, subtle and delicate notions, whose investigation and analysis ramify into essentially every major topic in metaphysics and ontology—the nature of space and time themselves, the nature of change and motion, causality, the identity of physical systems at a moment and over time, how physical systems are to be classified into different species, the nature and possible existence of mathematical structures, and so on. St. Augustine again indicated the richness of these ramifications in what he said immediately subsequent to the above passage: "Yet I say with confidence, that I know that if nothing passed away, there would not be past time; and if nothing were coming, there would not be future time; and if nothing were, there would not be present time."

In this course we will focus on four topics:

1. the classical 17th century debate about the nature of space among, primarily, Newton, Huygens, Leibniz and Clarke
2. the elaboration and extension of the classical debate in the 19th century primarily at the hands of Riemann, Helmholtz and Poincaré, based on the revolutionary developments in mathematical and physical theory

3. the radical change in our conception of the nature of time, and in particular in our notions of simultaneity and becoming, required by the advent of Einstein's theory of special relativity, and the subsequent problems with understanding the idea of "becoming" (or "change")
4. how the even more radical conceptual changes forced on us by the theory of general relativity change not only the terms of the classical debates, but possibly even the questions it is cogent to formulate and investigate in the first place

No prior knowledge of physics will be assumed, though an acquaintance with basic classical Newtonian mechanics (*e.g.*, Newton's Second Law: force equals mass multiplied by acceleration, $\vec{F} = m\vec{a}$) will be helpful. Students should have a basic knowledge of algebra and geometry, at the level expected of a Gymnasium student.

2 Structure and Evaluation

The class period will begin with approximately one hour of lecture by Dr. Curiel covering the required reading for that week. In the final half hour or so, the class will engage in informal seminar-type discussion, based on study questions Dr. Curiel will send out every week.

The course is worth 9 ECTS. The grade for the course will be determined by a 16–18 page term paper, due sometime in the spring of 2016 (exact date to be determined later). The paper will be on a subject of the student's choice; I strongly urge students to consult with me, however, before choosing a topic. I will be happy to read and comment on rough drafts of the final paper, so long as they are given to me at least three weeks before the due date.

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

3 Readings

The only required book for the course is *General Relativity from A to B*, by R. Geroch, available used at most online booksellers (*e.g.*, Amazon). Most of the required and suggested readings (including the Geroch book) will be made available online at the course's website:
http://strangebeautiful.com/lmu/2015-winter-space-time-st.html
though they may not be listed as such in the bibliography of the schedule of lectures. Any readings not available on the website should be downloadable directly from the journals in which they appear, through the university library's online e-journal access system (https://login.emedien.ub.uni-muenchen.de/menu).

4 Tentative Schedule

INTRODUCTION, HISTORICAL BACKGROUND, AND OVERVIEW

Week 1 introduction and overview; Descartes' catastrophic fuck-ups to set the stage for Huygens and Newton (Oct. 14)

THE CLASSICAL 17TH CENTURY DEBATE: HUYGENS, NEWTON, LEIBNIZ AND CLARKE

Weeks 2–3 Newton's *Principia* (Oct. 21–28)

Week 4 the Leibniz-Clarke Debate, Part I (Nov. 4)

Week 5 the Leibniz-Clarke Debate, Part II; Huygen's Views (Nov. 11)

19TH CENTURY REVOLUTIONS

Week 6 Riemann (Nov. 18)

Week 7 Helmholtz (Nov. 25)

Week 8 Poincaré (Dec. 2)

TIME AND SIMULTANEITY IN SPECIAL RELATIVITY, AND THE PROBLEM OF BECOMING

Week 9 the kinematics of special relativity, and the geometry of Minkowski spacetime (Dec. 9)

Week 10 causal theories of time and the relativity of simultaneity (Dec. 16)

Week 11 the problem of becoming (Jan. 6)

HOLIDAY no lectures Dec. 23 and Dec. 30

GENERAL RELATIVITY: THE NEW FUNKINESS

Week 12 curved spacetime: the unification of gravity and inertia (Jan. 13)

Week 13 matter, vacuum and the Einstein field equation (Jan. 20)

Week 14 diffeomorphism invariance; substantivalism versus relationalism (Jan. 27)

Week 15 the possible ontological status of other kinds of spatiotemporal structure (Feb. 3)

FINAL PAPER DUE: 21 MARCH 2016 soon