Topics in Relativity

Fall 2018 | Physics 366 | 10:20 A.M. CD

Instructor:

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Office: PEngel 136 Informal Office Hours: 8:00 A.M. – 5:30 P.M.

Text:

- *Basic Relativity* by Richard Mould (Springer-Verlag, 2001)
  Chapters: 1–8, (10), 11, 12, 14
- *Particle Physics Booklet* by the Particle Data Group
- `http://www.physics.csbsju.edu/366/`

Grading:

Your grade will be determined by averaging four scores: net homework score, midterm exam score, and the final exam score (which is double-counted). Assigned homework is due at the beginning of the next class period. You'll find daily assignments in the file `assignments.txt`. The approximate mid-term exam date is: November 19 (Monday). The final exam has been scheduled for Thursday December 13, 1:00 P.M..

Questions:

There is no such thing as a dumb question. Questions asked during lecture do not "interrupt" the lecture, rather they indicate your interests or misunderstandings. I'd much rather clear up a misunderstanding or further develop a topic of interest than continue a dull lecture.

Relativity is a really odd topic. If you don't have questions, you haven't thought enough about the material! Remember: you are almost never alone in your interests, your misunderstandings, or your problems. Please help your classmates by asking any question vaguely related to physics. If you don't want to ask your question during class, that's fine too: I can be found almost any time in my office (PEngel 136) or the nearby labs.

Topics:

This course deals with one of the great discoveries of the last century: special relativity. Unlike most great discoveries in physics, special relativity is not mathematically complex—we will use little math beyond linear algebra. Special relativity is as robust as euclidean geometry, but unlike euclidean geometry, special relativity's results violate your common sense notions of how things work. The irony of this situation was noted by FDP (famous dead physicist) Richard Feynman: "our imagination is stretched to the utmost, not, as in fiction, to imagine things which are not really there, but just to comprehend those things which *are* there."

Probably the most difficult part of relativity is understanding the notation behind its mathematical form: tensor theory. Tensor theory is simple, powerful, dangerous and deceptive. It is also a prerequisite for all advanced work in general relativity (hence its inclusion in this course). It is not, however, required for understanding the results of special relativity. There we can use the "complex metric" and the Lorentz transformation becomes as simple as rotation. Because special relativity should "blow your mind" you may want to seek out a more elementary treatment of it (e.g., *Spacetime Physics*, see below) to make sure you have an understanding of the physics.

We will spend a fair amount of time dealing with two areas in physics: particle physics and electricity and magnetism. In particle physics the objects of study are typically moving at speeds close to c, so special relativistic calculations are commonplace there. E&M was the first and remains the simplest example of a relativistically correct theory.

We will start by reviewing results you learned in Modern Physics: the Lorentz transformations, length contraction, time dilation, and the relativity of simultaneity. Then we'll go on to chapters you probably skipped in Mechanics and E&M . . . those dealing with relativistically correct physical theory.

References

Spacetime Physics : Introduction to Special Relativity — by Edwin F. Taylor and John Archibald Wheeler (QC173.65.T37)

Special Relativity — by J. G. Taylor (QC6.T37)

Essential Relativity : Special, General, and Cosmological; Also: *Special Relativity* — by Wolfgang Rindler (QC173.55.R56 1979 & Dewey 530.11 R47)

Introduction to Special Relativity — by Wolfgang Rindler (QC173.65 .R56 1991)

Introduction to the Special Theory of Relativity — by Claude Kacser (QC6.K23)

Introduction to Special Relativity — by Robert Resnick (QC6.R388)

An Introduction to Relativity — by L. Marder (QC6.M3513)

An Introduction to the Theory of Relativity — by W.G.V. Rosser (Dewey 530.11 R74 i)

Space and Time in Special Relativity — by N. David Mermin (QC6.M42 1989)

A Short Course in General Relativity — by J. Foster & J.D. Nightingale

Gravitation and Cosmology — by Steven Weinberg