The Theory of Relativity: Special and General

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* non-examinable

How to use these notes

This course has been given in Part II Astrophysics in similar form by several lecturers over the years. These notes are based on notes prepared by George Efstathiou who together with Mike Hobson and Anthony Lasenby has since written a nice textbook *General Relativity — An Introduction for Physicists* (Cambridge University Press). The book is more comprehensive then what can be presented in a first course on General Relativity but you will find the material of this course presented in a very similar fashion plus quite a bit of extra material. There are lots of other textbooks on special and general relativity. A very nice book is Weinberg's book *Gravitation and Cosmology* (John Wiley and Sons). This book is a bit old now and goes to a higher level than is required for this course. It is also expensive. Another book I can recommend for this course is d'Inverno's book *Introducing Einstein's Relativity* (Oxford University Press) . It is cheap and well written. However, it approaches the subject from an applied mathematician's point of view whereas our course here adopts a more intuitive 'physics' approach. The books by Schutz and Rindler are also worth a look. These notes were written for three purposes. Firstly, they introduce the mathematics *only as it is needed*. The physics behind the theory drives the need for mathematics, not the other way round. Secondly, although the course takes a 'physical' approach to the subject, some of the advanced mathematical techniques developed by professional relativists (*e.g.* Penrose diagrams) are not too difficult to understand and deserve exposure to an undergraduate audience. These advanced techniques can help you understand some of the more bizarre aspects of the theory that are often referred to in programmes like Star Trek. For example: What happens if you fall into a black hole? What is a wormhole? Can you travel to another Universe? Are these ideas pure science fiction, or do they have a basis in physical theory? Thirdly, General Relativity involves a lot of tedious algebra. Rather than plough through all this algebra on the blackboard, which would bore you and take a long time, you can often refer to these notes. Most of the algebra is worked through here. You will have seen cookery programmes where the cook prepares a dish, pops it in the oven, and then immediately pulls out another one saying 'here is one that I prepared earlier'. That is how I want to partially approach the lectures. Instead of ploughing through all complicated algebra, I will sometimes work partially through examples and then pull out results 'ready made' from these notes. There should be no sleight of hand, the algebra is done in the notes. To get the most out of the notes, you should *work through all of the algebra*. If you reproduce the calculations in these notes, you will gain experience in handling tensors and in solving problems in Special and General Relativity. The only way of gaining a thorough understanding of *any* branch of physics is by working through lots of examples. The course contains quite a bit of non-examinable material to make it more comprehensive and more interesting. Non-examinable material will be marked as such and you can also consult the syllabus in the Course Guide to see which part of the course is examinable.