

Physics 106c  
Problem set number 9  
Due Wednesday, April 6, 1999

**Notes about course:**

- Grade: Homework 100%.
- Collaboration policy: OK to work together in small groups, and to help with each other's understanding. Best to first give problems a good try by yourself. Don't just copy someone else's work – whatever you turn in should be what you think you understand. Don't look at solutions from earlier year(s), though you can ask people who took it before for advice.
- Text: *Classical Electrodynamics* (third edition), by J. David Jackson.
- The graders are the same as last quarter:

Yi Li	lym@its.caltech.edu	Tue 4-5	176 Watson
Chiyan Luo	chiyan@cco.caltech.edu	Sun 3-4	229 SFL
Federico Spedalieri	federico@cco.caltech.edu	Mon 4-6	201 Synchrotron
- Late policy: If you need to turn an assignment in late, get an OK from either me or from one of the TAs, and put a note on the late assignment saying that you got the OK. You should normally get the OK before the due date, but I'll be flexible if you are ill, or if there is an unexpected emergency.

If you turn in a late assignment without an OK, it is up to the discretion and mercy of the grader. Probably they'll subtract credit, or, if it is really late, they may not accept it at all.
- Web page: I'll try to put problem sets on a web page, with URL:  
<http://www.cithep.caltech.edu/~fcp/ph106/>

Reading: Jackson chapter 11, Sections 1-10.

48. Prove that the group of pure translations in space time (Tr) is an invariant subgroup of the group of all inhomogeneous Lorentz transformations ( $\bar{L}$ ). That is, prove that :

$$\Lambda(M, z)\Lambda(I, z')\Lambda^{-1}(M, z) = \Lambda(I, z'')$$

Determine  $z''$ .

49. Jackson problem 11.3.
50. Jackson problem 11.4.
51. Jackson problem 11.5.
52. Optional bonus question: Cosmic ray muons of 1 TeV strike the earth. Can these be of extraterrestrial origin? If not, where are they coming from? (To get full credit on bonus questions, you must give thorough answers. Bonus question credit will be recorded separately.)