# Physics 252 – Reading Exercise #3

(due Tuesday, April 26)

Read the paper:

M. L. Perl, *et al.*, Phys. Rev. Lett. **35**, 1489 (1975)

Write a brief summary of this paper. Include answers to the questions below.

This paper announces the discovery of the $\tau$ heavy lepton, a discovery that won Martin Perl the Nobel Prize. However, it was received at the time with great skepticism. Read the paper and see what you think.

1. What is the discovery claimed in this paper? It is a correct statement that no particle was known in 1975 that decays dominantly and roughly equally to an electron plus neutrinos and to a muon plus neutrinos. The main issue in the paper is that of whether the electron and muon are correctly identified.

2. What are the main processes considered in this paper that can fake the signature

$$e^+e^- \to e + \mu + \text{invisible particles} \tag{1}$$

   through misidentification or mismeasurement?

3. Note in the first column of p. 1490 that a particle is identified as a muon if it passes through 1.67 hadronic interaction lengths of material. How many cm of iron does this correspond to? What is the probability that a pion will pass through this iron without making a nuclear interaction? How do the authors control for this "punch-through" effect, which causes a pion to be misidentified as a muon?

4. What is the role of the coplanarity cut, eq. (2) on p. 1490? Which processes in (b) does this control?

5. What is the role of the requirement that the $e$ and $\mu$ have an energy above 0.65 GeV. What fraction of the beam energy does this represent? What processes listed in item 2 above does this control?

6. The authors note in the second column of p. 1491: "In order to explain Fig. 1(b), at least two particles must escape detection." Explain this.