Physics 252 – Reading Exercise #5

(due Tuesday, May 10)

Read the paper:

W. Bartel, *et al.*, Phys. Lett. **101 B**, 129 (1981)

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

This experiment studied the pattern of hadron production in 3-jet events from the process $e^+e^- \to hadrons$. In more modern terms, the question investigated is that of whether the q, $\overline{q}$, and g convert to hadrons independently of one another, or whether there is quantum coherence between pairs of partons in the process of converting to hadrons.

For orientation, the shape of an $e^+e^- \to hadrons$ event can be described by the *sphericity tensor*

$$Q^{ij} = \sum_a p_a^i p_a^j / \sum_a |\vec{p}_a|^2 \tag{1}$$

where the sum is taken over final state particles a. Let $Q_3 > Q_2 > Q_1$ be the eigenvalues of this tensor. A 2-jet-like event has $Q_3 \gg Q_1, Q_2$; a spherical event has all Q_i equal and equal to 1/3. The *sphericity axis* is the axis corresponding to the largest eigenvalue Q_3.

1. What is the observation claimed in this paper?

2. How are the planar events used in this study selected?

3. What are the relative roles of tracking, electromagnetic calorimetry, and hadron calorimetry in the measurements?

4. Explain the difference between the two theoretical model predictions in the bottom right-hand corner plot of Fig. 2.

5. Explain the difference between the two model predictions in Fig. 3.

6. The authors claim that conversion of quarks and gluons to hadrons is a process that occurs in a qg or $\overline{q}g$ system rather than occuring individually for each quark and gluon. What evidence to they present for this?