

# Analysis of Large Data Sets

## Project #10

### Computational Physics

*Due April 9, 2009*

(Homework, Part 1, is due Tuesday, March 31)

Studies of hadronic spectra via strong decays of hadrons provide insight regarding the Strong Force (i.e. QCD) at the confinement scale. These studies have led to phenomenological models for QCD such as the constituent quark model. Data from studies of  $\gamma p \rightarrow p\pi^0\pi^0$  are located at /export/home/crede/data/pi0pi0\_data.txt. This file contains over 1 million events of the reaction depicted above. The information for each reaction is given in a simple ascii format. An example of one such event is given below

21400.000	49.000	1900.610	2.000
282.366	-59.729	294.642	1024.923
-7.397	-243.317	1163.580	1196.409
-274.982	303.030	442.388	617.550

The first line of the event corresponds to run number, event number, beam energy, and an arbitrary float. After that, the next line corresponds to the first particle in the final state which is the proton. Following the proton are two pion mesons. The format of each particle line is: {p.x} {p.y} {p.z} {E}. The momentum and energy are given in MeV/c and MeV respectively. The target proton of the event is not given. The proton target interacts at rest with a rest mass  $m_p = 0.938 \text{ GeV}/c^2$ . Conservation of four-momentum (energy and momentum) can be readily employed to provide any missing four-momentum information.

1. Choose an event from the data file and calculate the magnitude of the four-vector for each particles listed in the event. Given your event and the fact that the target proton four-momentum (p.x, p.y, p.z, E) is ( 0,0,0,0.938) calculate the total mass produced in the event. Note, this does not require the use of a computer. Turn in, as homework for next Tuesday, the details of your calculation on paper.
2. Write a program that will read in one event at a time. For each event, calculate the four-momentum of the missing particle (in the final state) and verify that its rest mass is consistent with zero (Histogram).

3. Modify your program to use the ROOT framework. For each particle in the event define a `TLorentzVector` and create an `Ntuple` entry for the following 3 four-vector effective masses:  $p \pi_1^0 \pi_2^0$ ,  $\pi_1^0 \pi_2^0$ ,  $p \pi^0$  (both combinations together), the beam energy and the run number. After reading all events, histogram each `Ntuple` item with 4 plots per canvas (or page).
4. Look up in the Particle Physics Booklet either in class or online at [http://pdg.lbl.gov/2006/tables/contents\\_tables\\_baryons.html](http://pdg.lbl.gov/2006/tables/contents_tables_baryons.html) to identify possible candidate baryon resonances for the features observed in the  $p \pi^0$  and  $p \pi^0 \pi^0$  effective mass histograms.

Post exercise to your computational physics website. Create a html page for Project 10. Create a link from your main project web page to this html page. This html page should include the following heading information: exercise title, exercise number, your name, & today's date. The main content of this page should include the following:

- a short description of the exercise
- a link to the source code
- a text region which contains the actual source code text
- a link to your root output file containing your `ntuple`.
- images (not links) of canvas plots.

\*\* For text regions use the html object tag; example:

```
<object width="600" height="400" type="text/plain" data="yourProgram.cc" border="0" ></object>
```