Physics 499
Homework Assignment 3
Meson-Nucleus elastic scattering

Due Friday May 10th

Problem : $K^+ -^{12}C$ elastic scattering
Reference: Phys. Rev. C30, 1256-1266 (1984).

For this assignment you will determine (numerically) the elastic scattering cross section for K^+ scattering off of nuclei. You will use the Born approximation, which involves solving the following integral numerically:

$$\int_0^\infty V(r)r\sin(qr)dr \tag{1}$$

where $V(r) = V_0/(1 + e^{(r-R)/a})$, and $q = 2pc/(\hbar c)\sin(\theta/2)$. In this expression, θ is the scattering angle, p is the K^+ momentum, and $R = 1.28A^{1/3} \ fm$. We will take $a = 0.6 \ fm$. The scattring amplitude, $f(\theta)$ from the Born approximation is:

$$f(\theta) = -\frac{1}{\hbar c}\frac{mc^2}{pc}\frac{1}{sin(\theta/2)}\int_0^\infty V(r)r\sin(qr)dr \tag{2}$$

and the differential cross section is

$$\frac{d\sigma}{d\Omega} = |f(\theta)|^2 \tag{3}$$

I have attached the data for $K^+ -^{12}C$ elastic scattering for a kaon lab momentum of 800 MeV/c. Note: the kaon momentum in the center of mass frame is 740 MeV/c. The rest mass of the K^+ is 493 MeV/c^2.

Choose one of the following two assignments:

Assignment 3a:(the gcc or ROOT compiler)
Write a computer program that calculates the differential cross section, $|f(\theta)|^2$ for $K^+ -^{12}C$ elastic scattering at K^+ momentum 800 MeV/c. Your program should ask the user to input the potential strength V_0. Your program should then output to the screen the cross section for angles $10° \rightarrow 38°$ at two degree increments.

For what value of V_0 (if any) do you get a reasonable fit to the data in this angular range?

Assignment 3b:(the ROOT compiler only)
Write a program in ROOT that will make a publication quality graph of the $K^+ - {}^{12}C$ elastic scattering data plus error bars from the data of Marlow et. al., that is on the next page. In addition to your *.C program, you should e-mail me a *.eps file of your final graph.

You should turn in (e-mail) two files: your computer code that will run in either gcc or ROOT, and a file discussing your results. For the discussion file, you can use straight text (*.txt) or latex. No *.doc files. Be sure your name is somewhere in each file you e-mail to me.

$^{12}C(K^+,K^-)^{12}C$

| Angle | | Elastic c.m. cross section | | 2^+ (4.4 MeV) Cross section | |
lab	c.m.	(mb/sr)	Error	(mb/sr)	Error
3.5	3.79	971.00	280.62		
4.5	4.87	522.00	99.70		
5.5	5.95	343.32	44.29		
6.5	7.03	299.51	30.25		
7.5	8.11	257.63	20.38		
8.5	9.19	214.80	16.95	1.069	1.069
9.5	10.28	175.09	13.81	2.937	2.153
10.5	11.35	134.36	9.83	3.061	2.103
11.5	12.43	104.19	7.65	3.587	1.338
12.5	13.51	83.600	5.869	3.390	0.993
13.5	14.69	61.899	4.407	3.613	0.954
14.5	15.67	50.012	3.456	5.036	0.836
15.5	16.75	33.891	2.616	4.978	0.657
16.5	17.83	23.335	1.862	6.027	0.711
17.5	18.91	16.449	1.336	5.475	0.613
18.5	19.99	11.177	0.942	5.483	0.581
19.5	21.06	7.380	0.652	4.944	0.514
20.5	22.14	4.951	0.525	4.870	0.492
21.5	23.21	2.826	0.387	4.494	0.445
22.5	24.29	1.744	0.286	3.639	0.368
23.5	25.37	1.056	0.216	3.529	0.350
24.5	26.44	0.547	0.146	3.057	0.303
25.5	27.51	0.302	0.106	2.587	0.264
26.5	28.59	0.287	0.096	2.064	0.213
27.5	29.66	0.305	0.090	1.613	0.173
28.5	30.73	0.215	0.069	1.310	0.143
29.5	31.80	0.294	0.076	0.964	0.119
30.5	32.87	0.305	0.069	0.552	0.084
31.5	33.94	0.291	0.066	0.421	0.073
32.5	35.01	0.247	0.058	0.267	0.057
33.5	36.08	0.161	0.046	0.237	0.059
34.5	37.14	0.222	0.509	0.181	0.056
35.5	38.21	0.111	0.041	0.138	0.053
36.5	39.27	0.110	0.049		
37.5	40.34	0.147	0.072		
38.5	41.40	0.023	0.026		