Data Fitting
Exercise 4

The data given in the table was entered into the file `yukawa01.txt`. The script to do the fitting is `Exercise04.py`. It reads the data file, and does the fit. The fit returns the two parameters r' and g^2.

We must use error propagation formulas to compute the uncertainties in m and g from r' and g^2. Recall that the general error propagation formula for determining the uncertainty δf in some variable $f(x)$ is

$$\delta f = \left|\frac{\partial f}{\partial x}\right| \delta x, \tag{1}$$

where δx is the uncertainties in x. In this case, since $m = \frac{\hbar}{cr'}$,

$$\delta m = \left|\frac{\partial}{\partial r'}\left(\frac{\hbar}{r'c}\right)\right| \delta r' = \frac{\hbar}{c}\frac{\delta r'}{r'^2} = \frac{\hbar c}{c^2}\frac{\delta r'}{r'^2}. \tag{2}$$

To compute δg we must treat (g^2) as the variable x in equation 1, then

$$\delta g = \left|\frac{\partial\sqrt{(g^2)}}{\partial (g^2)}\right| \delta(g^2) = \frac{1}{2\sqrt{(g^2)}}\delta(g^2). \tag{3}$$

These equations are used in `Exercise04.py` to compute the uncertainties in m and g. Running `Exercise04.py` gave the following results:

```
In [31]: run Exercise04.py
mass of pion = 150.42 +/- 18.7628 MeV/c^2
coupling constant = 62.7632 +/- 9.52932 (MeV fm)^0.5
reduced chi^2 = 0.837342
goodness-of-fit = 0.473121
g2/hbarc = 19.9656 +/- 6.06276
```

The reduced χ^2 of 0.83 and the goodness-of-fit probability of 0.47 indicate a good fit as does looking at a plot of the fit with the data. The best fit values of $m = 150 \pm 19$ MeV/c^2 and $g = 63 \pm 10$ (MeV fm)$^{1/2}$ agree with accepted values of $m = 139.6$ MeV/c^2 and $g \approx 54$ (MeV fm)$^{1/2}$.

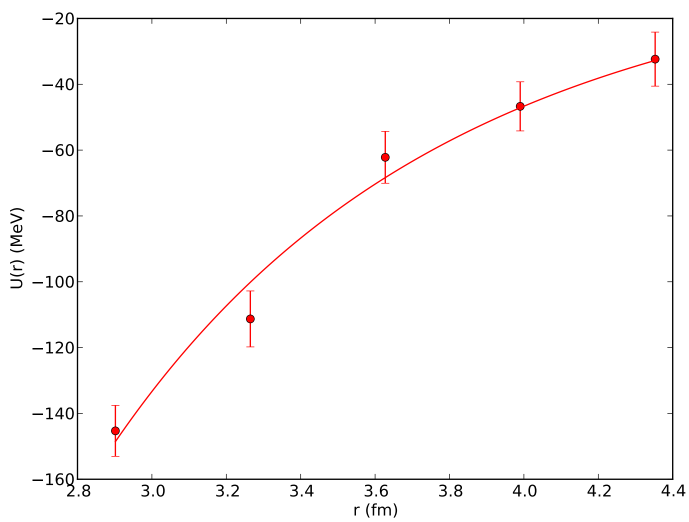

Figure 1: Plot of the data and fit.