Problem Set 4 **Physics 607** **(due Sept. 24, 2001)**

1. Use the FORTRAN program MOD_POT.F to determine the value of b in the parametric potential

$$V(r) = -\frac{Z}{r} + \frac{Z-1}{r}(1 - e^{-br}),$$

that gives the best least-squares fit to the $4s, 5s, 6s, 4p, 5p, 3d$ and $4d$ levels in potassium. Use the resulting potential to predict the value of the $1s$ binding energy in potassium. How does your prediction compare with experiment? The data for the energy levels are found in C.E. Moore, NSRDS-NBS 35, Vol. 1. You should average over the fine structure of the p and d levels.

   - The routine GOLDEN from the NUMERICAL RECIPES library is used to minimize the sum of squares of energy differences.
   - The linear algebra routines used in OUTSCH.F are to from the LINPACK library.

2. Use the FORTRAN program THOMAS.F to determine the Thomas-Fermi potential for potassium, Z=19.

3. Find the K^+ core radius R.

4. Plot the effective charge $Z_{\rm eff}(r)$, defined by the relation:

$$V(r) = -\frac{Z_{\rm eff}(r)}{r} = -\frac{Z-N}{R} - \frac{Z\phi(r)}{r}$$