Optical potentials are widely used in reaction calculations. A typical way to pin down the optical parameters is by performing a fit to the elastic scattering at the corresponding energy. In this homework you will perform a fit to the elastic and compare with global optical potentials. As a preparation it is helpful to review Chapters 4.1 and 15. of our book.

SFRESCO does \( \chi^2 \) data fitting using the MINUIT subroutine and calling FRESCO in each iteration. You can find in ‘/projects/phy982/inputs/example-fit.tar’ a tar with several files useful for this homework. It contains a typical input for sfresco (search.in) and also an initial input for fresco (elastic.in). You can also use the script ‘sfresco.in’ if you do not want to run SFRESCO interactively. A short description of how SFRESCO works can be found in the appendix of your book.

1. Chose a target nucleus (it can be the nucleus you used in hw2 or hw3) and find proton (and/or neutron) elastic data at an energy in the range \( E=5-70 \) MeV. The NNCD database provides an easy access, compilation of reaction data (http://www.nndc.bnl.gov/exfor3/cinda.htm).

2. Use SFRESCO to fit the elastic for this target at a chosen single beam energy. Choose as a starting point a global potentials appropriate for this nucleus. To begin with, neglect the spin-orbit interaction. Do not start with a six-parameters fit but rather gradually allow for parameter variations. Compare the quality of the optical potential obtained in this way (\( \chi^2 \)) and the global potential you started with.

3. Study the sensitivity of your final optical parameters to the initialization. In particular, analyze the correlation between parameters (parameter covariance matrix).

4. If you took a volume imaginary component, repeat the procedure of 2. assuming a surface imaginary component instead. If you took a surface imaginary component, repeat the procedure of 2. assuming a volume imaginary component instead. Determine which of the parameter sets (volume versus surface) is best pinned down to your case.

5. Add onto your best description so far, the spin-orbit term and perform a new fit. Can you improve the description of the data with this term?

6. Repeat the procedure for a different beam energy, and analyse critically the optical potential parameters you obtained in this way.

7. Prepare a report with your results, comments and conclusions. It should not exceed 10 pages.