Name: _____ PHYS 7501, FS 2021

Homework 5 **Due:** Start of class, October 26th

1. The Beam Swinger at the Edwards Accelerator Laboratory at Ohio University can be used to alter the angle at which the ion beam from the tandem Pelletron hits the target with respect to the fixed detector angle. If I want to maximize the outgoing neutron energies for a particular beam energy, at what angle should the Swinger be set?

2. Consider the reaction $^{96}Zr + \alpha \rightarrow {}^{99}Mo + n$ occurring at an energy of 2.5MeV/u.
Using your favorite kinematics calculator, determine the maximum and minimum neutron energies for two cases: (a) An α beam impinging on a ^{96}Zr target. (b) A ^{96}Zr beam impinging on a ^{4}He target. For each case, provide a print-out of the kinematics calculator plot if neutron lab energy versus lab angle.

3. According to R.Hannaske et al. EPJA 2013, the ^{197}Au + n cross section is ~6b at E_n=500keV. Estimate the neutron capture cross section at E_n=100keV. Compare to their value of ~11b.

4. You plan on measuring ^{24}Mg(α,p) directly in the lab. For $E_{cm} = 24.7MeV$, you expect 70μb/sr for this reaction at $\theta_{cm} = 40°$ [L. August et al. PRC 1971]. What will the differential cross section for Rutherford scattering be at this angle? What would it be at at $\theta_{cm} = 120°$, where the (α,p) differential cross section is about 20μb/sr?

5. We're going to make a measurement of 3 MeV/u ^{4}He fusing with ^{96}Zr and emitting a neutron. We plan on using Rutherford scattering of the α's into a silicon detector to normalize our beam intensity and target density. For this normalization to be valid, what is the maximum laboratory angle at which we can place our silicon detector?

6. Predict the locations of the first and second minima in the elastic scattering differential cross section for a 192MeV ^{16}O beam on a target of ^{208}Pb.

7. We noted in class that nuclear elastic scattering is analogous to diffraction of a plane wave on an opaque disk. For the case of diffraction on an opaque disk, diffraction minima have zero amplitude. However, diffraction minima have non-zero amplitude for nuclear elastic scattering. Why do you think this is?

8. At what center of mass angle are we most likely to detect protons from the ^{90}Zr(d,p) reaction for a 15.9MeV deuteron corresponding to a $l = 5$ transfer?
Compare to the result from Blok et al. Nucl. Phys. A (1976).