Brief Article

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February 25, 2014

1 Angular distributions of center of mass for nelastic excitation and scattering

Using the input files attached in the appendix, we produce the following graph of the elastic and inelastic cross section of a $p +^{58} Ni \to p +^{58} Ni^*$.

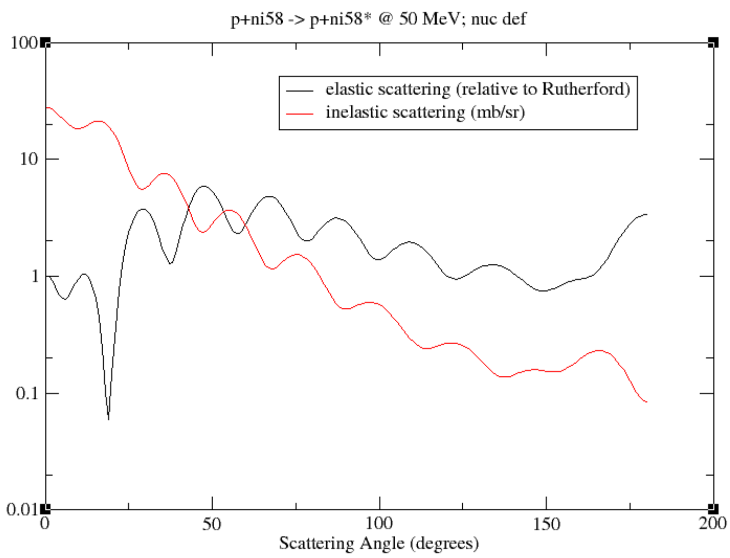

Figure 1: Cross Sections Including 2^+ Energy Level and Deformation Parameter

We can compare this to the elastic scattering in the case where there is no deformation nor energy level, as shown below.

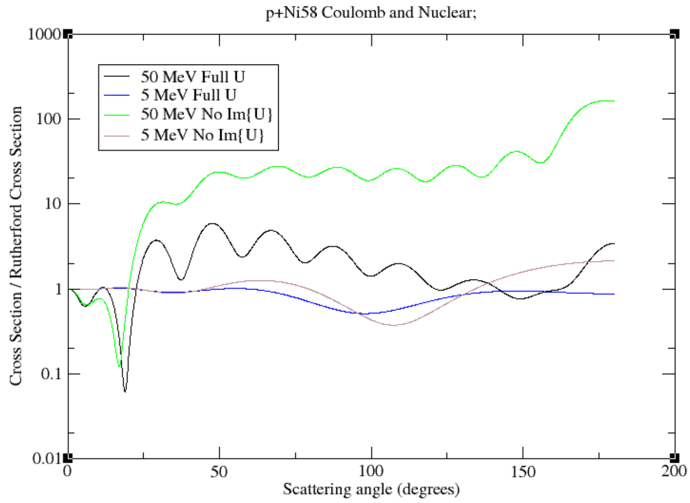

Figure 2: Cross Sections Without Explicit Deformation or Level Scheme

From this it is clear that the elastic scattering is the same in both cases, and as might be expected is generally insensitive to the deformation and especially the energy levels.

However, we do note that the inelastic differential crosssection is forwardly peaked, sharply decreasing with scattering angle. We can thereby note that this makes sense as the inelastic collisions leading to excitement are most likely those which can overcome the coulomb barrier and interact collectively with the nuclear forces and explicitly the terms represented by the imaginary potential. This is thus similar to the sharp forward peaking of the Rutherford cross section, although the cause of that is rather the infinite range of the coulomb force.

2 Varying the Deformation

We now compare the cases where the deformation is changed. This is shown in the graph below.

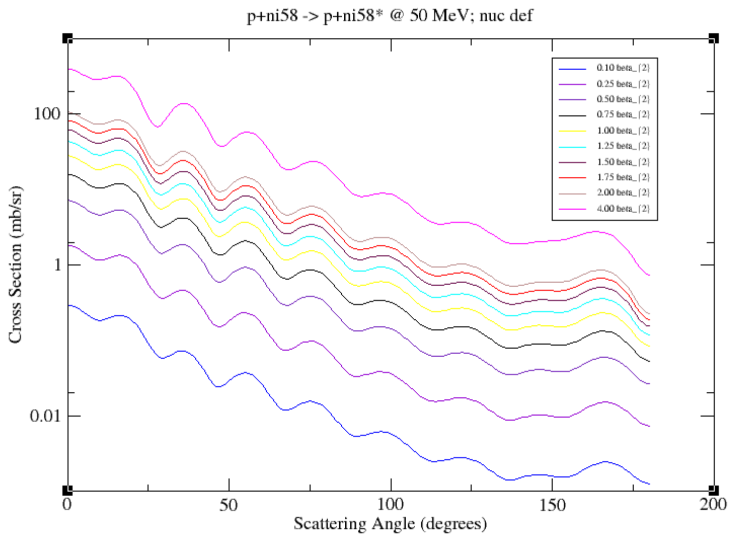

Figure 3: Cross Sections with Varying Deformation Parameters

We can see here that the major effect of the deformation parameter is to determine the overall size of the amplitude of the crosssection. This makes sense as the increased deformation means that there is a correspondingly larger $B(E2)$ and so an overall larger increase in the probability of a transition to the 2^+ state, and so an increase in the overall cross section for the reaction. However, as the change in parameter does not change the shape(i.e. each case is still only a quadrupole deformation), this does not change the relative angular distribution of the cross section.

3 Appendix

3.1 Input File for $p +^{58} Ni \rightarrow p +^{58} Ni^*$ at 50 MeV

```
p+ni58 -> p+ni58* @ 50 MeV; nuc def
NAMELIST
&FRESCO hcm=0.05 rmatch=20.0
        jtmin=0.0 jtmax=40 absend= -1     thmin=0.00 thmax=180.00 thinc=1.00
        iter=1 ips=0.0 iblock=0 chans=1 smats=2  xstabl=1
        elab(1)=50.0 /

 &PARTITION namep='p' massp=1.0000 zp=1
            namet='58Ni'    masst=58.000 zt=28 qval=0.0 nex=2  /
 &STATES jp=0.5 bandp=1 ep=0.0000 cpot=1 jt=0.0 bandt=1 et=0.00 /
 &STATES copyp=1                  cpot=1 jt=2.0 bandt=1 et=1.454 /
 &partition /
```

```
&POT kp=1 ap=1.000 at=58.000 rc=1.2  /
&POT kp=1 type=1  p1=48.3 p2=1.19 p3=0.66 p4=5.2 p5=1.19 p6=0.66
/
&POT kp=1 type=11         p2=0.849 /
&POT kp=1 type=2  p1=0.00 p2=0.00 p3=0.00 p4=4.4 p5=1.28 p6=0.55
/
&POT kp=1 type=11         p2=0.849 /
&POT kp=1 type=3  p1=4.9  p2=1.00 p3=0.58 p4=0.0 p5=1.00 p6=0.58
/
&POT kp=1 type=11         p2=0.849 /
&pot /
&overlap /
&coupling /
```