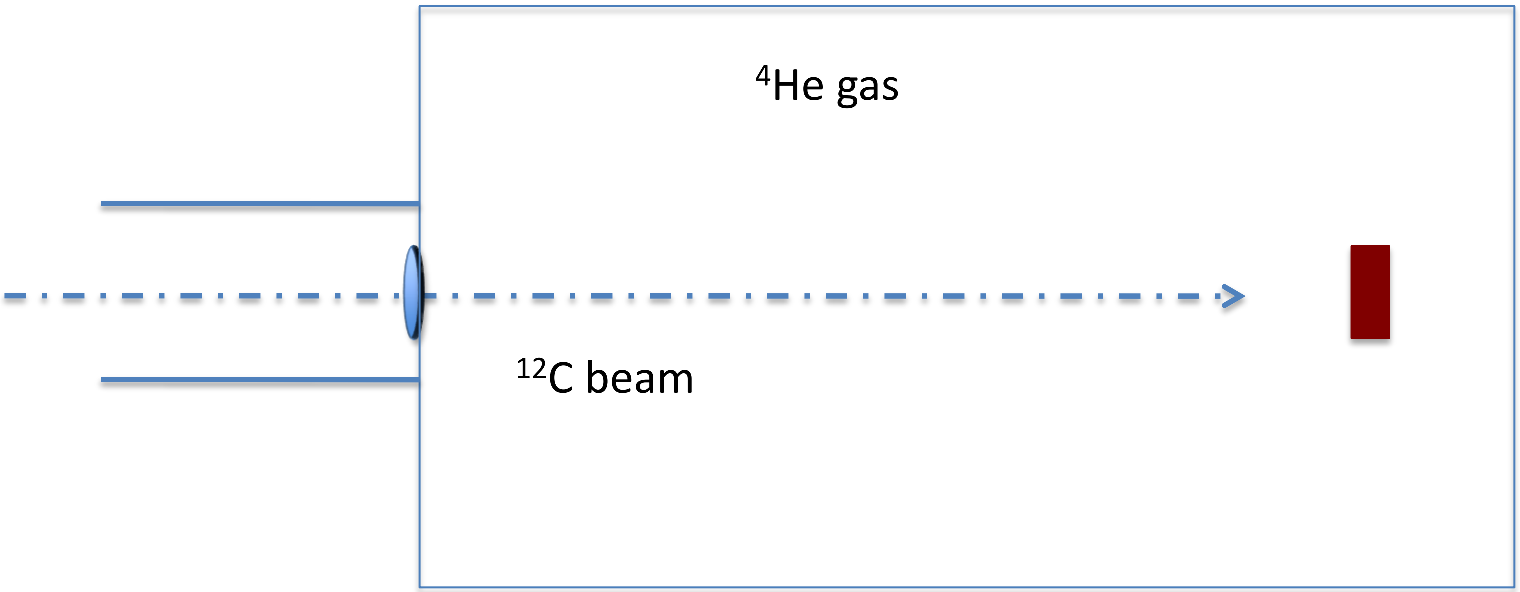
Measurement of cluster states of ^{16}O using the resonant elastic scattering $^{12}C+^{4}He$



Sketch of the set-up. Detector at 0^0 with respect to the entrance window.

1)Define the beam energy in order to study the ^{16}O excitation energy range 8MeV<E*<17MeV knowing that the entrance window that separate the beam line under vacuum from the gas target is made of Havar 2 μm thick.

2) Define the gas pressure needed to stop the beam at 500 mm and 1000 mm from the entrance window.

3) Knowing that the detector at 0^0 is placed 100 mm away from where the beam is stopped, estimate if, due to energy and angular straggling, one configuration (d=500 mm) gives a better resolution than the other (d=1000 mm).

4) Estimate the energy resolution at the maximum measured excitation energy and at the minimum measured excitation energy (the beam energy resolution is negligible with respect to the other effects).

1)

Q_{val}=2.425+4.737=7.2 MeV

E*=Ec.m.+Q

For E*=17MeV the energy of the beam roughly 40 MeV but to be exact I have to evaluate Eloss in the window. I vary the beam energy slightly to have Ebeam after window to be 40 MeV.

Eloss in Havar=3.3 MeV

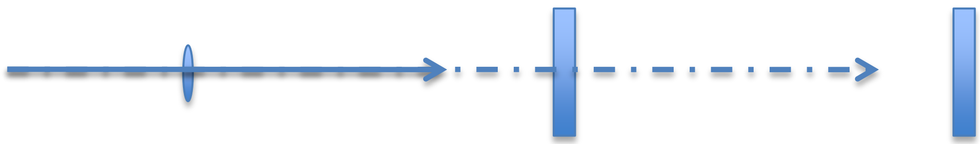
Residual energy of ^{12}C after Havar=39.8 MeV

Due to energy loss of recoiling αs in the gas before reaching the detector the minimum Ec.m. that one can measure corresponds to Elab=2.7 MeV (energy of recoil αs in the lab=2MeV).

Exitation energy explored 8 MeV<E*<17 MeV

2) Gas pressure to stop 40 MeV 12C in 1000 mm is 320 torr and in 500 mm is 640 torr

3) There is no difference between the two configurations because the number of target nuclei in the two conditions of pressure are the same so there are the same stragglings and energy losses.



4) Energy straggling in the Havar window=δE_{Havar}=0.085 MeV FWHM

Angular straggling in the Havar window= 1.2^0 FWHM

After the gas the energy and angular stragglings are:

$$\delta E = \sqrt{\delta E_{beam}^2 + \delta E_{Havar}^2 + \delta E_{gas}^2} = 0.3 MeV$$

$$\delta \theta = \sqrt{\delta \theta_{beam}^2 + \delta \theta_{Havar}^2 + \delta \theta_{gas}^2} = 1.62^0$$

Beam energy and angular straggling negligible.

Energy resolution in the c.m. at the minimum energy explored

$$\varepsilon = \frac{\Delta E}{4}\frac{z^2}{Z^2}\frac{m_2}{M} = \frac{\delta E}{4}\frac{4}{36}\frac{4}{16} = \frac{300keV}{144} = 2keV$$

Energy resolution in the c.m. at the maximum energy explored

$$\varepsilon = \frac{\Delta E}{4}\frac{z^2}{Z^2}\frac{m_2}{M} = \frac{\delta E}{4}\frac{4}{36}\frac{4}{16} = \frac{85keV}{144} = 0.59keV$$

We neglect the energy straggling of the αs in the gas