Determining the ANC for 13C→12C+n for Nuclear Astrophysical Studies

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The Big Picture

- The gamma ray signature from the reaction 12C+n→13C+p has been observed in the TAMU cyclotron.
- One possible explanation is that 22Na may be depleted by radiative proton capture on 22Mg.
- The experiment aims to determine the astrophysical S-factor and, thus, an accurate estimate of how much 22Na should be expected in nova explosions.

Experimental Setup

- A 197Au target is first placed in the target chamber for calibrating the detector.
- A similar setup is used with the elastic scattering on the real target to get an estimate of how much 22Na should be expected.
- The resulting experimental data can then be used in conjunction with a ray telescopes to determine a proper position calibration for the wires as well as the optical model parameters as well as the region of interest.

Data Analysis

- The scattered particles then enter the MDM (multipole-dipole-multipole) spectrometer.
- The detector system has 4 resistive wires to measure the x position and angle of the beam.

Theoretical Calculations

- Computer programs (JLM, Ptolemy…) are used to calculate:
  - the nucleon density for the incoming and outgoing channels
  - the double folded interaction potential
- A Woods-Saxon potential is then fit with the double folded potential in the region of interest allowing for the extraction of the optical model parameters

Calculating the Theoretical Cross Section

- Normally a 22Mg beam would be used and the proton transfer rate would be measured directly.
- Instead, we use a 197Au beam and measure the transfer rate.
- This indirectly measures the original system’s mirror system and uses charge symmetry to back out the appropriate parameters to relate the two.

Conclusions

- The calculated cross sections is known as the Spectroscopic Factor.
- The proportionality constant between the experimental and theoretical cross section is known as the Spectroscopic Factor.
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