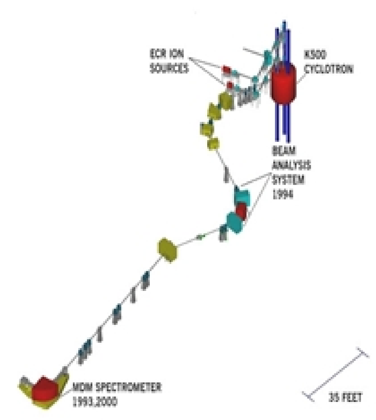
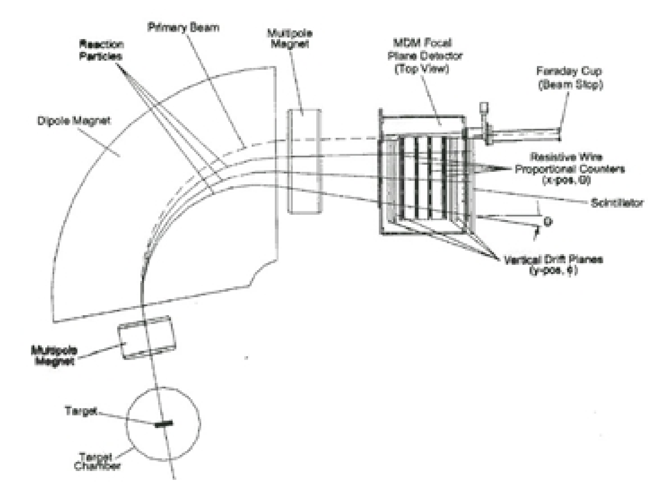
Detector Characterization and Installation for Study of GMR using 6Li Scattering

Beam Analysis and MDM



- Beam is dispersed and limited by first bend
- Second bend used for cleaning up beam
- With ΔE/E resolution of about 1/2500, provides very clean beam for zero degree inelastic scattering measurement

Experiment Setup



Description of Recent Experiment

- 40MeV beam of protons to see if installed scintillator works
- $^{28}Si + ^{12}C$
- $^{28}Si^* \to ^{27}Al + p$ or $^{24}Mg + \alpha$
- Installed scintillator detects the protons and alpha particles
- Focal Plane detector and scintillator at end of spectrometer counts Al and Mn

Motivation

Nuclear Matter

- Infinite system of nucleons with fixed ratio of neutrons to protons
- No Coulomb interaction
- Study is important for supernova collapse and neutron stars and testing many-body theories
- 3 properties obtained directly from nuclei
  - Binding energy per nucleon
  - Saturation Density
  - Compressibility of nuclear matter (from GMR)

Nuclear Compressibility

- At the saturation density n_0, define K_{nm} as directly related to the curvature of equation of state for nuclear matter
- Define K_A as effective compression modulus for finite nuclei
- Empirical relation between K_A and K_{nm} – not very relation, but shows dependence on symmetry term

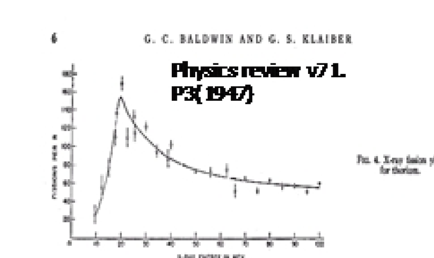
$$K_{nm} = k_F^2 \frac{d^2(\frac{E}{A})}{dk_F^2}\Big|_{k_{f0}} = 9n_0 \frac{d^2(\frac{E}{A})}{dn^2}\Big|_{n_0}$$

$$K_A = \eta_0^2 \frac{d^2(\frac{E}{A})}{d\eta^2}\Big|_{\eta_0}, \eta_0 = \frac{< r_0^2 >}{A}$$

$$K_A = K_{nm} + K_{surf}A^{\frac{-1}{3}} + K_{sym}\left(\frac{N-Z}{A}\right)^2 + K_{coul}\frac{Z^2}{A^{\frac{4}{3}}}$$

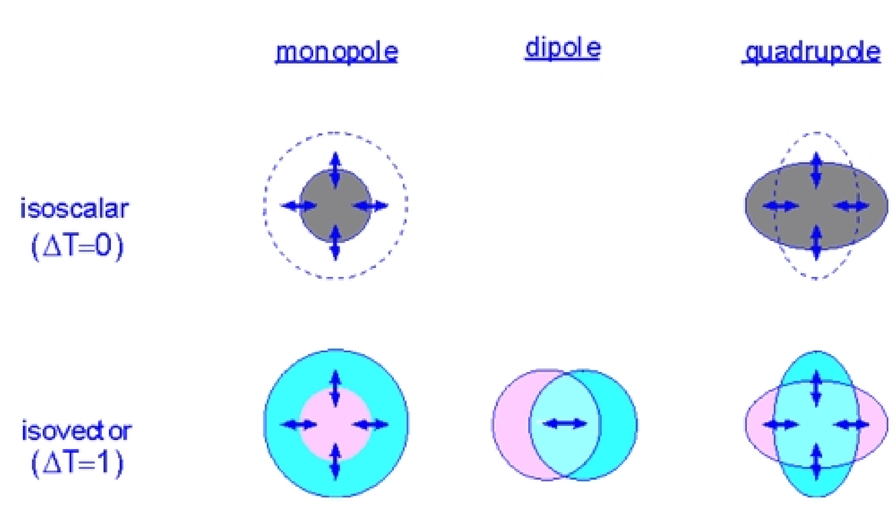
Giant Resonances

- Broad peak structure that shows up when excitation energy is higher than threshold of single nucleon emission
- Exhausts EWSR
- Centroid energy $E_x \sim A^{-1/3}$



Detector Installation

Macroscopic Picture



Scintillator Properties

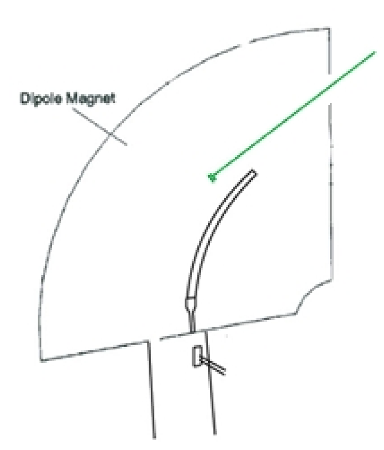
- Light output proportional to the exciting energy
- Fast time response allows timing info to be obtained with greater precision
- Possible to distinguish between different particles by analyzing shape of emitted light pulse

Plastics

- One of most widely used of organic detectors today
- Flexibility, important due to where scintillator was to be placed
- Extremely fast signal, decay constant ~2-3 ns

Installation

- Played with optical fiber bundles and string commonly used in weed whackers
- Test attenuation caused by optical coupling of scintillator to light guide, optical fiber bundle by using beta source



Double Folding Potential Model

Research on the Side

- While waiting for delivery of scintillator, thought it would be interesting to try to understand calculations used to fit cross-section data
- Deformed optical potential treats scattering as deformation of target
- Folding model potential looks at effective interaction between nucleons in target and particle

Classical Problem

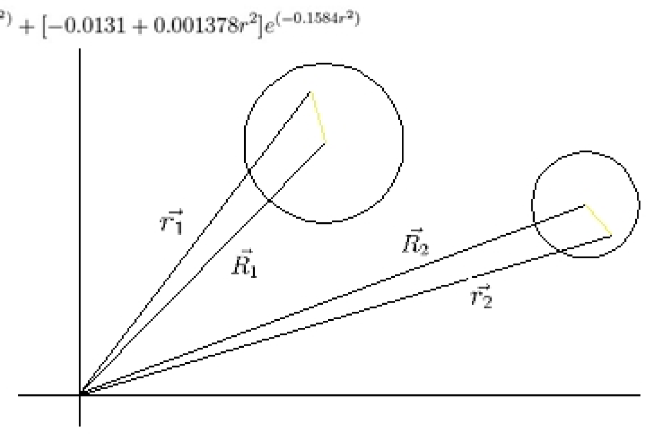
$$E = \frac{1}{2}mv^2 + U \qquad U = -\frac{GMm}{r} \qquad \frac{d^2u}{d\Theta^2} + u + \frac{m}{l^2}\frac{dV(1/u)}{du} = 0$$

$$U(r_{12}) = \int\int -\frac{G}{r_{12}}\rho_1(r_1)\rho_2(r_2)dr_1dr_2$$

Folding

$$\rho_{target}(r) = \frac{\rho_0}{1 + e^{(r-c)/a}}$$

$$\rho_{^6Li}(r) = .203e^{(-.3306r^2)} + [-0.0131 + 0.001378r^2]e^{(-0.1584r^2)}$$



$$U(r) = \int d\vec{r_1} \int d\vec{r_2}\rho_M(\vec{r_1} - \vec{R_2})\rho_m(\vec{r_2} - \vec{R_2})v(\vec{r_2} - \vec{r_1})$$

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