Isoscalar Giant Monopole Resonances in Unstable Nuclei

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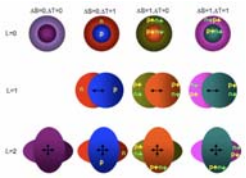
Isoscalar Giant Monopole Resonance (ISGMR)

- Giant resonance: a collective excitation of the nucleus
- ISGMR is the "breathing mode" of the nucleus; it expands and shrinks at a certain frequency
- Can calculate compressibility of nuclear matter from ISGMR (K_{NM} =231 ± 5 MeV)
- The normal method is to collide an alpha particle with a larger nucleus and thereby excite ISGMR



http://cyclotron.tamu.edu/pics/structure_01.bmp

ISGMR with Unstable Nuclei

- A target can not be made out of unstable nuclei, so the role of beam and target is switched
- A beam of unstable nuclei is incident on a lithium-6 target (helium is impractical as it is a gas at room temperature)
- The ISGMR centroid energy is above the particle threshold and can decay by p, alpha

Experimental Setup

A scintillation detector records the scattering angle of the protons and alphas. Residual ions pass through the Multipole-Dipole-Multipole Spectrometer into a wire detector. A Faraday cup blocks the beam in front of the detector.

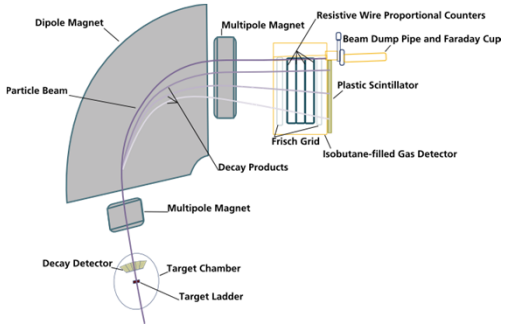


Image courtesy of Jonathan Button.

Scintillator Detector Layout

The detector consists of a layer of vertical plastic scintillator strips in front of a layer of horizontal strips.

By examining the layers in coincidence, the scattering angle of the particles can be determined.

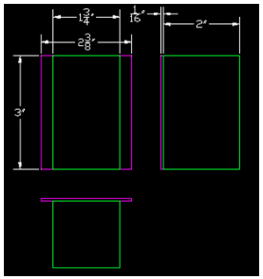
A block scintillator behind catches the particles.

All scintillators are attached to a fiber optic cable that carries the signal to photomultiplier tubes.

A hole in the center of the detector (positioned at vertical strip 7, horizontal strip 9) allows the beam to pass through, along with other residual nuclei.

Faraday Cup

The cup consists of a thin layer of aluminum to stop the beam, and a much thicker layer of tantalum to stop secondary decay particles.



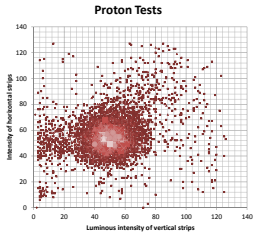
The cup will be contained in a box between the spectrometer and the wire detector.

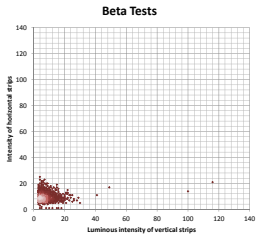
It is mounted onto a screw apparatus that allows the position to be changed. An optical position sensor will allow the position to be monitored.

Tests with Protons and Betas

The scintillation detector was tested both with a beam of protons scattering off a carbon-12 target and with a beta source

The beta results proved to be too close to the threshold of the PMTs to extract meaningful data

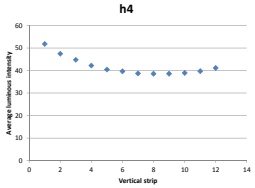


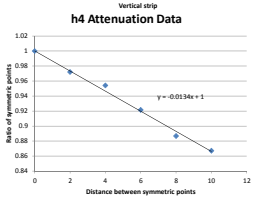


Attenuation

By comparing points symmetric about the center point v7 h9, the attenuation as a function of distance from the position of the event and the fiber optic cable-scintillator strip connection could be ascertained

Attenuation varied significantly between the various strips

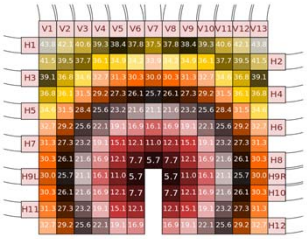




Relative Gain

Relative gain was calculated by comparing the average values of luminous intensity at points with the same angular position

v1	0.400351	h1	0.570794
v2	0.697348	h2	0.687817
v3	0.615323	h3	1.23333
v4	0.645465	h4	0.941256
v5	1	h5	1.147939
v6	0.936034	h6	2.006197
v7	1.10521	h7	1.849815
v8	1.177447	h8	1
v9	0.797938	h9	1.245181
v10	0.63286	h10	1.054053
v11	0.743524		
v12	0.481916		



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