USING GRETINA AS A COMPTON POLARIMETER

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for the ANL1475 Collaboration

PARITY

⇒ Nuclear Shell Structure

Difficult to determine
Often not determined experimentally

* Odd or even ℓ - states populated strongly in some direct reactions
* Internal conversion coefficients in heavy nuclei
* Allowed β decay – only select cases
* Linear polarization of decay photon

LINEAR PHOTON POLARIZATION

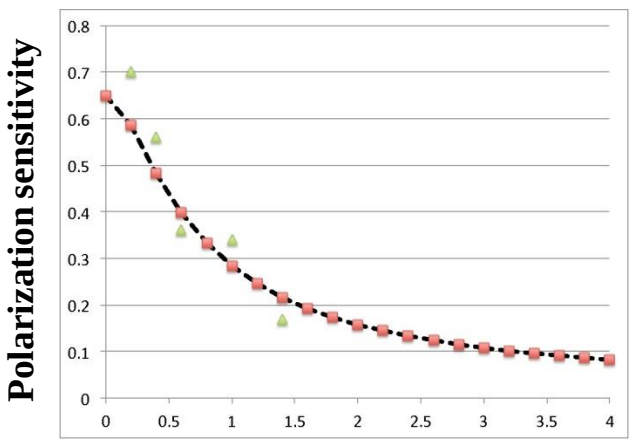
* photon-electron Compton scattering sensitive to polarization
* 4-crystal array (like Clover) – only for crystal to crystal scatters
* Tracking arrays like GRETINA-GRETA or AGATA much more ideal – can measure scattering angle accurately within crystal or crystal to crystal.

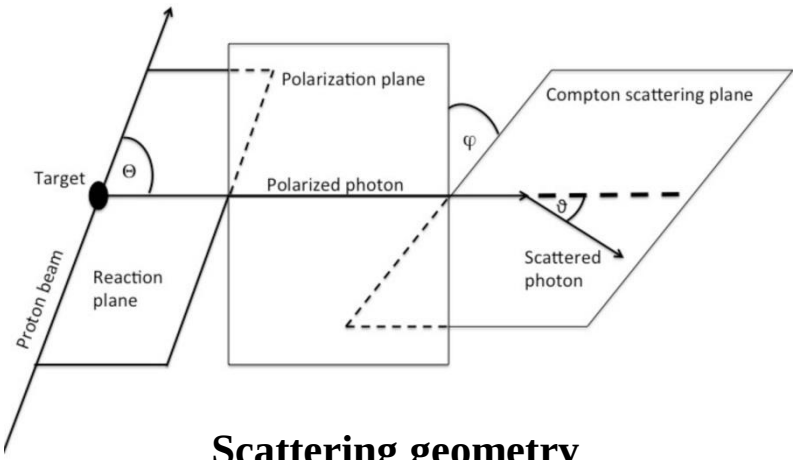
COMPTON SCATTERING & POLARIZATION

$$\frac{d\sigma}{d\Omega} = \frac{r_0^{\,2}}{2}\left(\frac{E'}{E}\right)^2 \left[\frac{E'}{E} + \frac{E}{E'} + sin^2(\theta)(1 + P\,cos(2\varphi))\right]$$

O. Klein & Y. Nishini – Z. Phys. 52, 853 (1929)

Where $r_0 = e^2/m_e c^2$, E, E' are the initial and scattered photon energies, and the Compton scattering angles θ and φ are defined in the figure below right: *P* varies from 0 to 1 depending on the degree of alignment of the parent state.





Scattering geometry

A. Wiens, A. O. Macchiavelli, *et al.*, BAPS 2014 HAW DK2

PRESENT POLARIZATION MEASUREMENT

$^{18}O + ^{18}O$ at E_{lab} = 28.7 MeV
7 modules of GRETINA + Phoswich Wall

First time GRETINA & PW used together!

Average angles of GRETINA modules:
θ: 59°, 90°, 90°, 90°, 121°, 121°, 147°
φ: 288°, 198°, 234°, 306°, 252°, 318°, 290°

CALIBRATIONS

^{152}Eu 1408 keV and ^{88}Y 1835 keV lines 8 hours each
Sources placed at target position with Phoswich Wall in place
<u>IDENTICAL</u> cuts placed in source spectra as on in-beam data

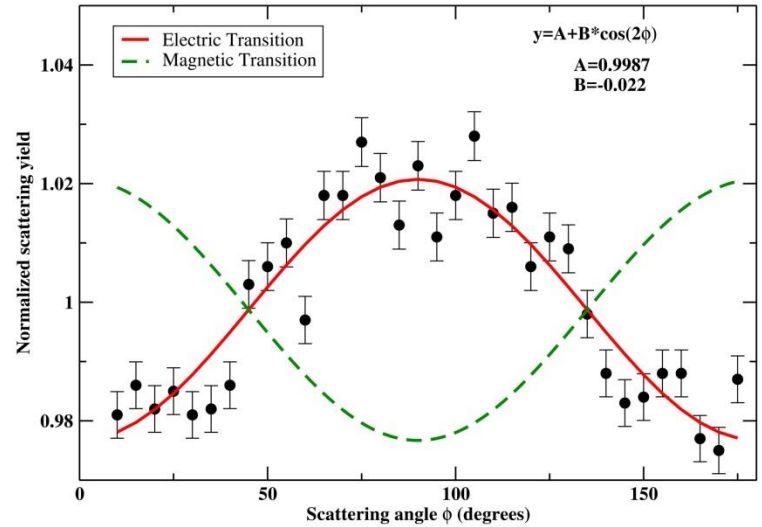
POLARIZATION of 2235 keV $2^+ \rightarrow 0^+$ LINE in ^{30}Si

Cuts made on

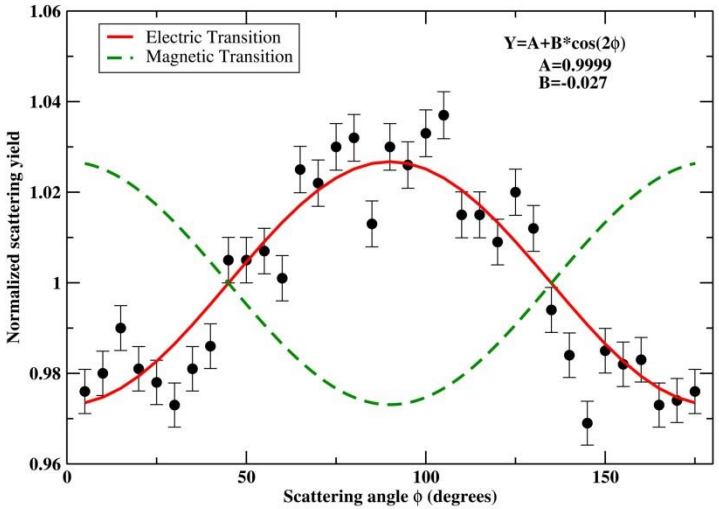
L: length of scattered γ

θ_G: angle of incoming γ relative to beam

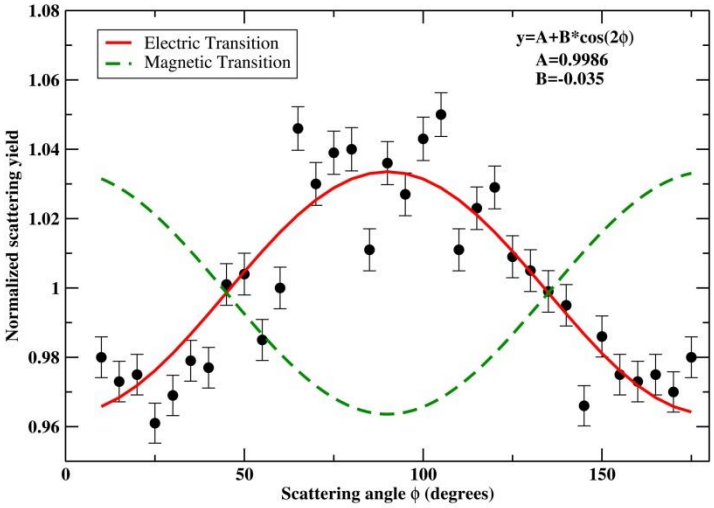
θ_S: angle of scattered γ relative to initial one



L: none; θ_G : 70º– 110º; θ_S : 70º– 110º



L: > 1 cm; θ_G : 70º– 110º; θ_S : 70º– 110º



L: > 1 cm; θ_G : 80º– 100º; θ_S : 80º– 100º

SUMMARY

*** GRETINA is the best Compton polarimeter in the U.S. and is ready to measure polarizations and parities in nuclear structure studies.**

*** Angle and position cuts enhance the polarization sensitivity at the expense of statistics.**

*** Identical cuts must be made on the normalization data so high statistics are needed to not limit accuracy**

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