Linearly polarized photons at ELSA

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CBELSA/TAPS Collaboration
DPG Spring Meeting
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investigation of the excitation spectrum of the nucleon

resonances are broad and overlapping
polarization observables for photon- and target-polarization in meson photoproduction:

<table>
<thead>
<tr>
<th>photon</th>
<th>target polarization</th>
</tr>
</thead>
<tbody>
<tr>
<td>unpolarized</td>
<td>( \frac{d\sigma_0}{d\Omega} )</td>
</tr>
<tr>
<td>linearly polarized</td>
<td>0</td>
</tr>
<tr>
<td>circularly polarized</td>
<td>( -\Sigma )</td>
</tr>
<tr>
<td>( \sigma_0 )</td>
<td>0</td>
</tr>
<tr>
<td>( T )</td>
<td>(-P)</td>
</tr>
<tr>
<td>( \gamma )</td>
<td>0</td>
</tr>
<tr>
<td>( G )</td>
<td>(-G)</td>
</tr>
<tr>
<td>( E )</td>
<td>(-E)</td>
</tr>
</tbody>
</table>

determine all amplitudes in PWA ("complete experiment")

measurement of 8 observables in pseudoscalar meson photoproduction (Chiang & Tabakin)

linearly polarized photons
coherent bremsstrahlung

- regular structure (diamond crystal)
- whole crystal can take over the recoil momentum (Laue-Bragg condition: $q = g$)
- loss of azimuthal symmetry
- linear polarization
coherent bremsstrahlung

bremsstrahlung from an amorphous radiator (Cu)

bremsstrahlung from a diamond crystal

normalized coherent spectrum
crystal alignment

Precise alignment of crystal axes referring to the goniometer axes and the beam axis.

↓

Determine all offsets: Sweep crystal axis C in a cone by stepping $\theta_h$ - and $\theta_v$ -axis (Stonehenge-Technique (K. Livingston))

↓

Possibility to get linearly polarized photons at deliberately chosen energies and polarization planes.
Precise alignment of crystal axes referring to the goniometer axes and the beam axis.

Determine all offsets:
Sweep crystal axis C in a cone by stepping $\theta_h$- and $\theta_v$-axis (Stonehenge-Technique (K. Livingston))

Possibility to get linearly polarized photons at deliberately chosen energies and polarization planes.
degree of polarization $(\text{ANB}_{(\text{Natter et al})})$

coherent peaks for polarization plane of $45^\circ$ with and without collimation of the photon beam

- calculated intensity
- measured intensity

$=>$ rel. Deviation $< 5\%$
measurement conditions

cohesent peaks for polarization plane of 45° (1150 MeV, 37 days, May/June 2008)
coherent spectra for different crystal settings
determination of polarization observables $\Sigma$ and $G$

cross section: $\sigma = \sigma_0 [1 - P_\gamma \Sigma \cos(2\Phi) + P_\gamma P_T G \sin(2\Phi)]$

$P_T \approx \pm 70\%$

↓

combination of beam/target polarizations

↓

$\Sigma$ and $G$

![Graphs showing preliminary results for $\Sigma$ and $G$.](image-url)
determination of polarization observables $\Sigma$ and $G$

$E_\gamma = 1055$ MeV

Preliminary

$E_\gamma = 1055$ MeV

Preliminary

→ Annika Thiel (HK 69.6)
summary

• linearly polarized photons at ELSA can be produced at deliberately chosen energies and polarization planes

• polarization degrees of more than 60% can be achieved

• coherent bremsstrahlung is routinely used at ELSA
  (Elsner et al, EPJA 39, 373-381, 2009)
Nucleon resonances

\[ \gamma p \rightarrow N^* \rightarrow p\pi^0 \]

\[ \gamma p \rightarrow N^* \rightarrow p\eta \]

broad and overlapping resonances

ambiguous solutions in PWA
ELECTRON STRETCHER ACCELERATOR (ELSA)
CBELSA-TAPS experiment