Spin density matrix elements for radiative decays of the omega meson in photoproduction at 5 GeV

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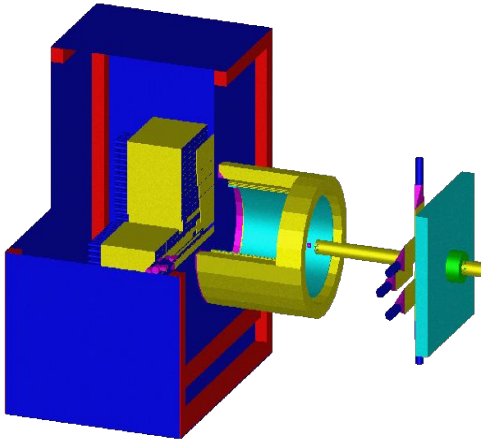
April 16th 2016

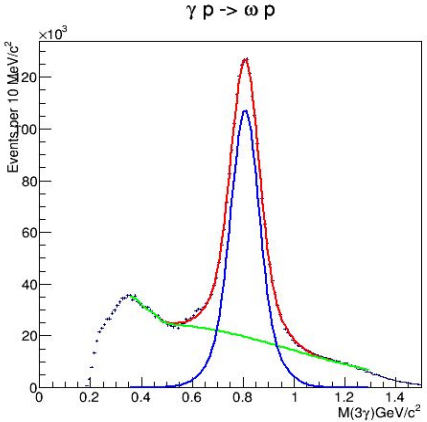
Introduction

- Photoproduction of vector mesons from hadrons has been an important tool to study pomeron exchanges at high energies and resonance exchanges at low energies.
- At intermediate energies, other Regge exchanges compete with the Pomeron
- Measure the Spin Density Matrix Elements(SDME) to study
- SDME help us understand the production mechanism of ω(782) meson at these energies.
- To extract the SDME, perform an unbinned extended maximum likelihood fit to the angular distribution of the vector meson decay products.

- The data for this analysis was taken at Jefferson Lab using the Radphi detector.
- The Radphi experiment was designed to trigger on all-neutral final states produced in a solid beryllium target by a tagged bremsstrahlung beam in the energy range 4.4-5.4 GeV
- The incident photon beam was unpolarized .



MonteCarlo simulation of the Radphi detector



3 γ sample reconstructed in the Radphi detector

Spin Density Matrix

The vector meson spin density matrix can be related to the to the incident photon beam density matrix by:

$$\rho_v = T\rho_\gamma T^\dagger$$

Where T is the production amplitude.

The photon density matrix can be written as a linear combination of the terms of the identity matrix,and Pau

matrix multiplied by the stokes parameter ,P, used to describe the photon polarization.

$$\rho_\gamma = \frac{1}{2}(\mathbb{I} + \vec{\sigma}.\vec{P}_\gamma)$$

Thus ρ(v) can similarly be constructed as

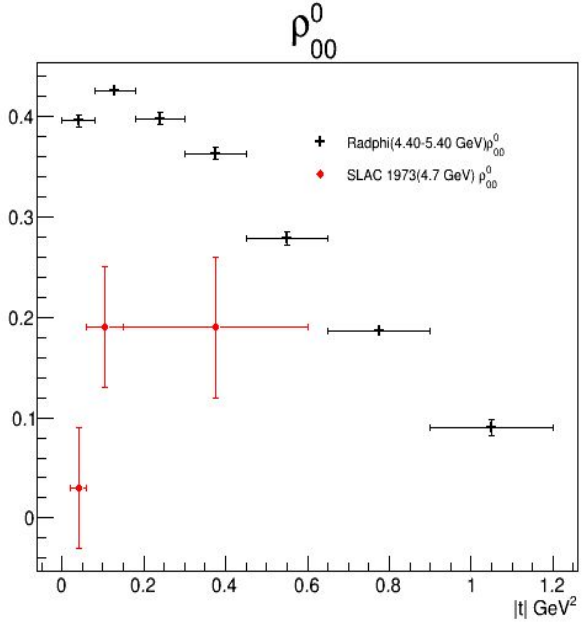
$$\rho_v = \rho_v^0 + \sum_{i=1}^{3} P_\gamma^i \rho_v^i$$

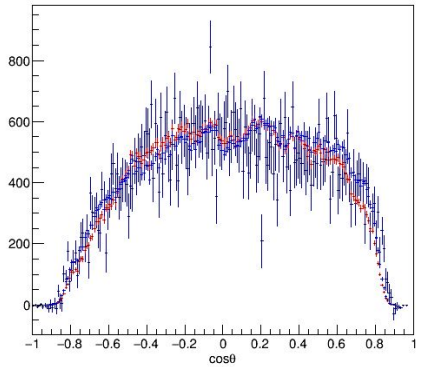
Where ρ^3 can only be obtained from experiments with circular polarization, while ρ^1, ρ^2 must come from a linearly polarized beam .

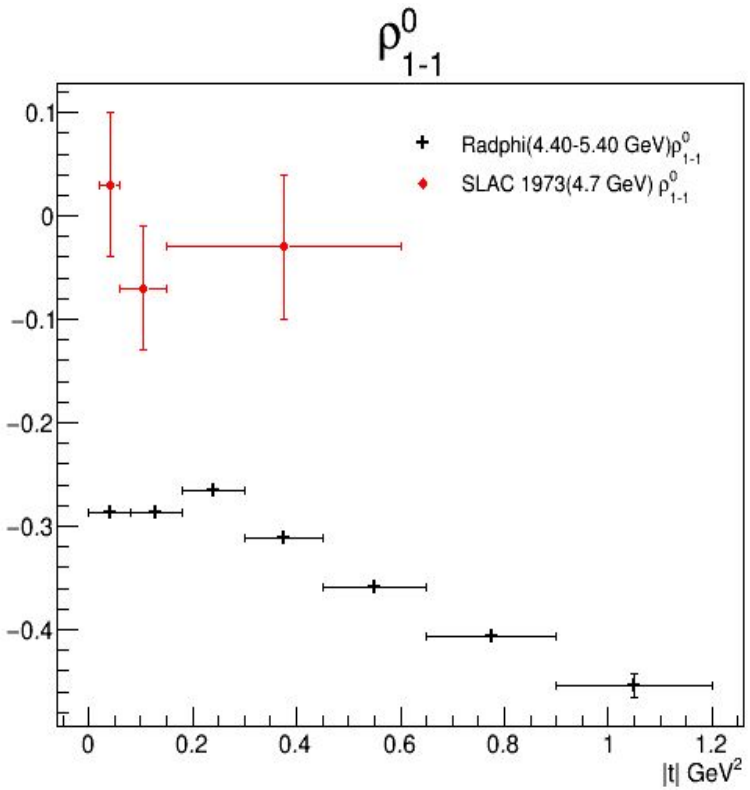
ρ^0 is the unpolarized part.

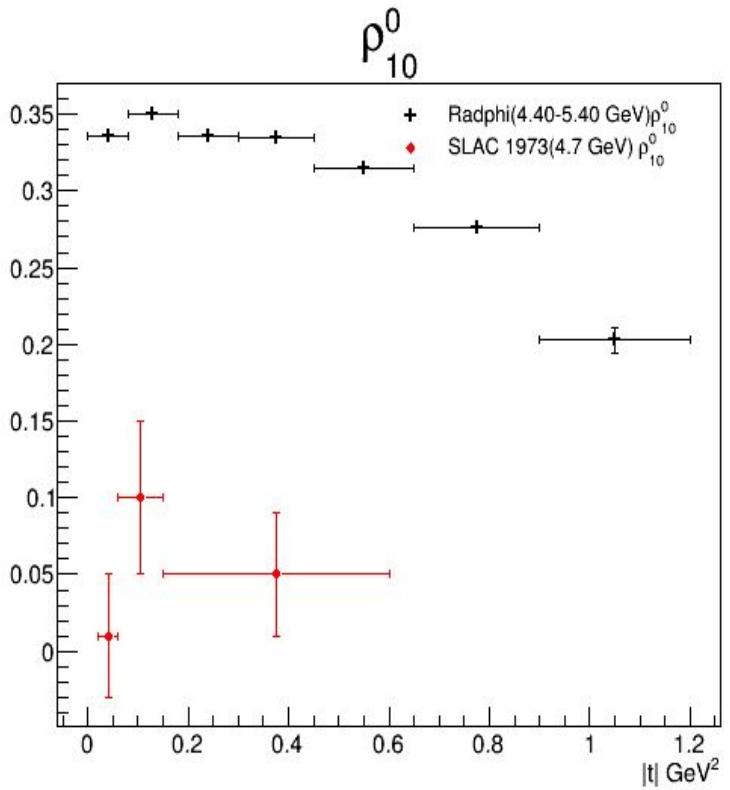
Helicity Frame

- The quantization axis is chosen as opposite the direction of recoiling nucleon in omega rest frame
- The data is binned in E_γ and |t|.
- The SDME are plotted vs |t| and compared to previous experiment.
- Deviation from s-channel helicity conservation.

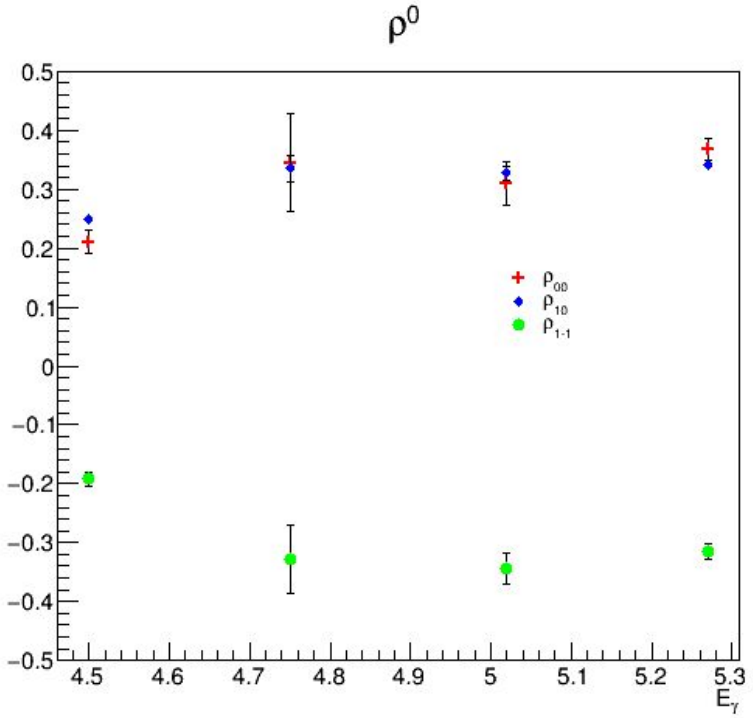





ρ^0_{1-1}
Radphi(4.40-5.40 GeV)ρ^0_{1-1}
SLAC 1973(4.7 GeV) ρ^0_{1-1}
0.1
0
−0.1
−0.2
−0.3
−0.4
0
0.2
0.4
0.6
0.8
1
1.2
|t| GeV^2

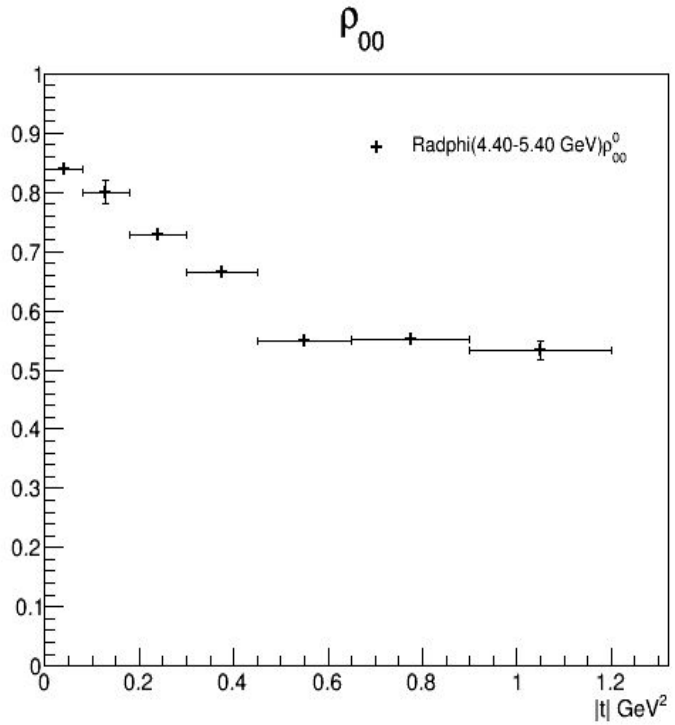

ρ^0_{10}
Radphi(4.40-5.40 GeV)ρ^0_{10}
SLAC 1973(4.7 GeV) ρ^0_{10}
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
0.2
0.4
0.6
0.8
1
1.2
|t| GeV^2

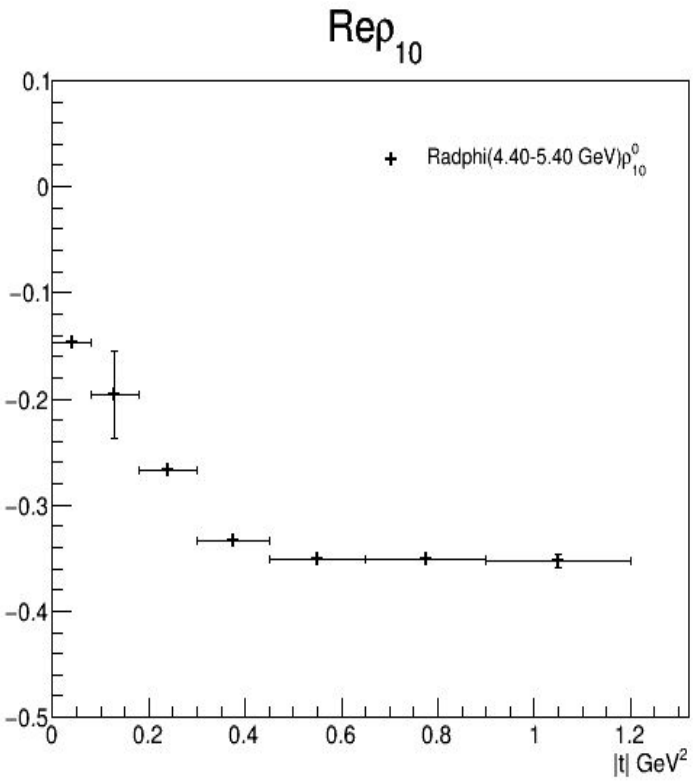
- SDME for a single |t| bin.
- 0.18 < |t| < 0.30
- SDME plotted vs Energy

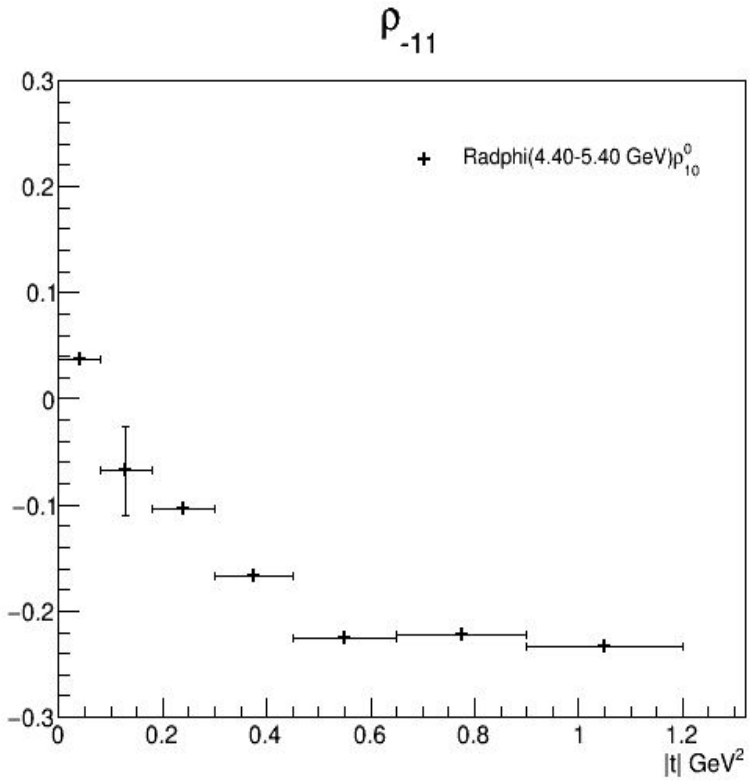


Gottfried Jackson Frame

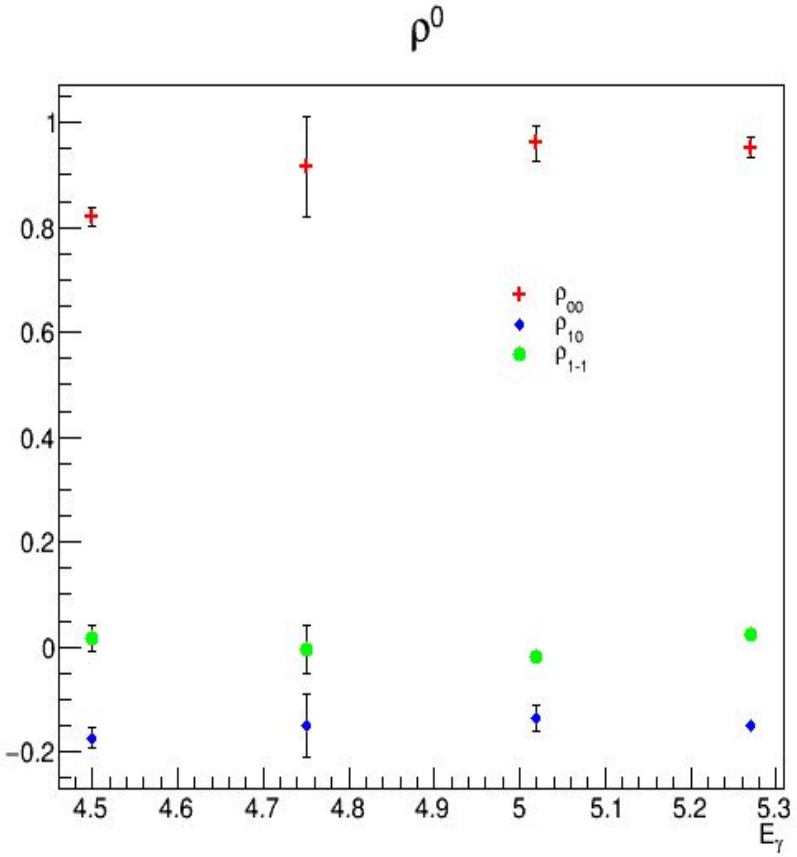
- Quantization axis chosen as direction of incident photon in the omega meson rest frame.
- The data is binned in E_γ and |t|.
- The SDME are plotted vs |t|




Reρ10
Radphi(4.40-5.40 GeV)ρ0 10
0.1
0
−0.1
−0.2
−0.3
−0.4
−0.5
0
0.2
0.4
0.6
0.8
1
1.2
|t| GeV2


ρ-11
Radphi(4.40-5.40 GeV)ρ0 10
0.3
0.2
0.1
0
−0.1
−0.2
−0.3
0
0.2
0.4
0.6
0.8
1
1.2
|t| GeV2

- SDME for a single |t| bin.
- 0.18 < |t| < 0.30
- SDME plotted vs Energy



Summary

- Both s-channel and t-channel helicity not conserved
- Comparison with a theoretical model .