2.15 Transparency studies in large angle exclusive $\gamma A \to$ meson + baryon + A^*reactions

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Abstract

We discuss that studies of the semiexclusive large angle photon-nucleus reactions with tagged photon beams of energies $6 \div 10$ GeV which can be performed in Hall D at Thomas Jefferson National Acceleration Facility (TJNAF) would allow to probe several aspects of the QCD dynamics: establish the t -range in which transition from soft to hard dynamics occurs, compare the strength of the interaction of various mesons and baryons with nucleons at the energies of few GeV, as well as look for the color transparency effects.

1. **Introduction** Large angle high energy exclusive processes provide an effective tool for probing the short-range structure of nuclei [1,2]. So far such studies were performed using proton and electron beams In most studies a rather limited statistics was accumulated. Complementary studies can be performed at Jlab using photon beams in reactions

$$\gamma + A \to h_1 + h_2 + (A-1)^* \; . \tag{1}$$

Such studies would allow to check validity of factorization of the cross section the product of the decay (spectral) function, elementary cross section and the absorption factor. They will also be sensitive to the EMC like effects due to break down of the many nucleon approximation for the nucleus wave function in the regime where the hard probe - nucleon interaction is dominated by scattering in point-like configurations [3].

Hence understanding of the interaction dynamics is critical for the program of study of the short - range correlations using reaction (1). It was pointed out in [4] that these reactions allow also to probe several aspects of the QCD dynamics: establish the t-range in which transition from soft to hard dynamics occurs, compare the strength of the interaction of various mesons and baryons with nucleons at the energies of few GeV, as well as look for the color transparency effects.

Experimentally the reactions $\gamma N \to "meson" N$ follow the expectations of the quark counting rules at $\theta_{cm} = 90^o$ [5] which predict that the s dependence of this process (s^{-7}) is slower than for the case of pion scattering. It is worth noting here that this statement is more solid than determination of the power itself as one can use more complicated parametrizations of the cross section in the limited s range to fit the γN data to a different power.

It would be desirable to study the reaction (1) in three kinematic regions where different physics dominates.

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- In the t-range $2 > -t > 1\text{GeV}^2$ geometric, Glauber - like dynamics is expected to dominate. It would be possible to address the question of the validity of the vector dominance model (VDM) approximation, compare strange and non strange channels. One would need to select sufficiently large s to avoid dominance of the processes of exclusive production of baryon resonances.
- For $-t > 3 \div 2\text{GeV}^2$ one is expected to reach the photon transparency - transition from regime of VDM hadron-like unresolved photon to the regime where photon is acting as an elementary (point-like) particle. For $\theta_{cm} = 90^o$ this regime may start right above the resonance region leaving little s range for the Glauber like regime. Hence covering a wide range of the c.m. angles in the planned studies is very important.
- The regime of photon transparency can be used also for comparing strength of interactions of mesons $(\pi, \rho, \eta, \eta', K^*)$, and baryons (N, Δ) using processes (1). The optimal quantity to study would be the double ratio

$$R(A) = \frac{\sigma(\gamma + A \to h_1 + N + (A-1)^*)}{\sigma(\gamma + A \to h_2 + N + (A-1)^*)} / \frac{\sigma(\gamma + N \to h_1 + N)}{\sigma(\gamma + N \to h_2 + N)}, \qquad (2)$$

  which is very sensitive to $\sigma_{in}(h_1N)/\sigma_{in}(h_2N)$, see Fig. 3 in [4].
- At large $-t \geq 4 \div 3\text{GeV}^2$ it would be possible to explore the onset of the color transparency regime. Such a study would help to resolve old puzzles of the transparency measurements with proton beam, and observe point-like configurations in hadrons. It would link in a natural way to the previous and future studies of color transparency at Jlab in the $(e, ep), (e, e\pi)$ reactions, see review in [6].

Numerical studies performed in [4] have found that the nuclear transparency in the discussed three regimes is significantly different already for light nuclei and has a very different A-dependence, see Fig. 1. In particular, photon transparency leads to a very large increase of transparency for heavy nuclei.

In conclusion, the discussed reactions have a strong potential for discovering new features of the QCD dynamics at intermediate energies. Further topics to be studied include spin effects in the initial state (photo polarization) and in the final state (ρ, Δ). Studying short-range correlations in the different transparency regimes would give an important additional information about short-range nuclear dynamics.

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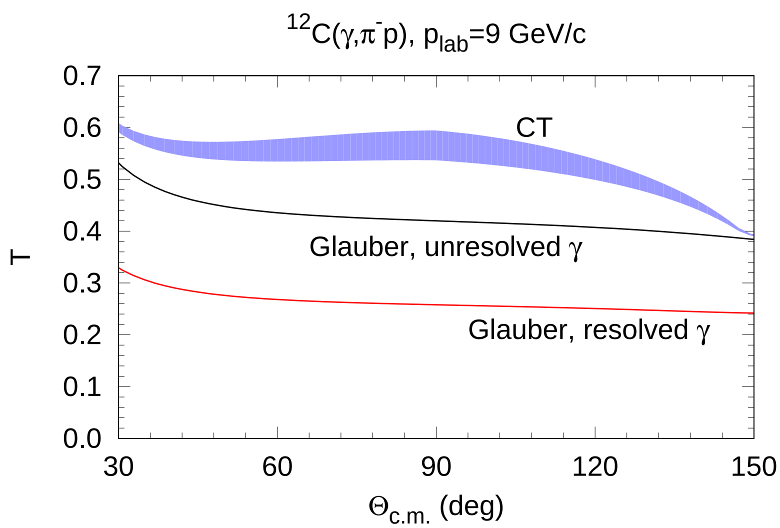

$^{12}C(\gamma,\pi^- p)$, p_{lab}=9 GeV/c
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
T
CT
Glauber, unresolved γ
Glauber, resolved γ
30
60
90
120
150
$\Theta_{c.m.}$ (deg)

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