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PHOTOPRODUCTION OF MESONS IN NUCLEI* **

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We calculate cross sections for inclusive pion and eta photoproduction in nuclei in the energy range from 300 to 800 MeV within the framework of a semi-classical BUU transport model. Our results are compared to existing experimental data.

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1. Introduction

The total photoabsorption cross section in nuclei shows as clear medium modification the disappearance of the $D_{13}(1520)$-resonance [1]. The investigation of photoproduction of mesons in nuclei offers the possibility to study the in-medium properties of mesons and baryons under, compared to heavy-ion collisions, clean and well-defined conditions at density ρ_0 and zero temperature.

2. The model

Our calculations are based on the BUU equation which describes the classical time evolution of a many particle system under the influence of self-consistent mean field potential and a collision term [2].

We assume that the photoproduction cross sections are the incoherent sums of contributions from all nucleons. For the one-pion production cross section we use partial-wave amplitudes and fit the contributions coming from the $P_{33}(1232)$, $D_{13}(1520)$, $S_{11}(1535)$ and $F_{15}(1680)$ resonances to these amplitudes. The structure of the two-pion production cross sections is not described by the resonance contributions that are induced by the two-pion

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decay widths of the resonances. The difference between the experimental cross section and the Breit–Wigner type resonance contributions is treated as background. Photoproduction of etas is described via an intermediate $N(1535)$-resonance.

3. Eta production

In nuclei we also have to take into account eta production by final state interactions of pions that were primary produced.

In figure 1 we compare the calculated total eta production cross section on ^{12}C, ^{40}Ca and ^{208}Pb with experimental data [2]. The contributions coming from secondary processes are almost negligible. On ^{12}C there is only good agreement with the experiment at low photon energies. For higher energies we overestimate the cross section by about 20%. On ^{40}Ca and ^{208}Pb the agreement with the experiment is very good.

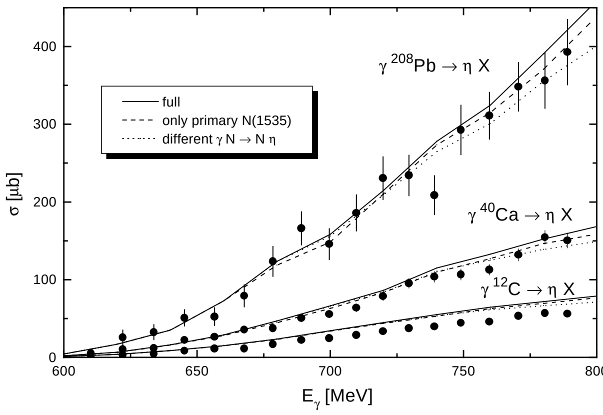

Fig. 1. Total eta photoproduction cross section on ^{12}C, ^{40}Ca and ^{208}Pb. All experimental eta photoproduction data are taken from [4].

The description of angular and energy differential cross sections requires a modification of the vacuum ηN cross section. A very good agreement with the experimental data is possible with an energy independent inelastic cross section $\sigma_{in} = 30$ mb and an elastic cross section $\sigma_{\rm el} = 20$ mb [5].

4. Pion production

The total π^0 cross section on ^{208}Pb is shown in figure 2. The dotted line is the result of a standard BUU calculation with a self-consistent treatment of the in-medium width of the $\Delta(1232)$-resonance [2]. Within this treatment there is only a small net in-medium broadening of the Δ-resonance because Pauli-blocking of the spontaneous decay and collision broadening nearly compensate each other [1]. However, studies of pion-nucleus scattering within the framework of the Δ-hole model usually need a larger broadening of the Δ-resonance. The dashed line in figure 2 results when using an imaginary part of the Δ-spreading potential of $-40\,\mathrm{MeV}\frac{\rho}{\rho_0}$ [6]. For the solid line we used a parameterization as given by [7]. This calculation gives a very good description of the experimental data from [3].

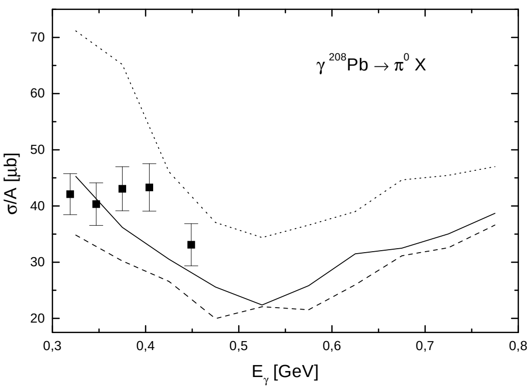

Fig. 2. Total π^0 photoproduction cross sections on ^{208}Pb. The experimental data are taken from [3]. The dotted line is the result of the standard BUU calculation. The solid and dashed lines result when using a larger $\Delta(1232)$-width as described in the text.

In near future there will be experimental data for photoproduction of π^0's available up to photon energies of 800 MeV. A detailed comparison of these data, especially of angular and momentum differential cross sections, to our calculations will help to furtherly constrain our description of the pion and resonance dynamics. Thus it should be possible to trace back true in-medium effects on the elementary (γ, π) production process.

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