QUASIELASTIC ELECTRON SCATTERING ON ^{63}Cu IN THE GIANT RESONANCE ENERGY REGION

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(Received May 30, 2008)

The result of the extraction of the quasielastic part from the electron scattered spectra on ^{63}Cu is reported. The position of the peak maximum was determined for each quasielastic spectrum and the momentum transfer dependence of its shift with respect to the case of scattering on a free nucleon is presented in the momentum transfer range of $q = 0.5 \dots 1.2\, fm^{-1}$.

PACS: 25.30.Fj

1. INTRODUCTION

The method of the separation of the resonance and quasielastic parts of the spectrum of scattered electrons elaborated recently [1] opens possibility to investigate the properties of the qusielastic electron scattering process at small momentums transfer. In this work we are continuing to elaborate the proposed method. The last one was used to obtain the spectra of quasielastically scattered electrons on ^{63}Cu nuclei in the momentum transfer range $q = 0.5 \dots 1.2\, fm^{-1}$.

Obtained pure quasielastic spectra were analyzed by means of three phenomenological methods to determine the position of the quasielastic peak maximum and its shift with respect to the peak of elastic scattering on a proton.

2. EXPERIMENT

The spectra under consideration were measured at electron initial energy of $E_0 = 150\, MeV$ for scattering angles of $\theta = 39°$ and $46°$and at $E_0 = 225\, MeV$ in the angular range $\theta = 34° \dots 74°$.

The experimental equipment and the procedure used for data processing are described in [1] and references therein. The principal idea of the method applied consists in the simultaneous multipole analysis of the mixture of resonance and quasielastic parts with their subsequent separation in the obtained multipole spectra.

3. QUASIELASTIC SPECTRA

The result of such analysis applied to the spectra of scattered on ^{63}Cu electrons is shown in Fig.1. The uncertainty of each point of the reconstructed quasielastic cross section should be treated as the confidence interval. The points themselves are not statistically independent that follows from the reconstruction method.

As in the case of ^{65}Cu quasielastic cross section is practically absent at excitations energies below $20\, MeV$.

4. SHIFT OF THE QUSIELASTIC PEAK ENERGY POSITION

The shift (ϵ_0) of the quasielastic peak maximum with respect to that in the kinematics of scattering on a free nucleon at the same momentum transfer was determined for each quasielastic spectrum according to the formula:

$$\epsilon_{max} = \frac{q^2}{2M} - \frac{q^2}{2AM} + \epsilon_0, \qquad (1)$$

where ϵ_{max} - the energy position of the quasielastic peak maximum, A - the atomic number of the element, M - the nucleon mass.

To determine the energy position of the quasielastic peak maximum the quasiellastic spectra were transformed into spectra with statistically independent points. The value of the quasielastic cross section at given energy was determined with Gauss random number generator considering its value in primary quasielastic spectrum as a maximum of Gauss distribution and the error of this value as a Gauss half-width.

As can be seen from Fig.1 in some spectra the reconstruction errors are not small enough to give distinct maximum position. Therefore three different methods were used to find the quasielastic peak maxim in the transformed spectra.

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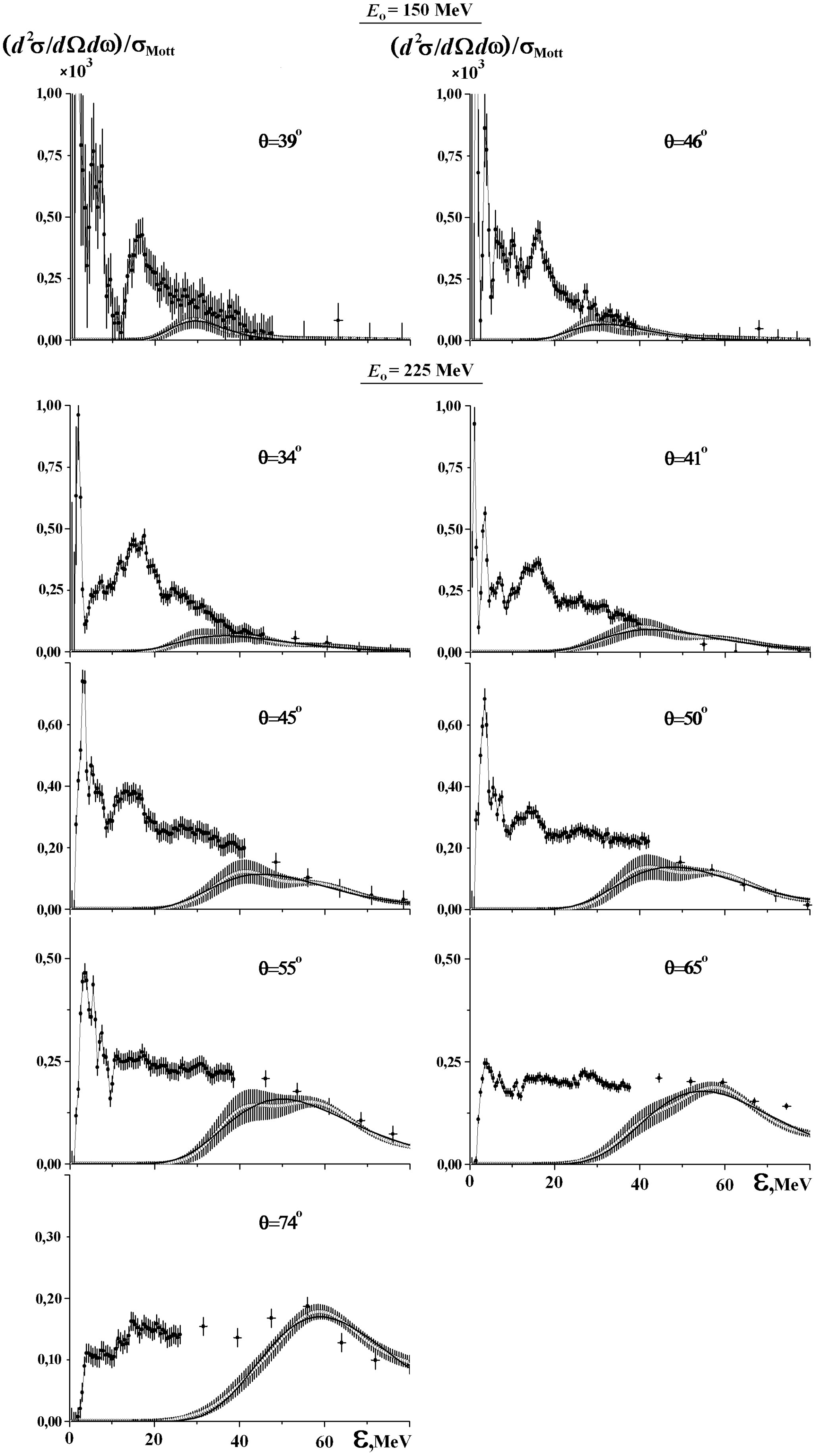

Fig.1. *Differential cross section of scattered electrons. Closed circles - measured spectrum. Open circles - reconstructed quasielastic part of the spectrum. Line - result of the log-normal curve fitting*

In the first method the peak maximum was approximated by the Gauss function. Taking into consideration essential asymmetry of the quasielastic cross section, only points, where this maximum may be located with the probability corresponding to two standard deviations, participated in the fitting process - points between line 1 and line 2 in Fig.2. It means that points that have the upper limit of the error bar lower than the highest bottom limit among all points were excluded from the adjustment.

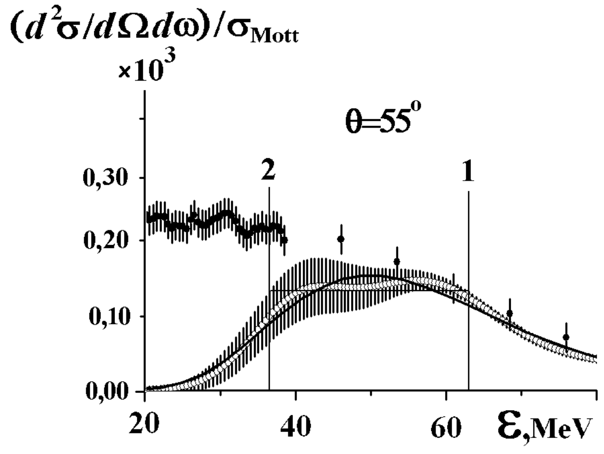

Fig.2. *Choice of points for the Gauss function fitting. Numbers 1 and 2 indicates upper and bottom limits of the peak maximum position. Line - result of the log-normal curve fitting*

In the second method all points of the spectrum participated in fitting process but the fitting curve was chosen as log-normal function:

$$y = A(1)exp(-\frac{ln^2(\frac{x}{A(2)})}{2A(3)^2}), \quad (2)$$

where A(1), A(2), A(3) - fitting parameters. As it can be see from Fig. 1 this curve describes the experimental points quite enough.

In the third method the Gauss function was also used but only points from the low energy front of the spectrum took part in fitting as it is shown in Fig.3.

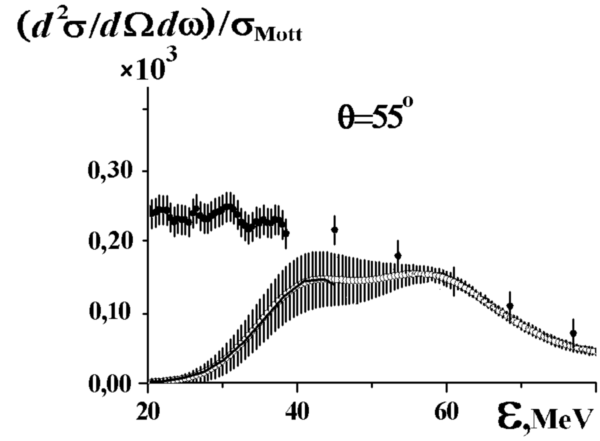

Fig.3. *Choice of points for third method. Line - result of the Gauss function fitting*

The result of the determination of the energy position shift is presented in Fig.4. Fist two methods gives similar results and shows distinctly that shift value has maximum at the momentum transferred $q \sim 0.8 \ldots 1.0\, fm^{-1}$. The third method doesn't show such maximum.

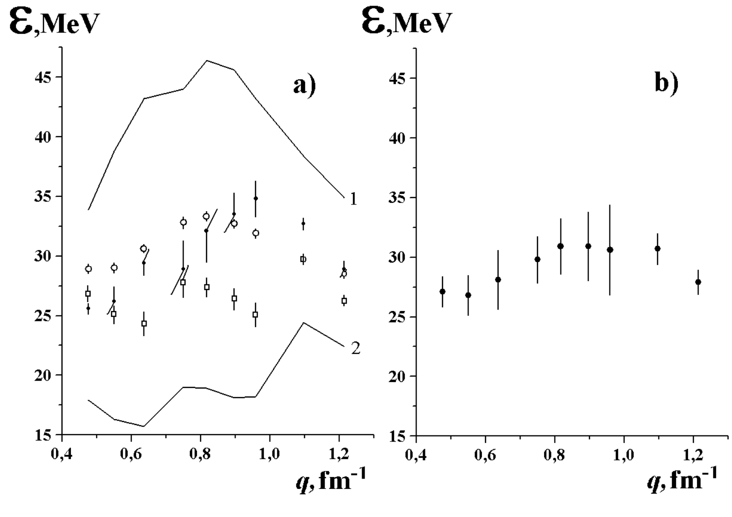

Fig.4. *Sift of the quasielastic peak maximum energy position with respect to that for kinematics of scattering on free nucleon: a) All methods used. Closed circles - Gauss function fitting, open circles - log-normal function fitting, open squares - fitting to the front of spectrum. Curves 1 and 2 - upper and bottom limits correspondingly, obtained from the energy position of the points that participated in the Gauss function fitting. b) Average of three methods*

In is necessary to mentioned that such dependence of the shift value is based on the idea that quasielastic cross section energy dependence has distinct maximum. Such idea is rather probable but was not proved in this momentum transfer region.

The value of the shift of quasielastic peak maximum averaged over the hole interval of q is $28.6 \pm 0.6\, MeV$. This value is somewhat smaller than for ^{65}Cu - $25.4 \pm 1.6\, MeV$ [1]. According to the investigation presented in [2] it is unlikely that ^{63}Cu and ^{65}Cu has such big difference in ϵ_0. More probably that such difference shows the accuracy of the method of the electron spectrum division into resonance and quasielastic parts.

5. CONCLUSION

The carried out investigation shows that as in the case of ^{65}Cu in the excitation energy range $10 \ldots 30\, MeV$ the quasielastic cross section in considerably smaller than that previously used in the studding of giant resonances.

There is an indication that the momentum transfer dependence of the shift of the quasielastic peak energy position has maximum at $q \sim 0.8 \ldots 1.0\, fm^{-1}$.

The estimated value of the error of the absolute value of the quasielastic peak shift is about $3\, MeV$.

References

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КВАЗИУПРУГОЕ РАССЕЯНИЕ ЭЛЕКТРОНОВ НА ^{63}Cu В ОБЛАСТИ ЭНЕРГИЙ ГИГАНТСКИХ РЕЗОНАНСОВ

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Представлен результат выделения квазиупругой части сечения из спектров рассеянных на ^{63}Cu электронов. В каждом из полученных квазиупругих спектров определено положение максимума и представлена зависимость сдвига его энергетического положения относительно кинематики рассеяния на свободном нуклоне в диапазоне переданных импульсов $q = 0.5 \ldots 1.2$ фм$^{-1}$.

КВАЗІПРУЖНЕ РОЗСІЯННЯ ЕЛЕКТРОНІВ НА ^{63}Cu В ОБЛАСТІ ЕНЕРГІЙ ГІГАНТСЬКИХ РЕЗОНАНСІВ

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Представлено результат виділення квазіпружної частини перерізу з спектрів розсіяних на ^{63}Cu електронів. У кожному з отриманих квазіпружних спектрів визначено положення максимуму та представлено залежність зсуву його енергетичного положення відносно кінематики розсіяння на вільному нуклоні в диапазоні переданих імпульсів $q = 0.5 \ldots 1.2$ фм$^{-1}$.