

PROCEEDINGS

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Book 5
**Mathematics, Informatics and
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BOOK 5

**"MATHEMATICS,
INFORMATICS AND
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CONTRIBUTIONS OF FOLDING, CLUSTER AND INTERFERENCE TERMS TO THE CHARGE FORM FACTOR OF ${}^6\text{Li}$ NUCLEUS

Galina Krumova

Angel Kanchev University of Ruse

Abstract: The contributions of the folding, cluster and interference terms to the formation of the charge form factor of ${}^6\text{Li}$ nucleus are investigated. The theoretical basis of this approach is described in the previous article. The obtained results are successfully compared with the available experimental data for the charge form factor of ${}^6\text{Li}$.

Keywords: Form factor, cluster structure, interference.

As described in the previous article here the squared nuclear charge form factor of the ${}^6\text{Li}$ nucleus

$$|F_{6\text{Li}}^{\text{ch}}(q)|^2 = A + B + C$$

is represented as a sum of three terms A, B and C of the following form:

$$A = c_1^2 |F_{4\text{He}}^{\text{ch}}(q)|^2 |F_d^{\text{ch}}(q)|^2 e^{\frac{q^2}{2A^{2/3}}},$$

$$B = \frac{c_2^2}{9} \left[4|F_{4\text{He}}^{\text{ch}}(q)|^2 + |F_d^{\text{ch}}(q)|^2 + 4|F_{4\text{He}}^{\text{ch}}(q)||F_d^{\text{ch}}(q)| \right] e^{\frac{q^2}{2A^{2/3}}},$$

$$C = \frac{2}{3} c_1 c_2 |F_{4\text{He}}^{\text{ch}}(q)||F_d^{\text{ch}}(q)| \left[2|F_{4\text{He}}^{\text{ch}}(q)| + |F_d^{\text{ch}}(q)| \right] e^{\frac{q^2}{2A^{2/3}}}.$$

They correspond to the folding, cluster structure and interference contributions to the charge density, respectively.

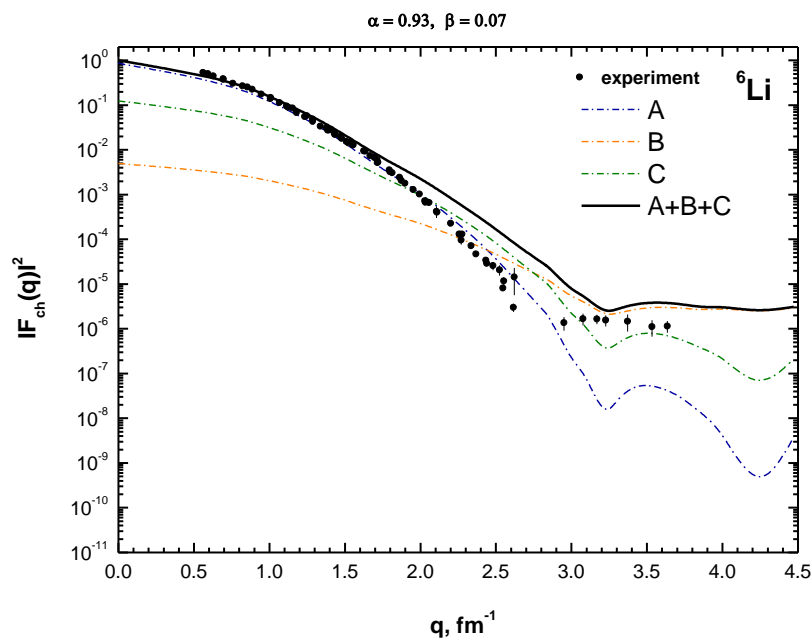


Fig. 1: The charge form factor of ${}^6\text{Li}$ calculated for $c_1=0.93$, $c_2=0.07$ in comparison with the experimental data. The contributions of A, B and C terms are presented.

An investigation of the sensitivity of the charge form factor to the values of the coefficients c_1 and c_2 , $c_1+c_2=1$, shows interesting results, displayed in **Figs. 1-10**.

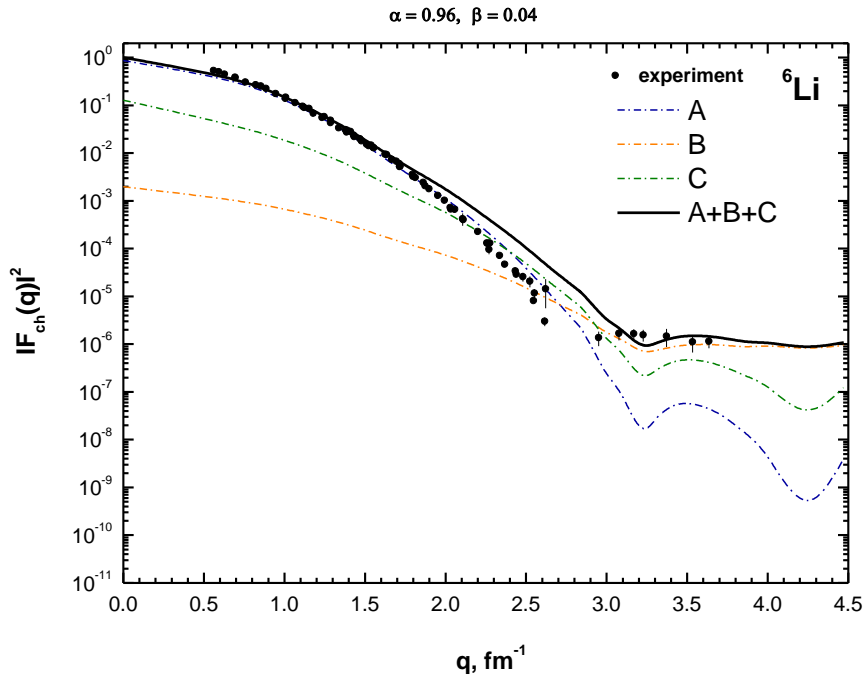


Fig. 2: The same as in **Fig. 1**, but for $c_1=0.96$, $c_2=0.04$.

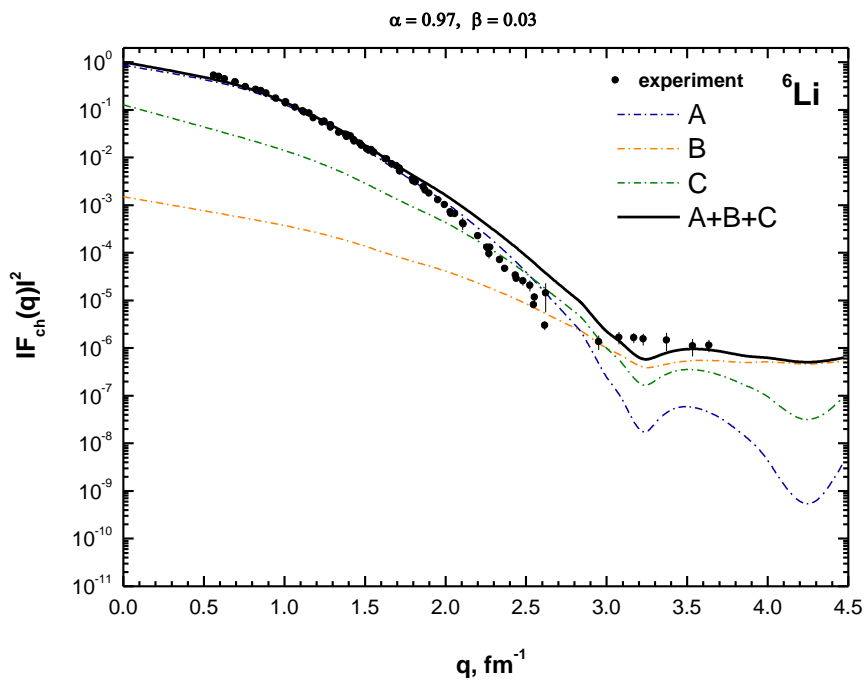


Fig. 3: The same as in **Fig. 1**, but for $c_1=0.97$, $c_2=0.03$.

The most convenient results obtained by different sets of values of the weight coefficients c_1 and c_2 are displayed. The same figures reveal the contributions of A, B and C terms to the squared charge form factor of ${}^6\text{Li}$ nucleus.

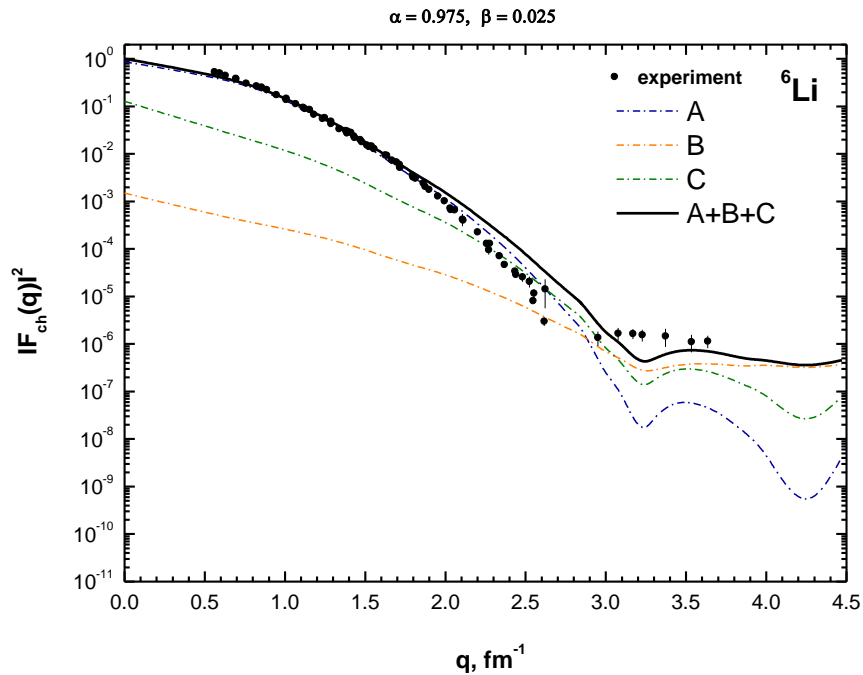


Fig. 4: The same as in Fig. 1, but for $c_1=0.975$, $c_2=0.025$.

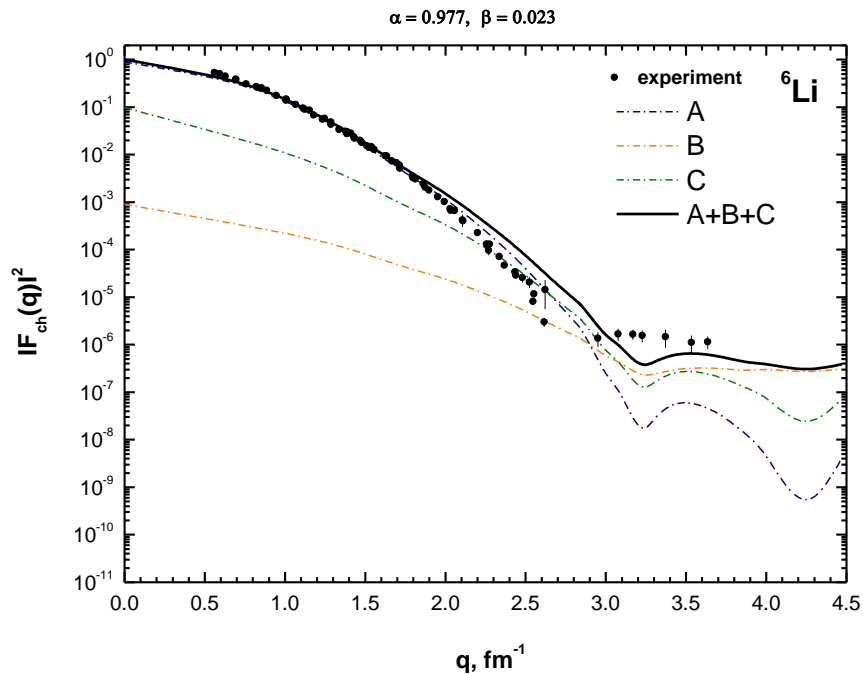


Fig. 5: The same as in Fig. 1, but for $c_1=0.977$, $c_2=0.023$.

It is obvious that in the interval of values of $c_1=0.975\div 0.985$ and, correspondingly, of $c_2=0.025\div 0.015$, the obtained results reasonably agree with the experimental data within the limits of the experimental errors. This fact has a clear physical meaning concerning the

clusterization represented by c_2 coefficient in the charge density distribution of this nucleus.

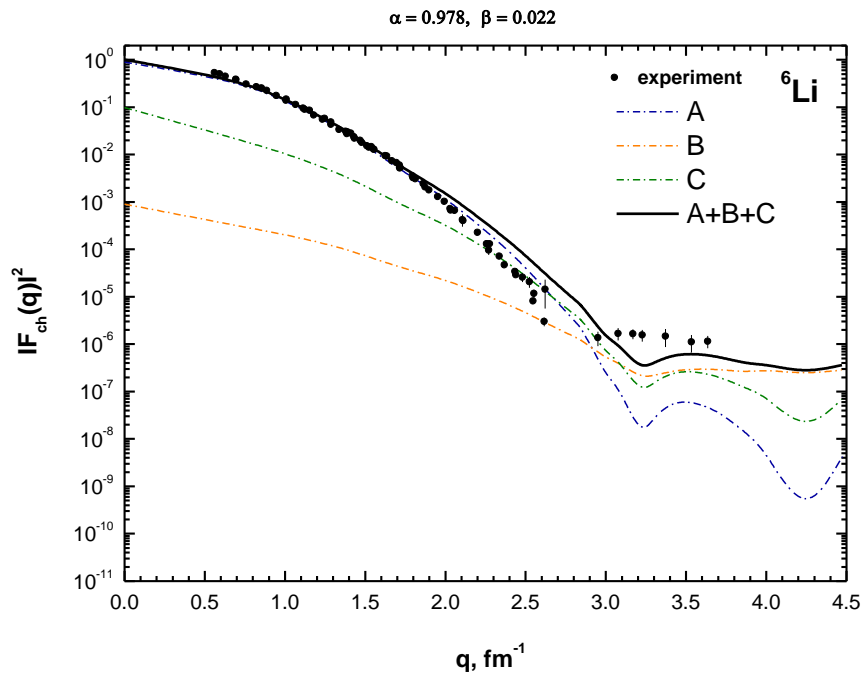


Fig. 6: The same as in **Fig. 1**, but for $c_1=0.978$, $c_2=0.022$.

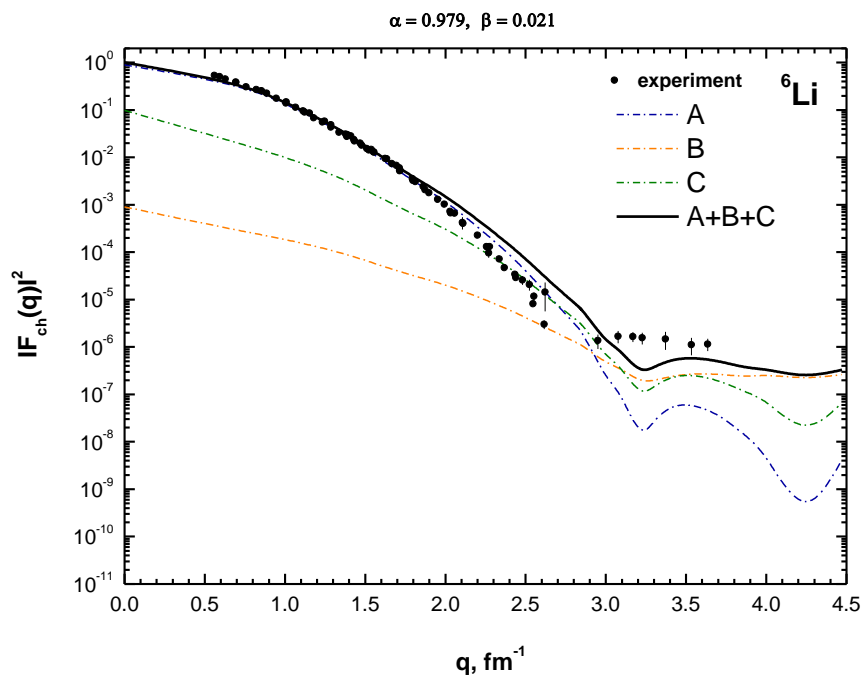


Fig. 7: The same as in **Fig. 1**, but for $c_1=0.979$, $c_2=0.021$.

The results presented in **Figs. 1-10** prove that the contribution of the folding density to the charge density of ${}^6\text{Li}$ is about 97.5÷98.5%. This corresponds to the weight of the contribution of the sum of ${}^4\text{He}$ and the deuteron densities of about 2.5÷1.5%. It is seen that the term A describes well the squared charge form factor of ${}^6\text{Li}$ in the interval $0 < q \leq 2.7 \text{ fm}^{-1}$, while the shell-model cluster density (related to the term B) is important for the description

of the charge form factor of ${}^6\text{Li}$ for the large values of q ($q \geq 3 \text{ fm}^{-1}$), related to the central nuclear density. The interference term C has a contribution to the charge form factor of ${}^6\text{Li}$ for $q \geq 3 \text{ fm}^{-1}$. The increase of c_1 within the above interval leads to a better description of the data for $q = 1.8 \div 2.9 \text{ fm}^{-1}$, but at the same time to a decrease of the values of the squared ${}^6\text{Li}$ charge form factor for $q \geq 3 \text{ fm}^{-1}$, underestimating the data. The calculations show that most reasonable results are obtained for 97.9% contribution of the folding term that corresponds to 2.1% weight of the contribution of the sum of ${}^4\text{He}$ and the deuteron charge densities to the ${}^6\text{Li}$ charge density.

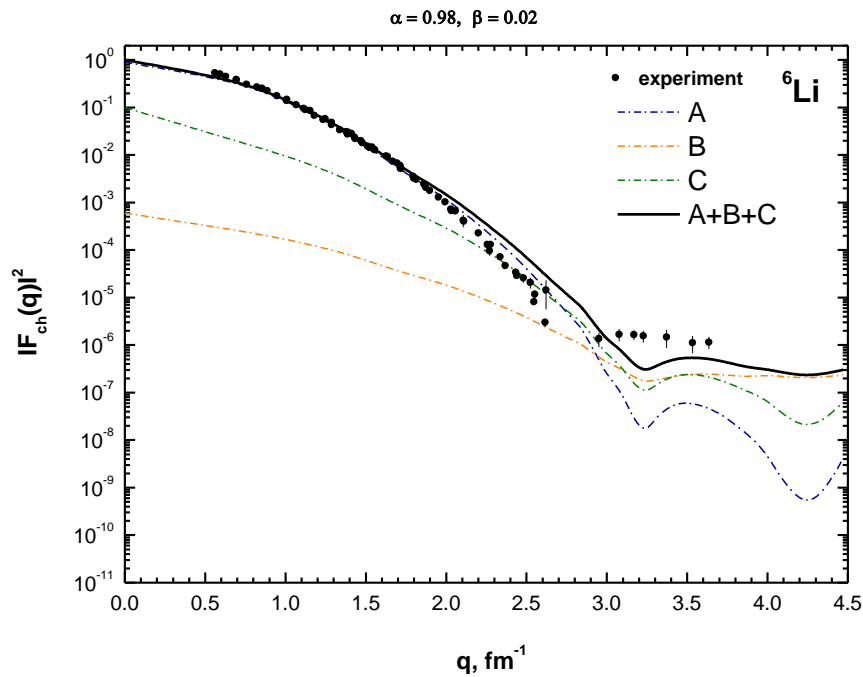


Fig. 8: The same as in Fig. 1, but for $c_1=0.98$, $c_2=0.02$.

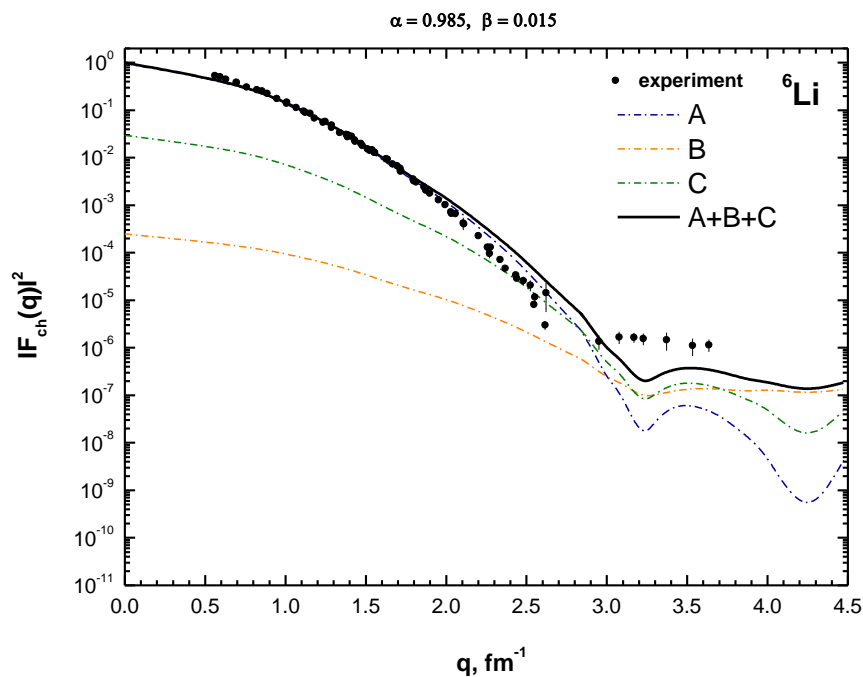


Fig. 9: The same as in Fig. 1, but for $c_1=0.985$, $c_2=0.015$.

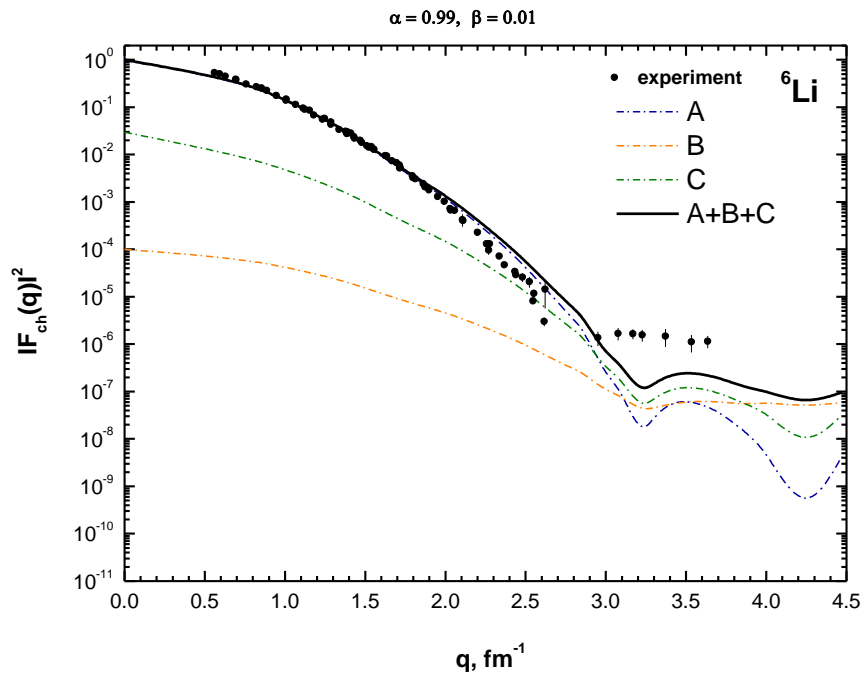


Fig. 10: The same as in Fig. 1, but for $c_1=0.99$, $c_2=0.01$.

CONCLUSIONS

The obtained results can be summarized as follows:

1) The calculations show a reasonable description of the charge form factor of ${}^6\text{Li}$ on the basis of a superposition of two density distributions:

- A folding density obtained from ${}^4\text{He}$ and the deuteron charge densities. Available experimental data for both densities are used, the calculations show that a good agreement with the data can be obtained when the weight of this contribution is about 97.5÷98.5%;
- A sum of the ${}^4\text{He}$ and deuteron charge densities with a weight of this contribution of about 2.5÷1.5%.

2) The scheme has only one free parameter (c_1 or c_2) - it is the weight of one of the contributions to the charge density of ${}^6\text{Li}$.

3) The behavior of the charge form factor of ${}^6\text{Li}$ for $0 < q \leq 2.7 \text{ fm}^{-1}$ is determined mainly by the folding contribution (of ${}^4\text{He}$ and the deuteron densities) to the charge density of ${}^6\text{Li}$ (its weight is about 97.5÷98.5%).

4) The shell-model α -d cluster density of ${}^6\text{Li}$ (i.e. the sum of ${}^4\text{He}$ and the deuteron charge densities) is important (though with a small weight of about 2.5÷1.5%) in the central nuclear region and, correspondingly, it is responsible for the values of the charge form factor of ${}^6\text{Li}$ at large values of q ($q \geq 3 \text{ fm}^{-1}$).

5) We would like to pay attention to the following facts:

- The minimum of the experimental charge form factor of the deuteron is at $q \approx 4.2 \text{ fm}^{-1}$;
- The minimum of the experimental charge form factor of ${}^4\text{He}$ is at $q \approx 3.2 \text{ fm}^{-1}$;
- The minimum of the experimental charge form factor of ${}^6\text{Li}$ is at $q \approx 2.9 \text{ fm}^{-1}$.

In this way our estimations show that the charge form factor of ${}^6\text{Li}$ is determined mainly by the contribution of the charge density and the corresponding form factor of ${}^4\text{He}$.

We expect that taking into account a possible deformation of ${}^6\text{Li}$ nucleus in future applications of the present approach, e. g. in certain direct reactions will improve the agreement with the empirical data for the form factor in the region of the minimum and for momentum $q > 3 \text{ fm}^{-1}$.

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**ПРИНОСИТЕ НА СГЪНАТИЯ, КЛЪСТЕРНИЯ И
ИНТЕРФЕРЕНЦИОННИЯ ЧЛЕН КЪМ ЗАРЯДОВИЯ ФОРМ ФАКТОР
НА ЯДРОТО ${}^6\text{Li}$**

Галина Крумова

Русенски университет „Ангел Кънчев“

Резюме: Изследвани са приносите на сгънатия, клъстерния и интерференционния член при формирането на зарядовия форм фактор на ядрото ${}^6\text{Li}$. Теоретичната основа на този подход е описана в предходната статия. Получените резултати са сравнени успешно с наличните експериментални данни за зарядовия форм фактор на ${}^6\text{Li}$.

Ключови думи: Форм фактор, клъстерна структура, интерференция.

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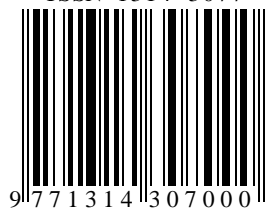
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