Conference Paper

Studying of the ^{9}Be structure

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Abstract

Experimental data on inelastic α+^{9}Be scattering induced by 30- and 90-MeV α-particles are analyzed. The question of the formation of the third rotational band based on the 2.78 MeV state is considered. The assumption is made about the occurrence of the 3.82 MeV state in the third rotational band.

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1. Introduction

In this paper the differential cross sections for elastic and inelastic scattering 90-MeV α-particle on ^{9}Be for excited states at 2.43 MeV, 2.78 MeV, 5.59 MeV and 7.94 MeV in ^{9}Be are analyzed. The purpose of these studies is to determine spin-parities of states which form the assumed third rotational band of the ^{9}Be (2.78 MeV, 5.59 MeV 7.94 MeV), based on the existed state 2.78 MeV. In this paper we also use the data obtained earlier in an experiment on the α+^{9}Be scattering at 30 MeV [1].

In the levels scheme [2] for excited states 2.78 MeV, 4.7 MeV, 5.59 MeV and 7.94 MeV in ^{9}Be the following spin-parity values $\frac{1}{2}^{-}$, $\frac{3}{2}^{+}$, $\frac{3}{2}^{-}$ and $\frac{5}{2}^{-}$ have been given correspondingly. These values of spin-parities are considered to be generally accepted.

However, in 2015 an article [3] was published, in which new spin-parity values for the above-mentioned excited states were determined: J^{π}=$\frac{3}{2}^{-}$, $\frac{1}{2}^{-}$, $\frac{5}{2}^{-}$ and $\frac{3}{2}^{-}$ respectively. They differ from generally accepted values [2]. If this result is confirmed, it will revolutionize our understanding of the ^{9}Be structure. The proposed new spin-parity value at 4.70 MeV excited state destroys the positive-parity rotational band, based on existed state 1.68 MeV, $\frac{1}{2}^{+}$, by excluding one of its members as shown in [4]. Changes in the spin-parity of the other levels question the existence of third rotational band, based on 2.78 MeV, $\frac{1}{2}^{-}$.

Nevertheless, we are analyzing experimental data, obtained in experiments on α+^{9}Be scattering induced by 30- and 90-MeV α-particles in order to determine the spin-parity values of existed states that form the assumed third rotational band in the ^{9}Be nuclei. The analysis is based on diffraction method MDM [5] and by comparing the behaviour of the obtained differential cross sections with differential cross sections at well studied states.

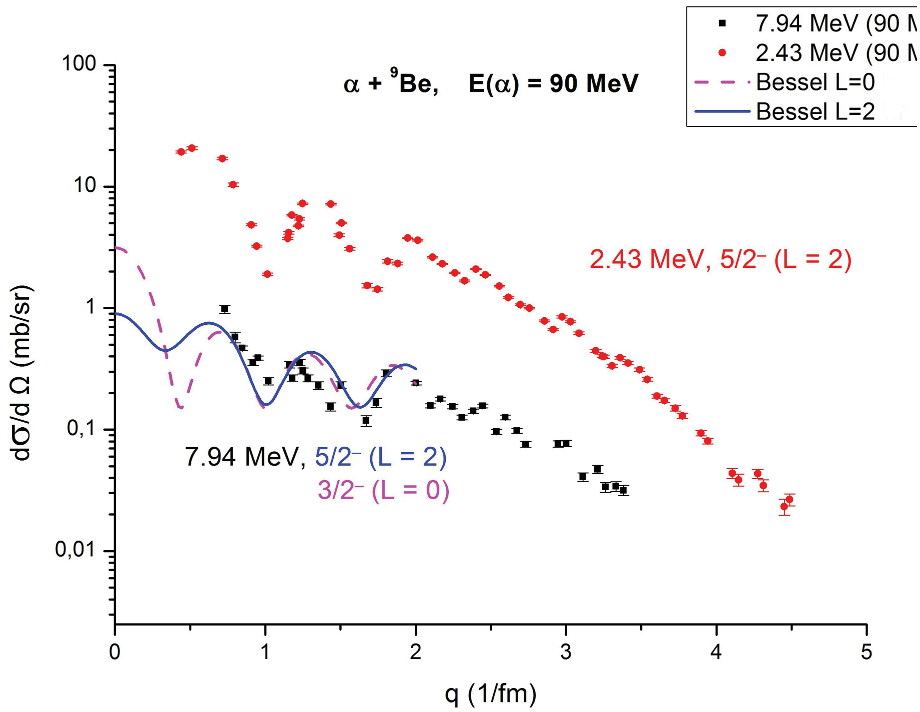

Figure 1: Differential cross sections for inelastic scattering induced by 90-MeV α-particles with excitation of 7.94 MeV (black dots) and 2.43 MeV (red dots) states in ^{9}Be. The curves correspond to the diffraction mechanism determined by a L = 0 (pink dashed curve) and L= 2 (blue solid curve).

2. Results

2.1. 2.78 MeV and 7.94 MeV states in ^{9}Be

Analysis, performed for 2.78 state in [4], showed that the spin-parity value for this existed state remains the same ($\frac{1}{2}^-$), as in [2].

In our research of 7.94 MeV state we have got the following results. On the fig.1 differential cross sections of inelastic α+^{9}Be scattering induced by 90 MeV α-particles at 2.43 MeV (red dots) and 7.94 MeV (black dots) in ^{9}Be nucleus are shown in the dependence of momentum transfer q, as it allows us to show the diffraction part of differential cross section, necessary for the analysis, more clearly.

As we can see on the fig.1, the behaviour of the differential cross section at 7.94 MeV coincide with the curve, which comply with the diffraction mechanism, described

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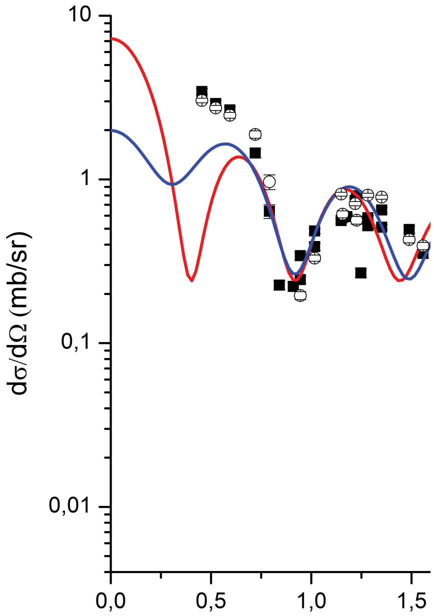

Figure 2: Differential cross sections for inelastic scattering induced by 30-MeV (open points) and 90-MeV (filled points) α-particles at 5.59 MeV excited state in ^{9}Be. The curves correspond to the diffraction mechanism at the L = 0 (red curve) and L= 2 (blue curve).

by the squared Bessel function (blue curve), whose order is determined by the angular momentum transfer L. This shows that the value of spin-parity should be $\frac{5}{2}^{-}$, i.e. remains generally accepted as shown in [2].

The additional factor in favor of keeping the generally accepted spin-parity value at 7.94 MeV is determined by comparison of the behaviour of differential cross section at 7.94 MeV with behaviour at well studied 2.43 MeV state, for which momentum transfer L = 2 and spin-parity equals $\frac{5}{2}^{-}$ is clearly established. This comparison shows that the position of extrema in diffraction part coincides.

Moreover, in article [6] the question of spin-parity values at 7.94 MeV has been raised. The authors have not confirmed the change of spin-parity value of this state, which corresponds to the saving of the value $\frac{5}{2}^{-}$.

2.2. 5.59 MeV state in ^{9}Be

As for 5.59 MeV state, we have not got definite answer. The comparison of diffraction mechanism depending on squared Bessel function of 0 and 2 order with differential cross section at 5.59 MeV (fig.2) has been made.

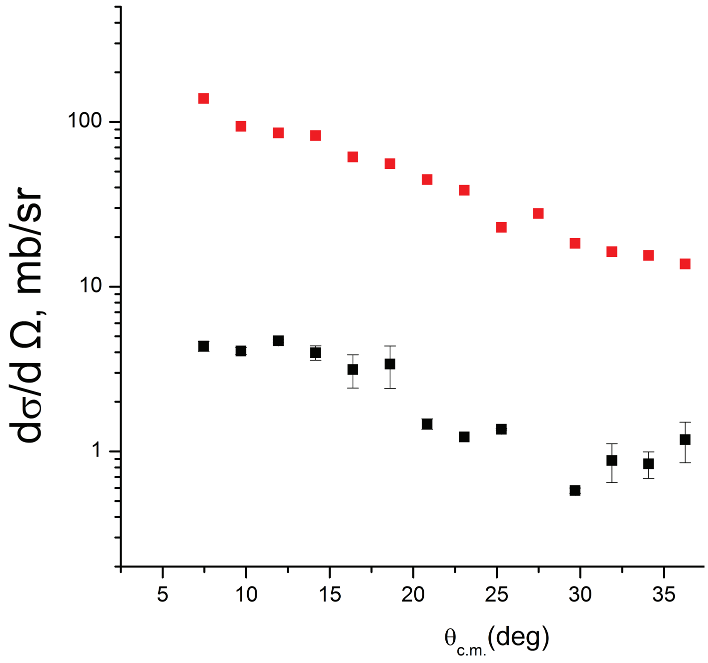

Figure 3: Differential cross sections for inelastic α+^{9}Be scattering induced by 30-MeV α-particles at 3.82 MeV state in ^{9}Be (black dots). The red dots correspond to the angular distribution of the background.

From this comparison we could not determine which linear momentum transfer corresponds to this state. In case when L equals 0, the spin-parity value remains generally accepted as $\frac{3}{2}^-$ [2]. However, if L equals 2, the spin-parity value will equal $\frac{5}{2}^-$, as predicted in [3].

2.3. 3.82 MeV state in ^{9}Be

In article of R.Smith [7] the question of existent of a new state in ^{9}Be nuclei at 3.82 MeV exited state has been arisen. This state was discovered with width Γ=1240^{+270}_{-90} keV, one of the assumed spin-parity values at this state equaled $\frac{3}{2}^-$. This value of spin-parity allows us to claim, that 3.82 MeV exited state may be the second member of assumed third rotational band.

The spectra, obtained from the experiment on α+^{9}Be scattering induced by 30- and 90-MeV α-particles, were analyzed. We could not identify this state from this experiment's data at 90 MeV.

As for the data, obtained in the experiment on α+^{9}Be scattering induced by 30-MeV α-particles, the differential cross sections for this state have been acquired (fig.3).

However, differential cross section at 3.82 MeV state was close to the differential cross section of the background, as shown on fig.3. In this case we can not claim that this state can be seen. However, the question of existence of this state still remains open.

3. Conclusion

For the first time differential cross sections for inelastic α+^{9}Be scattering induced by 90-MeV α-particles were obtained for the following states in ^{9}Be: 2.78 MeV, 5.59 MeV and 7.94 MeV.

The question of existence of the third rotational band, based on the 2.78 MeV, $\frac{1}{2}^{-}$ state, remains open. It has been shown that for the 5.59 MeV state the spin-parity value could be changed from $\frac{3}{2}^{-}$ to $\frac{5}{2}^{-}$. The assumption was made that in case of changing spin-parity value at 5.59 MeV, the second member of the third rotational band may be the 3.82 MeV state with assumed spin-parity value $\frac{3}{2}^{-}$.

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