BREMSSTRAHLUNG EMISSION IN PROTON-DEUTERON SCATTERING AND NUCLEON-NUCLEON FORCES

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We will present the results of a study of the bremsstrahlung emission of photons in a process of proton scattering on deuterons. Despite the long history of studies of the interaction of protons with deuterons and the existence of some studies on the subject in such reactions there are some interacting problems that need to be tackled. This stimulates us to develop a new model that allows us to gain more information about processes induced by the $p + d$ interaction and the properties of nuclear forces. Besides, this model is aimed at detailed analysis and interpretation of the existing experimental data on bremsstrahlung emission in these processes. The relative simplicity of the selected nuclei is explained by the fact that it is possible to demonstrate more clearly the effectiveness of the model.

The quantum model of photon emission developed by us is a continuation of the development of methods of bremsstrahlung emission in nuclear processes formulated in [1, 2] (see references therein) with new incorporating ideas of cluster models [3, 4] (see references therein). Within the framework of the model, proton scattering on a deuteron is described as a solution of the quantum-mechanical three-nucleon problem with semi-realistic nucleon-nucleon potentials. This model is applied to study wave functions of continuous spectrum states in the $p + d$ system and then to calculate cross sections of photon emission. Based on this model, a good description of the existing experimental emission data has been achieved [5, 6]. The dependence of the cross sections of bremsstrahlung emission on the shape of the nucleon-nucleon potential is studied in details.

We have applied our method to analyse results of experimental investigations [5, 6] of gamma ray production in $p + d$ interactions. Our analysis revealed that the results of the experiments [5, 6] with chosen parameters (incident energy of proton beam, energy of detected photons) are insensitive to the peculiarities of nuclear forces. However, we have identified another energy region for experiments where it is possible to obtain information about the properties of nuclear forces within the present method with higher accuracy. To make our analysis more complete, we analyze bremsstrahlung properties in a wide range of proton beam energies and photon energies.

Results of our model allow us to predict behavior of bremsstrahlung cross sections which can be used for planning of new experiments. The approach developed can be used to study the bremsstrahlung emission in a large variety of nuclear scattering processes, and also to determine effects of nuclear structure and nucleus-nucleus interaction on a such emission.

References

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