REVIEW

for the dissertation by Tkachenko Alessya Sergeevna
"Phase shift analysis of nuclear processes with the spin structure 1+1/2, 1+1, 1/2+3/2 and astrophysical applications", submitted for the degree of Doctor of Philosophy (PhD) in the specialty 6D060500 – "Nuclear physics"

The main goal of the research was to develop the mathematical formalism for the phase shift analyses of the high spin channel binary systems as there are no any such a kind data in open access scientific publications up today. It was done successfully in presented PhD thesis. The phase shift analyses itself is a path to construct the corresponding interaction potentials, that is open the wise variety of problems to be solved on their basis. The latter are the different nuclear reactions and nuclear structure, processes in laboratory and stellar plasma, elementary particle reactions.

The test computer program has been developed within the Simply Fortran software. Testing runs have been done for the available data on the phase shifts and scattering cross sections of the proton-deuteron system. It should be stressed that creation of the universal computing codes may take not less than few years as this is a task for the post-doc activity. At a time, the present thesis provides the detailed mathematical basis for such a computing project.

The level of implementing the phase shift research program is restricted by the available experimental data on the elastic scattering cross sections. So that the intermediate also experimentally substantiated way to obtain the potential parameters is based on the data for the nuclear energy spectra, resonance widths, asymptotic normalizing coefficients etc. This is known as Modified Potential Cluster Model (MPCM). Within this approach the radiative capture reactions $^{3}\mathrm{He}(^{2}\mathrm{H},\gamma)^{5}\mathrm{Li}$ and $^{10}\mathrm{Be}(n,\gamma)^{11}\mathrm{Be}$ relevant for the astrophysical interest have been examined.

The radiative capture reaction $^{3}\mathrm{He}(^{2}\mathrm{H},\gamma)^{5}\mathrm{Li}$ has been investigated for the purpose of the analyzing the high spin channel aside. Therefore, it turned to be the additional path for the production of the $^{6}\mathrm{Li}$ in Big Bang Nucleosynthesis as the neutron capture on $^{5}\mathrm{Li}$ leads to $^{6}\mathrm{Li}$ creation. The obtained results are the new ones in the wide long time discussion of the $^{6}\mathrm{Li}$ abundance. The obtained reaction rates may be recommended for the including into the evaluated data bases as NACRE – II. That is really high level result.

Reaction $^{10}\mathrm{Be}(n,\gamma)^{11}\mathrm{Be}$ is also one with the high spin structure in initial channel. The evaluation of its input into the beryllium chain of the stellar evolution is of great importance. Here, it should be appreciated the communication with prof. T. Aumann (Austria) and prof. Nacamura (Japan) on the Coulomb break-up data on this reaction. So far, as there are no direct measurements on the cross sections of reaction

$^{10}\mathrm{Be}(n,\gamma)^{11}\mathrm{Be}$, the corresponding recalculation procedure has been implemented successfully. It was extremely useful experience for the A. Tkachenko, which provides also the reliable calculations of the corresponding reaction rates within the MPCM.

At a time, experience in details of the phase shift formalism and operation within the MPCM makes it possible to analyze the *narrow* gaps in the latter approach due to the uncertainties in the interaction potentials, which may be closed by the consistent phase shift analyses.

All obtained results are new and perspective for the future applications and developments.

During the research Alessya Tkachenko has established herself as a competent young scientist, able to independently solve the scientific problems assigned to her. This is confirmed by publications in high-ranking scientific journals, such as Nuclear Physics A and Astroparticle Physics, and presentations at international scientific conferences, including International Conference on Few-Body Problems in Physics (FB22), Caen, France.

I believe that the results obtained in the work fully comply with the requirements for the results of the dissertation of Doctor of Philosophy, and the applicant Alessya Tkachenko undoubtedly deserves the award of the degree of Doctor of Philosophy (PhD) in the specialty 6D060500 – "Nuclear physics".

Local scientific supervisor:
Doctor of Science, Professor N.A. Burkova

(I assure the signature of Professor Burkova N.A.)

РАСТАЙМЫН
әл-Фараби атындағы Қаз
даярлау және аттестаттау басқарм
ЗАВЕРЯЮ
Начальник управления подгото
научных кадров КазНУ им
Р.Е. Кудайбергенова
«_____»