CROSS SECTION PARAMETRIZATION FOR THE HIGH SPIN ELASTIC SCATTERING

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Of particular interest to the two-particle photodisintegration and radiative capture reactions $A+\gamma \rightleftarrows a+b$ is due to the fact that these processes are directly related to the most advanced research in nuclear astrophysics (thermodynamics of the Universe [1], nucleosynthesis of chemical elements in the Sun and stars, the Big Bang theory [2]), as well as the physics of nuclear reactors and nuclear fusion.

Currently, with implementation of the novel method of inverse Compton scattering (ICPB) for the generating a quasi-monochromatic beams of photons experimental capabilities have reached a new level and is continuously expanding.

The analytics was implemented for the scattering processes with channel spin structure 1/2, 3/2 and 5/2. For the first time the parameterization of differential cross sections by orbital momentums $\ell = 0, 1, 2, \ldots$ for the quartet and quintet spin channels has been performed. The presentation is given in a universe form and may be applied for the phase shift analyses for the scattering of nuclei or elementary particles. Same amplitudes are used in the construction of the polarization characteristics as vector and tensor polarization. The following isotopes are in field of interests: $^{7}\mathrm{B}(3/2^{-})$, $^{9}\mathrm{B}(3/2^{-})$, $^{11}\mathrm{B}(3/2^{-})$, $^{12}\mathrm{B}(1^{+})$, $^{13}\mathrm{B}(3/2^{-})$, $^{5}\mathrm{Li}(3/2^{-})$, $^{6}\mathrm{Li}(1^{+})$, $^{7}\mathrm{Li}(3/2^{-})$, $^{9}\mathrm{Li}(3/2^{-})$, $^{10}\mathrm{Li}(1^{-})$, $^{9}\mathrm{C}(3/2^{-})$, $^{11}\mathrm{C}(3/2^{-})$ and protons, neutrons, deuterons as impact particles, as well some exotic elementary particles, for example, tau-lepton τ (1).

The differential cross section for elastic scattering of two particles system with spin structure 1 + 3/2 accounting spin-orbit splitting is $\frac{d\sigma(\theta)}{d\Omega} = \frac{1}{6}\frac{d\sigma_{1/2}}{d\Omega} + \frac{1}{3}\frac{d\sigma_{3/2}}{d\Omega} + \frac{1}{2}\frac{d\sigma_{5/2}}{d\Omega}$, where the indices and related to the *doublet*, *quartet* and *quintet* scattering states corresponding to the total spin channel $S = 1/2, S = 3/2$ and $S = 5/2$. For the partial cross sections 28 amplitudes have been analytically calculated.

The partial cross-section of the *quintet* spin channel $S = 5/2$ is a combination of 18 independent amplitudes.

Present work for the first time reported the formulas for the calculation of differential cross sections in scattering channels with spins 3/2 and 5/2 in addition to 1/2. The obtained representations are *universal* and can be used for a wide range of problems in nuclear and particle physics. Namely their different combinations depending on the spins of scattering particles cover cases $s_1 + s_2 = 1+1/2, 1+3/2, 2+1/2$. Due to the fact, that the orbital quantum number can take any value in, the obtained formulas are applicable for the calculation of reactions proceeding at low and ultra - low astrophysical energies, as well as for the high-energy processes.

Some results were applied for the calculations of proton radiative capture reactions on $^{10,11}\mathrm{B}$ isotopes at low astrophysical energies and show good agreement with available experimental data.

References

1 Ishhanov B.S., Kapitonov I.M., Judin N.P. Chasticy i atomnye jadra.– M.: Izdatel'stvo LKI, 2007. – 584 s.

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