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Prompt Photons Production in Compton Scattering of Quark-Gluon and Annihilation of Quark-Antiquark Pair Processes

Authors : Mohsun Rasim Alizada, Azar Inshalla Ahmdov

Abstract : Prompt photons are perhaps the most versatile tools for studying the dynamics of relativistic collisions of heavy ions. The study of photon radiation is of interest that in most hadron interactions, photons fly out as a background to other studied signals. The study of the birth of prompt photons in nucleon-nucleon collisions was previously carried out in experiments on Relativistic Heavy Ion Collider (RHIC) and the Large Hadron Collider (LHC). Due to the large energy of colliding nucleons, in addition to prompt photons, many different elementary particles are born. However, the birth of additional elementary particles makes it difficult to determine the accuracy of the effective section of the birth of prompt photons. From this point of view, the experiments planned on the Nuclotron-based Ion Collider Facility (NICA) complex will have a great advantage, since the energy obtained for colliding heavy ions will reduce the number of additionally born elementary particles. Of particular importance is the study of the processes of birth of prompt photons to determine the gluon leaving hadrons since the photon carries information about a rigid subprocess. At present, paper production of prompt photon in Compton scattering of quark-gluon and annihilation of quark–antiquark processes is investigated. The matrix elements Compton scattering of quark-gluon and annihilation of quark-antiquark pair processes has been written. The Square of matrix elements of processes has been calculated in FeynCalc. The phase volume of subprocesses has been determined. Expression to calculate the differential cross-section of subprocesses has been obtained: Given the resulting expressions for the square of the matrix element in the differential section expression, we see that the differential section depends not only on the energy of colliding protons, but also on the mass of quarks, etc. Differential cross-section of subprocesses is estimated. It is shown that the differential cross-section of subprocesses decreases with the increasing energy of colliding protons. Asymmetry coefficient with polarization of colliding protons is determined. The calculation showed that the squares of the matrix element of the Compton scattering process without and taking into account the polarization of colliding protons are identical. The asymmetry coefficient of this subprocess is zero, which is consistent with the literary data. It is known that in any single polarization processes with a photon, squares of matrix elements without taking into account and taking into account the polarization of the original particle must coincide, that is, the terms in the square of the matrix element with the degree of polarization are equal to zero. The coincidence of the squares of the matrix elements indicates that the parity of the system is preserved. The asymmetry coefficient of annihilation of quark–antiquark pair process linearly decreases from positive unit to negative unit with increasing the production of the polarization degrees of colliding protons. Thus, it was obtained that the differential cross-section of the subprocesses decreases with the increasing energy of colliding protons. The value of the asymmetry coefficient is maximal when the polarization of colliding protons is opposite and minimal when they are directed equally. Taking into account the polarization of only the initial quarks and gluons in Compton scattering does not contribute to the differential section of the subprocess.

Keywords : annihilation of a quark-antiquark pair, coefficient of asymmetry, Compton scattering, effective cross-section
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