Radiation of Twisted Photons from Planar Channeled Electrons

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Over the last years, a research direction in modern quantum optics is related with so-called "twisted photons". According to [1], such photons can be created from usual laser beams by means of specially designed holograms. Moreover, in Refs.[2] was demonstrated that micron-sized "particles" start to rotate after absorbing twisted photons.

The twisted photon states are the states of a free electromagnetic field with definite energy, the longitudinal projection of momentum, projection of the total angular momentum, and helicity [1]. Despite the number of theoretical and experimental works on twisted photons, some theoretical features of ones are not studied up to date.

Still there is no generally accepted quantum theory of twisted photons emission from charged particles. For example, in the Refs. [3] it was suggested an approach based on the quantum description of emitted photons and classical currents. It is some semiclassical model. Unfortunately, Refs. [3] does not contain sufficient theoretical substantiations of this approach.

Any beam of ordinary photon can be represented as the sum of twisted photons, but due to cylindrical (axial) symmetry number of photons "rotates to the right" (photons with positive longitudinal projection of momentum) is equal to number of photons "rotates to the left" (photons with negative longitudinal projection of momentum). As a result, the total longitudinal projection of momentum of beam is zero. Therefore, in order to obtain a beam of the twisted photons the cylindrical (axial) symmetry of radiation condition should be broken. Such a situation arises for example at electrons (positrons) planar channeling in a crystal.

In the present report, we developed the theory of radiation of twisted photons from planar channeling electrons (positrons) on the base of the approach developed in [1].

References

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