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Spin-statistic selection rules for multiphoton transitions in atomic systems

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We establish the existence of spin-statistic selection rules (SSSRs) for multiphoton transitions with equal photons in atomic systems. These selection rules are similar to those for systems of many equivalent electrons in atomic theory. The latter are a direct consequence of the Pauli exclusion principle. In this sense, the SSSRs play the role of the exclusion principle for photons: they forbid some particular states for the photon systems. We established several SSSRs for few-photon systems. (i) First rule: two equivalent photons involved in any atomic transition can have only even values of the total angular momentum, J. This selection rule is an extension of the Landau-Yang theorem to the photons involved in atomic transitions. (ii) Second rule: three equivalent dipole photons involved in any atomic transition can have only odd values of the total angular momentum, J=1,3. (iii) Third rule: four equivalent dipole photons involved in any atomic transition can have only even values of the total angular momentum, J=0,2,4. We also suggest a method for a possible experimental test of these SSSRs by means of laser experiments with Helium.

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