Interference of single photons (What is a photon?)

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Abstract – Photon is a relativistic particle. If the number of photons is small, they should be considered as a quantum object, but in the opposite case – as the classical field. The Schrödinger equation for the photon is the wave Maxwell equation, and the electromagnetic field should be considered as the wave function. The photon may be considered as a particle having the size ~λ, but localized in a long "packet".

Photon is a relativistic particle, and its rest mass is equal to 0. So, the relation between the momentum ep and the energy ε is defined by the ratio ε=cp, where c is the light velocity.

Minimal state of the electromagnetic field energy corresponds to the presence of one photon with the energy ℏω, where ℏ is the Planck constant, and ω the electromagnetic wave frequency. If the number of photons is small, they should be considered as a quantum object, and in the opposite case – as the classical field. The Schrödinger equation for the photon is the wave Maxwell equation, and the electromagnetic fields should be considered as the wave function. Landau and Peierls made a statement, that it is impossible to introduce the wave function for a photon in the x-space. The reason is that the photon is a truly wave object, and one can’t introduce the localization notion (one would need the space volume about λ2). This mathematically accurate statement may be disregarded, if we consider the scales more than one wavelength. Then, from the uncertainty principle it follows that at the production of a photon having the pulse p, its dimension Δx is ℏ/p, i.e. λ.

Thus, the photon may be considered as a particle having the size ~λ, and which is localized inside of a “packet”. The “packet” length is determined by the production time τ, i.e. the “packet” length cτ.