Periodic variations in the wavelength distributions following photon interferences : analogy with electron interferences

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Periodic variations in the wavelength distributions following photon interferences : analogy with electron interferences

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Synopsis In this report we investigate photon interferences in order to determine the wavelength distribution as a function of the position in the interference field.

Recently, we studied the process
$$\mathrm{He}^{2+} + \mathrm{H}_2(1\sigma_g) \to \mathrm{He}^{**}(2\ell n\ell', n \geq 2) + \mathrm{H}^+ + \mathrm{H}^+$$
where the outgoing autoionizing helium atom plays the role of the source of a single-electron emitter, while the two residual protons provide the double-center interferometer [1]. We focused on the single $2s^2\ {}^1S$ line, and determined its maximum and linewidth as a function of the detection angle [2]. The analysis gave evidence for well defined oscillations in the angular dependence of both the maximum and the linewidth of the wavelength distribution. The maximum oscillates in phase with the total intensity on the observed angular range. More surprisingly, the linewidth was found to strongly oscillate in counter phase with the maximum [2]. The question arises whether the analogy between photon and electron interferences can be extended to quantities such as the linewidth. In the present work, we revisit the photon interference experiment in order to determine the wavelength distribution as a function of the position on the detection screen.

The optical set-up is based on the classical Lloyd's mirror experiment. The light source is a *superluminescent erbium-doped* silica fibre. The output facet of the optical fiber acts as a coherent light source. A plane mirror is positioned at razing angle close to the optical fiber to create a virtual light source. Moving the fiber allows to adjust the distance between the real and virtual light sources. The reflected light interferes with the direct light. The pattern of interference fringes is detected point-by-point and is analyzed using an optical spectrum analyzer.

The upper part of Figure 1 shows a typical interference pattern, consisting of well defined oscillations in the intensity distribution versus the position in the interference field. The lower part of the figure represents the spectral width of the interfering light as a function of the position. The width is found to decrease from 0.94 to 0.92 nm as the position increases (dashed curve). A non-sinusoidal but periodic dependency is visible for the width, with very sharp minima which correspond to those seen in the intensity distribution. Also, the same period is obtained for the intensity and the width. These results are in agreement with our theoretical calculations.

The present work extends the analogy between photon and electron interferences. The observed differences can be attributed to the different nature of interaction in each case.

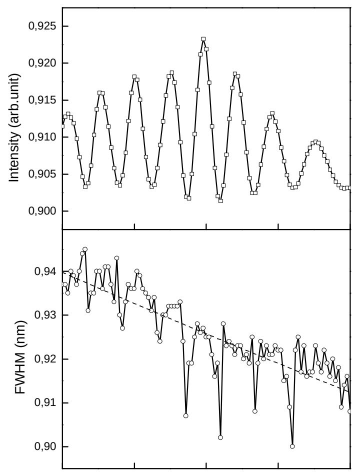

Figure 1. Total intensity (top) and full width at half maximum (bottom)

References

[1] J. Y. Chesnel et al. 2007 Phys. Rev. Lett. **98** 100403
[2] R. O. Barrachina et al 2010 Phys. Rev. A. **81** 06072

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