Interference fringes offset in the Lloyd's experiment

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It is shown that a rotation of the Lloyd mirror causes a shift in the interference pattern.
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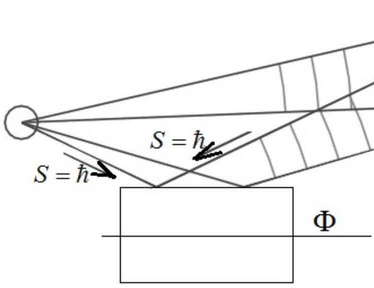
In the famous Lloyd's experiment, two coherent waves interfere, one of which is reflected from a mirror. We will assume, for the sake of reduced reasoning, that the angle of incidence-reflection is close to 90 degrees.



We noticed [1,2] that if electromagnetic waves are circularly polarized, then each photon that has the spin $S=\hbar$ will, when reflected, transmits the double spin angular momentum, $2\hbar$, to the mirror because, when reflected, the helicity of the wave is reversed, and thus the direction of the spin is reversed relative to the direction of the momentum. The angular momentum flux means a torque acting on the mirror. Therefore, if the mirror rotates around the axis parallel to the transmitted spin, work will be performed on the mirror. According to the conservation law, it will change the energy and frequency of the photon.

When the mirror is rotated by an angle Φ, the ***action*** (product of energy per time, ΔEt) will be performed by one photon.

$$2\hbar\Phi = \Delta Et\ .$$

Since the energy of this photon, equal to $E=\hbar\omega$, changes upon reflection on ΔE, such an action will entail the phase shift of the reflected wave $\Delta\varphi = \Delta\omega t$. As a result, we get the shift of the interference pattern into two fringes with each revolution of the rotating mirror:

$$2\Phi = \Delta\varphi$$

To implement the rotation of the mirror, it was proposed to use a rotating mirror cylinder as a mirror. [3].

References

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