Interference fringes shift in the Lloyd's experiment

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The transfer of spin from a light to a mirror is demonstrated.
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Undoubtedly, circularly polarized light possesses the spin angular momentum $S = \hbar$ per photon [1]. This means that energy flux in such a light, i.e. power P, is accompanied by the angular momentum flux, i.e. torque $\tau = P/\omega$. If the light is absorbed, the photons are absorbed, and the absorber gets these power P and torque τ [2-5]. When such light is passed through a transparent half-wave plate, the number of photons is conserved, but the plate gets the double torque, 2τ, because the plate reverses helicity of the light, and thus the direction of the spin $\boldsymbol{S}$ is reversed relative to the direction of the momentum $\boldsymbol{p}$ (Fig. ***a***). When such light is reflected from a mirror at an angle φ, the number of photons is conserved as well, and the mirror gets the double tangent component of the torque, $2\tau\sin\varphi$, because the mirror reverses the helicity of the light [6,7] (Fig. ***b***).

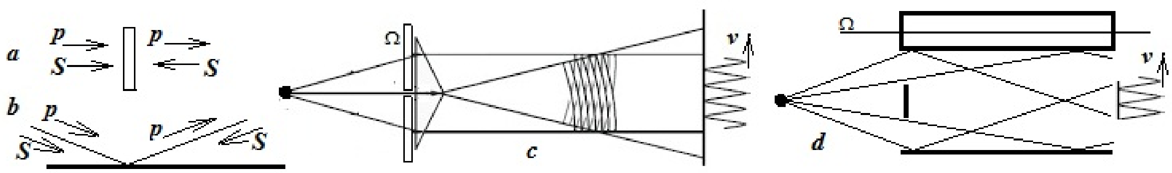

Figure. ***a***) Light passes through a half-wave plate. ***b***) Light reflects from a flat mirror. ***c***) Righi experiment: half-wave plates are in front of Fresnel biprism, and the upper plate rotates. ***d***) Modified Lloyd experiment: a flat mirror is located below, a rotating cylinder is at the top.

If the half-wave plate rotates with an angular velocity Ω, the torque τ does work with the power $\widetilde{P} = 2\tau\Omega$. Such work changed the oscillation amplitude of the Beth's torsional pendulum [8], although the Poynting vector equaled zero in the Beth experiment [9], and this rotation does not change the number of photons. So this work is done at the expense of the photons energy. The rotation changes photon's energy $\hbar\omega$ and frequency ω: $\Delta\omega/\omega = \widetilde{P}/P = 2\Omega/\omega$. But Beth was not interested in this frequency change $\Delta\omega = 2\Omega$.

Contrary, Righi measured the frequency change through an interference experiment [10]. In the Righi experiment (Fig. ***c***), two half-wave plates are placed in front of two halves of Fresnel biprism, and one of the plates rotates. Because of the frequency difference $\Delta\omega$, interference fringes move (the shift in two fringes for each turn of the half-wave plate).

Analogically, a rotation of the mirror changes energy and frequency of the reflected photons. We can measure this change by modifying the Lloyd experiment. To implement the rotation of the mirror, it was proposed to use a rotating mirror cylinder as a mirror. [11].

Let a flat mirror and a mirror cylinder are parallel to each other. The light running along the axis of the cylinder and reflected from the cylinder and from the mirror creates interference fringes (Fig. ***d***). Rotation of the cylinder will cause the fringes to move if the light is circular polarized (the shift in two fringes for each turn of the cylinder if $\sin\varphi \cong 1$).

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