Circular Polarization, Graphical Representation

Abstract

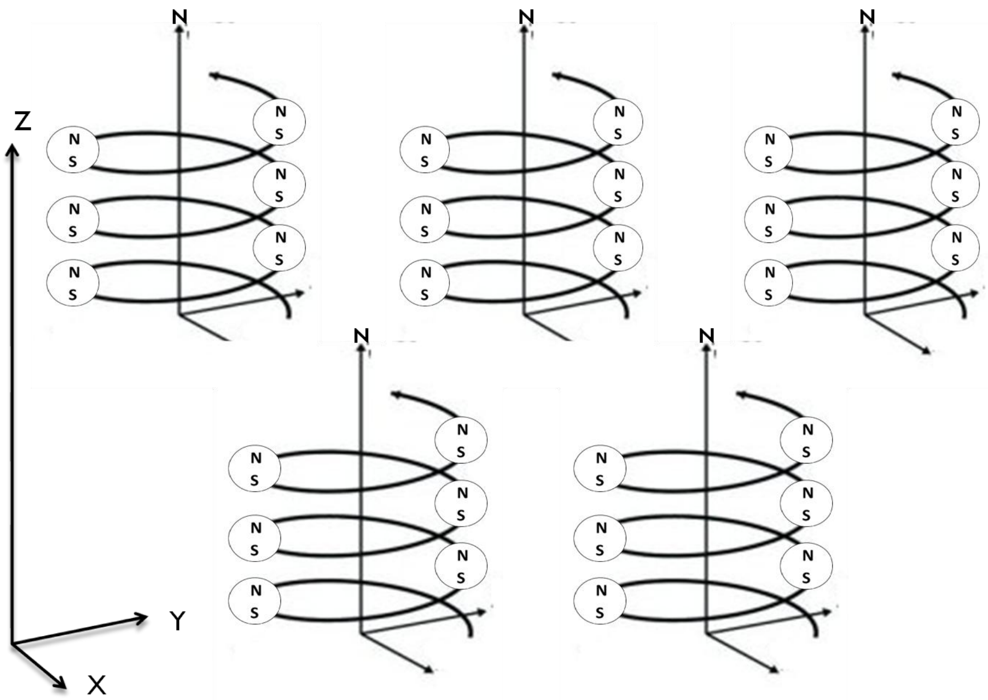
Circular (or elliptical) polarized light acts as a magnet upon interaction with matter. This is the 'inverse Faraday effect' (IFE). This behavior can be explained with the help of a mathematical analysis. This article explains it using a simple graphical approach.

"If I can't picture it, I can't understand it." Albert Einstein.

Frenchman Francois Jean Arago experimentally discovered circular polarization in quartz in 1811. In circular polarization the transverse magnetic (H) and electric (E) field vectors rotate rather than oscillate as in linear polarization. In both cases the transverse magnetic (H) and electric (E) fields are orthogonal and in phase quadrature. The magnetic field energy plus electric field energy is always a constant. This contributes to the electromagnetic inertia, SHM oscillations of the photon.

Figure below shows a *beam* of light consisting of 5 *rays* of circular polarized light [1]. All 5 rays are travelling in the +Z-axis direction. The magnetic dipole photons in each ray with their magnetic polarity NS along the Z-axis add up so that circular (or elliptical) polarized light acts as a magnet upon interaction with matter. This is the *'inverse Faraday effect' (IFE).*

This also explains the *'optical Faraday effect' (OFE)* and similar magneto-optical effects. The OFE is the rotation of the plane of polarization of a linear polarized probe beam by a second, circular polarized, pump laser. The latter substitutes for the magnetic field of the ordinary Faraday effect.



In a ray of circular polarized light, photons travel along a circular (clockwise or anti-clockwise) helix or spiral path of wavelength diameter, or radius equal to the amplitude. All photons in a ray have their magnetic polarity (NS or SN) parallel to the centerline of the spiral. The magnetic dipoles of all circular polarized photons, add up to give a net resultant magnetic field along the centerline of the spiral.

This magnetization is proportional to the light intensity, and the light intensity is proportional to the photon flux density, as per Einstein's correlation of the number of photons in a light beam with its intensity. A circular polarized laser beam of intensity 10^4 W m^-2 (1 W cm^-2), the magnitude of the longitudinal magnetic field is about 10^-5 Tesla or about 0.1 G, roughly a tenth of the earth's magnetic field [2].

REFERENCES:

[1] Rajpal K L, Wave Particle Paradox and Evans Photomagneton, 2013.
http://www.physicsphotons.org/Wave_Particle19.pdf

[2] Evans M W and J -P Vigier, The Enigmatic Photon, Volume 1: The Field B(3), Kluwer Academic Publishers, Dordrecht, 1994. Paperback 2002.

07 March 2013.

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