

Photons and the Diverse Nature of Light

Introduction

Electromagnetic radiation (EMR) can be produced by a range of large-scale events (nuclear reactions, galaxy collisions, the Big Bang etc.) or by smaller scale events such as the excitement of a gas or a chemical reaction. This short article focusses on the nature of photons and their transmission as 'normal' light, plane and circularly polarised light and transverse mode light.

Background Information : CESs, Electromagnetic Radiation and Nucleons

The **proton** and **neutron** (collectively the **nucleons**) are the building blocks of atoms. A proton consists of two **up quarks** and one **down quark**, whereas a neutron consists of two down quarks and one up quark. This is widely recognised by the Physics establishment (see the Wikipedia link <https://en.wikipedia.org/wiki/Quark>).

Energy to Matter (E2M) considers that up and down quarks each consists of six small **Concentrated Energy Sources (CESs)** held in place by their electromagnetic characteristics. The article '**Relevance of Atomic Structure to the Physical Characteristics of Matter**' (https://drive.google.com/open?id=1wCuPr6WaexlYk1OKO_epaWhCDPBKwmo0) explains how quarks form into nucleons, which in turn build into atoms, molecules, ions and compounds.

A CES consists of a spinning core of concentrated energy surrounded by an atmosphere of less dense swirling energy (its **magnosphere**) that presents as an electromagnetic field. E2M contends that magnetic and electric fields are both created from the same energy (i.e. magnosphere energy), and that it is differences in their respective divergent and convergent swirling flow patterns that makes them appear to be distinctly different but inter-related force fields.

Apart from the strong directional electric fields associated with up quarks, the bulk of outward-facing CESs within quarks (and thus within nucleons) have only minor electrical fields, but these are responsible for the emission of spectral line light and for the effect of Gravity. These topics are addressed in the article '**Spectral Lines and Gravity**' (https://drive.google.com/open?id=1KgiV_wq6C5rHPivcFUEMNFPVI87WaXkU).

The above 3 references provide important background information about CESs, atomic structure and gravity that are relevant to but considered to be outside the scope of this article.

Photons and Light

E2M contends that a photon is a lightweight or mini-CES, with an upper energy limit in the order of 1 electron volt, that forms as a constriction within the return vortex of a minor external face of a nucleon within a nucleus. When it reaches a critical size, it is violently ejected from the return vortex as a **photon**. It is the frequency of photon ejection that defines the wavelength of the emitted light rays (i.e. photon streams). Depending upon its location and electromagnetic disposition within the structure of the nucleus, each nucleon could have up to 12 (for protons) or 13 (for neutrons) photon generation sources, which accounts for the wide dispersion of light from light-emitting atoms.

The above referenced article '**Spectral Lines and Gravity**' states that several geometries for the core energy of a CES are possible, with the simplest being that of a sphere spinning on its polar axis. This simplistic spherical model is adequate to explain static CESs within the structure of a nucleus, but for photons a flatter disk-like model provides a better fit to the observed forms and behaviour of light. Figure 1 shows three feasible shapes for the core energy of a photon's CES: A flying-saucer styled spinning top, a Winger function and a flat horn torus. The flat horn torus form (figure 1(e)) is the simplest of these, and is thus the one used in this article to illustrate and explain the various forms of light transmission.

A photon is considered to be a flat mini-CES travelling at the speed of light. The electromagnetic energy escaping around a photon's equatorial plane is travelling at approximately same the velocity as its energy core, and is thus unable to move forwards (unless it can travel faster than light). It can only move out and backwards to form a conical comet-like magnosphere tail as in figure 1(b) and (d), with an electric field (the converging electromagnetic energy) in the return vortex region at the rear of the tail and a magnetic field (the divergent electromagnetic energy) more central near its energy core. It is the off-set of these electric and magnetic fields in the electromagnetic magnosphere tail that is interpreted as wave forms (figure 1(d)) used in many textbook to represent the transmission of light.

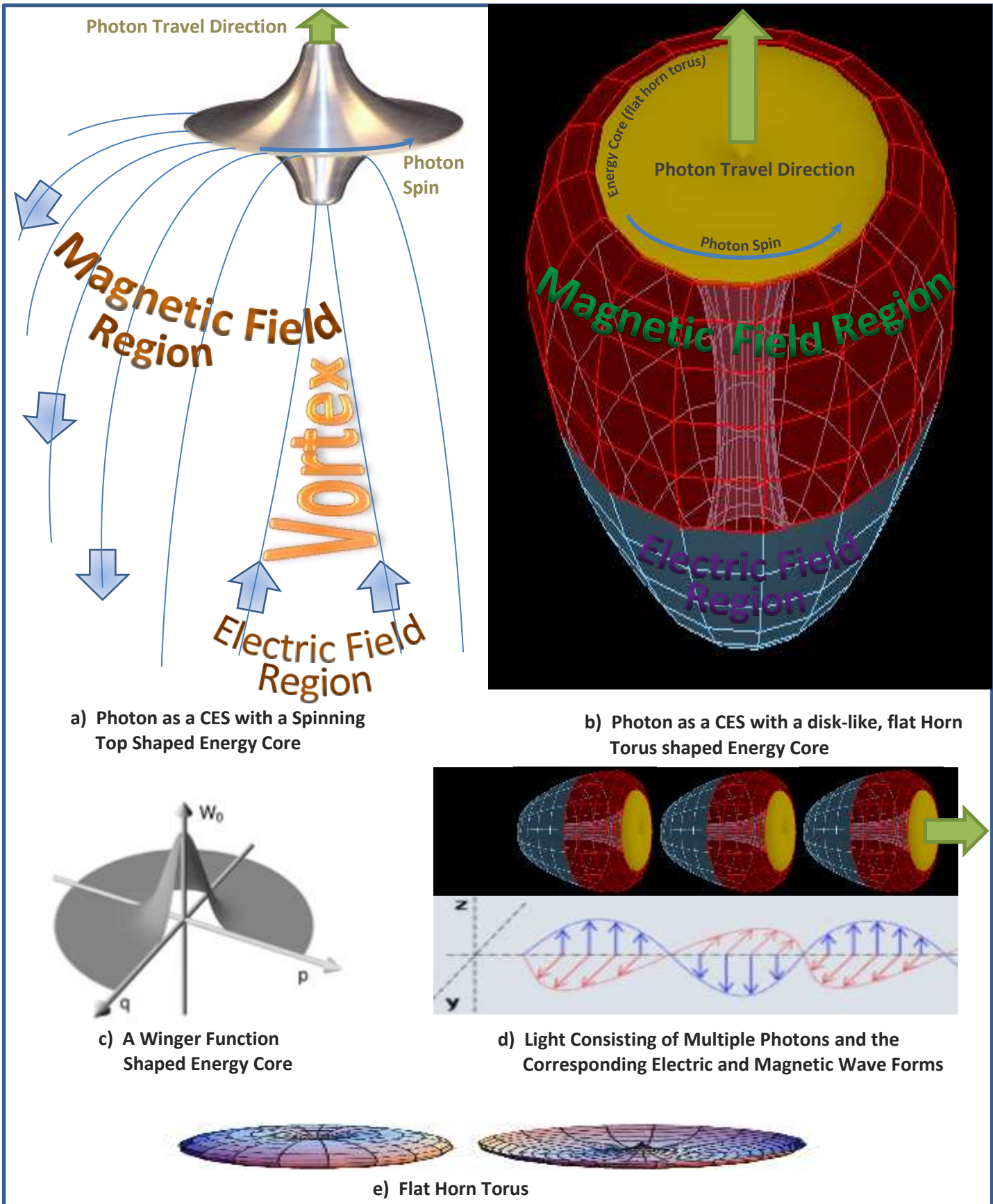


Figure 1: Photons and Ordinary Light

Polarisation of light occurs when the photon's energy core is rotated 90° so that its direction of travel lies within the energy core's equatorial plane (see figure 2(a)). As electromagnetic energy cannot move forward of the energy core's leading edge, a somewhat flattened electromagnetic tail is created. The spin momentum of the core energy prevents it from rotating around its line of travel; thus it maintains the stability of the polarisation plane.

For **plane polarised light** the orientation of successive photon energy cores is the same.

There are two distinct forms of rotation within a light beam, and both are associated with angular momentum. Circularly polarised light that is associated with **Spin Angular Momentum (SAM)**, and optical vortex light is associated with **Orbital Angular Momentum (OAM)**.

These forms of light are produced by refraction/reflection setups such as Spiral Phase Plates (SPP), Q-plates, Pitch-Fork Holograms and Cylindrical Mode Converters. They can transfer their angular momentum to suspended nanoparticles allowing such particles to be manipulated: SAM causes them to spin and OAM causes them to rotate and spin (see figure 2d)).

For polarised light the top-like spin of the photon's core energy that keeps the orientation of the polarisation plane steady. However, for **circularly polarised light** there is a slight refraction-induced angular rotation around the direction of travel between successive photons. This rotation gives the illusion of circular rotation of a wave plane as commonly shown in literature (red arrows of figures 2(b) and (d)). However, each successive photon in circularly polarised light keeps its polarised angle rather than physically rotating as it travels.

Optic vortex light, and thus OAM, is related to wavefront shape rather than to polarisation. For Optic Vortex light each photon's energy core is inclined at an acute angle to the direction of travel, creating precession around the direction of travel. The result is a spiral of energy which when viewed end-on has a central circular zone of no energy and an annular ring of energy (see transverse scan of figure 2(c)). Its OAM is sufficient to rotate and manipulate suspended nanoparticles.

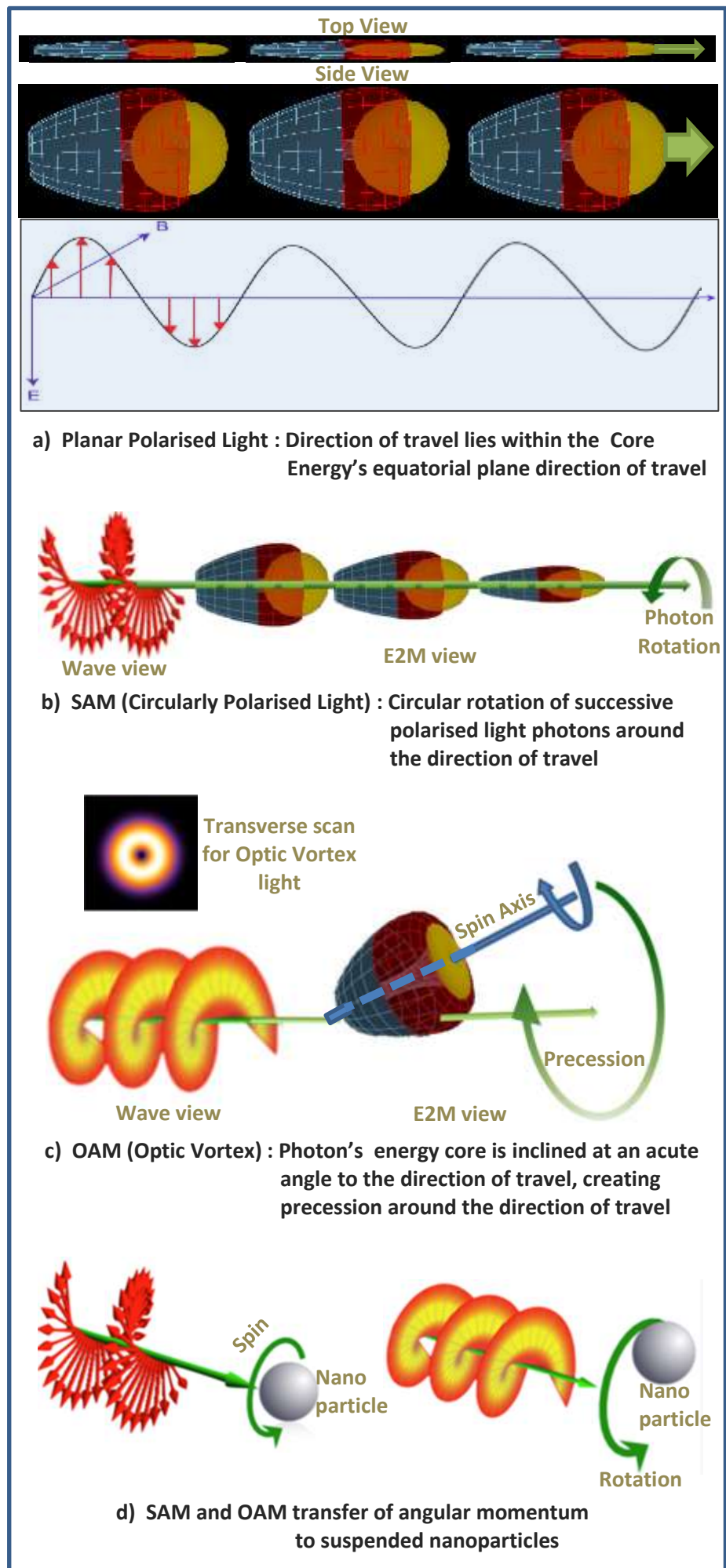


Figure 2: Polarised and Optic Vortex Light

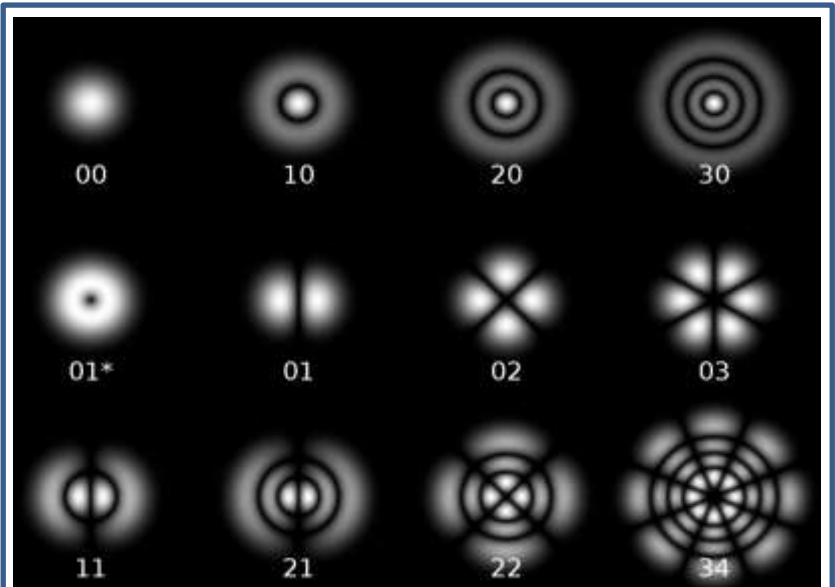
Transverse Electromagnetic Mode (TEM)

radiation occurs because of boundary conditions imposed on the wave by the waveguide. It is a particular electromagnetic field pattern of radiation measured in a plane perpendicular (i.e. transverse) to the propagation direction of the beam. Transverse modes occur in radio waves and microwaves confined to a waveguide, and also in light waves in an optical fibre and in a laser's optical resonator.

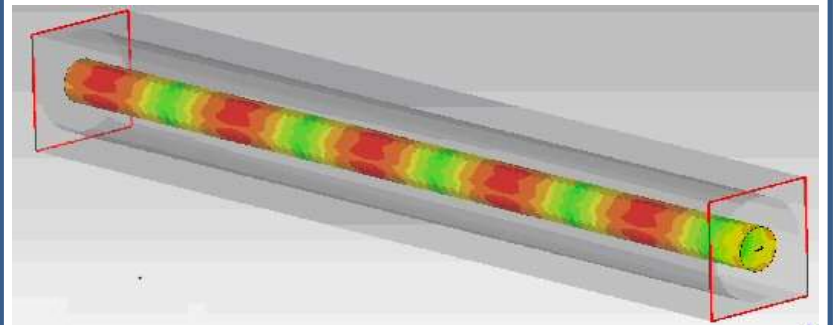
TEM₀₀ mode, whose cylindrical transverse plot is shown below, is the lowest order and is the fundamental transverse mode of a laser resonator. It has minimal fibre wall shaping and corresponds to the photon model for light as in figure 1(d). Shaping of higher order is due to the surface deflection and/or internal reflection of the photons by the optic fibre wall to produce the various TEM patterns of figure 3(a).



TEM₀₀



a) Cylindrical Transverse Mode Pattern for TEM_{nn}



b) TEM Surface Current Density at 26 GHz

Figure 3: TEM Light

Summary

The E2M model for EMR is based upon photons consisting of flattened mini-CESs. It can be used to explain the many forms and characteristics of light including plane and circularly polarised light, optic vortex light and TEM.

The flattened core energy model for a CES has now been retrospectively applied to E2M's models for quarks and nucleons. It provides a more consistent compact model than the spherical CES form used for earlier 3-dimensional modelling (used because it was the simplest form to assume at the time). The flattened form in no way alters the atomic structures developed or the way in which the structure of the nucleus relates to the observed physical and bonding characteristics of the elements and related chemicals.

E2M contends that ...

- each up/down quark consists of 6 CESs held in place by their electromagnetic characteristics,
- quarks (UDU for up quarks; DUD for down quarks) form into nucleons consisting of 18 CESs (3 quarks each),
- rather than being an amorphous conglomerate of nucleons, a nucleus has a structural geometry that defines an atom's physical and chemical properties and the way it bonds to form chemical compounds,
- rather than being in orbit in a range of 'spdf' orbitals around the nucleus, electrons are internally bonded within the nucleus's structure, externally bonded to other atoms and/or chemical compounds, or 'free',
- magnetic and electric fields are created from the same energy (i.e. magnosphere energy of a CES), and that it is the differences between their respective divergent and convergent swirling flow patterns that makes them appear to be distinctly different but inter-related force fields,
- the energy return vortices of CESs within nucleons draw on available external energy creating an inward suction-like pull between objects that presents as Gravity.

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