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Mass of light

KINETIC THEORY OF LIGHT

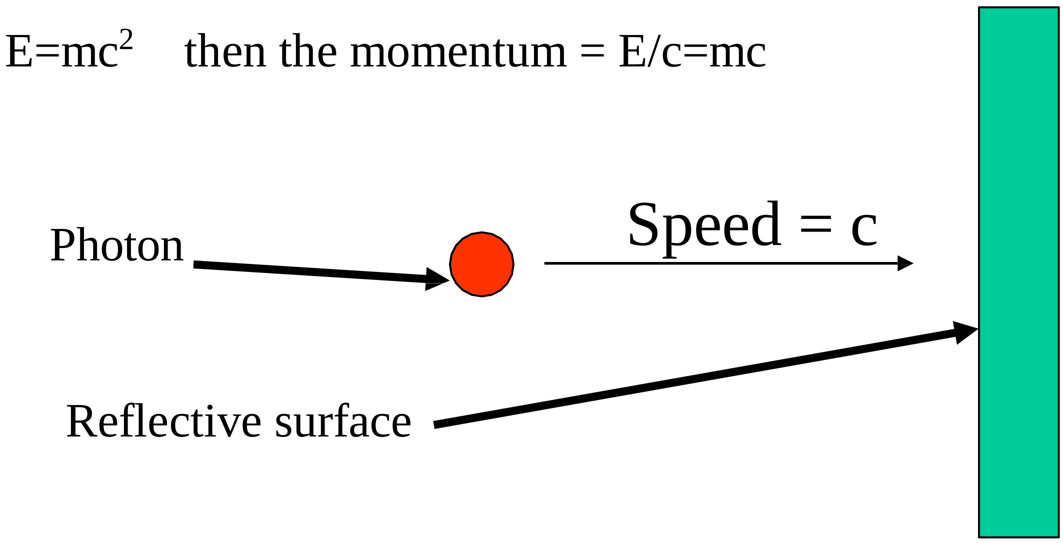
Abstract

In physics, **wave-particle duality** holds that light and matter exhibit properties of both waves and of particles. A central concept of quantum mechanics, duality represents a way to address the inadequacy of conventional concepts like "particle" and "wave" to meaningfully describe the behaviour of quantum objects.

Light momentum

Radiation pressure is the pressure exerted upon any surface exposed to electromagnetic radiation. If absorbed, the pressure is the energy flux density divided by the speed of light. If the radiation is totally reflected, the radiation pressure is doubled. For example, the radiation of the Sun at the Earth has an energy flux density of 1370 W/m^2, so the radiation pressure is 4.6 µPa (absorbed) .

By analogy to the kinetic theory or collision theory of gases formulated by the Scottish physicist James Clerk Maxwell, we will determine the radiation pressure by assuming that light is composed of particles of energy mc^2 where m denotes the equivalent masse of a given particle that collides on a reflective surface having a reflective coefficient of ψ ($1 \geq \psi \geq 0$).. The masse energy equivalence principle ($E = mc^2$) can be easily be derived from the Lorentz transformation.. $E = mc^2$, then momentum of a photon is masse*velocity = mc = E/c
Since light is attracted by the Sun and by the black whole, consequently photons have a masse.



Lets us determine the momentum of light before and after reflection of ray of light that is perpendicular to a reflective surface. m denotes mass of photons that strikes the reflective surface par unit area and per second. ψ = reflection coefficient, the reflective coefficient = the masse of the reflected photons/ the masse of the incident photons.

Momentum
before reflection
(Mb);
Mb=mc=E/c

Momentum after reflection (Ma)

Ma = -ψmc = -ψE/c

Radiation pressure = force per unit area = (momentum before – momentum after)

Radiation pressure = (Mb – Ma) = (1 + ψ)E/c.

If the light is totally reflected then ψ = 1 => **Radiation pressure = 2E/c**

If the light is totally absorbed then ψ = 0 => **Radiation pressure = E/c.**

Masse of light

The energy stored per unit volume in an electromagnetic wave is given by

$$w = \frac{\epsilon_0 E^2}{2} + \frac{B^2}{2\,\mu_0}.$$

Since, $B = E/c$, for an electromagnetic wave, and $c = 1/\sqrt{\mu_0\,\epsilon_0}$, the above expression yields

$$w = \frac{\epsilon_0 E^2}{2} + \frac{E^2}{2\,\mu_0\,c^2} = \frac{\epsilon_0 E^2}{2} + \frac{\epsilon_0 E^2}{2},$$

or

$$w = \epsilon_0\,E^2.$$

It is clear, from the above, that half the energy in an electromagnetic wave is carried by the electric field, and the other half is carried by the magnetic field.

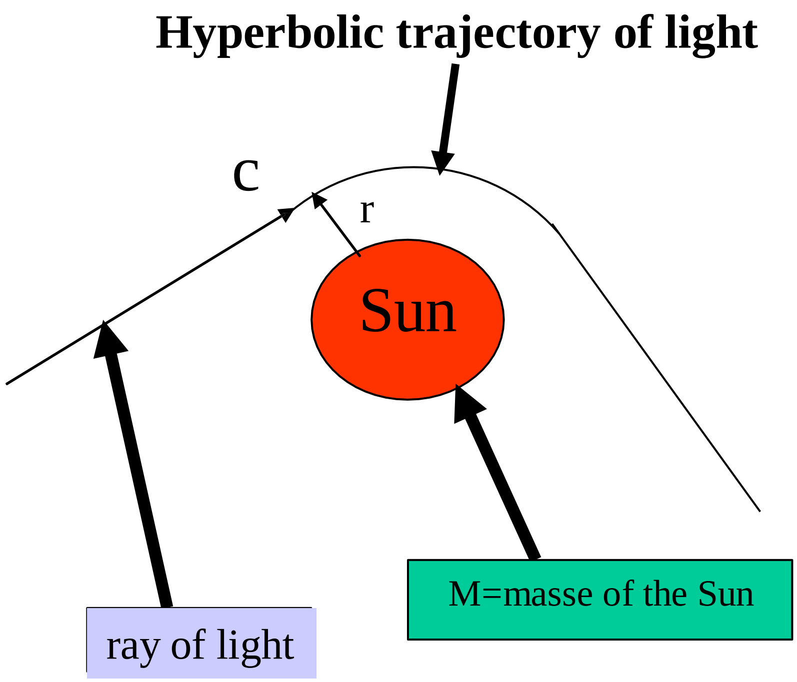
e=mc^2 (Einstein equation) then ε_0 E^2= mc^2 then we deduce the mass of light

Then the mass of light per unit volume is given by M$_l$ = ε_0 E^2/c^2

E=electric field, ε_0=permittivity in vacuum and c=speed of light

Hyperbolic trajectory of light near to the Sun

Since the speed of light is very high the light follows hyperbolic trajectory as shown bellow



The force exerted on a unit volume of light by masse M(here the Sun) is give below;

$$\mathbf{F = \frac{GM\,\varepsilon_0\,E}{r^2c^2}}$$

When the light approaches the Sun its speed increases(c+Δc), when it goes away from the Sun its speed drops down to c. On can used the equation of hyperbolic trajectory to calculate the deviation of light by the Sun. This means that the speed of light is not constant as state in general relativity by Einstein. Black wholes attract light, the speed of light increases(c+Δc), finally the light falls in the black where its converted to masse.