The structures of particles traveling at the speed of light

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Abstract

From the implications of special relativity, we know photons are massless. However, we also observe light being bent by the gravity of large bodies. To reconcile these two contradicting facts, here we propose a new model of photons using the idea of negative mass—a concept mentioned in the theory of gravitation—to explain this paradox of light. As a combination of mass and negative mass, a photon can have zero net inertial mass, yet simultaneously, move toward gravitational bodies. Furthermore, we will also introduce here several novel configurations of particles traveling at the speed of light, which have remarkable implications.

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In his seminal paper[1], Einstein proposed a relationship between mass and energy, transcribed below:

$$E\sqrt{(1 - v^2/c^2)} = mc^2$$

If a particle with "ordinary" mass moves at the speed of light *c,* then the expression inside the radical on the left side of the equation $(1 - v^2/c^2)$ is zero. We also know that the particle's energy E is finite, so the left side of the equation must equal zero. If this is true, then the right side of the equation (mc^2) must equal zero as well. Since the speed of light *c* is finite, it follows that the particle's mass must be zero, and therefore we consider the particle to be massless.

However, if we consider a proposal that the particle consists of equal quantities of both mass and negative mass[23], then it is possible that the *net* mass on the right side of the equation is still zero, and that the particle is in all other respects still considered massless.

According to the equivalence principle of general relativity we can deduce four fundamental attributes of negative mass (Bondi). They are important in later arguments and are listed below:

> *Attribute 1:* Negative mass repels negative mass—i.e. negative masses move away from each other.
>
> *Attribute 2:* Negative mass repels mass.
>
> *Attribute 3:* Mass attracts negative mass—i.e. negative mass moves toward mass.
>
> *Attribute 4:* Negative mass generates a gravitational field similar to that of mass, but with the opposite sign.

From *Attribute 1* it can be deduced that a plural quantity of negative masses is unstable if no other forces bind them together. However the smallest unit of negative mass is stable (the unit will be referred to as a ***Yinon*** in this essay).

In Fig.1, let a particle A (blue) have a mass m_a, and a particle B (green) have a negative mass $-m_b$. Let *r* be the distance between A and B. The force exerted on B by A is $F = G \cdot -m_b \cdot \frac{m_a}{r^2}$, and points from A to B. However, the acceleration of B is $a = G \cdot \frac{m_a}{r^2}$, and points from B to A. According to Luttinger's analysis, if $m_a > m_b$, then B (negative mass) will move toward A (mass).

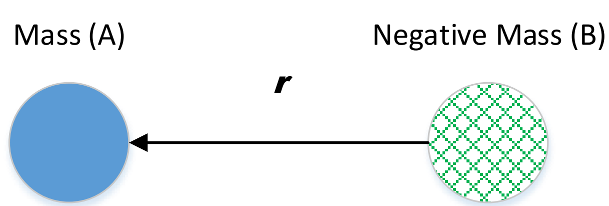

Fig.1 A negative mass moves toward a mass

Let us suppose that there exists a unit of "ordinary" mass that has an inertial mass equal to that of a yinon (the unit will be referred to as a ***Masson*** in this essay).

Because the inertial masses of a yinon and a masson cancel each other out exactly, if one considers a photon to consist of an equal number of yinons and massons, then the combination as a whole does not exhibit net inertial mass (in other words, it is observed to be massless). However, we do observe seemingly massless light being bent by large astronomical bodies, and this can be explained by the fact that both yinons and massons inside photons move toward mass (*Attribute 3*).

An existing explanation states that a photon's relativistic mass is responsible for the fact that light can be bent by gravity. However, upon further examination, this theory seems to be flawed. Specifically, because it can be concluded that there would be attraction between the photons making up light, those photons would eventually move toward each other. We should then observe a stream of light consolidate to form a giant photon after light has travelled through galaxies for many years. In reality, however, we have yet to observe this. For instance, assuming two red wavelength photons with relativistic mass $2.9 * 10^{-36}$ kg are separated by 10^{-9} m, then within $1.6 * 10^{9}$ seconds the two red photons would collide with each other. This means that clumping, and the eventual formation of giant photons, would occur under this theory.

An alternative explanation, proposed by this essay, is that the relativistic mass is not responsible for light being bent by gravity, but rather that the yinons and massons making up a photon move toward the gravity sources. Thus, it is the combination of mass and negative mass that causes light to appear to be bent by gravity. Additionally, in this model, the photons will not collapse in on each other, which was the flaw in the existing explanation. This is because we can deduce from *Attribute 4* that the active gravitational mass of the photon is zero because the gravitational fields of the yinons and the massons cancel each other out exactly. To see why this is the case, let d denote the diameter of the effective gravitational field of photon A. Let another photon B be placed at a distance ab from the photon A. If $ab >> d$ then there is no gravitational attraction or repulsion between A and B, implying that the two photons A and B are in equilibrium. Therefore, in general, all photons inside a stream of light are in equilibrium.

A luxon is defined as a massless particle travelling at the speed of light. Suppose we have a luxon that consists of an equal number of yinons and massons. Based on this assumption, various stable configurations can be obtained. We do not consider a configuration to be stable if yinons or massons inside the configuration move away forever from their original locations. In Fig.1, if the mass is a masson and the negative mass is a yinon then the configuration is not considered stable—the pair will move together forever and in the direction of the yinon toward the masson (Luttinger). In Fig.2, a yinon rotates around a masson. This configuration is not considered stable because the pair will spiral outward from its original location.

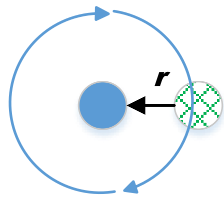

Fig.2 A yinon rotates around a masson in a plane

In the following paragraphs we will develop some stable configurations of luxons:

(1) Two yinons and two massons stick together in a line

Fig.3 shows two yinons and two massons stuck together in a line. There are four distinct ways these yinons and massons can be arranged in a line. Only the alignment of yinon-masson-masson-yinon is in equilibrium. Since the attraction on one outer yinon generated by the center massons is greater than the repulsion exerted on the same yinon by the other outer yinon, the yinons do not move away from the center massons (which also attract each other). We consider this configuration to be stable and thus a possible structure of a luxon.

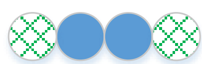

Fig.3 Two yinons and two massons stick together in a straight line

(2) Two yinons rotate around two massons in a plane

Fig.4 shows two massons at rest while two yinons rotate around them in a circular orbit. The two yinons (-*m*) are always on opposite sides in the orbit. The repulsion exerted on one yinon by the other is $F_{yy}=G \bullet -m \bullet \frac{-m}{4d^2}$, and the attraction exerted on each yinon by the massons is $F_{my}=G \bullet -m \bullet \frac{2m}{d^2}$. A centripetal acceleration $a = \frac{v^2}{d}$ of each yinon toward the massons keeps each yinon in a circular motion. We can calculate the speed to be $v = \sqrt{G \bullet \frac{7m}{4d}}$. The repulsions exerted on the center massons by each yinon cancel each other out. Thus the configuration is stable.

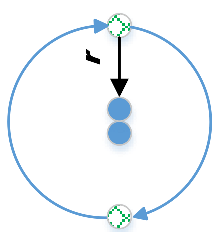

Fig.4 Two yinons rotate around two massons in a plane

So far we have proposed an alternative model of a type of luxon consisting of an equal number of yinons and massons. Within this model a luxon can travel at the speed of light and be bent by gravitational sources. Next we will go further and add another fundamental property of matter—electric charge—to this model.

(3) Luxons consist of yinons and a charged mass

Fig.5 shows another structure of a luxon. If *n* massons can make up a mass and the mass can carry an electric charge, then a luxon can consist of *n* yinons and the mass. In this configuration, the luxon can have an electric charge but still be considered massless.

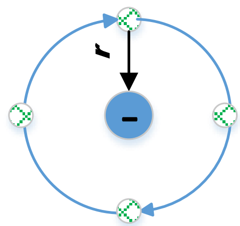

Fig.5 *n* yinons rotate around a charged mass

One implication of this configuration is that a luxon carries an electric charge when it travels at the speed of light. Therefore the electric charge also travels at the speed of light. An electric field generated by the electric charge is formed along the trajectory of the luxon.

There is another implication of this configuration. Let us assume a luxon A of this configuration carries a positive electric charge and another luxon B carries a negative electric charge. If the luxons A and B are separated by a distance *ab*, then the electric attractive force between them is $F = K \cdot -e \cdot \frac{e}{ab^2}$. Let *d* denote the diameter of the effective gravitational field of luxon A and B. If $ab >> d$, then the inertial mass of A is zero relative to that of B, and vice versa. Let us apply the above force equation to Newton's second law $F = m \cdot a$, where *a* is the acceleration of A. The left side of the equation (F) is finite, so the right side of the equation must also be finite. Since the net inertial mass *m* is zero, the acceleration *a* must not be finite.

Therefore, one can see that if we accept the existence of luxon structures consisting of mass and negative mass, there are many remarkable implications.

References

1. Einstein, A. "Does the inertia of a body depend upon its energy-content?". *Annalen der Physik* **18**: 639-641 (1905).

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3. Bondi, H. "Negative Mass in General Relativity". *Reviews of Modern Physics*. **29** (3): 423 (1957).