Weak equivalence principle check for non-barionic matter using eclipsing spectrometric binaries. No evidence for dark matter.

Dmitriy S. Tipikin,

Applications engineer at Photonis USA

660 Main Street, P.O. Box 1159, Sturbridge, MA, 01566-1159, USA

E-mail: Tipikin2001@yahoo.com

Abstract.

Weak equivalence principle (the bodies are gravitating equally per inertial mass irrespective of the chemical composition) was confirmed for barionic matter with very high accuracy. However, a priory it is not clear, how to check weak equivalence principle for the mixture of barionic and non-barionic matter (light is inside the ordinary matter). For example, how fast would the sphere full of photons fall in the Earth gravity field? The experiment is not possible on Earth. However, such verification is possible for stars using the observational data on binary stars. In this article the analysis of the mass-luminosity was made for similar stars forming binary versus different stars forming binary and the slopes were found the same with accuracy of 6%. That would be the accuracy of confirmation of the equivalence principle for non-barionic matter (actually a mixture of barionic and non-barionic matter with around 0.14% of non-barionic matter ratio). While some violations of weak equivalence principle are still possible (the idea of strong gravitation of slow light) the scale of such violations is clearly well below the level expected for explanation of dark matter.

Introduction.

In order to check the weak equivalence principle for non-barionic matter, it would be necessary to find the object where such form of energy would be present in great amount. The only such object which is relatively easy to find is a star. Indeed, the star should burn some matter and transform it into the light. The light can not leave star instantly and trapped inside for many thousands of years (possibly millions of years), slowly diffusing toward chromosphere. During such a process the light is absorbed and re-emitted again, and during the short life time the photons are gravitating independently of the surroundings and thus may be considered as the non-barionic matter trapped inside the barionic matter. If the light would gravitate differently, the obtained additional pulse would contribute back to barionic matter at re-absorption, thus making the overall gravitation of the mixture different from pure barionic matter. The total mass loss due to the thermonuclear synthesis in the star is around 1.4% of initial mass and the shortest lifetime for largest known stars is around 10 million years. Therefore, on average around 0.14% of total mass is emanating from the large star per million of years and assuming the light is trapped inside for around 1 million years too, the total energy kept inside the star as photons of all kinds (non-baryonic matter) would be around 0.14% of its barionic mass.

The idea is to use the data on binary stars and to compare the mass-luminosity curve for the stars with close masses and the mass-luminosity curve for the stars with as much difference in mass as possible.

There are many binary stars which are visible as double stars with resolved period and axis and ratio of inertial masses (through measurements of the velocities of stars). Many parameters of such stars are published in Internet.

Main part

The usual formula applied to the stars from the third Kepler Law:

$$T^2=4\pi^2*a^3/[G(m_1+m_2)] \qquad (1)$$

Here T is the period of rotation of one star around the second one, a is semi-axis, m_1 and m_2 are masses of the stars (assuming gravitational mass is equal to inertial mass) and G is gravitational constant.

However, the light theoretically may have much higher gravitational pull compare to the inertial mass from $E=mc^2$ relation (it is assumed that the inertial mass of light being emitted and reabsorbed inside star is still according to $E=mc^2$, as it was proved by Einstein himself). The presence of slow light may modify the gravitational pull, making it much stronger for the star which has more trapped light (and other non-baryonic matter). While the exact amount of trapped light is difficult to calculate (not much is known about the light content of the interior of fully ionized plasma), it is obvious that this amount is correlated with luminosity of the star - the higher the luminosity, the higher the amount of trapped light and the higher the additional gravitational pull on the star (the higher the deviation between the gravitational and inertial mass).

In the derivation of the formula (1) the gravitational masses are always comes as a product [1]:

$$F=G*M_1*M_2/r^2$$

Here M_1 and M_2 are gravitational masses. Assuming the added pull is proportional to luminosity which is proportional to mass (whether gravitational or inertial), it is possible to assume:

$$F=G*K_1*K_2*m_1*m_2/r^2$$

Here K_1 and K_2 are multiplicity coefficients, the value of K may be especially high to ultra-bright star (because due to very short life time the ultra- bright star should emit more light per second and as a consequence has more light "on hold", ready to be emitted but so far trapped inside). If weak equivalence principle hold, K=1. It is important that both coefficients for binaries are always a product.

The modified third Kepler Law:

$$T^2=4\pi^2*a^3/[G*K_1*K_2*(m_1+m_2)]$$

Here m_1 and m_2 are inertial masses. When $K_1=K_2=1$, the third Kepler Law for baryonic matter is obtained.

To determine the masses from the observation of binaries we need: T, a, and ratio of masses $m_1/m_2=n$. Since the ratio of masses is determined through the Doppler shift of spectra of stars, it is a ratio of inertial masses. We have two equations for masses m_1, m_2

$$G*K_1*K_2*(m_1+m_2)=4\pi^2*a^3/T^2$$

$$m_1/m_2=n$$

Then:

$$m_2=4\pi^2*a^3/[G*T^2*K_1*K_2*(n+1)]$$

$$m_1=4\pi^2*a^3*n/[G*T^2*K_1*K_2*(n+1)]$$

Suppose we decided to determine the inertial masses from the visual binaries with two distinct masses $m_1>>m_2$ taken in different combinations. How it would influence the mass-luminosity correlation?

It is possible to show that for very strong effect (K is large) the slope of mass-luminosity curve will depend upon the choice of stars in pair (Kepler third law is not valid any more).

Lets consider three cases:

1.Binary m_1 and m_1

2.Binary m_2 and m_2

3.Binary m_1 and m_2

In the first case the value of m1 is (because n=1)

$m_1=m_1(old)/[K_1*K_1]$, here $m_1(old)=4\pi^2*a^3/[G*T^2*2]$

Here m_1(old) is real inertial mass. K_1 is large and the value of m_1 is shifted strongly toward smaller mass compare to real inertial mass.

In the second case the value of m_2 (n is equal to 1)

$m_2=m_2(old)/[K_2*K_2]$

If K_2 is smaller (closer to 1) the mass of smaller star will be actually equal to inertial mass

In the third case the value of m_1 is

$m_1=m_1(old)/[K_1*K_2]$, $m_1(old)=m_1(old)=4\pi^2*a^3*n/[G*T^2*(n+1)]$

Since both coefficients K_1 and K_2 are here, one is small and one is big, the shift down compare to the real inertial mass is smaller compare to the case of the big equal masses, but still present.

$m_2=m_2(old)/[K_1*K_2]$

The smaller mass is becoming too small for this type of star, well below the real inertial mass for smaller star.

This idea may be immediately checked. If the mass-luminosity curve is plotted using first only stars with close masses, it will be compressed toward y-axis because of K_1*K_1 and K_2*K_2 coefficients along the x-axis (the slope will be larger). If the same curve is plotted using the stars with different masses the slope will be smaller. In addition since the same stars now would be in pairs with different masses the scattering will be much larger (the same star like Sun in pair with another Sun-like star would give almost the inertial mass, but in pair with blue giant a much smaller mass, thus creating additional to the experimental error scattering). In [2] this idea was checked for visual binaries from publication, which is 70 years old. The results showed that indeed the slope for the mass-luminosity curve was higher for close masses.

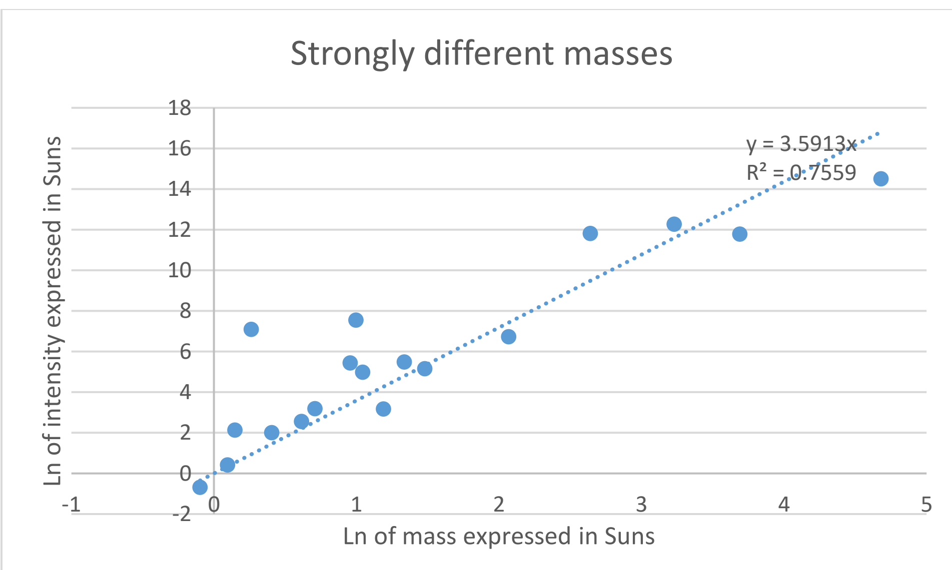
The results were checked with the help of visual binaries using the modern data from Wikipedia. The slope for the close masses was higher again. However, the most prominent effect is expected for the ultra bright stars with masses 30-100 of Sun mass. For them the percentage of trapped light should be tens of thousands times more compare to Sun and smaller stars (because the total amount of light trapped inside is inversely correlated with life time of star and ultra bright stars are very short lived).

In this case the only way to verify the idea it to use data on spectroscopic binaries. According to [1] the sum of masses is determined by the formula:

$m_1+m_2=[P/(2*\pi*G)]*[(V_1+V_2)^3/Sin^3(i)]$

and ratio of masses is determined through the ratio of velocities: $m_1/m_2=V_2/V_1$

Here P is the period of binary, G is gravitational constant, V_1 and V_2 are semi-amplitudes of velocities (they marked K_1 and K_2 in Wikipedia articles on binaries), Sin(i) is the sin of the angle between the axis of the rotation and Earth-binary direction. For very important subset of spectroscopic binaries called eclipsing spectroscopic binaries both stars are eclipsing each other thus guarantee that the angle i is close to 90 degrees and that allowed determination of masses of such stars using the known astronometric data. I used binaries: 1 Persei, Theta 1 Orioni 3, Prismis 24-1, NGC 3603-A1, CD Crucis for the brightest stars with close masses and WR22, LY Aurigae, AO Cassiopei for the largest stars with different masses. For the smaller masses the stars from the visual binaries were used (except for stars smaller than Sun). The results are below:



With accuracy of 6% the slopes are the same. Intercept on both curves put on zero.

<u>Conclusions</u>

The expected from the preliminary results [1] higher slope for the close masses is not confirmed for the ultra bright stars (where the effect should be the largest). While the weak equivalence principle still may be violated due to stronger gravitation of slow light (the observation error is rather large), the effect on rotation of Galaxy is negligible and by no means may be responsible for the explanation of large scale phenomena like dark matter.

References.

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2. https://vixra.org/pdf/2005.0250v1.pdf
3.