The Mass of the Universe

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Abstract

Using the photon universe model, as an alternative to the "missing mass" models (dark matter, MOND, etc), the mass of the Observable Universe is estimated.

Keywords: dark matter, visible matter, photon-photon collision, universe model photons, observable universe, missing mass.

1. Introduction

In a previous article **[1]**, with the intention of using the Fermi exercise technique (1901 - 1954), the model of the photon universe was introduced, the hypotheses of which we summarize below:

a) the galaxy (or the considered system) is permeated by cosmic *background* radiation with a density of about 400 photons per cm^3;

b) we consider the high-energy photon collision with a photon of the microwave *background* that gives rise to a mass (with large-scale gravitational effects); when the impact occurs in every cubic centimeter, a mass of about 10^{-26} *kg* is produced;

c) the galaxy (or the considered system) occupies a spatial volume $V \sim r^3$ with r the typical size of the considered system.

A recent article **[2]** describes the interaction between extragalactic background radiation (EBL) and high-energy photons, arguing that "[…] Gamma rays with sufficient energy can annihilate when they collide with EBL photons and produce electron-positron pairs (i.e., the reaction $\gamma\gamma \rightarrow e^+e^-$)" **[2]**.

For this reason we imagine that, in addition to hypothesis (b), the following can be inserted:

b-bis) the possible collision of a high energy photon with a photon of the EBL background which gives rise to a mass (with large-scale gravitational effects) is also considered.

In our photon model, therefore, it is imagined that a collision can occur between a high-energy photon with both CMB photons and EBL photons.
Estimates of the quantity of CMB photons and EBL photons have been indicated by physicists and the most shared are:
- for the CMB *background* it is estimated that there are 10^{89} photons in the observable universe **[3]**;
- for the EBL *background* it is estimated that there are 10^{84} photons in the observable universe **[2]**.

Estimates of the number of CMB and EBL photons take into account the size of the observable universe as they are known today[2].
Between the CMB photon gas and the EBL photon gas (both as possible targets of high energy photons, in our model) we use the order of magnitude of CMB photons because higher (the ratio between CMB photons and EBL photons is approximately 10^5).
As previously observed **[1]** we have estimated that at least one collision between a high-energy photon for every 1,000 photons of the CMB *background* can occur.

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2 The typical size of the observable universe is of the order of 10^{11} *light years*.

In a recent article **[4]** the mass created by the annihilation of a pair of high-energy photons was measured, the estimate of which is ($0{,}4 < M_{ee} < 2{,}6$) GeV.

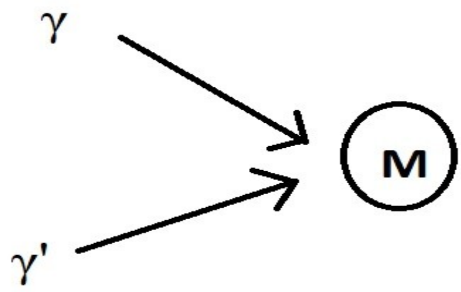

Fig. 1: photon-photon collision schematization that generates mass **[1]**.

The range of values indicated **[4]** provides a mass with an order of magnitude of about 10^{-10}J which, expressed in kilograms, leads

$$M \approx \frac{E}{c^2} \approx \frac{10^{-10}}{9 \cdot 10^{16}} kg \approx 10^{-25} kg$$

The numerical estimate obtained through a simple Fermi exercise **[1]** is consistent with the rigor of scientific work **[4]**.

2. Estimation of the mass of the Observable Universe.

In the model of the universe of photons **[1]** it is estimated that an order of magnitude for the collisions between a high-energy photon and a target photon (*background* CMB) can be one in a thousand. Taking into account the number of photons of CMB radiation **[3]** in the observable universe, the possible collisions are estimated at 10^{86}.
Using this estimate and taking into account the mass generated for each impact equal to 10^{-26} *kg*, an order of magnitude is obtained for the mass of the Observable Universe equal to 10^{60} *kg*. The estimate obtained exceeds the mass of ordinary visible matter in the Observable Universe so as to take into account the "missing mass" to which the current models address (dark matter, MOND, model of the universe of photons, etc).

3. Conclusion.

It must be emphasized that an extremely rapid estimate for the calculation of the mass of the Observable Universe can be obtained simply by taking into account the factor 10^{-26} kg/cm^3 and of the dimensions currently known for the universe (see note 2): this estimate leads to a mass of the universe similar to the previous one.
In summary, in the hypothesis in which:
- photons from CMB gas and EBL gas are target sources for high energy photons,
- that collisions can occur in the observable universe according to the reaction $\gamma\gamma \rightarrow e^+e^-$ with the creation of mass of the order of 10^{-26} kg/cm^3 and that this mass can have large-scale gravitational effects,

we have estimated the total mass of the Observable Universe. The creation of matter due to the photon-photon collision, on a large scale, can be an alternative to the "missing mass" models. The following work must also be considered as a Fermi exercise.

Bibliography

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