Dark Matter

The problem of dark matter has a surprising solution.

Dark matter is one of the big unresolved problems of present-day physics:

In the vicinity of galaxies, the observed strength of the gravitational field is much larger than would be expected based on Newtonian or Einsteinian gravity. In addition, it has an unexpected spatial distribution.

Present-day physics assumes a yet unknown type of particle which does not have any interactions except via gravity. But the intensified search for them over the past decades has not yielded the faintest result. And even if a particle were found, there is no explanation for the very specific distribution of these particles.

However, this spatial distribution is itself a strong indication of the nature of dark matter. It is a striking fact that the distribution is identical to that of photons in those areas, a fact which is at present not in the focus of the physical investigations.

The conclusion that photons themselves are the origin of the observations yields correct results - even *quantitatively* correct results. However, this requires a modification of the laws of gravity in such a way that gravitation is not caused by mass or energy.

This assumption may be felt to be shocking but is not in conflict with observation.

1 The manifestations of dark matter

1.1 Rotation of stars and galaxies

The phenomenon of increased gravity was first observed in connection with the fast rotation of galaxies in clusters. Other well investigated cases are individual stars orbiting a galaxy. The stars in the outer regions of galaxies orbit the center too quickly. In addition, the dependence of their speed on the distance from the center of the galaxy does not follow Newton's law but displays a flat shape (see figure 1 for the galaxy NGC 3198).

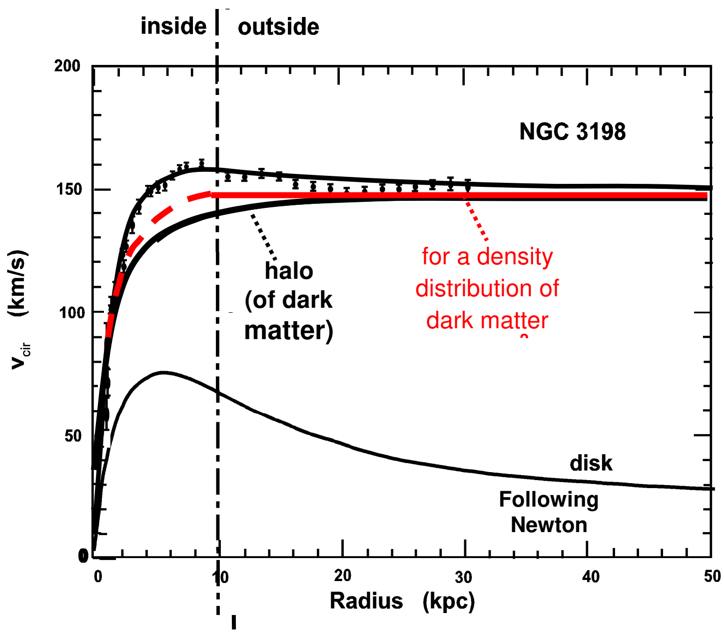

Figure 1: The galaxy NGC 3198

This flat shape of the curve is striking. For an explanation we have to conclude, if we follow Newton's law of gravity, that the dark matter causing this behavior has a spatial distribution of $1/r^2$ in the outer region of the galaxy (where r is the distance to the center of the galaxy). And this observed motion has led physicists to conclude that there is a huge amount of invisible matter. So the physical matter known to us should only account for a small portion - around 1/6 - of the matter in the universe, while the rest is completely unknown up to now.

1.2 Gravitational lensing in Abell 2261

Gravitational lensing is also stronger than explained by the masses of the lensing objects, which in general are also galaxies.

The huge galaxy cluster "Abell" A2261 has been thoroughly investigated with regard to gravitational lensing [1]. The results not only indicate a stronger gravitational field than the Newtonian prediction, but also reveal details of the distribution of dark matter. Figure 2 shows that at the far end, which is free of baryonic matter, the distribution of dark matter also follows the slope $1/r^2$.

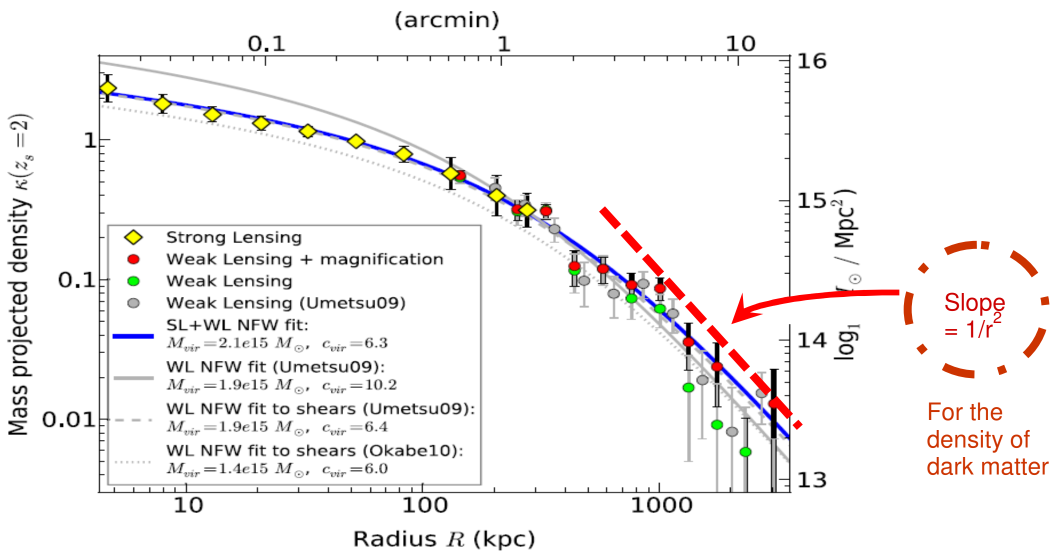

Figure 2: The strength of gravity in the vicinity of Abell 2261.

(2.1)

1.3 The bullet cluster

In this situation, two galaxies have passed each other. Their distribution after the passage shows the dark matter moving in front of both clusters (Figure 3). This is surprising since the assumed heavy dark matter particles should not move faster than normal baryonic matter.

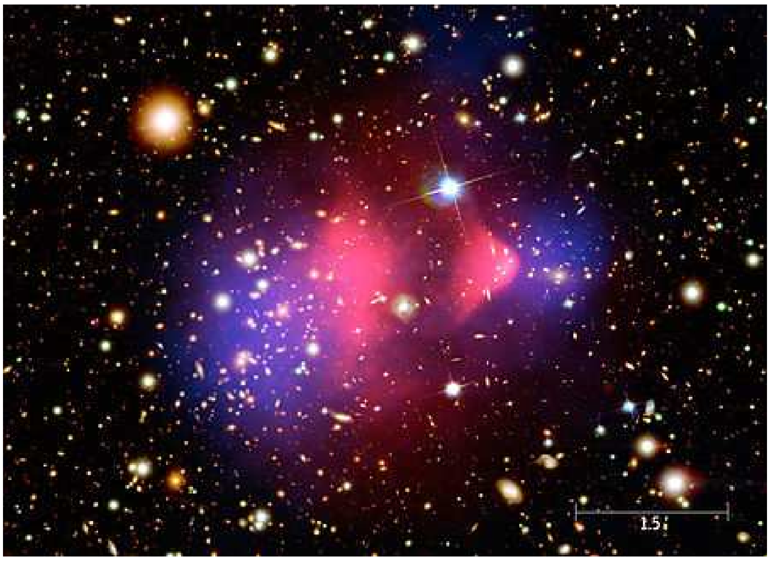

Figure 3: The bullet cluster – The areas of dark matter are colored blue

1.4 Renzo's rule

Renzo's rule refers to the observation that those parts of a galaxy having a reduced luminosity display a reduced gravitational field. This can be detected in orbiting stars whose path is modified when passing through such a region.

This conflicts with the general physical understanding that dark matter should remove any correlation between the luminosity and the rotation curves.

1.5 Fast formation building

In the cosmological development of the universe, the growth of clusters forming stars and galaxies has been faster that can be explained by baryonic matter. Again, the conclusion is that there must have been more gravitational than visible matter around to cause this rate of growth.

2 Current theories of dark matter

As mentioned above, present-day physics assumes that there is a currently unknown type of particle which interacts with matter only through gravity. There are two problems with this approach.

Despite a series of intensive searches during the past decades, not the faintest indication has been found for the existence of such types of particle.

Even if such particles existed, there is no detailed explanation as to why the distribution of these particles should be as observed. Particularly the rotation curves of galaxies, which provide a very strong quantitative indication of this spatial distribution, do not seem understandable from this approach.

Apart from this assumption of unknown particles, another theory has been proposed by the name of MOND ("modified Newtonian dynamics"). It assumes that Newton's law of gravity changes from the $1/r^2$ rule to a $1/r$ rule at a certain distance from the gravitational source. This is able to describe the shape of the rotation curve for galaxies having a specific radius defined by this theory.

The weakness of this theory is that

1) There are no physical arguments for such a law of gravity
2) The transition from $1/r^2$ to $1/r$ has to be adapted and can only fit for one radius
3) This approach does not explain any of the other manifestations of dark matter phenomena.

3 The photon solution

The assumption that photons are the originators of dark matter phenomena explains all observations. In the special case of the rotation curves it even yields quantitative results.

3.1 Quantitative result for galaxy NGC 3198

We can use the case of stars orbiting a galaxy like NGC 3198 (figure 1) to show that the assumption of photons as the particles of the dark matter has a quantitative proof.

We will here check the hypothesis that every elementary particle contributes to the gravitational field to the same degree, that is independently of its mass.

For this we will make the following assumptions:

- the proton and the neutron are composed of 3 elementary particles and the electron is 1 elementary particle.
- the photon is also taken to be 1 elementary particle. (Historically, Louis de Broglie once suspected that it might be appropriate to consider it to be composed of 2 elementary particles. This is not used in this calculation.)

Based on these assumptions and published data, the galaxy NGC 3198

- contains $3*10^{67}$ elementary particles
- contains $4.4*10^{67}$ photons, as can be concluded from its luminosity.

These two numbers are comparable in terms of the available accuracy. Looking at the graphical presentation (figure 1) we see that at the rim of the galaxy both particle types contribute equally to the gravitational field, whereas outside it the photons dominate strongly as the cause of the gravitational field.

The conclusion is that up to the edge of the galaxy the numbers of baryonic particles and of photons are comparable. So, if gravity is taken to be caused not by mass but equally by every elementary particle, both generate a comparable gravitational field at this distance, which in this example is the rim of the galaxy. This conforms to Figure 1. From this point outwards, beyond the baryonic body of the galaxy, the photonic field dominates over the baryonic one in the way that is visible from the flat shape of the rotation curves.

This seems an obvious proof that the assumption of photons as dark matter particles is supported by the rotation curve.

3.2 Renzo's rule

In areas of low luminosity, the gravitational field is diminished, as is apparent through the deflection of orbiting stars. This is a direct indication that light is the cause of gravity.

3.3 Fast formation building

If photons cause a gravitational field, then their existence everywhere explains the speed of formation building. And this fact also explains another phenomenon that is otherwise not understood: dark matter contributes considerably to the building of formations, i.e. objects; but it does not become parts of these objects.

4 Einstein's near solution

In 1911, Einstein attempted a new approach to gravitation.

He published a paper [2] in which he started to draw conclusions from the fact that the speed of light is reduced in a gravitational field. He deduced this reduction by considering the energetic state of a light-like particle moving in a field. That seemed plausible, however it is not correct. It seems that Einstein noticed that the results he was achieving were unphysical, and he therefore ceased pursuing this path and returned to the Newton's understanding which related gravity to mass – or with respect to his theory of special relativity – to energy.

It is possible to continue along the path followed by Einstein. His error with respect to the dependency of the speed of light on gravity has to be avoided, and our present understanding of particle physics will also be used. We know that the reduction in c depends on the direction of a light-like particle with respect to the source of gravity. From this, a functional model can be deduced which treats gravity as a universal feature of an elementary particle which does not depend on its mass or energy. This results in the conclusion that dark matter and photons have similar properties.

This model does in fact yield all the results which can be achieved using Einstein's GRT; however it does so much more simply, without resorting to Riemannian geometry and without special assumptions about space and time.

5 Conclusion

The analysis of the observations shows quite clearly that dark matter is made up of photons. The qualitative as well as the quantitative data do not allow for any other explanation.

The price to pay is that we have to modify our theories about gravitation, Newton's as well as Einstein's.

NOTE:
The concept of the Basic Model of matter was initially presented at the Spring Conference of the German Physical Society (Deutsche Physikalische Gesellschaft) on 24 March 2000 in Dresden by Albrecht Giese.

[1] CLASH: Precise new constraints on the mass profile of the galaxy cluster A2261; The Astrophysical Journal 757(1):22 (2012).

[2] A. Einstein A. Über den Einfluss der Schwerkraft auf die Ausbreitung des Lichtes. [On the Influence of Gravitation on the Propagation of Light]. Annalen der Physik, 340, 898-908 (1911).

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