Low surface brightness galaxies as additional support for pearls-in-necklace model for galaxies

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Abstract

Standard view about galactic dark matter strongly suggests that the stars moving around so called low surface brightness stars should not have flat velocity spectrum. The surprise has been that they have. It is demonstrated that this provides additional piece of support for the TGD view about dark matter and energy assigning them with cosmic strings having galaxies as knots along them.

1 Introduction

Sabine Hossenfelder had an inspiring post (see http://tinyurl.com/ybmbzczr) about some problems of the halo dark matter scenario (there are many of them [K3, K2] [L1]. My attention was caught by the title "Shut up and simulate". It was really to the point. People stopped first to think, then to calculate, and now they just simulate. Perhaps AI will replace them at the next step.

While reading I realized that Sabine mentioned a further strong piece of support for the TGD view about galaxies as knots along cosmic strings, which create cylindrically symmetric gravitational field orthogonal to the string rather than spherically symmetric field as in halo models. The string tension determines the rotation velocity of distant stars predicted to be constant constant up to arbitrarily long distances (the finite size of space-time sheet of course brings in cutoff length).

To express it concisely: Sabine told about galaxies, which have low surface brightness. In the halo model the density of both matter and dark matter halo should be low for these galaxies so that the velocity of distant stars should decrease and lead to a breakdown of so called Tully-Fisher relation. It doesn't.

2 The problem posed by low surface brightness galaxies

I am not specialist in the field of astrophysics and it was nice to read the post and refresh my views about the problem of galactic dark matter.

1. Tully-Fisher-relation (TFR) (see http://tinyurl.com/ybhaat64) is an empirically well-established relation between the brightness of a galaxy and the velocity of its outermost stars. Luminosity L equals to apparent brightness (luminosity per unit area) of the galaxy multiplied by the area $4\pi d^2$ of sphere with radius equal to the distance d of the observed galaxy. The luminosity of galaxy is also proportional to the mass M of the galaxy. TFR says that luminosity of spiral galaxy - or equivalently its mass - is proportional to the emission line width, which is determined by the spectrum of angular velocities of stars in the spiral galaxy. Apparent brightness and line width can be measured, and from these one can deduce the distance d of the star: this is really elegant.

2. It is easy to believe that the line width is determined by the rotation velocity of galaxy, which is primarily determined by the mass of the dark matter halo. The observation that

the rotational velocity is roughly constant for distant stars of spiral galaxies - rather than decreasing like $1/\rho$ - this led to the hypothesis that there is dark matter halo around galaxy. By fitting the density of the dark matter properly, one obtains constant velocity. Flat velocity spectrum implies that the line width is same also for distant stars as for stars near galactic center.

To explain this in halo model, one ends up with complex model for the interactions of dark matter and ordinary matter and here simulations are the only manner to deduce the predictions. As Sabine tells, the simulations typically take months and involve huge amount of bits.

3. Since dark matter halo is finite, the rotation velocity should decrease at large enough distances like $1/R$, R distance from the center of the galaxy. If one has very dilute galaxy - so called low surface brightness galaxy, which is very dim - the rotational velocities of distant stars should be smaller and therefore also their contribution to the average line width assignable to the galaxy. TFR is not expected to hold true anymore. The surprising finding is that it does!

The conclusion seems to be that there is something very badly wrong with the halo model. This is the message that the observational astrophysicist Stacy McGaugh is trying to convey in his blog (see `http://tinyurl.com/y9rwjjve`): about this the post of Sabine told.

Halo model of dark matter has also other problems.

1. Too many dwarf galaxies tend to be predicted.
2. There is also so called cusp problem: the density peak at the center of the galaxy tends to be too high. Observationally the density seems to be roughly constant in the center region, which behaves like rotating rigid body.

The excuses for the failures claim that the physics of normal matter is not well enough understood: the feedback from the physics of ordinary matter is believed to solve the problems. Sabine lists some possibilities.

1. There is the pressure generated when stars go supernovae, which can prevent the formation of the density peak. The simulations however show that practically 100 per cent of energy liberated in the formation of supernovas should go to the creation of pressure preventing the development of the density peak.
2. One can also claim that the dynamics of interstellar gas is not properly understood.
3. Also the accretion and ejection of matter by supermassive black holes, which are at the center of most galaxies could reduce the density peak.

One can of course tinker with the parameters of the model and introduce new ones to get what one wants. This is why simulations are always successful!

1. For instance, one can increase the relative portion of dark matter to overcome the problems but one ends up with fine tuning. The finding that TFR is true also for low surface brightness galaxies makes the challenge really difficult. Mere parameter fit is not enough: one should also identify the underlying dynamical processes allowing to get rid of the normal manner, and this has turned out to be difficult.
2. What strongly speaks against the feedback from the ordinary matter is that the outcome should be the same irrespective of how galaxies were formed: directly or through mergers of other galaxies. The weak dependence on the dynamics of ordinary matter strongly suggests that stellar feedback is not a correct manner to overcome the problem.

3 TGD view about low surface brightness galaxies

One can look at the situation also in TGD framework.

1. In pearls-in-necklace model galaxies are knots of long cosmic strings [K1, K2] [L1]. Knots have constant density and this conforms with the observation: the cusp problem disappears.

2. The long string creates gravitational field orthogonal to it and proportional to $1/\rho$, ρ the orthogonal distance from the string. This cylindrically symmetric field creates correlations in much longer scales than the gravitational field of spherical halo, which for long distances is proportional to $1/r^2$, r the distance from the center of the galaxy.

   Pearls-in-necklace model predicts automatically constant velocity spectrum at *arbitrary long*(!) distances. The velocity spectrum is independent of the details of the distribution of the visible matter and is proportional to the square root of string tension. There is almost total independence of the velocity spectrum of the ordinary matter as also the example of low surface brightness galaxies demonstrates. Also the history for the formation of the galaxy matters very little.

3. From TFR one can conclude that the mass of the spiral galaxy is (proportional to the luminosity proportional to the line width) and also proportional to the string tension. Since galactic mass varies also string tension must vary. This is indeed predicted. String tension is essentially the energy per unit length for the thickened cosmic string and would characterize the contributions of dark matter in TGD sense (phases of ordinary matter with large $h_{eff}h = n$ as well as dark energy, which contains both Kähler magnetic energy and constant term proportional to the 3-volume of the flux tube.

   Cosmology suggests that string thickness increases with time: this would reduce the Kähler magnetic contribution to the string tension but increase the contribution proportional to the 3-volume. There is also the dependence of the coefficient of the volume term (essentially the formal counterpart of cosmological constant), which depends on p-adic length scale like the inverse of the p-adic length scale squared $L(k) \propto 2^{k/2}$, where k must be positive integer, characterizing the size scale involved (this is something totally new and solves the cosmological constant problem) [K5]. It is difficult to say which contribution dominates.

4. Dwarf galaxies would require small string tension, hence the strings with small string tension should be rather rare.

If this picture is correct, the standard views about dark matter are completely wrong, to put it bluntly. Dark matter corresponds to $h_{eff}/h = n$ phases of ordinary matter rather than some exotic particle(s) having effectively only gravitational interaction, and there is no dark matter halo. TGD excludes also MOND. Dark energy and dark matter reside at the thickened cosmic strings, which belong to the simplest extremals of the action principle of TGD [K1, K4]. It should be emphasized that flux tubes are not ad hoc objects introduced to understand galactic velocity spectrum: they are a basic prediction of TGD and by fractality of TGD Universe present in all scales and are fundamental also for the TGD view about biology and neuroscience.

Maybe it might be a good idea to start to think again. Using brains instead of computers is also must a more cost-effective option: I have been thinking intensely for four decades, and this hasn't cost a single coin for the society! Recommended!

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