No dark matter – speed-dependent gravity can explain missing matter and flat rotation curves

Jose P Koshy

ABSTRACT

The alternate model put forth in my previous papers visualize that gravity is finite and G depends on the square of the speed. A higher G implies that less matter is required in galaxies for satisfying Kepler's laws of orbiting motion. A finite gravity implies that distance between bodies depend on mass, and so the distribution of bodies in galaxies is nearly uniform; this in turn gives flat rotation curves. The gravitational lensing maps of Bullet Cluster is in perfect agreement with speed-dependent gravity. Speed-dependent gravity thus resolves the anomaly of missing matter, and completely rules out the existence of any dark matter.

Key words: gravitation – dark matter – galaxies: clusters: individual: 1E 0657-558

1. INTRODUCTION

The amount of matter, estimated based on luminosity, cannot account for the speeds of the outer stars in galaxies. Vera *Rubin, Ford W. K. Jr., Thonnard N. (1980)* showed that visible matter in galaxies is only 1/7 of what is required and that the rotational curves of galaxies are flat outside the central bulge, indicating that missing is more in the outskirts. In galaxy clusters also, luminosity-based estimate of mass does not agree with the estimates based on other methods. The mainstream proposes the presence of non-baryonic dark matter to explain this. The latest estimate (NASA mission pages 2013) is that the ratio between dark matter and normal matter is (26.8):(4.9); that is, normal matter is only 1/6.5 of the total matter in the universe. However, the exact nature of such dark matter and why it remains so distributed are still unclear. Here, speed-dependent gravity is introduced as an alternate explanation.

2. SPEED-DEPENDENT GRAVITY

Speed-dependent gravity is based on a stronger equivalence principle connecting motion and gravity: like kinetic energy, gravitational energy also depends on mass and speed, and in a closed system, both are equal. So, G is proportional to the square of the speed. Balance between gravity and motion decides the distance between large-scale structures. Like speed, gravity also has limit; or gravity is finite. Like available energy, available gravitational energy should also be present in the system; that is, available gravity remains completely used at any given time.

Speed-dependent gravity is Newtonian gravity modified to that extent. Based on Newton's equations, force depends on the product of the masses. With the proposed modification, available gravitational energy depends on the sum of the masses. The force calculated should be equal to the available force. This gives an interesting result:

Force between two bodies = GM_1M_2 / d^2
Available force (Gravitational energy/distance) = $K(M_1+M_2) /d$,
where K is a constant. As both are equal,

$$GM_1M_2 / d^2 = K(M_1+M_2) /d$$

$$\text{So, } d = (G/ K) \times M_1M_2 /(M_1+M_2)$$

Thus, for a given G, distance depends on the total mass and the ratio in which it is split. That is, massive bodies remain farther apart and less massive ones remain crowded. So the distribution of matter in the universe has to be near uniform. An increase in G means more force is required to keep bodies at a given distance. As the available gravity always remains fully used, an increase in G moves bodies apart. Incidentally, this gives a very good theoretical picture of expansion: If the speeds of bodies increase at the expense of their internal energies, then G will increase, and the bodies will move apart, the system always remaining uniform; bodies moving apart implies that their directions of motion have to be in such a way that the system expands.

At the quantum level also, atoms and particles cannot come closer than a certain limit, the more massive ones remaining farther. At that level, electro-magnetic force also is involved, and the overall balance between attractive and repulsive forces decides the distance. This new proposal thus rules out gravitational collapse.

Finite gravity implies a limit to the amount of matter that a single object (like a star) can contain; that is, depending on speed, there will be an 'optimum mass-range' for such objects. Sun being an average star, its mass-speed ratio can be taken as a rough indicator of optimum mass. As speed-limit for large bodies may be well below 'c', the mass-limit will be below $(c/240)^2$, the speed of sun being 240 km s^{-1}. This gives the mass-limit to be roughly 10^6 solar-masses.

The crucial difference between Newtonian gravity and speed-dependent gravity is that the former visualizes matter to clump together, while the latter visualizes uniform distribution. In speed-dependent gravity, G varies with square of the speed. This makes the present measured value of G, the G of Earth moving at nearly 30 km s^{-1}. The sun is moving at 240 km s^{-1}, that is, 8 times the speed of Earth; so its G is 64 times that of Earth. The Milkyway is moving at nearly 600 km s^{-1} relative to the CBR; so its G is 400 times that of Earth.

3. UNIFORM DISTRIBUTION

Matter is distributed in lumps (objects) which remain in the 'optimum mass-range' for their speeds. The most massive objects will be having the highest speeds. Less massive objects orbit around these at a comparatively lower speed, and still smaller objects remain orbiting these, thus creating multilevel systems. These orbiting objects are gravitationally bound to the system. Laniakea supercluster may be the multi-level system in the case of our galaxy.

Structures like Laniakea can be expected to be unbound; that is, these may not be part of any larger orbiting system, but remain moving at very high speeds such that the distance between them is proportional to their masses. The galaxy clusters may not have stable nuclei because the G is very high that the force required to keep atoms together will be greater than the available force; the nuclei remain spread out as intra-cluster gas. Galaxies may invariably have central nuclei, and these will be the most massive objects in the universe.

4. AMOUNT OF MATTER IN GALAXIES

The mass of sun is inferred from GM. As the G of sun is nearly 64 times that of Earth, a solar-mass is only 1/64 of the now accepted mass. The amount of matter in galaxies is estimated based on mass-luminosity relation, which uses the present solar-mass, and so the estimate is 64 times high. Based on universal G, even that much is not enough; the mass required is 6.5 times that. But, based on speed-dependent gravity, the mass required is much less. Taking Milkyway as an example, its G is nearly 400 times that of Earth, and so the mass required is that much low. If the actual mass of our galaxy is M,

its estimated mass based on luminosity = 64M

Mass required based on present concepts = 6.5x64M = 416M

Mass required based on speed-dependent G = 416M/400 = 1.04M

Thus, the mass required is approximately the actual mass, and so there is no mass deficiency in our galaxy. This leads to an interesting conclusion: Luminosity depends on the total mass of the galaxy including non-luminous matter. A galaxy containing more matter will have proportionately more luminous matter for a given speed.

As force depends on GM, GM decides the luminosity of a star. A higher G means greater force, and to counter it, atoms have to be more energized, and so more luminous.

So mass- luminosity ratio is inversely proportional to G. A galaxy moving at a higher speed need less amount of matter to attain a given luminosity.

The galaxies in Laniakea supercluster are gravitationally bound together and so these will have more or less the same speed, and so like Milkyway, these also will not have any mass deficiency. Compared to galaxies, satellite galaxies will be less luminous and clusters, more luminous, for a given amount of matter. The higher mass-luminosity ratio indicates that there will be more non-luminous matter (would-be stars) in satellite galaxies. A lower luminosity ratio indicates that in clusters, the hot plasma between galaxies is less dense.

5. ROTATION CURVES OF GALAXIES

In Newtonian packing, density gradually decreases from a central point, and so the rotation curve rises in the beginning, reaches the maximum at a certain distance, and thereafter dips, the rotational velocity reaching zero only at infinity. But in uniform packing, if the system is made up of homogeneous objects, the density is the same at all points, and so the rotational velocities (with respect to a given centre) are the same at all points, and so the rotation curve is flat extending to infinity. However, if the system has a finite boundary, then, after a certain distance (from the centre), the curve rises continuously up to the border. If the system is made up of non-homogeneous entities, it will be uniform only on a certain scale, and below that scale, the system will be non uniform. In such cases, the rotation curve rises initially as in the case of Newtonian packing, and after a certain distance, it becomes flat. If the system has a boundary, the curve starts rising again.

Galaxies are made up of non-homogeneous objects. Heavier objects remain more or less equally distributed, with the heaviest one remaining at the galactic centre, and the outermost ones constituting the nuclei of satellite galaxies. Most of these objects will be burnt-out stars that are non-luminous. Stars and would-be stars constitute smaller objects. Stars remain some-what crowded around the galactic centre, and less crowded outwards, while would-be stars may be more in the outskirts. Thus there is relatively more luminous matter in the central region, while the outer region contains more non-luminous matter, making the distribution of matter near uniform in galaxies, and their rotation curves reveal this uniformity.

The presence of satellite galaxies makes a galaxy appear to be border-less as far as the stars in it are considered, and so the rotation curve is flat outside the central bulge. A satellite galaxy has a definite border, and so outside the bulge, the rotation curve, after becoming flat, starts rising slowly. Thus the flat rotation curves (obtained by Vera Rubin et al) arise from near uniform distribution of ordinary matter, not from any dark matter.

6. BULLET CLUSTER (1E 0657-558)

Douglas Clowe et al (2006) claim that the gravitational lensing maps of Bullet cluster provide direct empirical proof for the existence of dark matter. The cluster, as explained by them, is formed by high-speed collision of two sub-clusters (at about 4700 km s^{-1}), resulting in the separation of the mass-centres of the galaxies and the hot plasma. According to the data provided by them, the galaxies account for only 1−2 per cent of the mass of the cluster and the plasma accounts for 5−15 per cent; the rest is missing. That means, the mass required is nearly 10 times that of plasma, and plasma contains nearly 7 times the matter present in the galaxies taken together. But the gravitational lensing maps created by them show that the gravitational potential does not trace the plasma distribution, the dominant mass component, but approximately traces the distribution of galaxies. This anomaly, it is claimed, is due to the presence of dark matter surrounding the galaxies.

But based on speed-dependent gravity the plasma moving at a very high speed has a higher G and hence a proportionately lower mass- luminosity ratio. The average speed of the colliding sub-clusters should be at least 2350 km s^{-1} (nearly 9.8 times the speed of sun). So the G of the plasma is 96 times that of sun and hence its mass (relative to sun) is 1/96 of the present estimate (in the case of galaxies, the mass- luminosity ratio of stars is used and so the speed of the clusters does not affect the estimation of mass). This gives the result that the galaxies together have a mass nearly 14 times that of the plasma. This agrees perfectly with the gravitational lensing maps.

Based on universal G, the total mass required in the cluster is 10 times the estimated mass of the plasma. The present estimate of the mass of the plasma is 64 times high due to the difference in unit used (solar-mass), and 96 times high due to the difference in mass-luminosity ratio. So the mass required is 64x96x10 times the 'actual' mass of the plasma. Based on speed-dependent gravity the G of the plasma is 96 times that of sun; that is, 96x64 times that of Earth. So the mass required is that much less; that is, only 10 times the 'actual' mass of the plasma. The galaxies provide more than this (nearly 14 times); this gives the result that there is some 'excess' mass. However, the data used is only approximate, and using the best-fitting value within the allowed range of the data, this 'excess' can be removed. Thus in the case of Bullet cluster, there is neither any missing mass nor any anomaly in the gravitational lensing maps.

7. CONCLUSION

Speed-dependent gravity can resolve the anomalies that necessitate the introduction of dark matter, namely (i). the missing matter (ii). the flat rotation curves of galaxies (unexplainable as at present even with dark matter) (iii). the gravitational lensing maps of Bullet cluster (1E 0657-558). MOND, proposed as an alternative to dark matter, fails in the case of Bullet cluster. Thus speed-dependent gravity offers the best solution as at present, and it completely rules out the existence of any exotic dark matter.

Moreover, the observed uniformity of the universe is more in agreement with speed-dependent gravity (which predicts a near uniform distribution of matter) than with Newtonian gravity or General Relativity (both predict gravitational collapse) – an indication that the concept of speed-dependent gravity has more potential.

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