GALAXY ROTATION PROBLEM AND ACCELERATING EXPANSION OF THE UNIVERSE EXPLAINED BY RELATIVISTIC PECULIAR VELOCITY

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ABSTRACT

This paper describes the perceived spin (rotational) rate deduced from spectral redshift differences obtained with long-slit spectroscopy of a hypothetical spiral galaxy with a normal spin rate and a high (relativistic) peculiar velocity as seen from the Milky Way rest frame. With a sufficiently high relativistic peculiar velocity the perceived galaxy spin rate or galaxy rotation curve will correspond with the observed galaxy spin rates and flat rotation curves that led to the 'Galaxy Rotation Problem'; the discrepancy between observed galaxy rotation curves and the theoretical prediction from the law of gravity, which led to the inference of Dark Matter. This difference between actual and perceived spin rate / rotational curve can then be explained by the fact that at relativistic velocities a small difference in velocity between two objects or areas lead to an exaggerated difference in spectral redshift across the major axis of a galaxy.

Assuming a relativistic peculiar velocity thus provides a (partial) solution to the galaxy rotation problem, observed flat rotation curves and the missing mass problem which all have lead to the hypothesized existence of Dark Matter, among other proposed solutions. The perceived high spin rate is then caused by a normal spin rate measured as large redshift differences due to the relativistic velocity of the whole galaxy.

Assuming a relativistic peculiar velocity also provides a (partial) solution for the perceived accelerating expansion of the universe as measured by the lower than expected luminosity of supernovae which lead to the hypothesized existence of Dark Energy. The actual lower luminosity of supernovae is then caused by a significant additional distance covered due to a high peculiar motion over billions of years, adding to the distance increase by space-time expansion.

Key words: cosmology, galaxy rotation problem, flat rotation curve, missing mass problem, peculiar velocity, spectral redshift, long-slit spectroscopy, dark matter, dark energy, accelerating expansion of the universe, Hubble constant

1. Introduction

Spectral redshift can be caused by gravitation, relativistic velocity and the expansion of space-time. But there is no intrinsic difference in a galaxy's spectral redshift (z) caused by either the expansion of space-time or the peculiar velocity of that galaxy, that is the cause of redshift cannot be derived from the redshift itself. General scientific consensus is that all (or most) of the spectral redshift is caused by the continuous (Hubble) expansion of space-time, and the average peculiar velocity of galaxies with respect to the Milky Way is considered either zero or very small.

It is also possible to measure the spin rate of a galaxy using long-slit spectroscopy; measuring the different redshifts along the major axis of a spiral galaxy, whereby one side rotates towards us and one side rotates away from us. This method led to the galaxy rotation problem; the spin rate of galaxies is too high to be explained by Newtonian gravity / mechanics alone, mostly because the orbital speed of stars at the outside is so high they should be moving outwards instead of keeping their galactic orbit. Also the rotation curve of these galaxies is found to be flat instead of declining with distance to the galaxy center. To explain how this high spin rate is possible it is assumed there is more matter in these galaxies than the matter we can observe, and also with a very specific mass distribution. In short this led to the birth of dark matter halos to explain the missing matter problem and flat rotation curves.

2. Thought experiment

But what if we consider a spiral galaxy with a normal spin rate but moving away from us with a really high peculiar velocity, in terms of relativistic motions? What would the (long-slit) spectral redshift look like?

Because the whole galaxy is traveling at a high relativistic speed any small difference in velocity caused by the galaxy spin would lead to a big difference in redshifts measured at both sides of the spinning galactic disk. At high relativistic speeds any small deviation would not cause a linear but exponential difference in the measured redshift.

An analogy for this would be for a person who is traveling away from earth at 1% of the speed of light and is aiming a flashlight back at earth. If this person gains or loses 0.5% of the speed of light in velocity it would not lead to any large redshift change for an observer on earth.

But if this same person is traveling away from earth at 98% of the speed of light, a 0.5% velocity gain or loss would lead to a huge change in the measured redshift. At a 0.5% velocity gain it would be redshifted exponentially instead of linear as seen by an observer on earth, as opposed to the small increase in redshift travelling at 1% of the speed of light and gaining 0.5% velocity.

The big difference in redshifts from both sides of a galaxy might then simply be caused by the relativistic velocity of that whole galaxy, such that any small difference in velocity from the spin of that galaxy is greatly amplified. When assuming a peculiar velocity of zero this might lead to the assumption that the galaxy is spinning faster than it actually is, and the assumption that is has a flat rotation curve while in reality it has a declining rotation curve which follows the law of gravity.

Since it isn't possible to see or measure if a spectral redshift is caused by either expanding space-time or relativistic velocity, there might be a possibility that galactic redshifts are in fact partially caused by a high peculiar motion.

3. Confirmation by observation

At present time galactic distances and sizes are measured by many methods based on either redshift or luminosity, so confirmation by observation is not yet possible. Only until we can image (the size of) individual stars in other galaxies and so measure the true size and distance of other galaxies in kpc or light-years and compare this with its spectral redshift we can determine their true peculiar velocity. This is possible by comparing the calculated distance from a galaxy's redshift with its true distance, and the difference between these two distances is then the part of the redshift caused by peculiar velocity. This is far beyond the resolution of current telescopes, but may be possible with future improvements of current imaging technologies. It is however possible to roughly calculate the possible relativistic peculiar velocities of galaxies, explained below in **5. Additional information**

4. Conclusions

If the high spin rate of spiral galaxies in terms of redshift as measured by long-slit spectroscopy is actually a skewed representation caused by a high (relativistic) peculiar motion of the whole galaxy this would infer;

- The spin rates of galaxies could be in accordance with the (Newtonian) law of gravity
- There would be no need for additional matter and mass (e.g. dark matter), or by a much smaller amount than currently assumed
- A larger part of spectral redshift caused by relativistic peculiar motion would call for a redshift correction and adjustment of the value of the Hubble constant
- And as such would also have consequences for the interpretation of the measurements of the expanding universe / expansion of space-time (e.g. dark energy)

5. Additional information

A symmetrical correction of the difference in spectral redshifts from either side of a rotating (spiral) galaxy is possible, when the 'surplus' spin rate is considered to be caused by relativistic redshift.

This correction can have a number of different values. The minimal correction would be to a spin rate that is just within the acceptable Newtonian orbital velocities. The spin rate would be recalculated only so high as that the total observed matter of the galaxy is enough to account fully for it, and that the galaxy rotation curve follows the declining curve predicted by the law of gravity. Another possible value would be to recalculate to the measured spin rate of the Milky Way. Another consideration which has to be taken into account and makes the correction more complex is the surplus distance covered duo to the peculiar velocity over billions of years, which will be covered in **6. Accelerated expansion of space-time.**

At this point we have

- a galaxy that has a ‘normal’ spin rate
- a baseline measured redshift
- a relativistic velocity corrected redshift .

The difference between the measured and corrected redshift roughly gives the peculiar velocity of the galaxy, and as such a corrected distance and size. The corrected distance can then be used for comparison with the Hubble constant, continued below.

6. Accelerated expansion of space-time

Although at first sight it would seem that a galaxy that has a high relativistic peculiar motion would be closer to us than the distance calculated from a redshift caused solely by the expansion of space-time, this might not be true taking into account the timeframe it has been moving away from us.

When imagining a galaxy that has been moving away from us at a high peculiar velocity during billions of years this will add up to the distance it has been displaced away from us by the expansion of space-time alone.

Current observations of the luminosity of certain supernovae used as ‘standard candles’ in distant galaxies have resulted in a lower than calculated luminosity or brightness of these supernovae. This has led to the conclusion that the expansion of space-time is accelerating, which has lead to the hypothesized existence of Dark Energy to explain this acceleration. But as mentioned before this is based on the assumption that the peculiar velocities of (distant) galaxies are zero or very low.

Taking into account the additional distances these galaxies would have covered assuming high (relativistic) peculiar velocities during billions of years would correspond to the observed luminosities. This additional distance decreases the luminosity in comparison to the distance / luminosity expected from the expansion of space-time alone, and thus provides a (partial) solution to the perceived accelerating expansion of space-time. There might even not be any need for an expanding force such as Dark Energy, or by a much smaller amount than is currently calculated.

7. Follow-up

A follow-up paper will cover the question why galaxies would have high or any peculiar velocity at all with respect to each other.