Magnetism and dark matter

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In my research on electromagnetism, I have understood that magnetism is forces created by moving charges and felt by moving charges. An electric current is a model of continuous flow of uncountable electrons moving in the same direction. This scheme seems benign but when I applied it to the Universe, I find in it a surprisingly judicious approach to solve the mystery of dark matter.

1. What is dark matter?

It is a thing that was invented to account for the discrepancy of speed of stars in galaxies which are disks of stars rotating around the center. Galaxies are stable thanks to the balance between the force of gravitation and the centrifugal inertial force of the stars. Thus, Newton's law of gravity should completely determine the curve of speed of stars with respect to radius of orbits. But a big difference is found between the computed curve A, the dashed line in Figure 1 and the observation curve B in solid line. In reality, stars move much faster than gravitation allows. This is called "**The galaxy rotation problem**". Unable to explain this discrepancy, physicists suggest that there should be additional gravitational force from invisible matter, dubbed "dark matter".

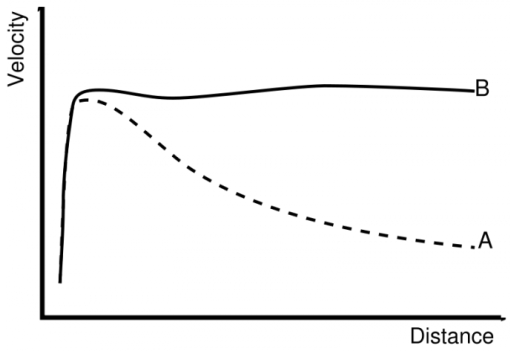

Figure 1

However, many physicists are unhappy of the invisible and undetectable dark matter and think it is an ad-hoc solution purposely created for a problem that is inexplicable otherwise. So, finding a rational solution without dark matter becomes a big challenge for modern astrophysics.

2. Analogy to magnetism

If we see galaxies as bunches of massive stars moving in quasi continuous flows, we find similarity with electric current. Magnetic field is in fact the electric field of charges dragged around by moving charged particles. Similarly, when the gravitational field of matter is dragged by moving stars, a sort of magnetic field should be created and felt by other moving stars like magnetic force.

This analogy to magnetism is illustrated in Figure 2 and Figure 3. In Figure 2, the electron at the bottom moves rightward with velocity v and feels a downward Lorentz force F_e. This force repels the electron out of the center because the current I_a and I_b are opposite. In the circular current, each moving electron feels an outward pushing force.

Now, we plot this circular current on a galaxy image and replace the electrons with stars, the bleu cyan dots in Figure 3. These stars circulate in their orbit around the center of the galaxy with speed *v* and would feel, in addition to gravitational force, an inwardly directed magnetism-like force F_m.

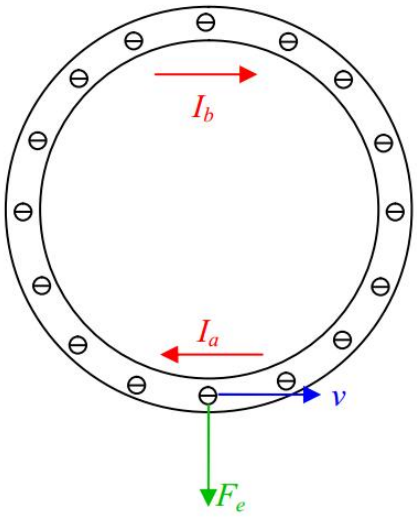

Figure 2

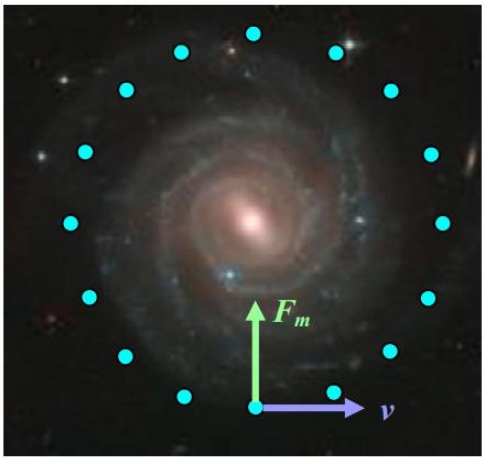

Figure 3

Why is this force directed inwardly? Let us make an analogy with Figure 2. If the electrons were stationary, the force they act on each other is repulsion. When the current is on, they move in opposite direction on opposite sides and the Lorentz force is still repulsion. We conclude that opposite movement of particles increases the original static force, or more generally, the direction of the original static force is the direction of the magnetism-like force for circular flow of particles.

For a galaxy, the original static force is gravitational attraction, thus the magnetism-like force created by circular matter currents must have the same direction, that is, pointed toward the center of the current, the center of the galaxy.

Now, lets us make an estimation of this force's magnitude. Special Relativity predicts that when a particle moves its mass increases and equals its rest mass m_0 multiplied by the Lorentz factor:

$$m = \frac{m_0}{\sqrt{1 - v^2/c^2}} = m_0 + \frac{m_0}{2}\frac{v^2}{c^2} + \cdots \quad \textbf{(1)}$$

The inertial force of a star is its mass multiplied by its acceleration. We apply this principle to the star's relativistic mass and acceleration *a*:

$$F_i = ma = \left(m_0 + \frac{m_0}{2}\frac{v^2}{c^2} + \cdots\right)a = m_0 a + \frac{m_0 a}{2}\frac{v^2}{c^2} + \cdots \quad \textbf{(2)}$$

Given *r* the radius of a circular orbit and ω the angular speed, the acceleration is:

$$a = -r\omega^2 = -\frac{v^2}{r} \quad \textbf{(3)}$$

Then the second term in equation (2) becomes:

$$F_m = \frac{m_0 a}{2}\frac{r}{c^2}\frac{v^2}{r} = -\frac{m_0}{2}\frac{r}{c^2}a^2 \quad \textbf{(4)}$$

The quantity F_m is identified as the magnetism-like force which is proportional to the square of the acceleration a. On may argue that the speed of light is so huge that the factor r/c^2 is surely negligible. This is without counting on the hugeness of r which is, for our Milky Way galaxy, 120 000 light-years, or 1.1 $\times 10^{21}$ m. The speed of light being 3 $\times 10^8$ m/s, the value of r/c^2 is 1.2 $\times 10^4$ s^2/m, which is far from negligible.

According to Newton's second law, the attraction force equals the inertial force and, it equals the sum of gravitational force and magnetism-like force given in equation (2):

$$F_{attraction} = F_i = m_0 a + F_m + \cdots = -\frac{v^2}{r}\left(m_0 + \frac{m_0}{2}\frac{v^2}{c^2} + \cdots\right) \quad \textbf{(5)}$$

3. Does this foolish idea make any sense?

Below are some supporting clues found in present Astrophysics theories:

1) There exists an alternative theory to dark matter called Modified Newtonian dynamics, **MOND**, proposed by Mordehai Milgrom, which suggests a modification of Newtonian gravitation law in such a way that gravitational force should be proportional to the square of the centripetal acceleration a^2 in very weak gravitational field. What a surprise! Exactly what we find in equation (4) just by taking relativistic effect into account without modifying Newtonian dynamics!

MOND says that alternatively a gravitational force inversely proportional to the radius of orbit is equivalent to that proportional to the square of the centripetal acceleration. Is the attraction force in our magnetism analogy inversely proportional to r? In typical spiral galaxies, the observed velocity is the curve B in Figure 1, which is almost constant at great radius. The attraction force is given in equation (5) from which we extract the constant g:

$$F_{attraction} = F_i = -\frac{g}{r}, g = v^2\left(m_0 + \frac{m_0}{2}\frac{v^2}{c^2} + \cdots\right) \quad \textbf{(6)}$$

In consequence, the attraction force on a star in a typical spiral galaxy is inversely proportional to r when relativistic effect is taken into account. However, unlike MOND, the attraction force is not gravitational force because it contains the magnetism-like force which, in addition to be proportional to the square of the acceleration, is also proportional to the orbit's radius. These new features could make the theory closer to reality.

The coefficient g of the attraction force is constant because the velocity of the stars is constant in most regions of the galaxies. The constancy of g may be the result of the action of magnetism-like force that tends to maintain the stars moving at the same velocity than the gravitomagnetic source.

Is the theory of MOND credible? Here is some observational support for it:

1. Observationally, the Tully–Fisher relation is found to conform quite closely to the MOND prediction.
2. MOND predicts strong correlation between features in the mass distribution and features in the rotation curve. Such a tight correlation is claimed to be observed in several spiral galaxies, a fact which has been referred to as "Renzo's rule".
3. MOND predicts that dark matter goes to zero when the stellar centripetal acceleration is greater than a critical value. Dark matter theory cannot explain why mass should correlate closely with acceleration and why above a critical acceleration dark matter is not required.
4. In some regions of particularly massive galaxies, MOND predicts that the rotation curve should fall as 1/r, while dark matter theory predicts much higher speed. Observations of high-mass elliptical bear out the MOND prediction.
5. Three Tidal Dwarf Galaxies appear to have the mass discrepancies that are in close agreement with the MOND prediction.

These natural phenomena bear out MOND theory and also my magnetism analogy approach.

2) The second clue is given by the discoverer of the galaxy rotation problem, Vera Rubin, who in her 1980 paper suggested that "conservatively, upwards of 50% of the mass of galaxies was contained in the relatively dark galactic halo".

Let us make an analogy with a circling electron beam in a magnetic field where the velocity-created magnetic force equals the electrostatic repulsion if the inertial force is negligible. Galaxies are stable thanks to the balance between attraction force and stars' rotation, which generates magnetism-like force which in turn increases the rotation. The magnetism-like force increases until a point where it would become comparable to the original gravitational force and thus, the two forces should have approximately the same magnitude. 50% of dark matter means 50% of the attraction force is of magnetism-like origin, this seems reasonable.

3) The third and fourth clues come from General Relativity. Einstein predicted the existence of gravitation wave. Waves are made by the back and forth conversions of energy from one form into another. If the first form of energy is gravitation then, what is the second if not magnetism-like energy?

4) The frame-dragging effect is a General Relativity prediction which is explained in the Wikipedia article Frame dragging where one reads "Qualitatively, frame-dragging can be viewed as the gravitational analog of electromagnetic induction". Aha! Frame-dragging is viewed as the creation of magnetism-like field. Near the Earth, this effect is very weak, but for galaxies, the huge scale should make it sufficient to accelerate stars near the edge of galaxies.

In fact, equation (5) expresses the inertial force of a single star. Magnetism-like force is generated by the totality of stars in a galaxy by frame-dragging effect and can be theoretically computed for a distribution of matter moving at known velocity. In case where the speed curve of a galaxy is not constant, the attraction force can be computed using equation (5) and the observed velocity:

$$F_i = -\frac{v^2}{r}\left(m_0 + \frac{m_0}{2}\frac{v^2}{c^2} + \cdots\right) = f \qquad (7)$$

f is a function of radius from which we subtract the gravitational force to obtain the observed magnetism-like force, which can be compared with theoretical frame-dragging effect in order to understand how the gravitomagnetic mechanism of galaxies works.

4. Comments

Seeing galaxies as matter currents and the analogy to magnetism explain qualitatively why there is an additional force in the gravitational game of galaxies; Special Relativity gives a mathematical estimation of the magnitude of the magnetism-like force. This approach seems to solve the galaxy rotation problem without modifying Newton's law of gravity. In addition, the dubious dark matter is thrown away making many physicists happy.

By reading the Wikipedia articles Frame dragging and gravitomagnetism, I see that magnetism-like force is already included in General Relativity, except that we have not understood that way. By prolonging this idea, one can expect unifying Electromagnetism and Gravitation just by digging deeper General Relativity. This is without counting on a big problem: Maxwell's electromagnetic

theory contains inconsistency. For example, if Lorentz force law were true, one can make perpetual machine; in some situations of my experiments Faraday's law predicts zero EMF, but the LEDs still light up. The numerous articles and experiments I have published in my blog and Academia prove this. A correct theory, General Relativity, cannot be unified with a wrong one. Correcting Maxwell's electromagnetic theory is absolutely necessary if we want reliable physics and new discovery.

So comes the original motivation of my writing the present article: to inform a great number of physicists about the inconsistency of Maxwell's electromagnetic theory. Until now, in spite of my numerous publications, few people react. The lack of feedback seems to show that the majority of physicists do not care. Indeed, as they expect nothing to happen in this theory, they do not care. What they want is excitement, especially solving subjects in vogue. Dark matter and the galaxy rotation problem are both in the **List of unsolved problems in physics**, they are focuses of interest. Solving them will surely attract people's eyes to me.

But once they look at me, what will I say to them? Well, I will explain that Maxwell's electromagnetic theory contains inconsistency that needs correction and on which I'm working. Please read the articles bellow to have an idea of my work.

Why magnetic field must be a tensor? pdf, word

Physical explanation of the tensor magnetic field.

Unknown properties of magnetic force and Lorentz force law, Blogspot, word

Synthetic study that summarizes studies about the flaw of the Lorentz force law, the corrected magnetic force law and perpendicular and parallel action experiments.