The Small Bang Model - A New Explanation for Dark Matter Based on Antimatter Super Massive Black Holes

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Abstract

This paper presents a new cosmological theory entitled the "Small Bang" model, a variation on the Big Bang theory, in which all of the energy and matter observed in the Universe are generated from the process of cosmic inflation.

In the Small Bang model, each galaxy arises from a small seed given by an antimatter micro black hole. In the cosmic inflation process this micro black hole grows exponentially, breaking up pairs of virtual particles and attracting those composed by antimatter, while repelling the matter particles relying on matter-antimatter repulsion interactions. At the culmination of this process, a rotating matter cloud is formed and at its center is an Antimatter Super Massive Black Hole (ASMBH).

The effect of the ASMBH mass over the galaxy rotation is very small. However if we consider that the ASMBH has a large angular momentum, a significant influence over the galaxy rotation should be observed. Thus, the authors believe that the effects currently attributed to some kind of Dark Matter, can be explained in a model that considers the mass and angular momentum of the ASMBH that exists at the center of each galaxy.

The Small Bang model also explains some open points in the Big Bang standard theory, like the missing antimatter in the galaxy, the galaxy formation process and the relation between the super massive black hole's mass and the galaxy mass. This new model also eliminates problems associated with the initial black hole singularity, like infinite temperature, by proposing a Universe that starts with an empty and cold space with a Planck length diameter.

The Small Bang model also represents an innovation to the Big Bang model that has remained virtually unchanged for over 70 years. These new ideas have potential to change the way cosmologists perceive the forming of galaxies and of our Universe.

1 – Introduction

Despite the advances of modern physics there are still many scientific questions that are unanswered, such as issues relating to the composition of dark matter, the formation of Super Massive Black Holes (SMBH) found at the centers of galaxies and also that the observable universe is composed predominantly of matter, instead of being composed of an equal amount of antimatter.

The authors believe that these issues are strongly correlated and thus propose a cosmological model called the "Small Bang", that is a variation of the Big Bang [1] model, where the space time begins from an empty and cold space with a Planck length diameter. In the Small Bang model, the formation of all energy and matter in our Universe occurs during the process of cosmic inflation [2]. In this process space expansion occurs when virtual photon pairs separate before they annihilate themselves, generating high energy real photons.

Some of these photons are divided, generating two micro black holes (with a diameter equal to the Planck distance), one composed of matter and the other of antimatter. Then in cosmic inflation the antimatter micro black holes grow exponentially, separating virtual particle pairs. For each matter particle that is created the black hole swallows an antimatter particle that is repulsive to the matter particle and of opposite charge, and so all the antimatter winds up concentrated at a single point, forming an Antimatter Super Massive Black Hole (ASMBH) at the center of each galaxy. Thus each galaxy will contain in its center an ASMBH, which rotates in the opposite direction of the galaxy matter, tending to a null total angular momentum.

In a general relativity (GR) context, rotating black holes can be modeled by the Kerr geodesic equation [3], that defines a region called the ergosphere. In the ergosphere surface the spinning black hole "drags" space-time at the speed of light.

By observing the rotational speed of stars in a galaxy, astronomers can estimate the mass of the galaxy based on Kepler's third law. However this calculation points to a galactic mass much larger than the estimated mass, based on observed stars and gas clouds. This additional mass has been referred to as dark matter (DM) [4].

The authors believe that dark matter in fact does not exist and that the effects attributed to dark matter arise from the ASMBH's large angular momentum that drags the space-time in the opposite direction of the galaxy rotation, generating velocities for stars in the galaxy that are higher than expected and in congruence with observed velocities. With the additional velocity the notion of dark matter no longer needs to be introduced.

Taking for example the sun speed orbiting the Milky Way, astronomical data points to a 220km/sec velocity, while the mass of "luminous matter" (LM) in the galaxy generates a theoretical speed of just 160km/s, and so the additional 60km/s is assigned to the dark matter gravitational attraction (or in GR, to the dark matter space-time distortion.) Considering the effect of the AMSBH mass in the Milky Way center (estimated at approximately four million solar masses) over the sun speed, we can obtain only a 1.5 km/sec speed increase, and so the mass of this black hole does not explain the additional speed attributed to dark matter.

However if the Kerr equation is used and the angular momentum of the ASMBH is about 1/4500th of the Milky Way angular momentum, the addition to the sun's velocity is approximately 60km/s, which coincides with the observed velocity of the sun without having to rely on dark matter.

In the following sections, the Small Bang model will be explained in more detail and the Kerr geodesic reduction to Kepler's third law for a rotating black hole will be introduced. The effects of dark matter will be considered and the Small Bang model and Kerr GR equation used to reveal that dark matter is unnecessary.

2 – Small Bang Model

The big bang theory is currently the most widely accepted cosmological model to explain the origin and evolution of our Universe. In this model, all space-time begins at a small point, with temperatures tending to infinity, which concentrates all energy in the Universe at a singularity. The Universe undergoes a process of cosmic inflation, consisting of an extremely fast space expansion (faster than the speed of light), in which its temperature decreases and energy forms matter and antimatter particles as it cools. As matter and antimatter annihilate each other, producing energy again, some authors like the Russian physicist Andrei Sakharov [5] claim that in this process of matter and antimatter formation and annihilation occurs a small asymmetry, favoring the generation of matter. This theory in principle explains the observation that the Universe is composed of more matter than antimatter, but to the authors' knowledge this asymmetry has not been experimentally shown to be true.

The authors agree with some parts of the big bang theory, including the initial Planck length space-time size and the cosmic inflation process but disagree with the fact that all energy was created at time zero. To supplant this notion, the authors are proposing an alternative theory called the Small Bang model, in which space-time still begins with an infinitesimal volume, but contains a null amount of energy.

Figure 1 shows the basic difference between the two models: in the Big Bang model the energy density (and temperature) tend to infinity, while in the Small Bang model the energy and temperature are initially zero. Note that after cosmic inflation both models lead to the same energy density, one indistinguishable from the other.

Is important to observe that Alan Guth, the creator of cosmic inflation theory has already proposed an early universe with low energy density [6]:

"This borrowing of energy from the gravitational field gives the inflationary paradigm an entirely different perspective from the classical Big Bang theory, in which all the particles in the Universe (or at least their precursors) were assumed to be in place from the start. Inflation provides a mechanism by which the entire Universe can develop from just a few ounces of primordial matter"

Going beyond this Guth proposal, the authors believe that cosmic inflation provides a mechanism by which the entire Universe can develop just from nothing. On this way in the Small Bang model all energy and all matter that is observed today in our Universe has been generated by cosmic inflation: the energy being generated directly by the space expansion, that breaks apart virtual photon pairs and generates high energy photons. The matter is being generated at the antimatter black hole's event horizon, which breaks apart matter-antimatter virtual particles and is detailed below.

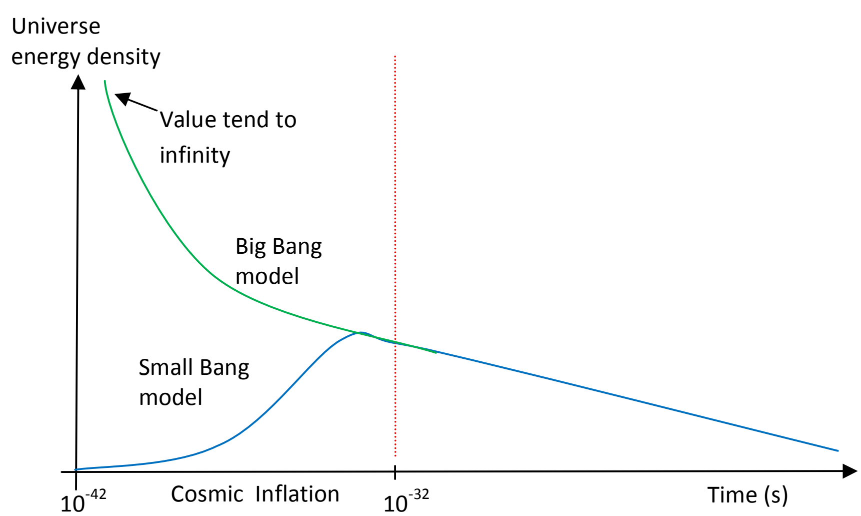

Figure 1 - Comparison of the energy density in the Big Bang and Small Bang models.

3 – Small Bang Creation of Energy and Matter

In the Small Bang model the energy creation is based on the concept of virtual particles as defined in the context of quantum mechanics [7], but it is also possible to consider that part of the energy generating process of cosmic inflation is lost under the form of photon energy creation and mass creation.

From QM, in an empty space quantum fluctuations generate pairs of virtual particles (like virtual photons and also virtual massive particles) which emerge from nothing and then recombine again to annihilate themselves. During cosmic inflation space expands so abruptly (at faster than light speed) that it prevents the recombination of virtual photons, generating real photon pairs of very high energy. After being generated, these photons are expanded with the space expansion such that their energy decreases to very low values, which has been observed as the cosmic microwave background radiation that permeates all space. But during the inflation process some of these high-energy photons are split forming two micro black holes (with the event horizon radius equal to the Planck distance), one composed of matter and the other of antimatter.

If we consider from Dr. Villata's paper [8] that matter and antimatter are repulsive to each other while matter is attractive to matter and antimatter is attractive to antimatter, an antimatter micro black hole tends to capture antimatter particles and "expel" matter particles arising from virtual pairs that appear near the event horizon, due to quantum vacuum fluctuations. Likewise a matter micro black hole will tend to separate pairs of virtual particles collecting matter and expelling antimatter.

In these scenarios, two micro black holes will expand in nearby regions of space. With just a small imbalance in this process, one of these black holes will grow much faster and "swallow" the other black hole. If this imbalance favors the antimatter black hole, cosmic inflation itself will generate in its first moments a cloud of antimatter micro black holes (AMBH's), spread throughout all of space. Each of these AMBH's serves as the seed for the creation of one galaxy. On the other hand if the imbalance is somewhat randomized, in some regions the matter micro black holes will grow and serve as seeds for generating antimatter galaxies (which has not yet been confirmed by astronomical data.) Since antimatter galaxies have not yet been observed, the authors believe that the predominant galaxies that are formed have an antimatter black hole at the center and are composed primarily of matter.

In this way, during the inflation process, each ASMBH grows exponentially, separating pairs of virtual particles, and the galactic center absorbs antimatter particles until forming an ASMBH. So the antimatter particles (positrons and anti-protons) fall into the hole black and the particulate matter (electrons and protons) are expelled generating momentum.

It is important to note that although the ASMBH repel matter particles, from GR field equations the ASMBH mass distorts the space-time fabric creating geodesic trajectories where the matter particles are repelled in elliptical geodesic paths. Thus the trajectory of a star orbiting an antimatter black hole center is the same as if this star were orbiting a matter black hole, even though in an antimatter rotating black hole the orbital radius will be larger than the radius of a rotating black hole with the same mass.

In this way the mass particle linear momentum is converted into angular momentum and so the black hole tends to rotate in the opposite direction of the orbiting star systems. When the ASMBH begins to spin its rotation creates an ergosphere that drags space-time at the speed of light so the next particle of matter created tends to rotate in the same direction (opposite to the black hole rotation direction) in the same plane of rotation, as shown in Figure 2. Finally all matter in the galaxy has the same angular momentum direction that is opposite to the black hole angular momentum direction.

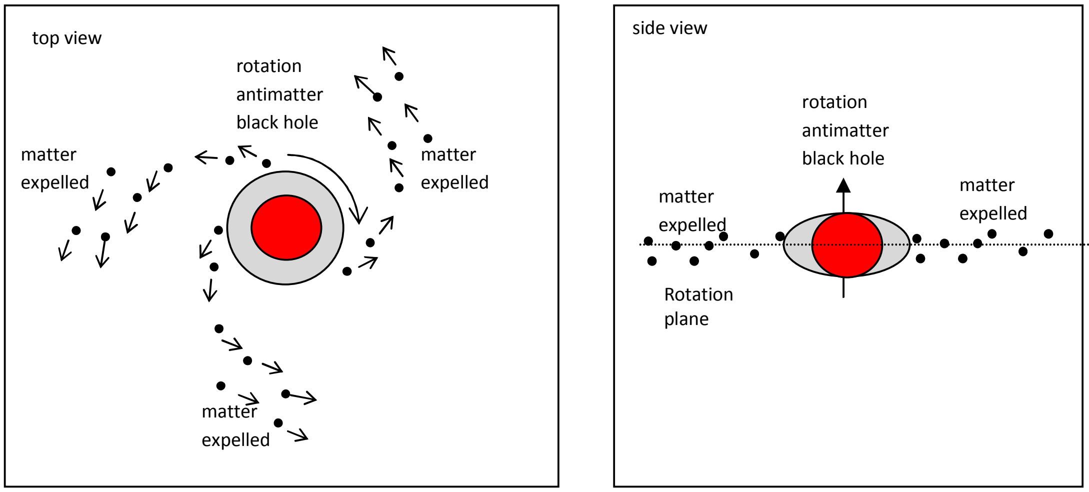

Figure 2 - Emission of matter particles by a rotating antimatter micro black hole.

Thus in the Small Bang model a micro black hole evolves into an ASMBH "expelling" during this process a cloud of matter (electrons and protons) and forms a spiral disk, according to a well defined rotation plane. Note that in this model, at the end of cosmic inflation, the sum of matter and energy will be similar to that defined by the Big Bang model, but with matter and energy being created during cosmic inflation, instead of already existing at an initial time.

Figure 3 shows three frames of the evolution of the universe according to the Small Bang Theory. In frame (a) one small region of space is observed, which is at the beginning of cosmic inflation. In this region high-energy photons are being generated, creating antimatter micro black holes shown as white dots in this figure. In frame (b) the cosmic inflation has ended, and the original region is now a few light years in size. Each antimatter black hole has grown exponentially, becoming a supermassive black hole that is orbited by a spiral cloud of matter particles, forming a protogalaxy. Frame (c) represents the present time and now the original region occupies some millions of light years. Each protogalaxy has expanded billons of years and has become a mature galaxy, in which the hydrogen clouds are fragmented by the gravitational forces in billions of clusters that form all stars in each galaxy.

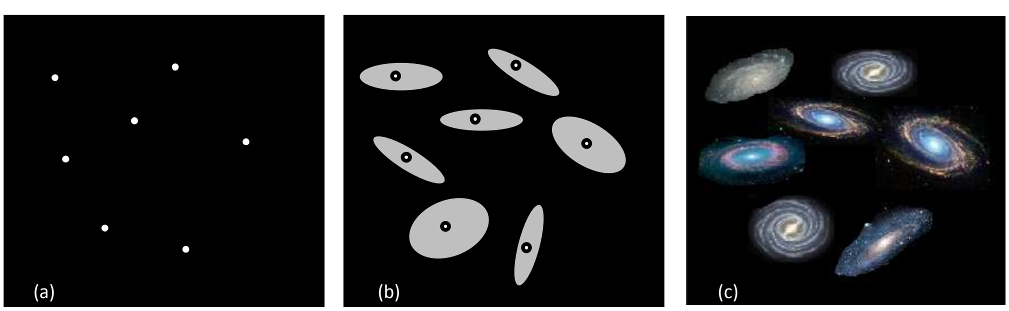

Figure 3 - Evolution of the Universe according to the Small Bang Theory.

This new Small Bang model avoids the problems associated with a space temperature tending to infinity, generates an explanation for the observed discrepancy between matter and antimatter, explains why all observed galaxies have a super massive black hole at the center of the galaxy, and explains how this black hole is formed.

4 – Kerr Equation for a Rotating Black Hole

A black hole is basically characterized by a mass (*M*), an electric charge (*Q*) and an angular momentum (*J*).

From GR vacuum field equations, black holes without charge and rotation distort the space-time according to the Schwarzschild equation [9][10]:

$$ds^2 = (1 - \frac{2GM}{c^2 r})c^2 dt^2 - \frac{1}{1 - \frac{2GM}{c^2 r}} dr^2 - r^2 d\theta^2 - r^2 \sin^2(\theta)\, d\phi^2 \tag{1}$$

Where (r, θ, ϕ) indicate the point considered in a spherical coordinate system centered on the black hole.

The event horizon of the black hole is defined by the value of the Schwarzschild radius:

$$r_s = \frac{2GM}{c^2} \tag{2}$$

For analyzing a rotating black hole without charge, Kerr's equation [11], is used as an exact solution to the GR vacuum field equations:

$$ds^2 = (1 - \frac{r_s r}{\rho^2})c^2 dt^2 + \frac{2 r_s r \alpha \sin^2(\theta)}{\rho^2} c\, dt\, d\phi - \frac{\rho}{\Delta} dr^2 - \rho^2 d\theta^2 - \left(r^2 + \alpha^2 + \frac{r_s r \alpha^2}{\rho^2} \sin^2(\theta) \right) \sin^2(\theta)\, d\phi^2 \tag{3}$$

Where:

$$\alpha = \frac{J}{Mc^2} \tag{4}$$

$$\rho^2 = r^2 + \alpha^2 \cos^2(\theta) \tag{5}$$

$$\Delta = r^2 - r_s r + \alpha^2 \tag{6}$$

Equation (4) defines a new region surrounding the black hole that is called the ergosphere, and in this region space-time is "dragged" at light speed.

Whereas from equation (3) a body in a geodesic orbit in the plane of rotation will have an angular velocity (w) described by:

$$w = \pm \frac{\sqrt{MG}}{r^{3/2} \pm \alpha\sqrt{MG}} \tag{7}$$

For a body without rotation ($\alpha = 0$) equation (7) leads to Kepler's Third Law:

$$w_0 = \pm \frac{\sqrt{MG}}{r^{3/2}} \tag{8}$$

Equation (7) can also be set depending on the rotation period T:

$$T = \frac{2\pi}{w} = 2\pi\left(\frac{r^{3/2}}{\sqrt{MG}} \pm \alpha\right)$$

$$T = \frac{2\pi}{w_0} \pm 2\pi\alpha \tag{9}$$

In equation (9) for a large α value, the following simplification can be made:

$$\alpha >> \frac{r^{3/2}}{\sqrt{MG}} \;\Rightarrow\; J >> \frac{r^{3/2}c^2\sqrt{M}}{\sqrt{G}}$$

$$T \approx \pm 2\pi\alpha \tag{10}$$

Equation (10) implies that for a large angular momentum, in regions near the black hole, the angular velocity tends to be constant, which implies that orbital speed increases with distance, as in the case of a rigid body.

$$v = \frac{2\pi\, r}{T} = \pm \frac{r}{\alpha} \tag{11}$$

In contrast for a radius much larger than the α value, the α value can be neglected:

$$\alpha << \frac{r^{3/2}}{\sqrt{MG}} \;\Rightarrow\; J << \frac{r^{3/2}c^2\sqrt{M}}{\sqrt{G}}$$

$$T = \frac{2\pi}{w_0} \tag{12}$$

$$v = \frac{\sqrt{MG}}{\sqrt{r}} \tag{13}$$

Figure 4 shows orbital velocity versus distance for equation (7) and is divided into three regions as considered by equations (11) and (12), and in an intermediate region in which the speed can be considered approximately constant.

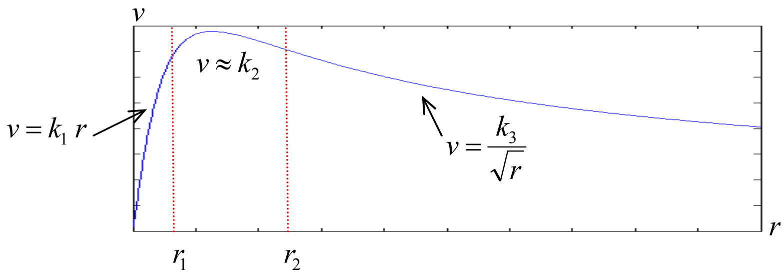

Figure 4 - orbital velocity curve for a black hole with high angular momentum.

5 – Dark Matter

The first evidence of the existence of DM was obtained when astronomers tried to calculate the mass of the Milky Way, based on some observed stars' orbital velocities. Figure 5 shows two velocity curves for stars in the Milky Way that present the expected speed and the observed speed. This figure indicates that our sun's speed should be about 160km/s but the observed speed is 220km/s. The additional speed observed was originally associated with the gravitational influence of dark matter.

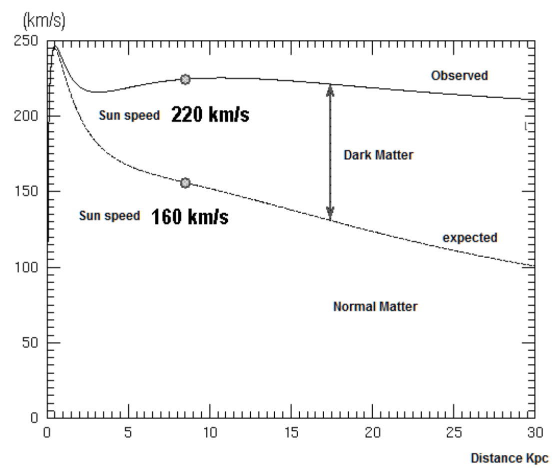

Figure 5 - orbital velocity curves for stars in the Milky Way.

In Figure 6, the speed remains somewhat constant along the galaxy's axis, as would be expected for a speed that decreases in inverse proportion to the square root of the distance away if the Milky Way were composed only of "normal" or luminous matter. This behavior indicates that DM extends well beyond the confines of the Milky Way as shown in Figure 3. Thus the mass of DM will be around six times that of luminous matter and the diameter of DM in the galaxy will be around five to ten times the diameter of luminous matter in the galaxy.

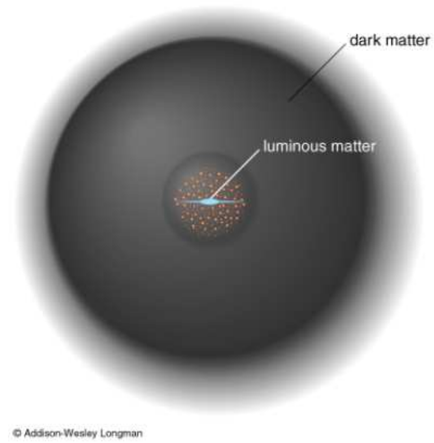

Figure 6 - Representation of dark matter in a galaxy.

6 – Rotating Super Massive Black Hole

In the Small Bang model every galaxy must have a Super Massive Black Hole (SMBH) at its center, whose mass should be roughly equal to the galaxy mass (considering only the luminous matter) and whose angular momentum should be equal and opposite to the galaxy angular momentum. However the observed SMBH mass is in an order of 1/1,000th to 1/10,000th of the galaxy mass (excluding DM.)

The authors believe that this reduction in the SMBH mass may be due to the following factors:

a) There are errors associated with the SMBH mass, such as the consideration that it is formed by matter instead of being composed of antimatter [12]. However these errors could only account for cases in which the SMBH mass is about 1/10th to 1/100th of the galaxy mass.
b) Some other unknown factors cause the antimatter SMBH mass to behave like an SMBH composed of matter but with a much smaller mass.
c) The number of antimatter particles that fell into the black hole is equal to the number of matter particles in the galaxy, but the process of cosmic inflation changed the mass of these particles in a manner analogous to that changed by the photon energy. In this case the mass particles inside the SMBH have been reduced relative to the mass particles in the normal space.
d) The matter particles are formed by strings [13] which are wound in a three-dimensional space of which the mass is proportional to the number of turns. The particles that fall into a black hole form winding changes and therefore the black hole forms a two-dimensional surface and hence decreases the mass of the particles. In this model the mass of a proton which falls into the black hole becomes equivalent to the mass of an electron.

The authors believe that regardless of which explanation above is considered or another explanation that has not been yet introduced, the scenario in which antimatter still exists in our Universe is much more plausible than the scenario in which antimatter simply ceases to exist because of an asymmetry in the creation of matter and antimatter. This second scenario also has no experimental support.

If the Small Bang model is correct then the ASMBH angular momentum can be of the same order of the galaxy's angular momentum. But as the ASMBH mass is seen as a factor of up to 1/10,000th of the galaxy mass, the ASMBH angular momentum should also be around 1/10,000th of the galaxy's angular momentum.

For example the SMBH at the Milky Way center is equivalent to about 4 million solar masses (or roughly 1/3500th of the luminous matter.) If this SMBH consists entirely of antimatter and in considering the repulsive effects between matter and antimatter, the ASMBH mass could be around 10 million solar masses (or roughly 1/1,300th of the luminous matter mass.)

Thus the ASMBH maximum angular momentum can be estimated as being of the order of 1/3,500th to 1/300th of the Milky Way's angular momentum in considering that only the luminous matter angular momentum [14] can be calculated as $2x10^{66}$ J's.

7 – An Alternative to Dark Matter

Considering only the SMBH mass effect over the galaxy's rotation, we see that it is very small. For example, based on Kepler's Third Law (Equation 8) the increase in sun speed caused by this black hole is only about 1.5 km/s.

However considering that the ASMBH has a high angular momentum, by equation (7) we get:

$$\Delta v_{sun} = r_{sun} w = r_{sun} \frac{\sqrt{M_{BH} G}}{r_{sun}^{3/2} - \alpha_{BH} \sqrt{M_{BH} G}} \tag{14}$$

Where:

$$\alpha_{BH} = \frac{J_{BH}}{M_{BH} c^2} \tag{15}$$

Considering:

$r_{sun} = 2.5 \times 10^{20} m$

$M_{BH} = 8 \times 10^{33} Kg$

$J_{BH} = \frac{J_{MilkWay}}{4500} = 3.99 \times 10^{62} Kgm^2 s^{-1}$

This gives us:

$\alpha_{BH} = 1.635 \times 10^{17} m$

$\Delta v_{sun} = 60 Km / s$

So if the ASMBH has an angular momentum of about 1/4,500th of the Milky Way's angular momentum, its influence over our sun's orbital velocity will generate an increase in speed of 60km/s without using any type of dark matter.

Also, the Kerr model points to a limit of electrical charge and angular momentum (expressed in units of Planck) defined by:

$$Q_{BH}{}^2 + (\frac{J_{BH}}{M_{BH}}) \leq M_{BH}^2 \tag{16}$$

Considering a null electric charge, in the case of the SMBH at the center of the Milky Way, we obtain:

$$J_{BH} \leq M_{BH}^{2} \qquad (17)$$
$$J_{BH} \leq 1.5 \times 10^{55} Js$$

The value of the SMBH angular momentum, considered in the sun velocity calculation, violates this limit, and thus the value obtained by equation (14) shows only the order of magnitude correctly but not a precise result. This points out that we need more data to use the Kerr equation (or another model) for analysis of an ASMBH with high angular momentum and its effects over one galaxy's rotation.

8 – Conclusion

The Small Bang model presented in this paper considers that the matter and energy in the Universe may have not been created in an initial instant. According to this new model, matter and energy were null at the first moment of the Universe, and so initially the Universe consisted of empty space with a size equal to the Planck length.

In this new model, matter and energy were created in a cosmic inflation process in which the space-time expanded exponentially, and the energy came directly from the separation of virtual photons due to the expansion of space at rates faster than the speed of light.

Matter in turn arises from the division of high-energy photons that generate micro black holes (mBH) of matter and antimatter. Considering that antimatter repels matter (while the distortion caused by antimatter in space-time generates geodesic curves in which matter follows elliptical trajectories) an antimatter mBH tends to grow exponentially to become a super massive black hole (SMBH), ejecting during this process a cloud of matter (consisting primarily of hydrogen and helium) that adopts the configuration of a rotating spiral disk, eventually coalescing to form stars.

Due to some factor that warrants further study, the mass of the antimatter SMBH is smaller than the galaxy mass by a factor analogous to the mass of an electron divided by a proton mass.

Yet each SMBH at the center of a galaxy maintains a high angular momentum, in the opposite direction of the rotation of the galaxy. Thus the SMBH drags space-time in the opposite direction of the stars orbiting it and generates a velocity that remains constant initially and slows down with time.

For the case of the Milky Way galaxy, as shown previously in this paper, the Kerr equation for a rotating black hole and no electrical charge with a high angular momentum (1/4500th of that of the galaxy) will increase the sun's orbital velocity about 60km/s. This eliminates the reliance on dark matter to explain the discrepancy between the observed and calculated values.

However the Small Bang model still shows some inconsistencies, such as:

- The hypothesis that matter repels antimatter [8] still needs experimental validation.
- The mass of the central SMBH is smaller than the mass of the galaxy, when it should be about the same or at least of the same order of magnitude.
- The angular momentum of the SMBH (in order to display equivalent effects as dark matter) is above the limit set by the Kerr model.

Despite these shortcomings, the Small Bang model solves several open issues not addressed in the current Big Bang model. The model:

- explains where antimatter goes without needing to rely on asymmetries in the conversion of energy into matter and antimatter (Note that this asymmetry has no experimental support.)
- avoids energies tending to infinity which occurs in the Big Bang model.
- converts part of the energy responsible for the process of cosmic inflation into photon energy and mass energy.
- explains the process of galaxy formation arising from antimatter micro black holes which serve as seeds for generating random quantum fluctuations which lead to cosmic inflation.
- explains why galaxies should have a super massive black hole at their center and why the mass of the galaxy is proportional to the SMBH mass.
- explains that the effects that have been attributed to dark matter are really due to the SMBH high angular momentum, which drags space-time and influences orbiting bodies.

The Big Bang theory has been upheld since 1929, when Edwin Hubble observed the expansion of the Universe, creating the basis for an initial Universe of microscopic size.

Besides the advantages presented by the Small Bang model, it represents a fundamental paradigm shift from the Big Bang theory. This new model takes into consideration quantum mechanics and fluctuations in the formation of antimatter black holes and their observed effects on galaxy rotation.

The Small Bang model can also be used in computer simulations that involve the creation of the galaxy, the overall structure of large galaxy clusters and for use in comparisons with astronomical data.

The authors believe that this new theory has the potential to supplant or augment the traditional Big Bang theory or at least generate some new insights into how our Universe was created and actually functions.

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