That is what cosmology is based on: interpretations of interpretations of observations. We should not fall victim to cosmological hubris, but stay open for any surprise." ------ Hans-Dieter Radecke

Application of fluid mechanics to the dark matter

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Introduction

The modern nucleosynthesis theory indicates that only 4% or less of the total mass in a flat universe is “baryonic” matter. More than 96% of the mass is in the dark ---- dark matter.

The properties, distribution and interaction of the dark matter with ordinary baryonic matter are unknown.

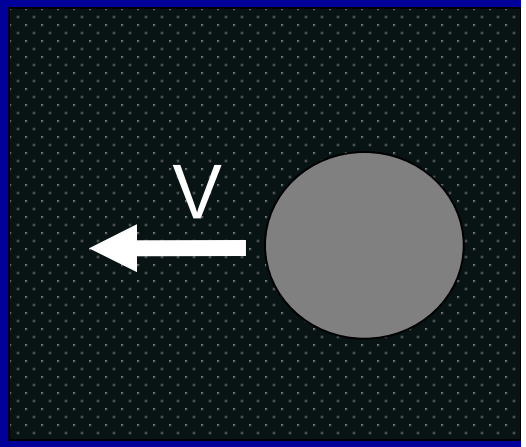
In this talk, a field fluid model of the dark matter is proposed, which may give some interesting results. The “dark matter” means everything in the dark (dark matter, dark energy, etc).

The field fluid model of the dark matter

The model assumes that:

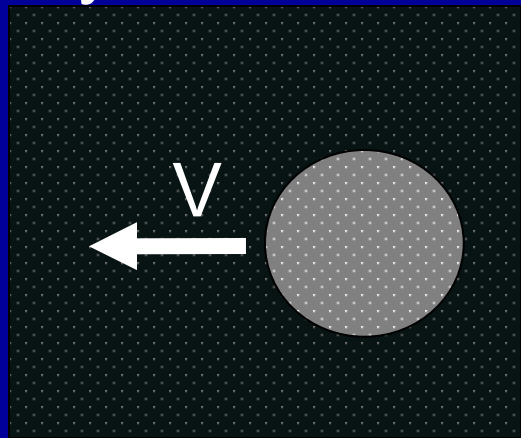
1. The interstellar space is “uniformly” filled with the dark matter which has a fluid property and a field property.
2. The fluid property follows the general fluid mechanics, the field property is unknown at this time, it is assumed that its interaction with an ordinary baryonic object is proportional to the mass of the object.
3. The dark matter particle is very small, it can easily permeate into the ordinary baryonic objects, therefore, the ordinary object is fully soaked with such field fluid.

According to Stokes's law, a rigid sphere moving through a quiescent fluid in a low Reynolds number condition experiences the resistance force F:



$$F = -6\pi\mu\, av \qquad (1)$$

For a rigid sphere moving in the dark matter field fluid, due to the dual properties and its permeation to the sphere, the force may not be proportional to its radius (soaking effect), the proposed force is



$$F = -6\pi\eta a^{1-n} mv \qquad (2)$$

According to Newton's second law of motion:

$$m\frac{dv}{dt} = -6\pi\eta a^{1-n} mv \qquad (3)$$

Then:

$$v = v_0 \exp(-6\pi\eta a^{1-n} t) \qquad (4)$$

If the sphere circulates around a gravitational center, the gravitational force must equal the centripetal acceleration force:

$$\frac{GMm}{R^2} = \frac{mv^2}{R} \qquad (5)$$

One can get:

$$R = \frac{GM}{v_0^2}\exp(12\pi\eta a^{1-n}t)$$

$$R = R_0\exp(12\pi\eta a^{1-n}t) \qquad (6)$$

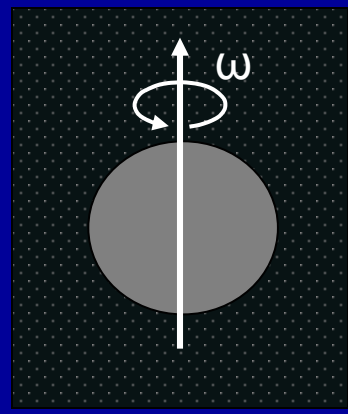
The recessional rate of the sphere is:

$$\frac{dR}{dt} = 12\pi\mu a^{1-n}R_0\exp(12\pi\eta a^{1-n}t)$$

$$\frac{dR}{dt} = C_0 R \qquad (7)$$

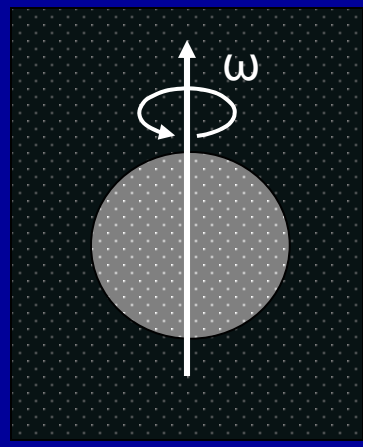
According to the mechanics of fluids, for a rigid sphere rotating about its central axis in the quiescent fluid, the torque T exerted by the fluid on the sphere is:

$$T = -8\pi\mu a^3\omega \qquad (8)$$



In the case of a sphere rotating in the quiescent dark matter field fluid with angular velocity ω, similar to Eq. (2)

$$T = -8\pi\eta a^{3-n} m\omega \qquad (9)$$



The torque causes the negative angular acceleration:

$$T = I\frac{d\omega}{dt} \quad (10)$$

Where, I is the moment of inertia of the sphere:

$$I = \frac{2}{5}ma^2 \quad (11)$$

Therefore

$$\frac{d\omega}{dt} = -20\pi\eta a^{1-n}\omega \quad (12)$$

and

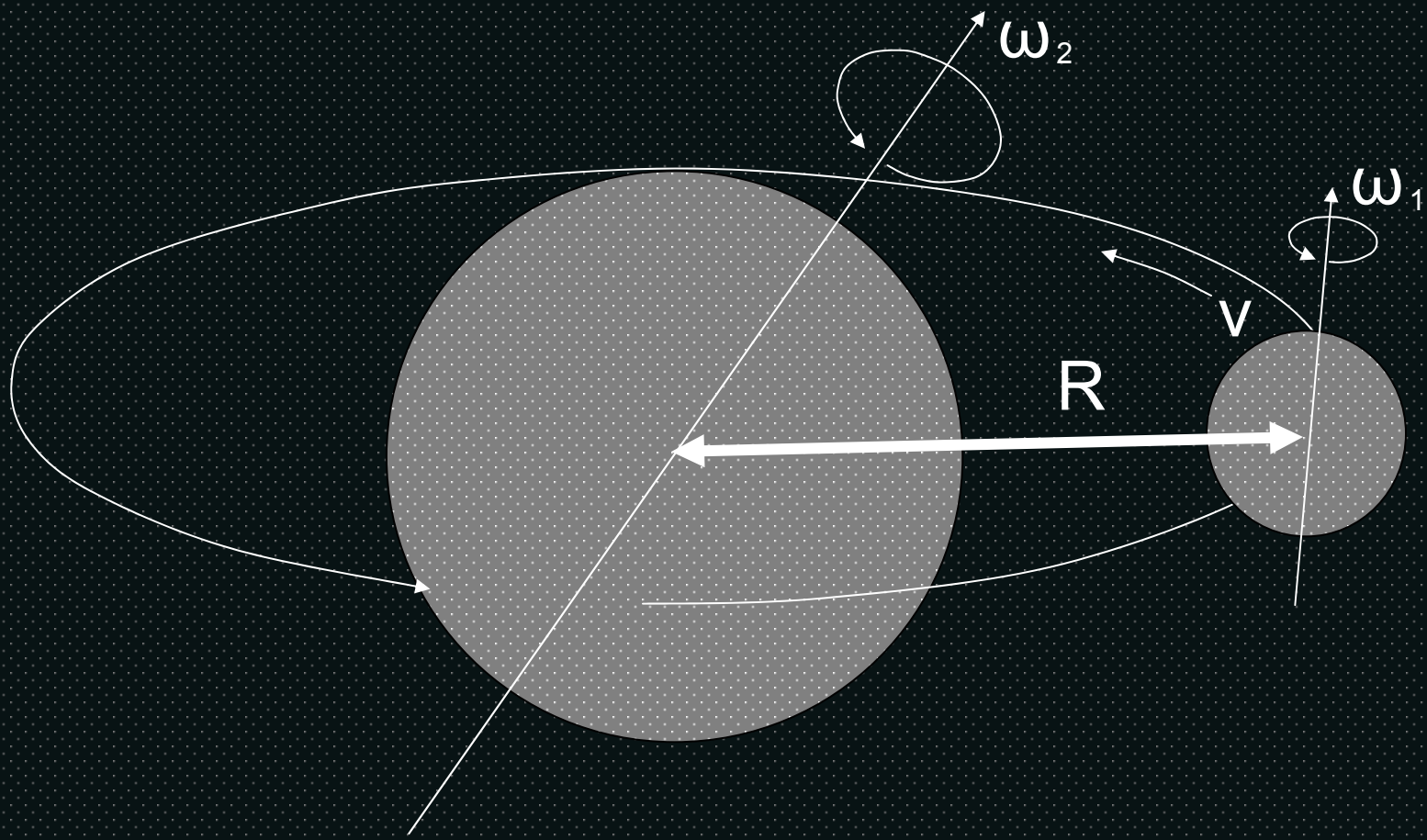
$$\omega = \omega_0 \exp(-20\pi\eta a^{1-n}t) \quad (13)$$

Combine (7) and (12):

$$\frac{\frac{d\omega}{dt}\frac{1}{\omega}}{\frac{dR}{dt}\frac{1}{R}} = -\frac{5}{3} = -1.67 \qquad (14)$$

The significance of Eq. (14) is that it contains only observed data without assumptions and undetermined parameters; therefore, it is a critical test for this model.

Moon-Earth Gravitational system



Insert Moon's data in to (14) (from lunar laser ranging of Apollo Program, by Dickey et al., Science 265 482-490 and from professor Lang's book Astrophysical data, Planets and Stars.)

$$\frac{-1.260\times10^{-23}\times3.92509\times10^{8}}{1.21\times10^{-9}\times2.662\times10^{-6}}=-1.54$$

It is in good agreement with the theoretical value of -1.67.

The errors come from three sources:

1. The errors in both data sets
2. The Moon is not perfect rigid sphere
3. Possible effects from Sun and other members of Solar system

The two parameters n and η can be calculated from two data sets and the third data set can be used to further test the model. If the model is correct, it should give consistent results from different datasets.

The value of n: $n = 0.64$

From Moon's rotation: $\eta = 4.27 \times 10^{-22} s^{-1} m^{-(1-n)}$

From Earth's rotation: $\eta = 4.26 \times 10^{-22} s^{-1} m^{-(1-n)}$

From Moon's recession: $\eta = 4.64 \times 10^{-22} s^{-1} m^{-(1-n)}$

Average value of η $\eta = 4.39 \times 10^{-22} s^{-1} m^{-(1-n)}$

The field fluid model is solidly confirmed by this result !!!

Sonett *et. a*l. found that the length of the terrestrial day 900 million years ago was about 18 hours based on the laminated tidal sediments on the Earth.

According to this model, back to that time, the length of the day was about 19 hours, this agrees with Sonett *et. al*'s result with consideration of errors in both data sets. This is another support to this model.

Tidal brake is not the main reason for the slowing down the rotation of the earth.

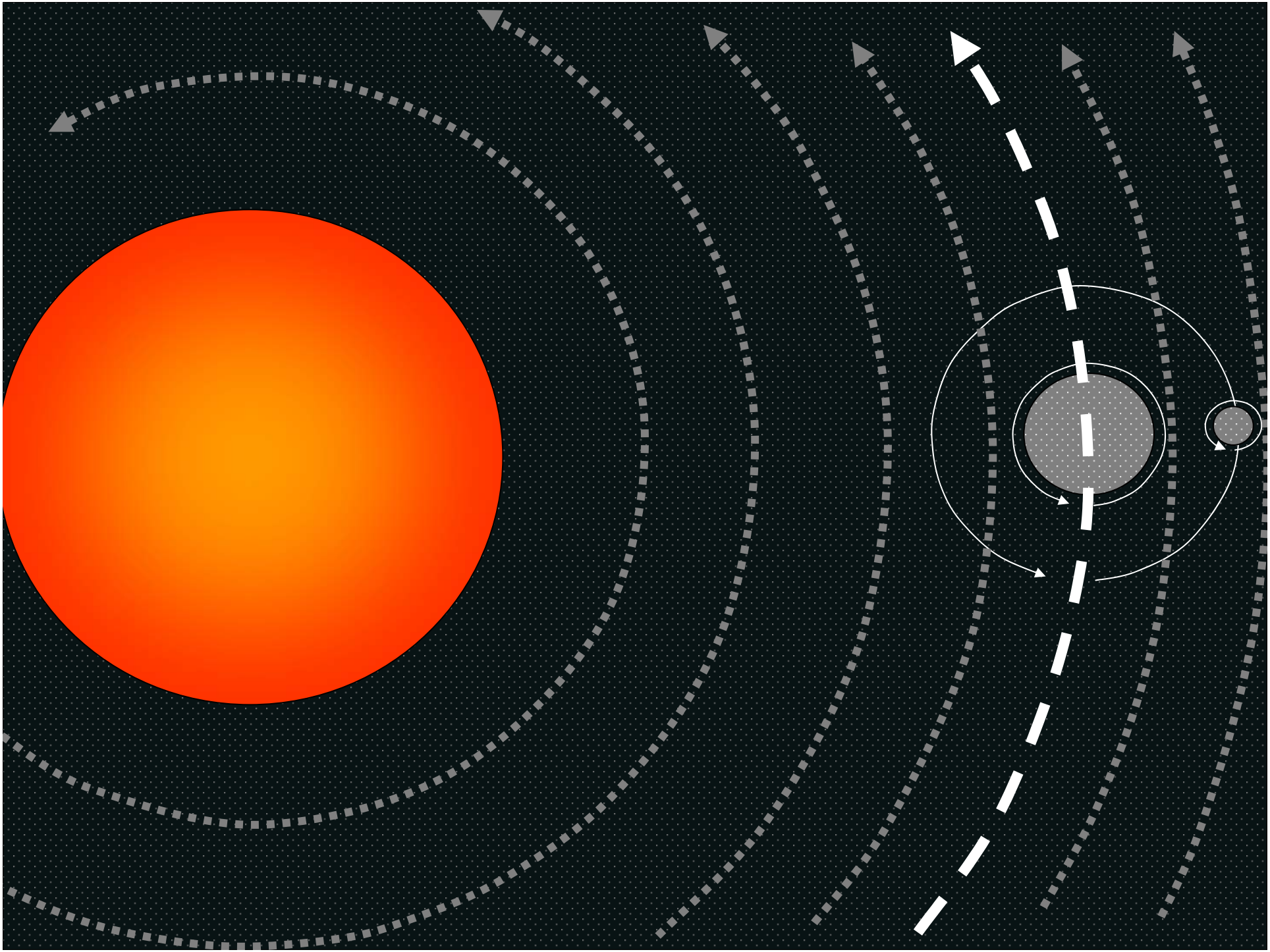
It is possible that the n may vary with density of the objects (different soaking effect).

Orbital motion of the Earth

According to this model and values of n and η, the recessional rate of the Earth should be 6.86×10^{-7} m/s = 21.6 m/year = 2.16 km/century and the length of the year would change substantially over the billion years.

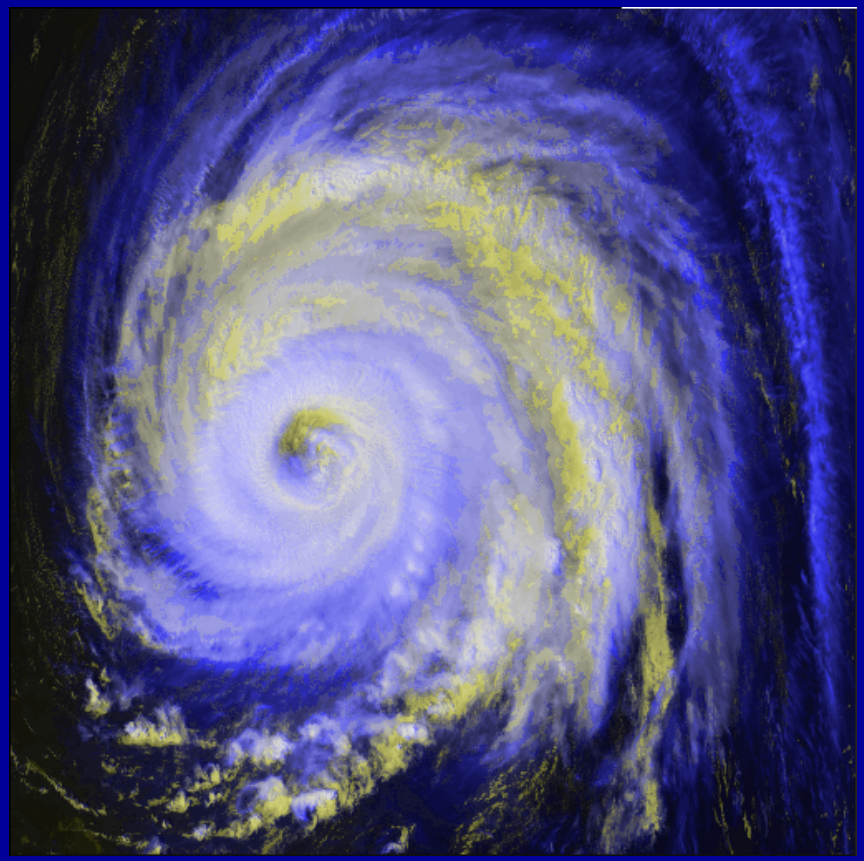
This is not true.

This clearly suggests that the dark matter field fluid is circulating around the Sun in the same direction as Earth's orbital motion with its speed similar to the Earth's orbital speed, therefore the Earth experience no or very little dragging force from the dark matter field fluid.



It is strongly believed that fluid mechanics is involved in the behavior of the universe and formation of the galaxies

Similarity between hurricanes and galaxies



Luis in September 1995

M77 galaxy

Possible redshift effect on light

Does the field fluid affect light? Let's move one step further

$$m\frac{dv}{dt} = -6\pi\eta a^{1-n} mv \qquad (3)$$

This formula can be written as:

$$\frac{d(mv)}{dt} = -6\pi\eta a^{1-n}(mv) \qquad (15)$$

or

$$\frac{dp}{dt} = -\alpha p \qquad (16)$$

p is the momentum and α is a constant depending on the individual objects. It is further assumed that (16) is good for all ordinary objects including photons moving in the dark matter field fluid. (16) is the law of motion in the dark matter field fluid.

The momentum of a photon is p = h/λ,

$$h\frac{d\left(\frac{1}{\lambda}\right)}{dt} = -\alpha\frac{h}{\lambda} \qquad (17)$$

or

$$\lambda = \lambda_0 e^{\alpha t} = \lambda_0 e^{\alpha\frac{D}{c}} = \lambda_0 e^{\beta D} \qquad (18)$$

D is the distance. β=α/c, the redshift effect constant of the dark matter field fluid,

The wavelength of the light exponentially increases with the time or distance it travels. This is the redshift effect of the dark matter field fluid.

The redshift z caused by the dark matter field fluid is:

$$z = e^{\beta D} - 1 \tag{19}$$

When βD << 1, (19) reduces to the regular cosmological redshift form:

$$z = \beta D = \frac{\alpha}{c} D \tag{20}$$

The conventional cosmological redshift formula is:

$$z = \frac{H}{c} D \tag{21}$$

α is equivalent to H (Hubble's constant), The physical meaning in (20) and (21) is completely different. (20) is due to the dragging force of the dark matter field fluid; (21) is due to space expansion and the light wave is stretched. Which one is more reasonable? Time will tell.

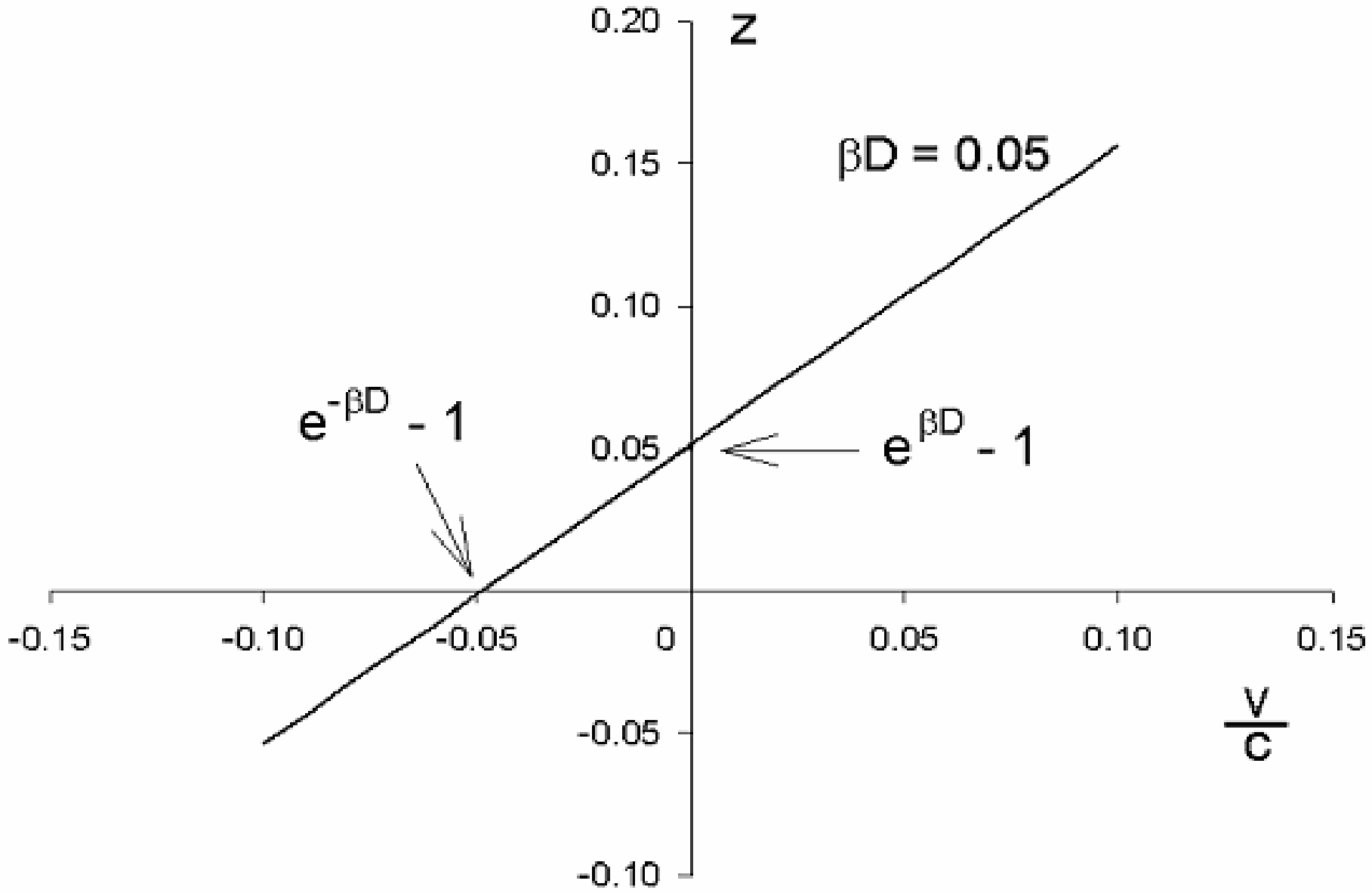
The emitter, however, may move with a speed v relative to the observer, such motion has a Doppler effect on the emitted light.Therefore, the actual wavelength λ of the light detected by the observer is:

$$\lambda = \lambda_r (1 + \frac{v}{c}) e^{\alpha \frac{D}{c}} \qquad (22)$$

where, λ_r is the wavelength of the light when the emitter is at rest. Then the observed redshift z is:

$$z = \frac{\lambda - \lambda_r}{\lambda_r} = (1 + \frac{v}{c}) e^{\beta D} - 1 \qquad (23)$$

Figure 1, the relationship between the redshift and the speed



- Much more redshifts than blueshifts should be observed for stars, galaxies and supernovae in the sky.
- A redshift ($z > 0$) is always observed for any stars, galaxies and supernovae in all directions as long as the their distance is large enough.
- This conclusion agrees with current observed data.
- The CMBR could be just the thermal black body radiation of the dark matter field fluid at 2.7K

The redshift effect constant β is one of the natural parameters. Based on the value of redshift of galaxy M31 (Andromeda), β is in the range of :

$$10^{-3} / MPc > \beta > 10^{-5} / MPc$$

According to (20) and (21), if α is really equal to H,

$$\beta = \frac{\alpha}{c} = \frac{H}{c} = 2.5 \times 10^{-4} / MPc$$

assume that H = 75 km/s/Mpc, it is just in the middle of the estimated range.

Conclusion

1. The field fluid model of the dark matter was proposed and the Moon-Earth data agrees with the model very well. The fluid does exist and may play important rules in evolution of the universe. Tidal brake is not the main reason for the slowing down the rotation of the earth.

2. The dark matter field fluid may have redshift effect on light due to its dragging force, the cosmological redshift formula was derived.

3. More redshifts than blueshifts should be observed. A redshift is always observed in all directions as long as the distance of the object is large enough.

4. A large redshift is not necessary to indicate that the object is fast receding from us, i. e, the universe may not expand as fast as we thought, even no expansion at all.


The vast interplanetary and interstellar regions will no longer be regarded as waster places in the universe, which the creator has no seen fit to fill with symbols of manifold order of his kingdom. We shall find them to be already full of his wonder medium. …. It extends unbroken from star to star. ------ James Clerk Maxwell
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