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APPLICATION OF FLUID MECHANICS TO DARK MATTER

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A dark matter field fluid model is proposed. This model assumes that interstellar space is uniformly filled with dark matter, which possesses a fluid property and a field property; the fluid property follows general fluid mechanics, the interaction of the field with an ordinary baryonic object is proportional to the mass of the object, it also has a force opposing gravity. The data of the Moon-Earth gravitational system agrees with this model very well and the average dark matter field fluid constant is $4.39 \times 10^{-22} s^{-1} m^{-(1-n)}$. This is the first proof that the motion of celestial objects can be treated in a fluid medium. The cosmological redshift formula derived from this model describes the observed redshifts very well. A huge redshift from a distant celestial object may not necessarily indicate that it is quickly receding from us. The universe may not expand as rapidly as thought.

Keywords: Dark matter; field; fluid; redshift

1. Introduction

The possible existence of Dark Matter(DM) in the universe has been extensively studied and direct evidence has been sought in recent years. No evidence has been found. The dark matter particles may be too small to be detected. This paper will apply fluid mechanics to dark matter and study its effect on the motion of celestial bodies and investigate its redshift effect based on the proposed field fluid model.

2. The field fluid model of the dark matter

The model assumes the following: Interstellar space is uniformly filled with DM which possesses a fluid property and a field property; the fluid property follows general fluid mechanics, the field property may have a repulsive force against the gravity, its interaction with an ordinary baryonic object is proportional to the mass of the object. The dark matter particles are very small, can easily permeate into ordinary objects, therefore, the objects is saturated with such a fluid.

The shape of most celestial bodies is spherical. According to fluid mechanics, a rigid sphere moving through a fluid in a low Reynolds number condition experiences a resistance force following Stokes's law, the force is negatively proportional to the radius r and the velocity v of the sphere. For the sphere moving in the Dark Matter Field Fluid (DMFF), the saturation effect may cause the force no longer be proportional to its radius, but to r^{1-n}; the force is also proportional to the mass m

of the sphere (field interaction). The proposed force (modified Stokes's law) is

$$F = -6\pi\eta r^{1-n} mv. \tag{1}$$

η is DMFF constant and n is a parameter. The equation of motion is

$$m\frac{dv}{dt} = -6\pi\eta r^{1-n} mv. \tag{2}$$

When the sphere circulates around a massive gravitational center with the distance R, if the force in Eq. (1) is very small, the sum of the acceleration force and repulsive force of DMFF is slightly greater than the gravity, the receding will be extremely slow, the gravity will approximately balance the centripetal acceleration force at any time. The description of the repulsive force is unknown at this time. The recessional rate is

$$\frac{dR}{dt} = 12\pi\eta r^{1-n} R. \tag{3}$$

The increase of orbital energy comes from the repulsive force of DMFF. According to fluid mechanics for a rigid sphere rotating about its central axis in the fluid, the fluid will exert a torque T on the sphere. For the sphere rotating in DMFF with angular velocity ω, with modifications similar to Eq. (1), the proposed torque T is

$$T = -8\pi\eta r^{1-n} m\omega. \tag{4}$$

The equation of rotation for the sphere in the DMFF is:

$$\frac{d\omega}{dt} = -20\pi\eta r^{1-n}\omega. \tag{5}$$

Combining Eq. (3) and Eq. (5) yields

$$\frac{\frac{1}{\omega}\frac{d\omega}{dt}}{\frac{1}{R}\frac{dR}{dt}} = -\frac{5}{3} = -1.67. \tag{6}$$

The significance of Eq. (6) is that it depends only on observed data and is independent of undetermined parameters. Therefore, it is a critical test for this model. It is well known that the rotations of Moon and Earth are slowing and that Moon is receding from Earth. The eccentricity of Moon's orbit is very small and can be ignored. Inserting Moon's recessional and rotational data[1,2]into Eq. (6) yields the result -1.54, which agrees well with theoretical value of -1.67. This provides critical support for this model. Using available data,[1,2] n is 0.64 and η is calculated from three different motions: Moon's rotation and recession, and Earth's rotation, which yields $4.27 \times 10^{-22} s^{-1} m^{-(1-n)}$, $4.64 \times 10^{-22} s^{-1} m^{-(1-n)}$ and $4.26 \times 10^{-22} s^{-1} m^{-(1-n)}$, respectively. The three values of η are consistent which solidly comfirms the model. Based on this result, it is calculated that 900 million years ago the length of the day on Earth was about 19 hours, which is very close to Sonett *et al.*'s data (18 hours).[3] This also supports this model. However, the recession of Earth from the Sun is not as fast as the model prediction. This suggets that DMFF is circulating around Sun with the same direction and similar speed of Earth (at least in Earth's orbital range). The angular rotation acceleration of Mars is predicted to be $-4.38 \times 10^{-22} rad/s$. This can be tested in the future Mars exploration.

3. Possible redshift effect of DMFF

The momentum of a sphere is $p = mv$. Eq. (2) can be written as

$$\frac{dp}{dt} = -\alpha p. \tag{7}$$

It is further assumed that Eq.(7) is good for all ordinary objects including photons moving in the DMFF and α depends on each individual object. Eq. (7) is the law of motion in DMFF. Applying Eq. (7) to a photon yields the wavelength λ

$$\lambda = \lambda_0 e^{\alpha t} = \lambda_0 e^{\alpha \frac{D}{c}} \tag{8}$$

where D is the distance the photon travels. The redshift z caused by DMFF is

$$z = e^{\frac{\alpha}{c}D} - 1. \tag{9}$$

When $\frac{\alpha}{c}D$ is $\ll 1$, Eq.(9) reduces to the regular cosmological redshift formula:

$$z = \frac{\alpha}{c}D \tag{10}$$

Eq. (10) is the same as the conventional cosmological redshift formula, and α is equivalent to the Hubble's constant H; however, the mechanism is completely different. When a photon passes through DMFF, its energy decreases due to the dragging force of DMFF; therefore, the wavelength increases. Such a mechanism is similar to a photon climbing out of the gravitational field. The interaction between DMFF and ordinary matter could be the fifth natural force. The emitter may also have motion relative to the observer, which produces a Doppler effect on λ_0 (wavelength of the photon just emitted). So the observed redshift z ($v \ll c$) is

$$z = (1 + \frac{v}{c})e^{\frac{\alpha}{c}D} - 1. \tag{11}$$

Three cases are: $v > c(e^{-\frac{\alpha}{c}D} - 1)$, $z > 0$, redshift; $v = c(e^{-\frac{\alpha}{c}D} - 1), z = 0$, no shift; $v < c(e^{-\frac{\alpha}{c}D} - 1), z < 0$, blueshift. Therefore, much more redshifts than blueshifts should be observed for objects in the sky; a redshift ($z > 0$) is always observed for any object in all directions if its distance is large enough. This conclusion agrees with observation. A huge redshift of a distant object may not necessarily indicate that it is fast receding from us. The universe may not expand as rapidly as thought. The cosmic background radiation could be the 2.7K black body radiation of DMFF.

4. Conclusion

The proposed dark matter field fluid model describes the Moon-Earth system and the observed redshifts of celestial objects very well. The universe may not expand as rapidly as thought.

References

1. J. O. Dickey, *et al.*, *Science*, **265**, 482(1994).
2. K. Lang, *Astrophysical Data: Planets and Stars*, (Springer-Verlag, New York, 1992).
3. C. P. Sonett, *et al.*, *Science*, **273**, 100(1996).