NEWTON'S LAWS OF MOTION BASED SUBSTANTIAL AETHER THEORY OF THE UNIVERSAL GRAVITY FORCE

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ABSTRACT

Even though the universal gravity force has been formulated and used for more than three hundred years, the cause of the universal gravity force has not been fully understood. This paper proposes a substantial aether model to derive universal gravity force based on Newton's laws of motion and Bernoulli's equation. The authors suggest that every aether particle has a mass and occupies a volume in space. Every aether particle has translational movement and particle spin movement. The particle spin movement does not produce the universal gravity force. The translational movement is similar to the gas particle moving in the air and produces aether pressure. The difference of aether pressure generates an aether flow velocity. The difference of aether flow velocities creates a pressure difference according to Bernoulli's equation. The summation of aether pressure difference around an object is shown to be the universal gravity force. A detailed derivation of universal gravity force from the proposed substantial aether model is presented in this paper to show the validation of this model.

Keywords: Newton's law of universal gravitation, Substantial aether theory, Kinetic theory of gas, Bernoulli's equation, Thermal dynamic, Laplace's equation.

1. INTRODUCTION

The law of universal gravitation was formulated by Issac Newton in 1687 [1], He believed an aether medium as the cause of the gravity force in a letter to Henry Oldenburg, dated February 25, 1693 [2]. He wrote "Gravity must be caused by an agent acting constantly according to certain laws."

Since Isaac Newton, many physicists [3] considered the aether as a static massless medium. Therefore, Michelson and Morley [4], and many others tried to look for the absolute stilled aether from its relative motion to the Earth, but only get a small fraction of the predicted relative speed.

Miller then considered the aether as tangible with sufficient substance to be entrained at the Earth's surface. At Mount Wilson (6000' from sea level), from long-term observations Miller [5] acquired 200,000 data points to prove the existence of the aether.

The elder John Bernouilli in 1734 [6] devised a very curious combination of aetherial vortices and Newtonian emissions. But the vortex is not so rapid as to carry the planets around the Sun. LeSage in 1764 [7], related law of the inverse square of the distance to the shadow behind the planet.

In this paper, we view the aether as a small particle with mass which was the same as Miller's experiments proved. The energy to keep the motion of the planet is provided by the Sun as an energy source. It is the aether with mass to transmit the energy to the planets. And the energy field provided by the Sun is stored in the aether inside the volume.

The cause of Newton's law of universal gravitation is derived in this paper based on applying Newton's laws of motion to the aether. The aether is a particle with mass. Therefore we can use some theories already known. The following formulations are explained and used to derive the gravity force.

(1) Kinetic theory of gas,

(2) Laplace's equation of aether energy density,

(3) Laplace's equation of aether mass density, and

(4) Bernoulli's equation.

Kinetic theory of gas is used to relate aether energy density, or pressure and its collision speed. This theory describes the state of aether at any point. Kinetic theory of gas was discovered by Waterston in 1843 [8]. Herapath in 1847 [9] and Seguin in 1824 [10], independently, had some ideas on the probable nature of heat and the theory of gaseous temperature, which were somehow close to kinetic theory of gases.

Laplace's equations describe the distribution of energy density in a space (or aether pressure field) and mass density field.

Bernoulli's equation is used to relate aether steady flow velocity change and aether pressure change. A key concept of calculating universal gravity force is that the pressure acting on an object is induced by aether steady flow velocity variation. Bernoulli published "Hydrodynamica" in 1738 [11], in which he described

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that the pressure in a fluid decreases as its velocity increases. Jules Guyot in 1832 [12] had used an idea similar to Bernouilli's equation to explain the gravitation force.

Universal gravitation is derived and explained in this paper through integration of these formulations.

The authors and theories mentioned above are only those that are somehow closely related to this paper. More theories about gravity may refer to "The Kinetic Theory of Gravitation" by Taylar [2] and "Earlier Theories of Gravity" by Carrington [13].

2. AETHER COLLISION SPEED, PRESSURE AND ENERGY DENSITY

Kinetic energy of one particle moving at constant speed is shown below.

$$K_a \equiv \frac{1}{2} m_a v_{ca}^2 \tag{1}$$

where

K_a is kinetic energy of one particle,

m_a is mass of one particle,

v_{ca} is collision speed of one particle.

Note that, the subscript c in v_{ca} represents collision and a in v_{ca} represents one particle.

Assume this particle is moving inside a spherical ball with radius R_a as shown in Fig. 1. And assume this particle always passes through the center of the ball and collides into the wall of the ball without energy loss. Since it is elastic collision, the momentum change of collision is two times its momentum, $2m_a v_{ca}$. Aether energy density is calculated from dividing kinetic energy by the volume occupied by this particle.

$$E \equiv \frac{K_a}{V_a} = \frac{1}{2}\frac{m_a}{V_a} v_{ca}^2 = \frac{1}{2}\rho v_{ca}^2 \tag{2}$$

where

V_a is volume occupied by a particle,

ρ is mass density,

E is energy density of particles with constant collision speed.

The reaction force on the wall can be determined by the conservation of momentum as shown below.

$$F_a = \frac{\Delta(m_a v_{ca})}{\Delta t} = \frac{2m_a v_{ca}}{\frac{2R_a}{v_{ca}}} = \frac{m_a v_{ca}^2}{R_a} \tag{3}$$

The average aether pressure of particles can be calculated from dividing the collision force by the total surface area as

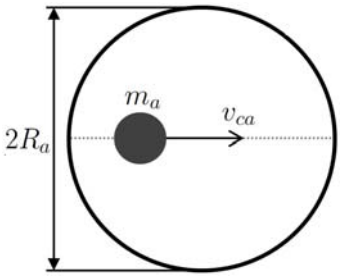


Fig. 1 One particle inside a sphere

$$p = \frac{F_a}{4\pi R_a^2} = \frac{\frac{m_a v_{ca}^2}{R_a}}{4\pi R_a^2} = \frac{m_a v_{ca}^2}{4\pi R_a^3} \tag{4}$$

where

p is pressure from collision of particles,

F_a is collision force on the walls,

Δt is the duration between two adjacent collision,

R_a is radius of the spherical ball occupied by one particle.

Replace mass with mass density in Eq. (4) and note that $V_a = 4\pi R_a^3 / 3$ to get

$$p = \frac{m_a v_{ca}^2}{3V_a} = \frac{1}{3}\rho v_{ca}^2 \tag{5}$$

Assume mass of every aether particle is the same. And assume the collision speed of the aether particle follows Maxwell's speed distribution.

$$\psi(v) = \frac{4v^2}{\sqrt{\pi}\hat{v}_c^3} e^{-v^2/\hat{v}_c^2} \tag{6}$$

where

$\psi(v)$ is Maxwell's speed distribution,

$\hat{v}_c$ is collision speed at maximum probability.

The root-mean-square speed of a group of particles is shown below to be linearly related to the particle collision speed at its maximum probability $\hat{v}_c$. Note that speed v_c without hat represents root-mean-square (RMS), and with hat represents the maximum probability speed of Maxwell's distribution. Thus, the root-mean-square (RMS) speed of Maxwell's distributed collision speed can be written as

$$v_c^2 \equiv \int_0^\infty v^2 \psi(v) dv = \frac{3}{2}\hat{v}_c^2 \tag{7}$$

Therefore, aether energy density is

$$E = \frac{1}{2}\rho v_c^2 = \frac{3}{4}\rho \hat{v}_c^2 \tag{8}$$

Similarly, aether pressure is

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$$p = \frac{1}{3}\rho v_c^2 = \frac{1}{2}\rho \hat{v}_c^2 \tag{9}$$

Both aether energy density and pressure are linearly related to aether mass density and collision speed square at maximum probability as shown in Eqs. (8) and (9), aether pressure can be expressed in terms of aether energy as

$$p = \frac{2}{3}E \tag{10}$$

This equation is similar to the ideal gas formula of $pV = nRT$. The ideal gas formula can be derived from Eq. (9), for n moles gas by replacing mass density with mass and volume occupied by n moles of gas as

$$p = \frac{1}{3}\frac{m}{V}v_c^2 = \frac{1}{3}\frac{nN_A m_a}{V}v_c^2 \tag{11}$$

where

n is number of moles of gas,

N_A is Avogadro's constant [14] representing the number of molecules per mole,

m is total mass of n moles of gas($= nN_A m_a$),

V is total volume occupied by n moles of gas.

Rewriting Eq. (11), we get

$$pV = n\left(\frac{N_A m_a v_c^2}{3}\right) \tag{12}$$

$N_A m_a v_c^2/3$ is proportional to total kinetic energy of gas. Also, temperature is proportional to the total kinetic energy. Therefore, Eq. (12) can be written as the ideal gas formula by transferring kinetic energy into temperature through gas constant R.

$$R = \frac{N_A m_a v_c^2}{3T} \tag{13}$$

Substitute Eq. (13) into Eq. (9) to get

$$pV = nRT \tag{14}$$

Even though Eqs. (14) and (9) have the same physical meaning, Eq. (14) relates pressure with temperature while Eq. (9) relates pressure with particle collision speed.

3. AETHER STEADY STATE FLOW VELOCITY

In the previous section, aether energy density and pressure are calculated from aether's collision speed. In this section, the aether steady flow velocity will be calculated from the gradient of aether energy density and pressure.

Fourier's Law implies that the energy flow rate $E\vec{v}_f$ is proportional to the energy gradient as

$$E\vec{v}_f = -k_E \nabla E \tag{15}$$

where

E is aether energy density,

$\vec{v}_f$ is aether steady flow velocity,

k_E is energy conductivity.

Note that the multiplication of aether energy density E and steady flow velocity $\vec{v}_f$ is energy flow through an unit area per unit time, called energy flow rate.

The negative sign indicates that the energy flow direction is the opposite of the energy increase direction.

Similar to energy flow velocity, Fourier's law also implies that the mass flow rate $\rho\vec{v}_f$ is proportional to the gradient of ρ as

$$\rho\vec{v}_f = -k_p \nabla\rho \tag{16}$$

Since aether energy density and pressure are linearly related as $p = 2/3E$ in Eq. (10), the aether steady flow velocity $\vec{v}_f$ can also be calculated from aether pressure p.

$$p\vec{v}_f = -k_p \nabla p \tag{17}$$

Rewrite energy flow rate $E\vec{v}_f$ as $\vec{Q}$, Eq. (15) becomes

$$\vec{Q} = -k_E \nabla E \tag{18}$$

Fourier's law is also called law of heat (or heat conduction) and which is based on experimental observation.

4. AETHER ENERGY DENSITY FIELD

Aether energy density field $E(\vec{r})$ is calculated from Laplace's equation of energy density $\nabla^2 E = 0$ and its boundary conditions. Laplace's equation of aether energy density will be derived in this section from Fourier's law of energy flow (Eq. (18) in section 3) and the conservation of energy (Eq. (20) in this section). When energy flows through a cubic with an energy source g inside it, the conservation of energy inside the cubic can be represented as

$$\begin{aligned}\rho C_p \frac{\partial E}{\partial t}\Delta x\Delta y\Delta z = {} & g\Delta x\Delta y\Delta z + Q_x \Delta y\Delta z - \left(Q_x + \frac{\partial Q_x}{\partial x}\Delta x\right)\Delta y\Delta z \\ & + Q_y \Delta x\Delta z - \left(Q_y + \frac{\partial Q_y}{\partial y}\Delta y\right)\Delta x\Delta z \\ & + Q_z \Delta x\Delta y - \left(Q_z + \frac{\partial Q_z}{\partial z}\Delta z\right)\Delta x\Delta y\end{aligned} \tag{19}$$

where

ρ is mass density,

C_p is specific energy capacity,

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E is energy density,

t is time,

x, y, z are coordinates,

g is energy source,

Q_x, Q_y, Q_z are energy flow rates in x, y, z directions.

The conservation of energy in Eq. (19) implies that the increase of inner energy (left term) is equal to the summation of: (1) energy generated inside the cubic, (2) energy flow into the cubic, and, (3) energy flow out of the cubic. Equation (19) can be simplified to

$$\rho C_p \frac{\partial E}{\partial t} = g - \nabla \cdot \vec{Q} \tag{20}$$

For steady state $\partial E/\partial t = 0$, and energy field outside of energy source $g = 0$, the conservation of energy can be further simplified to

$$\nabla \cdot \vec{Q} = 0 \tag{21}$$

Substitute Fourier's equation ($\vec{Q} = -k_E \nabla E$) into Eq. (21), gives Laplace's equation of aether energy density as

$$\nabla^2 E = 0 \tag{22}$$

Similar to aether energy density, Laplace's equation of aether pressure and aether mass density can be derived with similar approach and written as

$$\nabla^2 p = 0 \tag{23}$$

$$\nabla^2 \rho = 0 \tag{24}$$

Boundary conditions of aether energy field are required to solve Laplace's equation of energy field. Two boundary conditions are defined for solving Laplace's equation of aether energy density. First, the absolute energy density $\hat{E}$ at infinite distance from a source is defined as background energy density and written as $\hat{E}_\infty$ Second, the absolute energy density $\hat{E}$ at surface of an energy source with radius r_s is assumed to be constant and written as $\hat{E}_s$. Two boundary conditions (BC) are expressed as

BC 1: $\hat{E}(\vec{r}\,; |\vec{r} - \vec{r}_1| = \infty) = \hat{E}_\infty$ is constant background energy density,

BC 2: $\hat{E}(\vec{r}\,; |\vec{r} - \vec{r}_1| = r_s) = \hat{E}_s$ is constant source surface energy density.

The solution of Laplace's Equation Eq. (22) for one energy source located at the origin with two boundary conditions as above, can be represented as

$$\hat{E}(\vec{r}) - \hat{E}_\infty = (\hat{E}_s - \hat{E}_\infty)\frac{r_s}{|\vec{r}|} \tag{25}$$

To simplify the energy density field equation, define relative energy density as

$$E(\vec{r}) \equiv \hat{E}(\vec{r}) - \hat{E}_\infty \tag{26}$$

and

$$E_s \equiv \hat{E}_s - \hat{E}_\infty \tag{27}$$

Using the defined relative energy density, the energy density field Eq. (25) can be written as

$$E(\vec{r}) = E_s \frac{r_s}{|\vec{r}|} \tag{28}$$

The energy density field for multiple energy sources can be written as the superposition of energy density field due to individual source i at location $\vec{r}_i$.

$$\hat{E}(\vec{r}) = \sum_i E_{si} \frac{r_{si}}{|\vec{r} - \vec{r}_i|} \tag{29}$$

Similar to the derivation of the energy density field, the aether pressure field and mass density field can be written as

$$p(\vec{r}) = \sum_i p_{si} \frac{r_{si}}{|\vec{r} - \vec{r}_i|} \quad \text{for} \quad \hat{p}\left(\vec{r}\,; |\vec{r} - \vec{r}_i| = \infty\right) = \hat{p}_\infty$$
$$\text{and} \quad \hat{p}\left(\vec{r}\,; |\vec{r} - \vec{r}_i| = r_{si}\right) = \hat{p}_{si} \tag{30}$$

$$\rho(\vec{r}) = \sum_i \rho_{si} \frac{r_{si}}{|\vec{r} - \vec{r}_i|} \quad \text{for} \quad \hat{\rho}\left(\vec{r}\,; |\vec{r} - \vec{r}_i| = \infty\right) = \hat{\rho}_\infty$$
$$\text{and} \quad \hat{\rho}\left(\vec{r}\,; |\vec{r} - \vec{r}_i| = r_{si}\right) = \hat{\rho}_{si} \tag{31}$$

5. INTERACTION BETWEEN AETHER STEADY FLOW VELOCITY AND AETHER PRESSURE

Aether moves fast at a microscopic scale and slowly at a macroscopic scale. Under a microscopic scale, aether pressure p is related to aether collision speed v_c as shown in section 2. And, under a macroscopic scale, aether steady flow velocity $\vec{v}_f$ is related to aether energy density gradient ∇E as shown in section 3. Then, energy density is calculated from Laplace's equation of energy density and its boundary conditions as shown in section 4.

Based on Bernoulli's principle of fluid, the pressure will change with the velocity. Similarly, aether pressure will fluctuate with aether steady flow velocity. Therefore, the actual aether pressure is the interaction result of both (1) aether pressure and (2) aether steady flow velocity. Both pressure and steady flow velocity are calculated from aether energy density field E, which is the solution of Laplace's equation of energy density and its boundary conditions.

In this section, Bernoulli's equation for compressible flow of (1) pipe and (2) space source is first derived. The relationship between pressure difference Δp and steady flow velocity $\vec{v}_f$ will then be derived from Bernoulli's equation.

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Bernoulli's equation for compressible flow of a pipe can be derived from a control volume between narrower cross section A_1 and wider cross section A_2 (Fig. 2). The control volume has density ρ_1, velocity v_1, and pressure p_1 at cross section A_1, while density ρ_2, velocity v_2, and pressure p_2 at cross section A_2. After a small time interval dt, the control volume moves a distance dx_1 at cross section A_1 and a distance dx_2 at cross section A_2.

Because the flow is steady state, the dynamic properties of volume V_o, exclusion of V_1 or V_2, remain the same during the time interval dt. Only dynamic properties of volume V_1 and V_2 inside dx_1 and dx_2 are required to be considered in the derivation process.

Based on the conservation of energy, the work done $\vec{F} \cdot d\vec{s}$ of a system by force $\vec{F}$ applied through distance $d\vec{s}$ is equal to the kinetic energy change as shown below.

$$\vec{F} \cdot d\vec{s} = d\left(\frac{1}{2}mv^2\right) \tag{32}$$

where

$\vec{F}$ is force act on the system,

$d\vec{s}$ is acting distance of force,

m is mass,

v is velocity.

Since the volume V_o stays the same during time interval dt, the mass in volume V_1 and V_2 are

$$m = \rho_1 A_1 dx_1 = \rho_2 A_2 dx_2 \tag{33}$$

Conservation of energy for the control volume in the pipe can be described as the work done to the control volume is equal to the kinetic energy change from volume V_1 to V_2.

$$p_1 A_1 dx_1 - p_2 A_2 dx_2 = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2 \tag{34}$$

Divide both sides by m and rearrange terms to get

$$p_1 \frac{A_1 dx_1}{m} + \frac{v_1^2}{2} = p_2 \frac{A_2 dx_2}{m} + \frac{v_2^2}{2} \tag{35}$$

Substituting of Eq. (33) into Eq. (35) yields

$$\frac{p_1}{\rho_1} + \frac{v_1^2}{2} = \frac{p_2}{\rho_2} + \frac{v_2^2}{2} \tag{36}$$

This equation describes the relationship of pressure, mass density and flow velocity at any point in the field. Therefore, we get Bernoulli's equation as

$$\frac{p}{\rho} + \frac{v^2}{2} = \text{constant} \tag{37}$$

Note that Bernoulli's equation was not derived from force balanced as following, because of the unknown reaction force f by the pipe wall.

$$p_1 A_1 - p_2 A_2 + f = m\frac{dv}{dt} = m\frac{v_2 - v_1}{dt} \tag{38}$$

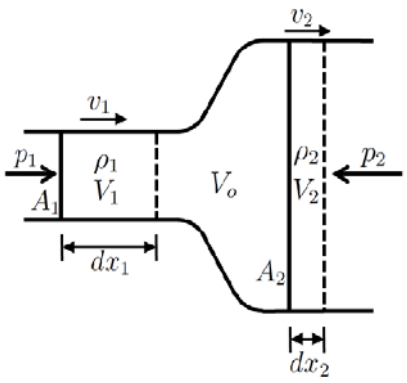


Fig. 2 Control volume in a pipe

But Eq. (38) can be used to calculate the reaction force f once the pressure p_1, p_2 and velocity v_1, v_2 are calculated from Bernoulli's equation.

Aether flows out of a source into space at all direction is similar to the flow in the pipe. For aether flow, the control volume from $V_o + V_1$ to $V_o + V_2$ moves toward the radial direction.

Since the volume V_o remains the same during time interval dt, the mass in volume V_1 and V_2 are

$$m = \rho_1 A_1 dr_1 = \rho_2 A_2 dr_2 \tag{39}$$

where

$A_1 = 4\pi r_1^2$ is inner spherical surface area,

$A_2 = 4\pi r_2^2$ is outer spherical surface area,

dr_1 is inner surface moving distance,

dr_2 is outer surface moving distance,

ρ_1 is mass density at inner surface,

ρ_2 is mass density at outer surface.

Conservation of energy for the control volume moving in the radial direction is

$$p_1 A_1 dr_1 - p_2 A_2 dr_2 = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2 \tag{40}$$

Divide both sides by m and rearrange terms to get

$$p_1 \frac{A_1 dr_1}{m} + \frac{v_1^2}{2} = p_2 \frac{A_2 dr_2}{m} + \frac{v_2^2}{2} \tag{41}$$

Substituting of Eq. (39) into Eq. (41) yields

$$\frac{p_1}{\rho_1} + \frac{v_1^2}{2} = \frac{p_2}{\rho_2} + \frac{v_2^2}{2} \tag{42}$$

This equation describes the relationship of pressure, mass density and flow velocity at any point in the field. Therefore, we get Bernoulli's equation as

$$\frac{p}{\rho} + \frac{v^2}{2} = \text{constant} \tag{43}$$

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6. RELATIONSHIP BETWEEN PRESSURE DIFFERENCE AND STEADY FLOW VELOCITY DIFFERENCE

In Eq. (37), v^2, represents the kinetic energy, will change to $v_c^2 + v_f^2$. Note that $\vec{v} = \vec{v}_c + \vec{v}_f$ and $v^2 = (\vec{v}_c + \vec{v}_f)\cdot(\vec{v}_c + \vec{v}_f) = \vec{v}_c \cdot \vec{v}_c + 2\vec{v}_c \cdot \vec{v}_f + \vec{v}_f \cdot \vec{v}_f = v_c^2 + v_f^2$, where $\vec{v}_c$ is the particle random velocity relative to the steady (fixed) flow velocity $\vec{v}_f$, the mean of $\vec{v}_c$ is zero, therefore, the mean of $(\vec{v}_c \cdot \vec{v}_f) = \vec{0} \cdot \vec{v}_f = 0$, Bernoulli's equation for the relationship between pressure, flow velocity and mass density are shown as

$$\frac{p}{\rho} + \frac{v_f^2}{2} + \frac{v_c^2}{2} = \text{constant} \tag{44}$$

Since $v_c^2 = 3p/\rho$ from Eq. (9), after substituting it to the equation above, the coefficient of the term p/ρ is 1+ 3/2 = 2.5, and let 2.5 = γ to distinguish it from other constants, above equation changes to

$$\gamma \frac{p}{\rho} + \frac{v_f^2}{2} = \text{constant} \tag{45}$$

Mean while, the relationship between pressure difference, steady flow velocity difference and mass density difference can be obtained by taking derivatives on both sides of Bernoulli's equation as

$$d\left(\gamma \frac{p}{\rho}\right) + d\left(\frac{v_f^2}{2}\right) = 0 \tag{46}$$

The steady flow velocity v_f in the above equation can be expressed by mass density using Eq. (16) and rewritten as

$$\vec{v}_f = -k_\rho \frac{\nabla\rho}{\rho} \tag{47}$$

Substituting of Eq. (47) into Eq. (46) yields

$$d\left(\gamma \frac{p}{\rho}\right) + \frac{k_\rho^2}{2} d\left[\frac{|\nabla\rho|^2}{\rho^2}\right] = 0 \tag{48}$$

Expand Eq. (48) and get

$$\frac{\gamma dp}{\rho} - \frac{\gamma p d\rho}{\rho^2} + \frac{k_\rho^2}{2}\frac{d\left[|\nabla\rho|^2\right]}{\rho^2} - k_\rho^2 \frac{|\nabla\rho|^2\, d\rho}{\rho^3} = 0 \tag{49}$$

Multiple $2\rho^2$ on both sides of equation above and rearrange terms to get

$$k_\rho^2 d\left[|\nabla\rho|^2\right] + 2\gamma\rho dp - 2\rho\left[\frac{\gamma p}{\rho} + k_\rho^2\left(\frac{|\nabla\rho|}{\rho}\right)^2\right] d\rho = 0 \tag{50}$$

Further substituting of Eq. (47) into above equation yields

$$k_\rho^2 d\left[|\nabla\rho|^2\right] + 2\gamma\rho dp - 2\rho\left[\frac{\gamma p}{\rho} + v_f^2\right] d\rho = 0 \tag{51}$$

$\sqrt{p/\rho}$ has the same order as aether collision speed v_c which also has the same order as the speed of light c. v_f is the aether steady flow velocity which is much smaller then the speed of light c. Therefore, Eq. (51) can be approximated by neglecting v_f^2 and get

$$k_\rho^2 d\left[|\nabla\rho|^2\right] + 2\gamma\rho dp - 2\gamma p d\rho = 0 \tag{52}$$

To eliminate $d\rho$ in the above equation, $d\rho$ can be replaced by the following equation.

$$d\rho = \frac{3\rho}{5}\frac{dp}{p} \tag{53}$$

This equation can be derived through (1) the state of aether $pV_a = 1/3 m_a v_{ca}^2$ and (2) the conservation of energy and work done and (3) the definition of mass density $\rho = m_a / V_a$.

First, the state of aether derived from Newton's laws of motion as shown in section 2 Eq. (5) can be written as

$$pV_a = \frac{1}{3} m_a v_{ca}^2 \tag{54}$$

where

- p is aether pressure due to collision of particles,
- V_a is volume occupied by one particle,
- m_a is mass of one particle,
- v_{ca} is collision speed of one particle.

Take derivative of both sides of Eq. (54) and get

$$pdV_a + V_a\, dp = d\left(\frac{1}{3} m_a v_{ca}^2\right) \tag{55}$$

Second, the conservation of aether kinetic energy $1/2\, m_a v_{ca}^2$ and work done $-pdV_a$ can be written as

$$-pdV_a = d\left(\frac{1}{2} m_a v_{ca}^2\right) \tag{56}$$

To eliminate v_{ca}, Eq. (55) and Eq. (56) can be arranged and written into one equation as

$$dp = -\frac{5p}{3}\frac{dV_a}{V_a} \tag{57}$$

Third, mass m_a can be written by definition of mass density ρ for particles with mass m_a occupied a volume V_a as

$$m_a = \rho V_a \tag{58}$$

Take the derivative of both sides of Eq. (58) and get

$$V_a\, d\rho + \rho dV_a = 0 \tag{59}$$

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Rewrite Eq. (59) and get

$$\frac{d\rho}{\rho} = \frac{-dV_a}{V_a} \tag{60}$$

The relationship between ratio dp/p and $d\rho/\rho$ can be obtained by combining Eq. (57) and Eq. (60) as

$$\frac{d\rho}{\rho} = \frac{3}{5}\frac{dp}{p} \tag{61}$$

Substitute Eq. (61) into Eq. (52) to eliminate $d\rho/\rho$ and get

$$dp = -\frac{k_\rho^2 d\left[|\nabla\rho|^2\right]}{2\rho} \tag{62}$$

7. UNIVERSAL GRAVITY FORCE FROM SOLVING LAPLACE'S EQUATION ALONE

Universal gravity force acting on the surface of an object is calculated by integrating the pressure force of the whole surface. The pressure $p = 2/3\ E$ is the solution of Laplace's equation of energy density E and modified by the steady flow velocity v_f by using Bernoulli's equation.

This section shows that the gravity force calculated from solving Laplace's equation along is zero. Two energy sources with radius r_{s1} and r_{s2}, respectively, are placed at a distance r apart in space of energy density field $E(\vec{r})$. At distances r_{s1} and r_{s2} to center of source one s_1 and source two s_2, respectively, the pressure field will be calculated by solving Laplace's equation and its boundary conditions.

The Laplace's equation of energy density field $\hat{E}(\vec{r})$ and its boundary condition were shown in section 4 and rewritten for two sources field as

$$\nabla^2\hat{E}(\vec{r}) = 0 \tag{63}$$

$$\hat{E}\left(\vec{r}\ ;|\vec{r}-\vec{r_i}|=\infty\right) = \hat{E}_\infty \tag{64}$$

$$\hat{E}\left(\vec{r}\ ;|\vec{r}-\vec{r_1}|=r_{s1}\right) = \hat{E}_{s1} \tag{65}$$

$$\hat{E}\left(\vec{r}\ ;|\vec{r}-\vec{r_2}|=r_{s2}\right) = \hat{E}_{s2} \tag{66}$$

where

$\hat{E}$ is the absolute energy density field,

$\hat{E}_\infty$ is the absolute universe background energy density,

$\hat{E}_{s1}$ is the absolute constant energy density at surface of source one,

$\hat{E}_{s2}$ is the absolute constant energy density at surface of source two.

The energy density field of the two energy sources can use the asymptotic solution of Laplace's equation assuming

$$r_1 = |\vec{r}-\vec{r_1}| >> r_{s1} \tag{67}$$

$$r_2 = |\vec{r}-\vec{r_2}| >> r_{s2} \tag{68}$$

According to section 4, the energy density field can be written for two sources field as

$$\hat{E}(\vec{r})-\hat{E}_\infty = (\hat{E}_{s1}-\hat{E}_\infty)\frac{r_{s1}}{|\vec{r}-\vec{r_1}|} + (\hat{E}_{s2}-\hat{E}_\infty)\frac{r_{s2}}{|\vec{r}-\vec{r_2}|} \tag{69}$$

By using relative energy as defined in Eqs. (26) ~ (27), Eq. (69) can be written as Eq. (70). (as shown in Fig. 3)

$$E(\vec{r}) = E_{s1}\frac{r_{s1}}{|\vec{r}-\vec{r_1}|} + E_{s2}\frac{r_{s2}}{|\vec{r}-\vec{r_2}|} \tag{70}$$

According to section 2, pressure is linearly related to energy density as

$$p(\vec{r}) = \frac{2}{3}E(\vec{r}) = \frac{2}{3}\left(E_{s1}\frac{r_{s1}}{|\vec{r}-\vec{r_1}|} + E_{s2}\frac{r_{s2}}{|\vec{r}-\vec{r_2}|}\right) \tag{71}$$

According to boundary conditions Eqs. (65) ~ (66), the energy density field at a source surface is constant. The total force acting on surface A_{s1} of source one is zero as

$$\text{Force} = \int_{A_{s1}} p\vec{n}ds = 0 \tag{72}$$

where $\vec{n}$ is normal direction of the area ds. A_{s1} is surface area of source one s_1.

The same result can be obtained for the total force acting on surface of source two as

$$\text{Force} = \int_{A_{s2}} p\vec{n}ds = 0 \tag{73}$$

This shows that the gravity force can not be calculated by the pressure from solving Laplace's equation of energy density alone.

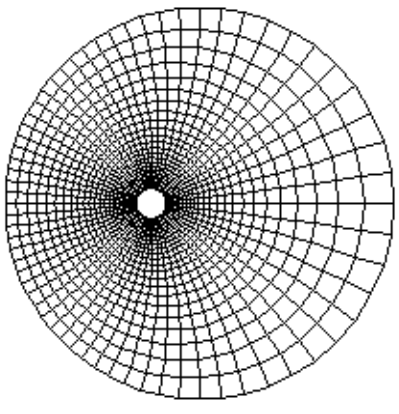


Fig. 3 Iso-energy and streamline for one of two energy sources

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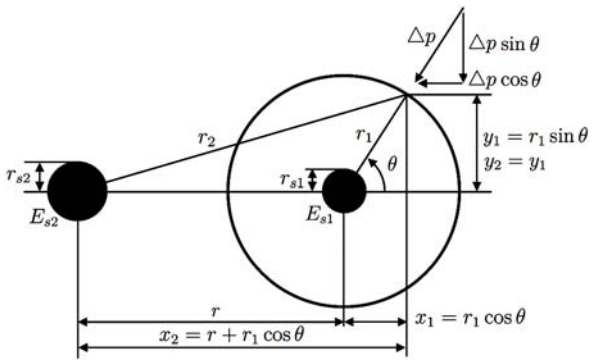


Fig. 4 Geometry for two energy sources

8. UNIVERSAL GRAVITY FORCE

In the previous section, the universal gravity force has been shown to be zero using pressure $p = 2/3\ E$ calculated from Laplace's equation and its boundary conditions. In this section, the pressure will be modified by Bernoulli's equation using calculated steady flow velocity $\vec{v}_f$. First, steady flow velocity will be calculated from the gradient of energy density field $E(\vec{r})$. Second, pressure will be modified by Bernoulli's equation using the calculated steady flow velocity. Third, universal gravity will be calculated from the modified pressure by integrating over a spherical surface with the center located at one of the two source centers.

The energy flow rate $\vec{Q}$ is calculated from the gradient of energy density field by Eq. (18) in section 3 as

$$\vec{Q}(\vec{r}) = -k_E \nabla E(\vec{r}) = -k_E < e_x\ e_y\ e_z > \begin{Bmatrix} \frac{\partial}{\partial x} \\ \frac{\partial}{\partial y} \\ \frac{\partial}{\partial z} \end{Bmatrix} E(\vec{r}) \qquad (74)$$

The energy flow rate $\vec{Q}$ of energy density field $E(\vec{r})$ of two sources system s_1, s_2 can be obtained by substitute Eq. (70) into Eq. (74) and get

$$\vec{Q}(\vec{r}) = -k_E < \vec{e}_x\ \vec{e}_y\ \vec{e}_z > \begin{Bmatrix} \frac{\partial}{\partial x} \\ \frac{\partial}{\partial y} \\ \frac{\partial}{\partial z} \end{Bmatrix} \left(E_{s1} \frac{r_{s1}}{r_1} + E_{s2} \frac{r_{s2}}{r_2} \right)$$

$$= -k_E < \vec{e}_x\ \vec{e}_y\ \vec{e}_z > \begin{Bmatrix} \frac{\partial}{\partial x} \\ \frac{\partial}{\partial y} \\ \frac{\partial}{\partial z} \end{Bmatrix} \left(\frac{E_{s1} \cdot r_{s1}}{\sqrt{x_1^2 + y_1^2}} + \frac{E_{s2} \cdot r_{s2}}{\sqrt{x_2^2 + y_2^2}} \right) \qquad (75)$$

where

$$r_1 = \sqrt{x_1^2 + y_1^2} \qquad (76)$$

$$r_2 = \sqrt{x_2^2 + y_2^2} \qquad (77)$$

$$x_1 = r_1 \cos\theta \qquad (78)$$

$$y_1 = r_1 \sin\theta \qquad (79)$$

$$x_2 = r + r_1 \cos\theta \qquad (80)$$

$$y_2 = y_1 \qquad (81)$$

Expand the derivatives in Eq. (75) to get

$$\vec{Q} = -k_E E_{s1} r_{s1} < \vec{e}_x\ \vec{e}_y\ \vec{e}_z > \begin{Bmatrix} \frac{-1}{2}(x_1^2 + y_1^2)^{\frac{-3}{2}}(2x_1) \\ \frac{-1}{2}(x_1^2 + y_1^2)^{\frac{-3}{2}}(2y_1) \\ \frac{-1}{2}(x_1^2 + y_1^2)^{\frac{-3}{2}}(0) \end{Bmatrix}$$

$$-k_E E_{s2} r_{s2} < \vec{e}_x\ \vec{e}_y\ \vec{e}_z > \begin{Bmatrix} \frac{-1}{2}(x_2^2 + y_2^2)^{\frac{-3}{2}}(2x_2) \\ \frac{-1}{2}(x_2^2 + y_2^2)^{\frac{-3}{2}}(2y_2) \\ \frac{-1}{2}(x_2^2 + y_2^2)^{\frac{-3}{2}}(0) \end{Bmatrix} \qquad (82)$$

Replace x_1, x_2, y_1, y_2 in Eq. (82) with r_1, r_2 and θ by Eqs. (76) ~ (81), the energy flow rate $\vec{Q}$ can be written as

$$\vec{Q} = k_E E_{s1} r_{s1} < \vec{e}_x\ \vec{e}_y\ \vec{e}_z > \begin{Bmatrix} \frac{r_1 \cos\theta}{r_1^3} \\ \frac{r_1 \sin\theta}{r_1^3} \\ 0 \end{Bmatrix}$$

$$+k_E E_{s2} r_{s2} < \vec{e}_x\ \vec{e}_y\ \vec{e}_z > \begin{Bmatrix} \frac{r + r_1 \cos\theta}{r_2^3} \\ \frac{r_1 \sin\theta}{r_2^3} \\ 0 \end{Bmatrix}$$

$$= k_E < \vec{e}_x\ \vec{e}_y\ \vec{e}_z > \begin{Bmatrix} E_{s1} r_{s1} \frac{\cos\theta}{r_1^2} + E_{s2} r_{s2} \frac{r + r_1 \cos\theta}{r_2^3} \\ E_{s1} r_{s1} \frac{\sin\theta}{r_1^2} + E_{s2} r_{s2} \frac{r_1 \sin\theta}{r_2^3} \\ 0 \end{Bmatrix} \qquad (83)$$

Equation (83) is simplified by defining constants C_1 and C_2 as

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$$\vec{Q}(\theta) = < \vec{e}_x \ \vec{e}_y \ \vec{e}_z > \begin{Bmatrix} \frac{C_1}{r_1^2}\cos\theta + \frac{C_2}{r_2^3}(r + r_1\cos\theta) \\ \frac{C_1}{r_1^2}\sin\theta + \frac{C_2}{r_2^3}(r_1\sin\theta) \\ 0 \end{Bmatrix} \quad (84)$$

where

$$C_1 = k_E E_{s1} r_{s1}$$

$$C_2 = k_E E_{s2} r_{s2}$$

The energy flow rate square can be calculated as

$$Q^2(\theta) = \left[\frac{C_1}{r_1^2}\cos\theta + \frac{C_2}{r_2^3}(r + r_1\cos\theta)\right]^2 + \left[\frac{C_1}{r_1^2}\sin\theta + \frac{C_2}{r_2^3}(r_1\sin\theta)\right]^2$$
$$= \frac{C_1^2}{r_1^4} + \frac{C_2^2}{r_2^4}\left(\frac{r^2 + 2rr_1\cos\theta + r_1^2}{r_2^2}\right) + \frac{2C_1C_2}{r_1^2 r_2^2}\left(\frac{r_1 + r\cos\theta}{r_2}\right) \quad (85)$$

Since $r >> r_1$, therefore

$$\frac{r}{r_2} \cong 1$$

$$\frac{r_1}{r_2} \cong 0$$

The energy flow rate square can be simplified to

$$Q^2(\theta) = \frac{C_1^2}{r_1^4} + \frac{C_2^2}{r^4} + \frac{2C_1C_2}{r_1^2 r^2}\cos\theta \quad (86)$$

In Eq. (72), the universal gravity force is calculated by integrating pressure which is calculated from solving Laplace's equation and its boundary conditions. The resulting gravity force has been shown to be zero using this pressure from Laplace's equation alone. Therefore, Eq. (72) must consider pressure difference Δp due to the steady flow velocity square difference Δv_f^2 as

$$\text{Force} = \int (p + \Delta p)\vec{n} ds = \int \Delta p \vec{n} ds \quad (87)$$

Since all forces perpendicular to connecting direction passing through centers of the two sources will be cancelled, only the force component at connecting direction is needed to be calculated as shown.

$$\text{Force} = \int_0^{\pi} \Delta p \cos\theta \, (2\pi \, r_1 \sin\theta) \, r_1 \, d\theta \quad (88)$$

Pressure difference Δp is proportional to steady flow velocity square difference $\rho\Delta v_f^2$ as shown in Eq. (62). Since the pressure difference is measured from the no flow state, that is $v_f^2 = 0$ and p = pressure obtained from Laplace's equation or called original pressure, therefore, $\Delta v_f^2 = v_f^2 - 0 = v_f^2$. At the source surface, E and ρ are constant, Eq. (88) can be written in terms of the energy flow rate square as

$$\text{Force} \propto \int_0^{\pi} Q^2 \cos\theta \, (2\pi \, r_1 \sin\theta) \, r_1 \, d\theta \quad (89)$$

Finally, substitute the energy flow rate square in Eq. (86) into Eq. (89) and get

$$\text{Force} \propto \int_0^{\pi} \left[\frac{C_1^2}{r_1^4} + \frac{C_2^2}{r^4} + \frac{2C_1C_2}{r_1^2 r^2}\cos\theta\right] 2\pi r_1^2 \cos\theta \sin\theta \, d\theta$$
$$= 2\pi r_1^2 \int_0^{\pi} \left[\frac{C_1^2}{r_1^4} + \frac{C_2^2}{r^4} + \frac{2C_1C_2}{r_1^2 r^2}\cos\theta\right] \cos\theta \sin\theta \, d\theta \quad (90)$$

Since C_1^2 / r_1^4 and C_2^2 / r^4 are constant, therefore Eq. (90) is reduced to

$$\text{Force} \propto 2\pi r_1^2 \frac{2C_1C_2}{r_1^2 r^2} \int_0^{\pi} \cos^2\theta \sin\theta \, d\theta$$
$$= \frac{4\pi C_1C_2}{r^2}\left[-\frac{1}{3}\cos^3\theta\right]_0^{\pi} = \frac{4\pi C_1C_2}{r^2}\left[\frac{1}{3} + \frac{1}{3}\right]$$
$$= \frac{C_1C_2}{r^2}\frac{8\pi}{3} \quad (91)$$

Equation (91) shows that the universal gravity force due to aether pressure modified by the aether steady flow velocity is proportional to $1/r^2$. The force is similar to the equations for Newton's law of universal gravitation and Coulomb's law of electric force.

9. CONCLUSIONS

The universal gravitation on an object is determined by integrating the aether pressure around the surface of the object. The final aether pressure is the combination of (1) pressure from the energy density field, and (2) pressure modified by the aether steady flow velocity. It is shown that the pressure from the energy density field contributes no gravity force. The universal gravity force is determined by only the pressure modified by the aether steady flow velocity through Bernoulli's equation.

The universal gravity force is the force between a source (such as the Sun) and a sink (such as the Earth). The source has higher energy than the sink. Therefore, aether flows from the higher energy source into the sink following the streamline (tangent to gradient vector) of energy density field. The aether steady flow velocity modified the aether pressure around the sink and the source to create the universal gravity force. The universal gravitation between the Earth and Objects on Earth is the same as "Sun and Earth".

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APPENDIX A
FLOWCHARTS

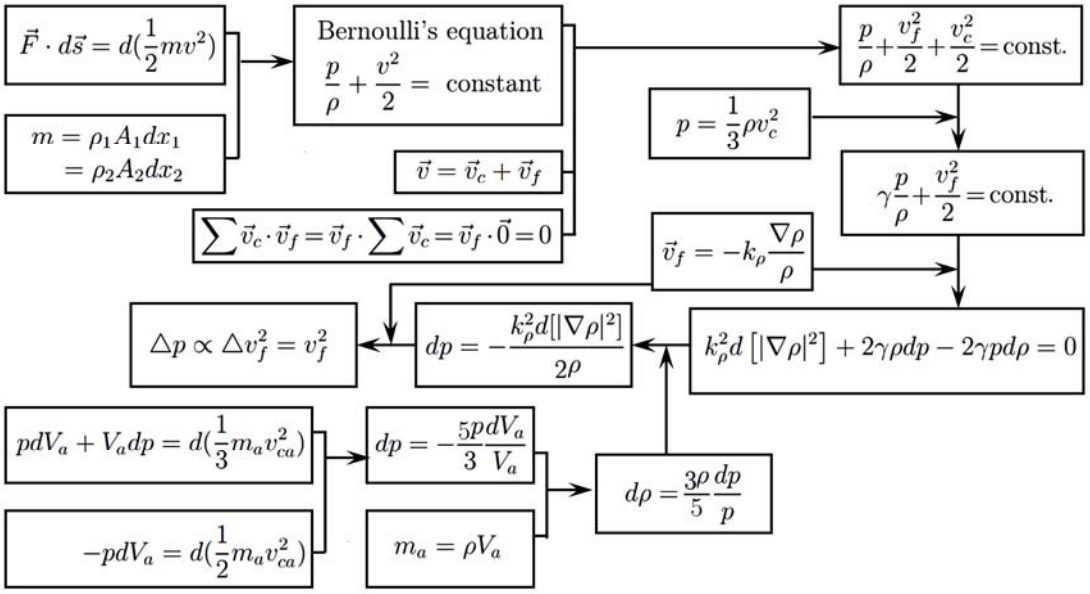


Fig. A1 Flowchart to derive pressure difference

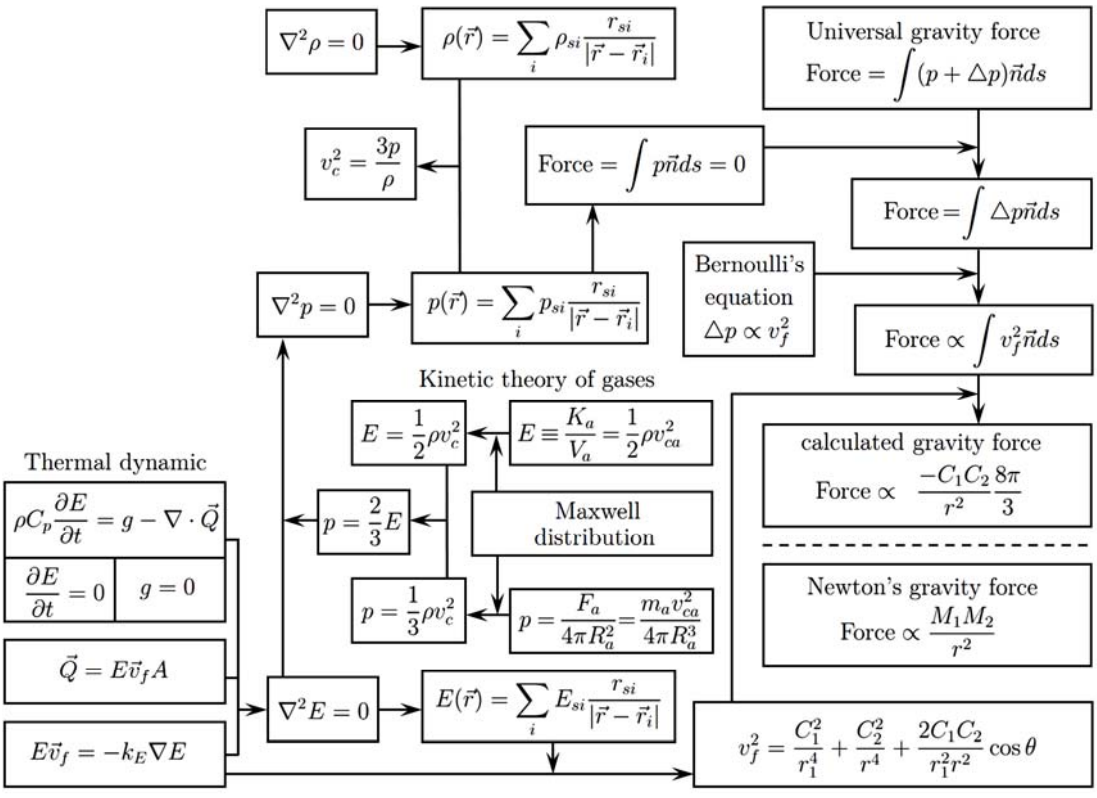


Fig. A2 Flowchart to derive gravity force

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