The Weber Cosmological Condition and Wesley Gravitation

J.P. Wesley

Abstract

Weber electrodynamics applied to gravitation, $-Gmm'$ replacing qq', yields an inverse force of induction, the only force produced by the distant masses in an infinite uniform isotropic universe, equal to $\mathbf{F} = -m\mathbf{a}\Phi_0/c^2$, which is Newton's second law in conformity with Mach's principle, if the "Weber cosmological condition," $\Phi_0(\text{Weber}) = c^2$, is true. Wesley gravitation, which includes in the source mass the mass equivalent of the gravitational field energy, $\rho' = -(\nabla\Phi)^2/8\pi Gc^2$, yields the gravitational potential $\Phi_0(\text{Wesley}) = 2c^2$ due to the distant masses in an infinite uniform isotropic universe. The factor of two discrepancy with the Weber theory remains unexplained.

Key words: Weber gravitation, Wesley gravitation, Mach's principle

1. WEBER GRAVITATION

A number of authors[1–4] have applied Weber electrodynamics[5] to gravitation by replacing the charges qq' with the masses $-Gmm'$. The gravitational potential energy U is then given by

$$U = -\left(\frac{Gmm'}{R}\right)\left[1 - \frac{(dR/dt)^2}{2c^2}\right], \tag{1}$$

where

$$\mathbf{R} = \mathbf{r} - \mathbf{r}' \tag{2}$$

is the separation distance between mass m at $\mathbf{r}$ and mass m' at $\mathbf{r}'$.

From the time rate of change of the energy U for mass m moving with the velocity $\mathbf{v}$ and the mass m' stationary, where

$$\frac{dU}{dt} = -\mathbf{v}\cdot\mathbf{F}, \tag{3}$$

the Weber gravitational force on mass m becomes

$$\mathbf{F} = -\left(\frac{Gmm'\mathbf{R}}{R^3}\right)\left[1 + \frac{v^2}{c^2} - \frac{3(\mathbf{R}\cdot\mathbf{v})^2}{2c^2R^2} + \frac{\mathbf{R}\cdot\mathbf{a}}{c^2}\right], \tag{4}$$

where $\mathbf{a}$ is the acceleration of the mass m.

For a source mass density ρ' the mass m' may be replaced by $\rho' d^3r'$, and (4) integrated over all space; thus,

$$\mathbf{F} = -Gm\int d^3r'\rho'(\mathbf{r}')\left(\frac{\mathbf{R}}{R^3}\right)\left[1 + \frac{v^2}{c^2} - \frac{3(\mathbf{R}\cdot\mathbf{v})^2}{2c^2R^2} + \frac{\mathbf{R}\cdot\mathbf{a}}{c^2}\right]. \tag{5}$$

Introducing the potentials

$$\Phi = G\int d^3r'\rho'(\mathbf{r}')/R, \qquad \mathbf{H} = G\int d^3r'\rho'(\mathbf{r}')\frac{\mathbf{R}}{R}, \tag{6}$$

the force on m becomes

$$\frac{\mathbf{F}}{m} = \left(1 + \frac{v^2}{2c^2}\right)\nabla\Phi - \mathbf{v}(\mathbf{v}\cdot\nabla)\frac{\Phi}{c^2} - \mathbf{a}\frac{\Phi}{c^2} + (\mathbf{v}\cdot\nabla)^2\frac{\mathbf{H}}{2c^2} + (\mathbf{a}\cdot\nabla)\frac{\mathbf{H}}{c^2}. \tag{7}$$

The correctness of this result (7) may be confirmed by simply substituting (6) into (7) and performing the indicated operations to obtain (5).

In an infinite uniform isotropic universe, the "cosmological principle," the potentials produced by the far masses cannot vary from point to point locally. Consequently, all of the terms in (7) involving differentiation with respect to ∇ must vanish, and the force due to the far masses is then given only by the third term on the right of (7), the inverse force of induction; thus,

$$\mathbf{F}(\text{due to far masses}) = -m\mathbf{a}\frac{\Phi_0}{c^2}. \tag{8}$$

The force on a slowly moving mass m, where v^2/c^2 and $\mathbf{a}/c^2$ can be neglected, due to local source masses, is given only by the first term on the right of (7); thus,

$$\mathbf{F}(\text{due to local masses}) = m\nabla\Phi. \quad (9)$$

If only gravitational forces act on the mass m, then, using Newton's third law, or the postulate that the sum of all forces, including the inertial reaction, on a material body is zero,[3] the net force, as given by (8) and (9), must be zero, which gives

$$m\nabla\Phi = m\mathbf{a}\frac{\Phi_0}{c^2}. \quad (10)$$

This result, (10), is simply Newton's second law for a body of mass m acted on by a gravitational potential field Φ due to local masses, provided the "Weber cosmological condition" for the potential Φ_0 produced by the distant masses is satisfied, namely

$$\Phi_0(\text{Weber}) = c^2. \quad (11)$$

This result, (10) and (11), confirms Mach's principle, a principle also recognized by most physicists, that the inertial force $m\mathbf{a}$ is produced by the gravitational action of the distant masses in the universe. (Mach's assumption that the action of the distant stars on the mass m is *instantaneous* is rejected; as it may be assumed that all action proceeds with the finite velocity c, and that the present Φ_0 field has become established only after eons of past time.)

It may also be noted that the Weber gravitational theory, yielding (10), also accounts for the singular equivalence between gravitational and inertial mass.

The Weber theory is a fundamental theory based upon the interaction between two (slowly) moving bodies, charges, or gravitating masses, which satisfies Newton's third law and the conservation of energy. Its great success in electrodynamics indicates its validity and importance for gravitation as well. The Weber theory predicts the correct result for many experiments, where the Maxwell theory fails: (1) Ampere's bridge,[6-8] (2) exploding current-carrying wires,[9,10] (3) Hering-Graneau submarine,[11-13] (4) Pappas–Vaughan Z-shaped antenna,[14,15] (5) Hering's pump,[16,17] (6) localized unipolar induction,[18] (7) induced back emf (the force giving rise to Lenz's law and the force $m\mathbf{a}$ for the case of gravity, but not the Maxwell theory, which violates Newton's third law), and (8) the nonradiating Bohr H-atom. (The Weber theory, conserving energy, does not allow the moving electron in the ground state of the Bohr H-atom to radiate. The Maxwell theory, which does not conserve energy for the moving electron, requires the electron to lose its energy and to spiral into the nucleus.)

The Weber theory has been extended to fast particles, fields, and radiation.[19,20]

2. WESLEY GRAVITATION[21,22]

Introducing time retardation for a finite velocity of action c, the Poisson equation for the gravitational potential Φ becomes the wave equation

$$\nabla^2\Phi - \frac{\partial^2\Phi}{\partial t^2 c^2} = -4\pi G\rho \quad (12)$$

for matter source density ρ. Considering classical wave theory, (12) may be multiplied by $\partial\Phi/\partial t$ to yield

$$\nabla\mathbf{S} + \frac{\partial E}{\partial t} = -4\pi\rho G\frac{\partial\Phi}{\partial t}, \quad (13)$$

where the energy flux $\mathbf{S}$ and energy density E of the gravitational field are given by

$$\mathbf{S} = \nabla\Phi\left(\frac{\partial\Phi/\partial t}{4\pi G}\right), \qquad E = -\frac{[(\nabla\Phi)^2 + (\partial\Phi/\partial tc)^2]}{8\pi G}. \quad (14)$$

The quantity $-\rho\partial\Phi/\partial t$ on the right of (13) is the rate that the field does work on the matter per unit volume; as $-\rho\Phi$ is the energy of the matter in the field Φ. In regions where the matter density is zero, (13) is the equation of continuity, indicating the conservation of the gravitational field energy.

Mass-energy equivalence may be regarded as a perfectly general principle that is not restricted to the type of energy involved; hence, introducing the mass equivalent of the field energy,

$$\rho' = \frac{E}{c^2}, \quad (15)$$

as part of the source of the field, where E is given by the second equation of (14), (12) may be generalized to read

$$\nabla^2\Phi - \frac{\partial^2\Phi}{\partial t^2 c^2} = -4\pi G\rho + \frac{(\nabla\Phi)^2}{2c^2} + \frac{(\partial\Phi/\partial tc)^2}{2c^2}. \quad (16)$$

For the case of interest here, where ρ and Φ are not functions of time, a new potential function Ψ may be defined such that

$$\Phi = -2c^2\ln\Psi. \quad (17)$$

Equation (16) then reduces to the Helmholtz equation for Ψ; thus,

$$\nabla^2\Psi - \beta^2\Psi = 0, \tag{18}$$

where

$$\beta^2 = \frac{2\pi G\rho}{c^2}. \tag{19}$$

Considering the Green's function

$$\Lambda(\mathbf{r},\mathbf{r}') = \frac{1}{|\mathbf{r}-\mathbf{r}'|} \text{ satisfying } \nabla^2\Lambda = -4\pi\delta(\mathbf{r}-\mathbf{r}'), \tag{20}$$

an integral equation for Ψ that gives $\Psi = 1$ and $\Phi = 0$ when $\rho = 0$ may be obtained by multiplying (20) by $(\Psi - 1)$ and (18) by Λ, subtracting, integrating over all space, and using the divergence theorem, where $\mathbf{n} \cdot [(\Psi - 1)\nabla\Lambda - \Lambda\nabla\Psi]$ vanishes on the sphere at infinity:

$$\Psi(\mathbf{r}) = 1 - \left(\frac{G}{2c^2}\right)\int\frac{d^3\mathbf{r}'\rho(\mathbf{r}')\Psi(\mathbf{r}')}{|\mathbf{r}-\mathbf{r}'|}. \tag{21}$$

Since the integral term on the right of (21) involves the small constant factor $G/2c^2$, the gravitational potential from (17) is given approximately by

$$\Phi(\mathbf{r}) = G\int\frac{d^3r'\rho(\mathbf{r}')\Psi(\mathbf{r}')}{|\mathbf{r}-\mathbf{r}'|}, \tag{22}$$

which reduces to Newtonian gravitation when $\Psi = 1$.

For the contribution to Φ due to the far masses in the universe, the case of interest here, Ψ becomes the asymptotic isotropic solution to (18) that remains finite for $r \to \infty$ and where $1/\beta r$ can be neglected compared with unity; thus,

$$\Psi = e^{-\beta r}, \tag{23}$$

where the coefficient has been chosen unity so that $\Psi = 1$ and $\Phi = 0$ when $\rho = \beta = 0$.

Substituting (23) into (22) then yields

$$\Phi(\mathbf{r}) = G\int\frac{d^3r'\rho(\mathbf{r}')e^{-\beta r'}}{|\mathbf{r}-\mathbf{r}'|}. \tag{24}$$

A cosmological constant β, (19), appears in this result, (24). This parameter β is a physical quantity derived from first physical principles. It should not be confused with the usual mathematical parameter arbitrarily introduced to avoid divergences for $r \to \infty$.

The gravitational potential at the origin, $\mathbf{r} = 0$, due to the far masses in an infinite uniform isotropic universe Φ_0, may be obtained from (24) and (19) for $\rho(\mathbf{r}')$ a constant and $d^3r' = 4\pi r'^2 dr'$; thus,

$$\Phi_0(\text{Wesley}) = 4\pi G\rho\int_0^\infty r'dr'e^{-\beta r'} = 2c^2, \tag{25}$$

which is to be compared with the Weber cosmological condition, (11).

Wesley gravitation provides many desirable features: (1) It is based upon only *one necessary assumption:* the mass equivalent of the gravitational field energy, $\rho' = -(\nabla\Phi)^2/8\pi Gc^2$, is included as part of the source of the field. (2) It predicts gravity waves, (12), as a trivial consequence of a finite velocity of action c. (3) It resolves Seeliger's[23] paradox as a consequence of a finite potential Φ_0, (25), due to the distant masses in the universe, instead of the infinite potential predicted by the Newtonian theory. (4) It permits the existence of super massive bodies (black holes) that are prohibited by other gravitational theories.[22] (5) Finally, it predicts a reasonable value for the cosmological redshift[21,22] as a gravitational effect, instead of a Doppler shift due to an impossible ad hoc expanding universe. This redshift resolves Olbers' paradox.

3. DISCUSSION

Apart from the factor of two difference, the two values of the gravitational potential produced by the far mass in the universe, Φ_0, that given by the Weber cosmological condition, (11), and that given by the Wesley theory, (25), are both equal to the same universal constant c^2. The gravitational potential due to the far masses in the universe, according to both theories, is independent of the characteristics of the distant universe, such as its mass-density ρ. Only the cosmological principle is assumed: an infinite uniform isotropic universe. The present results thus tend to support both theories, although the reason for the factor of two difference still needs to be explained.

Received 19 January 2000.

Résumé

Quand l'électrodynamique de Weber, avec −Gmm' remplaçant qq' est appliquée à la gravitation, et livre une force inverse d'induction, la seule force produites par les masses distantes dans un univers infini uniforme et isotopique, est égale à $\mathbf{F} = -ma\Phi_0/c^2$*, qui est la deuxième loi de Newton, en conformité avec le principe de Mach, si la "condition de Weber cosmique",* $\Phi_0(\text{Weber}) = c^2$*, est vraie. La gravitation de Wesley, qui est inclue dans la masse source la masse équivalente à l'énergie du champ gravitationnel,* $\rho' = -(\nabla\Phi)^2/8\pi Gc^2$*, produit un potentiel gravitationnel* $\Phi_0(\text{Wesley}) = 2c^2$*, dû aux masses distantes dans un univers infini uniforme et isotopique. Le facteur de 2, qui est en désaccord avec la théorie de Weber, reste inexpliqué.*

References

1. M.F. Tisserand, Comptes Rendus **75**, 760 (1872).
2. E. Schrödinger, Ann. Phys. **77**, 325 (1925), for his ad hoc ξ factor equal to unity.
3. A.K.T. Assis, Found. Phys. Lett. **2**, 301 (1989).
4. J.P. Wesley, *Advanced Fundamental Physics* (Benjamin Wesley, 78176 Blumberg, Germany, 1991), pp. 185–189.
5. W.E. Weber, Ann. Phys. **73**, 229 (1948); Wilhelm Weber's Werke (Julius Springer, Berlin, 1893), Vols. 1–6.
6. A.M. Ampere, Mem. Acad. R. Sci (Paris) **6**, 175 (1823).
7. P.T. Pappas and P.G. Moyssides, Phys. Rev. Lett. A **111**, 193 (1985).
8. J.P. Wesley, in *Progress in Space-Time Physics 1987*, edited by J.P. Wesley (Benjamin Wesley, 78176 Blumberg, Germany, 1987), pp. 170–180; in Eqn. (12), −(2/3) ln 2 should read +(2/3) ln 2.
9. P. Graneau, J. Appl. Phys. **55**, 2598 (1984).
10. See Ref. 4, pp. 233–235.
11. C. Hering, Trans. Am. Inst. Electr. Eng. **42**, 311 (1923).
12. P. Graneau, Nature **295**, 311 (1982).
13. See Ref. 4, pp. 235–236.
14. P.T. Pappas and T. Vaughan, Phys. Essays **3**, 211 (1990).
15. See Ref. 4, pp. 245–254.
16. E.F. Northrup, Phys. Rev. **24**, 474 (1907).
17. J.P. Wesley, Found. Phys. Lett. **5**, 77 (1992).
18. F. Müller, in *Progress in Space-Time Physics 1987*, edited by J.P. Wesley (Benjamin Wesley, 78176 Blumberg, Germany, 1987), pp.156–169.
19. J.P. Wesley, Found. Phys. Lett. **3**, 443; 471; 641 (1990).
20. *Idem*, Found. Phys. Lett. **10**, 189 (1997).
21. *Idem*, Phys. Essays **1**, 85 (1988).
22. See Ref. 4, pp. 172–184; 195–211.
23. H. Seeliger, Berichte Bayerische Akad. Wiss. **9** (1909).

J.P. Wesley
Weiherdammstrasse 24
78176 Blumberg, Germany