GENERAL ECE THEORY OF ALL COSMOLOGY FROM BASIC KINEMATICS: EXPLANATION OF THE VELOCITY CURVE OF A WHIRLPOOL GALAXY.

by

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ABSTRACT

A general ECE theory of all cosmology is developed straightforwardly from the fundamentals of planar kinematics, first for the velocity, then the acceleration. The kinematics become ECE theory by realizing that the angular velocity is a Cartan spin connection, an inference that also makes the theory fully relativistic and generally covariant. It is shown that the planar kinematics of velocity imply that the orbit of stars in a whirlpool galaxy is a hyperbolic spiral if, inter alia, their velocity becomes a constant at infinite r. The analysis of planar acceleration results in a force equation more general than that of Newton or Einstein, one which is rigorously consistent with Lagrangian dynamics, and one which is generally covariant.

Keywords: ECE theory, fundamental planar kinematics, angular velocity as spin connection.

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1. INTRODUCTION

Recently in this series of papers and books {1 - 10} applying ECE theory, it has been shown that the spin connection of Cartan {11} can be identified with the angular velocity of fundamental kinematics. Consideration of planar kinematics considerably reduces mathematical complexity and is also important for planar orbits of all types, ranging from solar system orbits to whirlpool galaxies. Throughout the series of 236 papers to date attempts have been made to explain the velocity curve of a whirlpool galaxy in the simplest possible way in accordance with Ockham's Razor. In Section 2 it is shown that the planar kinematics of velocity explain why the orbit of stars in a spiral galaxy must be a hyperbolic spiral if their velocity becomes constant with infinite r, the radial vector magnitude. This experimental observation was made in the late fifties and immediately refuted the Einsteinian and Newtonian theories. As part of the development of this series of papers it has been shown that the Einsteinian general relativity and cosmology can be refuted straightforwardly even in the solar system, leaving ECE as the only valid cosmology. In Section 3 it is shown that the planar kinematics of acceleration produce a force equation that is more general than those of Newton and Einstein, and which is correctly relativistic. This equation is shown to be rigorously consistent with Lagrangian dynamics in a plane. In Section 4 some graphical results are given for various orbits and force laws.

2. A GENERAL COSMOLOGY BASED ON VELOCITY IN A PLANE.

Consider the radial vector in a plane:

$$\underline{r} = r\,\underline{e}_r \qquad -(1)$$

where $\underline{e}_r$ is the radial unit vector {12}. The velocity is defined {13, 14} as:

$$\underline{v} = \frac{d\underline{r}}{dt} = \frac{dr}{dt}\underline{e}_r + r\frac{d\underline{e}_r}{dt} \quad -(2)$$

because in the plane polar coordinates {12 - 14} the unit vector $\underline{e}_r$ is a function of time. In the Cartesian system, the unit vectors in a plane, $\underline{i}$ and $\underline{j}$, are not functions of time. The unit vectors of the plane polar system are defined {12 - 14} by:

$$\underline{e}_r = \cos\theta\,\underline{i} + \sin\theta\,\underline{j} \quad -(3)$$

$$\underline{e}_\theta = -\sin\theta\,\underline{i} + \cos\theta\,\underline{j} \quad -(4)$$

so it follows that:

$$\frac{d\underline{e}_r}{dt} = \frac{d\theta}{dt}\underline{e}_\theta \quad -(5)$$

The velocity in a plane is therefore:

$$\underline{v} = \frac{dr}{dt}\underline{e}_r + \omega r\,\underline{e}_\theta \quad -(6)$$

$$= \frac{dr}{dt}\underline{e}_r + \underline{\omega} \times \underline{r}$$

in which the angular velocity vector:

$$\underline{\omega} = \frac{d\theta}{dt}\underline{k} \quad -(7)$$

is a Cartan spin connection as proven in the preceding paper UFT235 on www.aias.us.

Using the chain rule:

$$\frac{dr}{dt} = \frac{dr}{d\theta}\frac{d\theta}{dt} \quad -(8)$$

it is found that the velocity in a plane is always defined for any orbit by:

$$v^2 = \omega^2\left(\left(\frac{dr}{d\theta}\right)^2 + r^2\right) \quad -(9)$$

and is therefore defined by the angular velocity or spin connection magnitude:

$$\omega = \frac{d\theta}{dt} . \quad -(10)$$

The orbit itself is defined by $dr/d\theta$ because any planar orbit is defined by r as a function of θ .

Eq. (9) is the general equation of velocity for any planar orbit.

The angular momentum of any planar orbit is defined {12 - 14} by:

$$\underline{L} = \underline{r} \times \underline{p} = m\underline{r} \times \underline{v} \quad -(11)$$

and its magnitude is:

$$L = mr^2\omega . \quad -(12)$$

Therefore the general equation of velocity for all planar orbits is:

$$v^2 = \left(\frac{L}{mr}\right)^2\left(1 + \frac{1}{r^2}\left(\frac{dr}{d\theta}\right)^2\right) . \quad -(13)$$

This equation can be written as:

$$v^2 = \left(\frac{L}{mr}\right)^2 + \left(\frac{L}{mr^2}\left(\frac{dr}{d\theta}\right)\right)^2 \quad -(14)$$

and as

$$r \rightarrow \infty \quad -(15)$$

the limiting expression for the velocity is:

$$\frac{dr}{d\theta} = \left(\frac{mv_\infty}{L}\right) r^2 \quad -(16)$$

in which v_∞ is the velocity for infinite r. In whirlpool galaxies it was observed in the late fifties that v_∞ is a constant. The angular momentum is a constant of motion.

Therefore:

$$\frac{d\theta}{dr} = \left(\frac{L}{mv_\infty}\right) \frac{1}{r^2} \quad -(17)$$

and:

$$\theta = \frac{L}{mv_\infty} \int \frac{dr}{r^2} . \quad -(18)$$

This is the equation of a hyperbolic spiral:

$$\theta = -\left(\frac{L}{mv_\infty}\right) \frac{1}{r} . \quad -(19)$$

In UFT76 in this series on www.aias.us a hyperbolic spiral was compared with the observed whirlpool galaxy M101. So it has been shown that fundamental planar kinematics explain why the orbit of a star in a whirlpool galaxy must be a hyperbolic spiral if the velocity of the star is constant for infinite r.

Newtonian dynamics does not explain this result at all and fails qualitatively because the orbit in Newtonian dynamics is the ellipse or conical section {1 - 10}:

$$r = \frac{\alpha}{1 + \epsilon \cos\theta} \quad -(20)$$

where α is the half right latitude and ϵ the eccentricity. From Eq. (20):

$$\frac{dr}{d\theta} = \frac{\epsilon r^2}{\alpha} \sin\theta . \quad -(21)$$

Using Eq. (21) in Eq. (9):

$$v^2 = \omega^2 r^2 \left(1 + \left(\frac{\epsilon r}{\alpha} \right)^2 \sin^2\theta \right) \quad -(22)$$

where:

$$\sin^2\theta = 1 - \cos^2\theta = 1 - \frac{1}{\epsilon^2}\left(\frac{\alpha}{r} - 1 \right)^2 \quad -(23)$$

So the Newtonian velocity is:

$$v^2 = \omega^2 r^2 \left(2\frac{\alpha}{r} - \left(\frac{r}{\alpha} \right)^2 \left(1 - \epsilon^2 \right) \right) \quad -(24)$$

The semi major axis of the ellipse is defined by:

$$a = \frac{\alpha}{1-\epsilon^2} \quad -(25)$$

so:

$$v^2 = \frac{1}{\alpha}\left(\frac{L}{m} \right)^2 \left(\frac{2}{r} - \frac{1}{a} \right) \quad -(26)$$

Finally use the Newtonian equation for half right latitude:

$$\alpha = \frac{L^2}{m^2 MG} \quad -(27)$$

to find that {12 - 14}:

$$v^2 = MG\left(\frac{2}{r} - \frac{1}{a} \right) \quad -(28)$$

Note that:

$$\frac{1}{a} = \frac{1-\epsilon^2}{\alpha} = \frac{1}{r}\left(1 + \epsilon\cos\theta \right)\left(1 - \epsilon^2 \right) \quad -(29)$$

so the Newtonian velocity is:

$$v^2(\text{Newton}) = \frac{MG}{r}\left(2 - (1-\epsilon^2)(1+\epsilon\cos\theta)\right). \quad -(30)$$

It follows that:

$$v(\text{Newton}) \xrightarrow[r\to\infty]{} 0 \quad -(31)$$

and the Newtonian theory fails completely for a whirlpool galaxy.

The Einstein theory does no better beasue it sets out to explain the precessing elliptical function:

$$r = \frac{\alpha}{1+\epsilon\cos(x\theta)} \quad -(32)$$

from which:

$$\frac{dr}{d\theta} = \frac{x\epsilon r^2}{\alpha}\sin(x\theta). \quad -(33)$$

Using Eq. (33) in Eq. (9) gives the result:

$$v^2 = \left(\frac{L}{mr}\right)^2\left(1 + \left(\frac{x\epsilon\sin(x\theta)}{1+\epsilon\cos(x\theta)}\right)^2\right) \quad -(34)$$

and again it is found that:

$$v \xrightarrow[r\to\infty]{} 0. \quad -(35)$$

It has been shown in many ways in this series {1 - 10} that the Einstein theory fails even in the solar system, for example it produces the wrong kinematic force law for the function (32). The correct kinematic force law is given in Section 3.

This leaves ECE theory as the only correct and general theory of cosmology.

3. THE GENERAL FORCE LAW FOR ALL PLANAR ORBITS.

Consider the acceleration in a plane {1 - 14}:

$$\underline{a} = \frac{d\underline{v}}{dt} = \left(\ddot{r} - r\dot{\theta}^2\right)\underline{e}_r + \left(r\ddot{\theta} + 2\dot{r}\dot{\theta}\right)\underline{e}_\theta . \quad -(36)$$

As shown in the preceding paper UFT235:

$$\left(\ddot{r} - r\dot{\theta}^2\right)\underline{e}_r = \frac{d^2 r}{dt^2}\underline{e}_r + \underline{\omega}\times\left(\underline{\omega}\times\underline{r}\right) \quad -(37)$$

and:

$$\left(r\ddot{\theta} + 2\dot{r}\dot{\theta}\right)\underline{e}_\theta = \frac{d\underline{\omega}}{dt}\times\underline{r} + 2\,\underline{\omega}\times\dot{\underline{r}} . \quad -(38)$$

Eq. (38) is the Coriolis acceleration, and $\underline{\omega}\times\left(\underline{\omega}\times\underline{r}\right)$ is the centrifugal acceleration. In previous work it has been shown that for all planar orbits the Coriolis acceleration vanishes, so for all planar orbits:

$$\underline{a} = \frac{d\underline{v}}{dt} = \frac{d^2\underline{r}}{dt^2} = \frac{d^2 r}{dt^2}\underline{e}_r + \underline{\omega}\times\left(\underline{\omega}\times\underline{r}\right) . \quad -(39)$$

Using the chain rule it has also been shown in the preceding few papers {1 - 10} that:

$$\frac{d^2 r}{dt^2} = \left(\frac{L}{mr}\right)^2\left(\frac{dr}{d\theta}\right)\frac{d}{dr}\left(\frac{1}{r^2}\frac{dr}{d\theta}\right) . \quad -(40)$$

The centrifugal acceleration is defined by:

$$\underline{\omega}\times\left(\underline{\omega}\times\underline{r}\right) = -\omega^2 r\,\underline{e}_r = -\frac{L^2}{m^2 r^3}\underline{e}_r \quad -(41)$$

so the acceleration is defined by:

$$\underline{a} = \left(\frac{L}{mr}\right)^2\left[\left(\frac{dr}{d\theta}\right)\frac{d}{dr}\left(\frac{1}{r^2}\frac{dr}{d\theta}\right) - \frac{1}{r}\right]\underline{e}_r \quad -(42)$$

for all planar orbits.

In Eq. (42)

$$\frac{d}{dr}\left(\frac{1}{r^2}\frac{dr}{d\theta}\right) = \frac{d\theta}{dr}\frac{d}{d\theta}\left(\frac{1}{r^2}\frac{dr}{d\theta}\right) \quad -(43)$$

so:

$$\underline{a} = \left(\frac{L}{mr}\right)^2\left[\frac{d}{d\theta}\left(\frac{1}{r^2}\frac{dr}{d\theta}\right) - \frac{1}{r}\right]\underline{e}_r \quad -(44)$$

Now note that:

$$\frac{d}{d\theta}\left(\frac{1}{r}\right) = \frac{d}{dr}\left(\frac{1}{r}\right)\frac{dr}{d\theta} \quad -(45)$$

So:

$$\frac{d}{d\theta}\left(\frac{1}{r^2}\frac{dr}{d\theta}\right) = \frac{1}{r^2}\frac{d}{d\theta}\left(\frac{dr}{d\theta}\right) = -\frac{d^2}{d\theta^2}\left(\frac{1}{r}\right). \quad -(46)$$

Therefore the acceleration equation is:

$$\underline{a} = -\left(\frac{L}{mr}\right)^2\left(\frac{d^2}{d\theta^2}\left(\frac{1}{r}\right) + \frac{1}{r}\right)\underline{e}_r \quad -(47)$$

and is true for all planar orbits of any kind. Eq. (47) is therefore more general than the Newtonian force law, and is also generally covariant. Using the definition of force:

$$\underline{F} = m\,\underline{a} \quad -(48)$$

Eq. (47) becomes the general force equation of all planar orbits, QED:

$$\left(\frac{d^2}{d\theta^2}\left(\frac{1}{r}\right) + \frac{1}{r}\right)\underline{e}_r = -\frac{mr^2}{L^2}\,\underline{F} \quad -(49)$$

This is exactly the same in structure as the Eq. (7.21) of ref. (13), which is obtained in ref. (13) from Lagrangian dynamics in a plane. The Lagrangian is:

$$\mathcal{L} = \frac{1}{2}mv^2 - U \quad -(50)$$

in which the velocity is that defined in Section 2 of this paper:

$$v^2 = \left(\frac{dr}{dt}\right)^2 + r^2\left(\frac{d\theta}{dt}\right)^2 \quad -(51)$$

and the potential energy U is the general potential energy from which the force is defined by:

$$F = -\frac{\partial U}{\partial r}. \quad -(52)$$

The two Euler Lagrange equations are:

$$\frac{\partial \mathcal{L}}{\partial \theta} = \frac{d}{dt}\left(\frac{\partial \mathcal{L}}{\partial \dot{\theta}}\right), \quad \frac{\partial \mathcal{L}}{\partial r} = \frac{d}{dt}\left(\frac{\partial \mathcal{L}}{\partial \dot{r}}\right), \quad -(53)$$

and the angular momentum is defined by the lagrangian to be a constant of motion:

$$L = \frac{\partial \mathcal{L}}{\partial \dot{\theta}} = mr^2\frac{d\theta}{dt} = \text{constant}. \quad -(54)$$

Eq. (49) has been used {1 - 10} in several papers of this series, notably to obtain the correct force law of a precessing ellipse (32). It has been shown that this is not the force law of Einsteinian general relativity, a theory which therefore fails qualitatively in the solar system and also in whirlpool galaxies as shown in Section 2. It is now clear that Eq. (49) is the result of pure kinematics in a plane, i.e. it is the result of Eq. (36). Eq. (49) contains the centrifugal acceleration automatically. It also contains the Coriolis acceleration because the latter is also the result of pure kinematics. However the Coriolis acceleration vanishes for all planar orbits. Finally Eq. (49) is an equation of Cartan geometry because the spin connection is the angular velocity, as shown in the preceding paper UFT235 on www.aias.us.

So Eq. (49) is the planar part of a generally covariant equation of motion, part of the generally covariant unified field theory known as ECE theory and now accepted worldwide.

So the entire ECE analysis is rigorously self consistent, and consistent with lagrangian dynamics.

For an elliptical orbit Eq. (49) produces the result obtained in previous papers {1 - 10}:

$$\underline{a} = \frac{d^2 \underline{r}}{dt^2} = -\frac{1}{\alpha}\left(\frac{L}{mr}\right)^2 \underline{e}_r = -\frac{1}{\alpha}\left(\frac{L}{m}\right)^2 \frac{\underline{r}}{r^3}. \quad -(55)$$

This is the inverse square law of Hooke and Newton, but it is now known that it is the result of general planar kinematics constrained by the elliptical function (20). As shown in ref. (12) and in note 236(3) accompanying this paper on www.aias.us, Eq. (55) can be integrated to give the elliptical function (20) if and only of Eq. (27) is used. As shown in Section 2, Eq. (55) fails completely in whirlpool galaxies. The observed orbit in the solar system is the precessing ellipse (32), for which Eq. (49) gives the force law:

$$\frac{d^2 \underline{r}}{dt^2} = -\left(\frac{x^2}{\alpha} + \frac{(1-x^2)}{r}\right)\left(\frac{L}{m}\right)^2 \frac{\underline{r}}{r^3}. \quad -(56)$$

This force law is the true equation of orbits in the solar system, and replaces the now obsolete Einstein equation. The latter does not give the correct result (56) as shown in previous papers of this series {1 - 10}.

4. GRAPHICAL ANALYSIS AND ILLUSTRATIONS

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